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DISTRIBUTIONAL ANALYSIS AND AIRPORT LOCATION

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ABSTRACT: *The paper has two main objectives. The first is to argue that there is more to distributional analysis than the allocation of the cost and benefit components of an estimated net present value to selected social groups. Transfers and secondary effects should be analysed, data disaggregated often substantially, social groups chosen by some criteria, the shifts of costs and benefits between groups predicted, and the results interpreted. The second objective is to demonstrate an approach to these problems. In order to make the discussion realistic, the problems and their resolution are discussed in the context of the Sydney airport location study.*

Background Paper for
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DISTRIBUTIONAL ANALYSIS AND AIRPORT LOCATION *

INTRODUCTION

Much has been written about the need to analyse the distributional effects of projects but little about how to do the analysis. It is often assumed that the assignment of estimated costs and benefits to selected social groups and the interpretation of the results are straight forward matters. Such an assumption is unduly sanguine, especially for large projects.

Only a few issues need be mentioned in the Introduction. First, many factors, notably transfers and secondary effects, should be taken into account in distributional analysis (DA) although they may be ignored in an analysis (NPVA) which is concerned only with a project's net present value. In general, more disaggregate data is required for DA than for NPVA. Secondly, in addition to the normal value judgment inherent in NPVA that individual preferences matter, it is necessary in DA to decide which groups of individuals matter most. Thirdly, in order to determine the true distributional effects, we need to predict how costs and benefits will be passed on between social groups, especially from producers and governments to households. And fourthly, unless weights can be attached to the costs and benefits of the selected social groups, there is no unit of measure of the distributional effects of a project. It is likely therefore that the analyst and the decision maker(s) will be confronted with an array of results which will be difficult to interpret.

The main aims of this paper are twofold. One is to dispel the idea that distributional analysis is simply a matter of reallocating the costs and benefits estimated in NPVA to a few chosen groups. Such a procedure is often inadequate and sometimes misleading. The second aim is the more positive one of demonstrating an approach to DA, and how the problems noted above, amongst others, may be tackled. The discussion is conducted within the context of an airport location study, and supported with some results from the Incidence Analysis made for the Sydney Airport Study (Planning Workshop Pty. Ltd., 1978).

In the first section of the paper we outline a framework for the DA.

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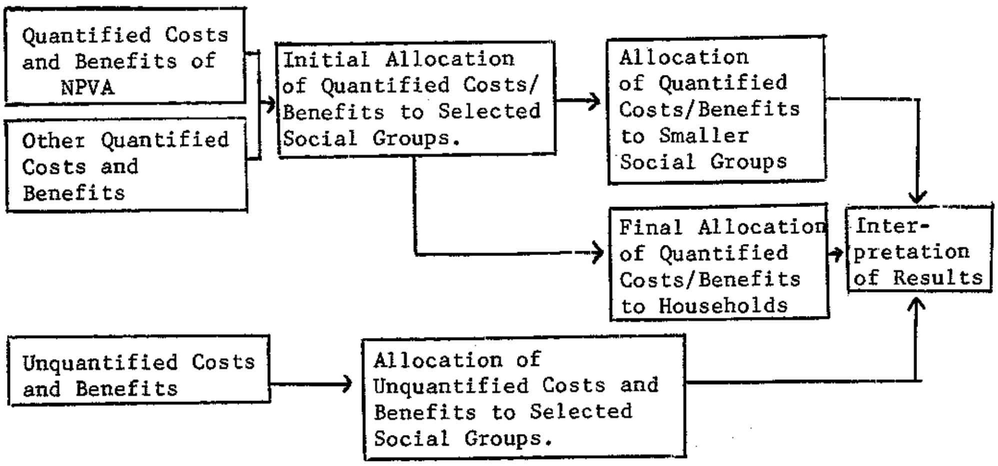
* This paper is based on the Incidence Analysis for the major Airport Needs for Sydney (MANS) study by Planning Workshop Pty. Ltd. I am grateful to David Hensher for comments. Naturally I am responsible for any errors in the paper.

We then discuss the initial allocation of costs to social groups. In the third section we consider shifts in costs between groups and the final incidence of costs borne by householders according to their incomes. In the final substantive section, interpretation of results is discussed.

1. A FRAMEWORK FOR THE DISTRIBUTIONAL ANALYSIS.

As shown in Figure 1, inputs to the DA are likely to include quantified and unquantified elements and to be derived from the NPVA and other sources.

Figure 1. Broad Framework for the Distributional Analysis.



Conventionally NPVA is used to determine the airport location which minimises the total social costs of meeting the forecast air traffic. (1) The main costs taken into account are airport construction (including the costs of land) and operation, aviation costs on the ground and in the air, the capital and operating costs of access to airports, the costs of aircraft noise and possibly 'urbanisation' costs. If a site by reason of its accessibility generates more air travel than do other sites, a benefit (in the form of a negative cost) is attributed to it. All these costs are estimated for each year for some 20 to 30 years and discounted to a base date.

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1. The forecast air traffic may be in the form of a distribution rather than a single figure.

This evaluation procedure has been described elsewhere (Abelson 1979, Flowerdew 1972, Roskill 1970) and is reasonably well established. However, it is necessary to define 'urbanisation costs', which are an exception to this statement. Like any large project an airport may make a major impact on the location of employment and of households. Such effects are ignored in most NPVA on the grounds that they represent a transfer of resources from one area to another but not a net change in the aggregate amount of goods and services available to the community as a whole. With good reason, planners tend to distrust this view and have insisted on some accounting for the employment and household effects of alternative airport sites. Unfortunately, without a comprehensive land use transportation urban model most attempts to estimate urbanisation costs have been extremely partial, sometimes being no more than an estimate of the journey to work costs of airport employees. Therefore, for the purpose of this paper we shall assume that 'urbanisation costs' are the differences between the public and private costs of providing houses to all workers on the airport and the rentals (benefits) which workers are willing to pay for their houses.(1) The costs and benefits of the relocation of industry related to the airport, of population service industries, and of the externalities of the urbanisation process are assumed to be unquantified.

As shown in Figure 1, a number of costs and benefits may be quantified for the DA which are not estimated in NPVA. Indirect taxes (for example on fuel) and subsidies (on public transport for instance) should be accounted for in DA although they may be ignored in an estimate of aggregate net costs. It may also be considered desirable to attempt to quantify more urbanisation costs and benefits in the DA than in NPVA, as these costs and benefits are borne unevenly according to geographical area.

The selection of groups to whom costs and benefits will be assigned depends generally on the value judgment of the analyst (or very rarely on the decision maker). In this regard it should be noted that the size of the groups affects the apparent results. The smaller the groups, tending in the limit to the household, the more significant will the distributional consequences appear. For the purposes of our discussion we assume that the estimated quantified costs and benefits might be assigned initially (as they were in the MANS Incidence Analysis) to the following groups (see also Table 1).

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1. If the public and private costs of housing for airport workers are less than the rentals, 'urbanisation costs' are negative, (i.e. they are urbanisation benefits).

(i)	Government	- (a)	Central
		(b)	State
(ii)	The Airport Authority		
(iii)	Airlines -	(a)	Local public enterprise
		(b)	Local private
		(c)	Foreign
(iv)	Other Businesses	(a)	Local public enterprise
		(b)	Local private
		(c)	Foreign
(v)	Foreign leisure travellers		
(vi)	Local business travellers		
(vii)	Local leisure travellers		
(viii)	Local residents affected by the airport		

However, if the household groups (vi, vii and viii above) affected by the alternative airports are not homogeneous, it is desirable to show how the alternatives affect households according to certain distinguishing characteristics correlated with social advantage. In his classic article Weisbrod (1968) suggested that the important discriminating characteristics are income, age, race and area. In this paper we concentrate on the effects of alternatives on households according to their income and nationality (local or foreign) and according to their area of residence.

One well known problem with income as a measure of social advantage is that current income (for example of students and pensioners) is not so satisfactory a measure of advantage as permanent income. But the latter is often difficult to measure. A further issue arises with increases in real income over time. Should costs be assigned to households according to their forecast real income group ($0 to $9.999 and so on), or to their forecast relative income group (say households with the lowest 20 per cent of incomes etc)?(1) If income is expected to rise significantly, use of a relative income measure may conceal a transfer of welfare from the poor to the rich. On the other hand, many consider that relative poverty is as important as absolute poverty. In the Sydney MANS study, costs were allocated to households according to both their estimated relative and real incomes, (see Tables 4 and 5).

1. For example, suppose a household earns $8,000 per annum in 1980 and $10,000 in 1995. In 1980 it may be in the second poorest group of households (in the 21 to 40 per cent range) whereas in 1995 it could be amongst the poorest (in the lowest 20 per cent of households).

Area of residence is also a rough measure of social advantage unless the households in each area are peculiarly homogeneous. Secondly it should be noted that the allocation of costs to areas appears to imply that future costs will be borne by the existing households in those areas even if the households move (or else we have to predict the kind of households who will move into the area). This implication is not entirely implausible as future costs are likely to be reflected in present capital losses in property values. However taking this argument a step further, some of these losses may have been borne by previous landowners. Thirdly, value judgments are required for the selection of areas. Despite these problems, decision makers are interested in the geographical effects of their decisions as geographical units are the basis of political power. Thus in the MANS study, the incidence of costs was assessed with respect to local government areas (see Table 3) as well as for Federal and State government electorates.

Another major reason for considering that the allocation of costs and benefits to the social groups shown in Table 1 is insufficient is that government agencies and firms do not in themselves suffer gains or losses in welfare. Although decision makers may be interested in the effects of airport options on government agencies and firms, the normal unit of analysis in welfare economics is the household or individual. Therefore in order to assess the overall effects of the options on community welfare it is necessary to determine the financial relationships between government agencies and firms and households and thus the final incidence of costs on households.

For clarification, the points made above are illustrated in the accounting framework shown as Table 1. In the left hand column are the major cost areas. These can of course be subdivided many times over. In the other columns are the 12 groups identified above which bear the initial incidence of costs. These groups can also be subdivided. Thus the initial costs of local travellers and residents are shown allocated to areas (at the bottom of the relevant columns). The x's in the matrix indicate likely cost allocations. In the bottom row are shown the models required to convert the initial incidence into an estimated final incidence experienced by households according to their income levels. This framework is basically the one used for the MANS study in which the initial incidence of costs borne by households was estimated for various areas and the final incidence borne by households was estimated in terms of income levels (1)

1. Clearly it would be possible to estimate initial household costs according to the areas of incidence <u>and</u> the income levels of the households. Likewise an attempt could be made to estimate final incidence by areas of residence.

Table 1 An Accounting Framework for Distributional Analysis
Total Discounted Costs $m

	Government		Airport	Airlines			Businesses			Air Passengers		Local Residents
	Central	State	Authority	Foreign	Local Public	Local Private	Foreign	Local Public	Local Private	Business	Leisure	
Airport Costs												
Land Take		x	x									x
Other Capital		x	x									
Operating		x	x									
Aviation Costs												
Groundside	x	x		x	x	x	x	x	x	x	x	
Airspace	x	x		x	x	x	x	x	x	x	x	
Congestion/Closure	x	x		x	x	x	x	x	x	x	x	
Surface Access Costs												
Capital	x	x										
Operating	x	x					x	x	x	x	x	
Generated or Suppressed Trips	x	x					x	x	x	x	x	
Aircraft Noise Costs	x	x						x	x	x	x	x
Urban & Regional												
Husing/Environm.												x
Other secondary Economic Effects	x	x					x	x	x			x
Disaggregation of Initial Incidence Costs									Area of Incidence Models			
Final Incidence Models Relating Incidence to Households.	Taxpayer Model		Airport Model	Foreign Trade Model	Public Enterprise Model	Share-holder Consumer Model	Foreign Trade Model	Public Enter-prise Model	Share-holder Model	Income Models.		Income Models

A word must now be said about the allocation of costs over time which we have ignored so far. Ideally it is desirable in NPVA, as the UNIDO Guidelines (1972) argue, to distinguish between investment expenditures and consumption benefits and to discount them at the social opportunity cost of capital and the social time preference rate respectively. This would likewise be appropriate for DA. However in practice it is often difficult to predict investment and consumption expenditures and it may be considered expedient to discount all costs and benefits in NPVA on the assumption that the investment alternative always exists. This may indeed be expedient also for DA, but it is not a very attractive solution when household consumption is reduced involuntarily, for example when aircraft noise is imposed on a household. Such social costs should be discounted at the social time preference rate.

In addition to the quantified costs, there may be many unquantified costs and benefits. Typical examples include the loss of recreational land, the costs of noise to visitors in the noisy areas, the externalities (air pollution and noise) caused by access traffic to the airport, the costs and benefits to industry of the airport options, and the air safety benefits of a cross-wind runway. Some of these are borne by air travellers or households in certain areas. However, other costs, for example the recreational losses and the annoyance felt by visitors to noisy areas, may not be identified with a particular social group, but experienced by many sections of the community

2. THE INITIAL INCIDENCE OF COSTS

Airport Costs

Airport costs consist of the costs of land (including the losses of landowner surplus), site preparation, airport construction and operation. Most of these costs can be allocated without difficulty, but two points deserve mention. First, if an area has been considered a possible airport site for some time the loss of landowner surplus may have been incurred partly or wholly by previous owners, who received a reduced price for the land.(1)

Second, the loss of property associated with a new airport may reduce the rateable base of the local government authority.(2) It is true that the local authority will also have to provide fewer services. But if services such as water and power are established, the chances are that the loss of revenue will exceed the savings from the marginal reduction in the provision of services.

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1. Of course if the anticipated development does not occur, the existing owner receives a capital gain.

2. We say 'may' because the attraction of new industry to the area may offset the loss of property on the airport site.

Aviation Costs

Aviation costs arise in the use of airports (notably in aircraft taxying and delays), in flying (which includes route costs and the cost imposed on others so that conflicts are avoided), and in airport closure. Although the NPVA will provide much of the data on the incidence of these costs, additional data will probably be required for the DA. For example, in order to determine the incidence of delay costs it will probably be necessary to predict the market shares of local and foreign airlines, the proportion of local and foreign leisure travellers, and the proportion of business travellers who work for the local government or private sector or for a foreign interest. Furthermore, if travel time costs are incurred on business trips, some of the cost may be borne by the employee who loses some of his leisure time, rather than by the employer (R. Travers Morgan 1974).

Access Costs

The initial allocation of the capital costs of access systems to the responsible authority is generally straightforward. However allocation of user costs to groups is complicated because ideally it depends on knowledge of the origins and destinations of passengers of different types. Whereas foreigners, public servants and out-of-town businessmen tend to travel to the city centre, local residents tend to journey to the suburbs. Typically a NPVA will provide origin and destination data by trip purpose (business or leisure) but not by the passenger groups that would be considered of interest in the DA. A second problem is the division of the access costs incurred on business travel between the employer and the employee. Travers Morgan (1974) estimated that the Australian employee incurred 61 percent of the access time costs on domestic flights and 29 per cent of these costs on international flights.

The allocation of two other types of access costs may also pose difficulties. As we noted above, lengthy access trips may deter some air travellers. For the NPVA it is sufficient to estimate the elasticity of demand with respect to the generalised costs (time and money costs) of business and leisure travellers, and the numbers of business and leisure travellers from each zone. Ideally for the DA we should like to know these elasticities of demand for each social group as well as the numbers in each group travelling from each zone. Another access cost which is sometimes calculated is the congestion cost which airport trips impose on other traffic. This can be calculated for the NPVA from data on speeds, on business and leisure traffic volumes and on network capacity. In order to allocate congestion costs to our 12 principal social groups, however, additional data on the nature of the traffic, especially of the business traffic would be required.

Noise Costs

Most of the quantified noise costs will be borne by local residents though some will be borne by the businesses or by governments who have to insulate or move their facilities. The only point we would make on this again concerns the role of expectations. When future runway developments have been correctly anticipated, the noise costs will have been borne by the previous generation of landowners rather than by the existing residents under the projected flight paths.

Urbanisation Costs and Benefits

The distribution of urbanisation costs and benefits depends mainly on the relationship between the public and private costs (C_1 and C_2) of housing for airport employees and the rentals (R) which employees are prepared to pay for their housing. If $R > C_1 + C_2$ the existing landowners in the areas for development are likely to gain from the increase in land values. If $R < C_1 + C_2$, the airport workers will require an incentive to be attracted to work in the area. In the latter case either the public sector will not recover its costs, or the Airport Authority will provide airport workers with a housing allowance or higher pay to compensate them for living where they do not want to and/or for the high cost of housing.

The Allocation of Initial Household Costs to Areas

Many of the initial household costs, for example access, noise and urbanisation costs, are determined partly by the area in which they arise. It may be necessary to estimate a correspondence between areas which form the basis for the cost estimates (noise exposure forecast areas or traffic zones for example, and those chosen for the DA, but this is a trivial problem.

A greater problem arises if the estimates of noise or transport costs are based (as they normally are) on runs of the noise or transport model for only two or three years, say 1985 and 1995. Thus the transport model would enable the analyst to calculate the sum of the access costs from all zones in the selected years. In order to estimate access costs in other years, the analyst would interpolate or extrapolate the estimated aggregate costs as required. On the other hand, to obtain annual access costs by traffic zone, it is necessary to interpolate or extrapolate the costs of households in each zone. Thus allowance should be made for differences in the rate of growth of households in each area.(1)

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1. With this procedure, the sum of the zonal costs may not equal the aggregate access costs. Since the former costs are more accurate, the latter should be adjusted to ensure consistency.

Some costs, notably aviation costs, do not depend on the area of residence of the traveller. Therefore the aviation costs of local business and leisure travellers would be allocated to areas according to the number of travellers of each journey purpose from each area. Since these numbers will have been predicted for the NPVA for only two or three years, interpolation or extrapolation of the numbers travelling from each area will be required for the other years.

Finally, some quantified household costs may not be assigned accurately to areas. For example, although the location of the congestion costs caused by airport traffic might be predicted, these costs may be borne mainly by households from different, often unknown areas. Likewise, although it may be possible to quantify roughly the costs of the loss of recreational land, these losses may be borne by many sections of the community, not only by local residents.

3. FINAL INCIDENCE ANALYSIS

For convenience of exposition, we describe first how the initial incidence of the costs of government and business in any one year may be converted into final incidence borne by households according to their income group (both real and relative income groups as shown in Tables 4 and 5). Secondly we describe how the final incidence may be estimated over the life of a project.

However, before discussing the financial relationships between government and business on the one hand and households on the other, the relationship between government and business should be noted. In addition to the initial incidence costs borne by government, the government has to meet the losses of the Airport Authority and other public enterprises. Also it suffers a loss of taxation revenue due to the higher costs of business which are not passed on in higher prices. The MANS study treatment of these relationships is shown in Figure 2.

Government Costs

In order to allocate government costs to households,(1) the following parameters are required.

(i) The proportion of costs to be met by an increase in taxation and by a reduction in expenditure (other sources of funds, e.g. printing money, could normally be ignored)

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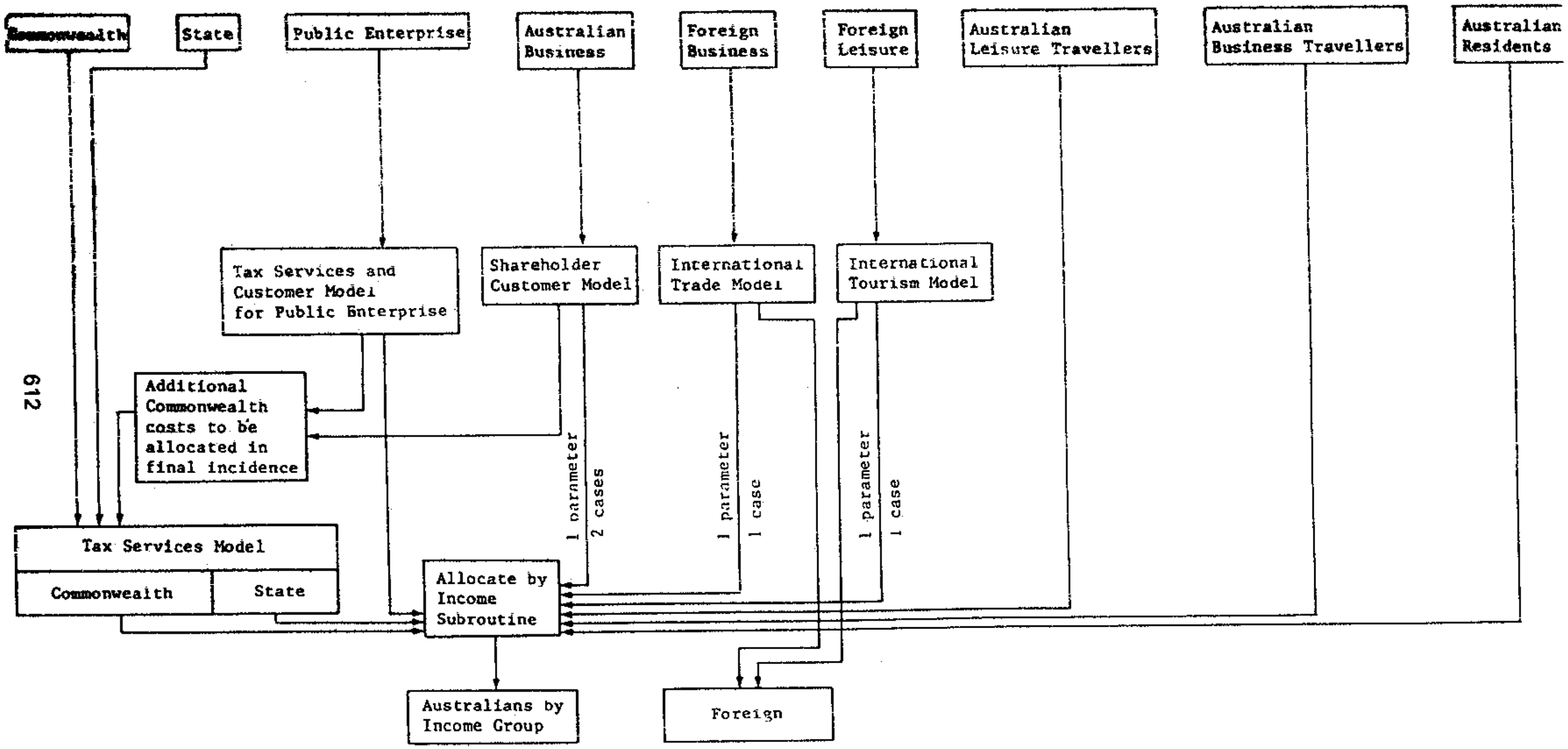
1. The structure of a central government and local government tax services model will be similar. The parameters will differ, of course.

Figure 2 A FINAL INCIDENCE MODEL



Source : Planning Workshop 1978.

(ii) The proportion of taxation that would be raised by direct and indirect household taxes and by company tax.

(iii) The marginal incidence of each of these taxes.

(iv) The areas in which government expenditures would be reduced, e.g. health, roads, etc.

(v) The marginal incidence of reductions in these government expenditures.

With regard to (i) Planning Workshop (1978) assumed that government costs would be financed half from an increase in taxes and half from reductions in expenditures. This is consistent with the notion that at the margin the benefit of a dollar of government expenditure equals its costs. The government would be indifferent therefore between marginal tax increases and marginal expenditure costs.

Concerning (ii), it was assumed that the proportions of tax paid by households and businesses would remain constant as they have during the 1970's. Turning to the incidence of taxation (iii), there is a two-fold problem. First, little may be known about the existing incidence of taxation, especially the incidence of indirect and of company tax and more especially about the marginal incidence of taxes. Secondly the structure of the tax scales and the distribution of income, and hence the incidence of tax, may change. For the MANS study estimates of existing tax incidence were drawn from the study by Bentley et. al. (1974). More fundamentally it was assumed that the tax scales and the relative distribution of income would not change over the life of the project. This meant that the poorest 20 per cent of households would pay the same proportion of government costs financed through extra taxation whenever the costs occurred. This is a major simplifying assumption, but it is difficult to see how to improve on it (although sensitivity tests are always possible). This point is discussed further below.

With respect to government expenditures, Planning Workshop (1978) assumed that expenditures in each sector (education, health and so on) would be cut by the same percentage. Unfortunately, with the exception of data on the income of recipients of government cash payments (Kakwani and Podder 1975), there is no information on the incidence of the benefits of government expenditures in Australia. It was assumed therefore that reductions in social services such as education would affect households equally regardless of income and that cuts in economic services such as transport would affect households in proportion to their expenditures; clearly the first of these assumptions may result in an underestimate of the incidence borne by poorer groups as they may receive more social services (for example in housing) than do the rest.

It may well occur to the reader at this stage to question the worth of final incidence analysis if it based on the kind of data available to and assumptions made in the MANS study. In our view scepticism is justified, but not nihilism. In the Sydney study a significant finding was made as a result of the final incidence analysed (see below). More fundamentally, given the importance of the household unit it is desirable to work towards achieving estimates of final incidence which ultimately matter more than initial incidence.(1)

Public Enterprise Costs

The costs of publicly owned businesses including the airport authority, will probably be met in one of two ways. They may be met by public subsidy and hence be a government cost. Alternatively users will pay higher prices. In this latter case, the incomes of households using the service(s) must be forecast.

Local Business Costs (including local airlines).

In order to predict the incidence of local business costs, it is necessary to forecast the proportion of costs that will be passed on to consumers in higher prices and the proportion that will be borne by lower profits, which in turn mean lower tax revenues and shareholders dividends. Bentley et al.(1974) assumed that 70 per cent of business cost increases in Australia would be passed on in higher prices, and that most of these would be borne by consumers rather than by other firms. The incidence of such price increases on households according to their incomes may be estimated with the assistance of data from household expenditure surveys. The reduction in tax revenue becomes, as noted above, a government cost. Unfortunately little is known about the incomes of shareholders in Australia. Planning Workshop (1974) assumed that such incomes would be similar to those of property owners (Kakwani and Podder 1975).

Foreign Business Costs (including foreign airlines).

Given the variety of foreign businesses affected by an airport, only crude estimates of final incidence are possible. Since foreign companies tend to sell more to foreigners than do local companies, it was assumed in the MANS study that 45 per cent of the costs of foreign companies would be passed on to the local consumer (compared with the 70 per cent assumed for local companies). Crude though such estimates are, they are probably superior to the major alternative assumption that local households would be unaffected by the costs of foreign businesses.

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1. It should be recognised that we have taken for granted the distinction between initial and final incidence. Often, however, the distinction is not clear. For example, who incurs the initial costs of aircraft noise when it is correctly anticipated ?

Foreign Air Travellers' Leisure Costs

Foreigners incur travel time costs and out-of-pocket travel expenses and a few may be deterred from travelling. Of these, only the last could significantly affect local businesses or households.(1) Moreover, a fall in foreign visitors is a cost to the local economy only if there are unemployed resources. In this case the cost is given approximately by the product of the loss of tourist expenditure and the expenditure multiplier (2). In practice, however, generally so few foreign tourists would be deterred that the costs to the local economy could usually be ignored.

Local Air Travellers' Costs

In many cases survey data on the incomes of local air travellers will be available so that allocation of travellers' current costs to households by income groups is straightforward. It may be necessary to distinguish between the costs of business and leisure travellers, though in Sydney there is apparently little difference between the incomes of the two groups (Travers Morgan 1974).

Local Residents' Costs

As noted above, the quantified costs of local residents include losses of householder surplus as a result of land resumption, noise and network congestion costs. Clearly most surplus losses accrue to landowners.(3) Likewise, since renters in noisy areas gain lower rents to compensate for the noise or generally speaking they would not live there, it is generally the landowners who suffer a loss of rental income or a reduction in wealth if they wish to sell the property. It is necessary therefore to estimate the incomes of local landlords. On the other hand it is difficult to determine who suffers network congestion costs.

Estimation of Final Incidence Over Time.

In considering government costs, a very helpful and not implausible simplifying assumption was made that the distribution of income and tax structures would remain constant. Thus a given group of households, say the poorest 20 per cent, would bear the same proportion of government costs at each point in time, and the same proportion of the total discounted costs. Likewise it is not implausible to assume that relative consumption expenditures are

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1. Any additional out-of-pocket travel expenses of foreigners could also change the level and distribution of their expenditure locally.
2. This formula will result in an overestimate of the losses from tourism in so far as tourist expenditure would reduce the production of other goods and services.
3. On the other hand, landowners may receive gains from urban development, but these may not be quantified.

constant, (i.e. that the richest 20 per cent tend to account for x per cent of total expenditure. The next 20 per cent for y per cent and so on). This assumption together with the assumption that the distribution of income will not change implies that households in each relative income group will bear a constant proportion of the costs of increased prices, and hence of the total discounted costs which businesses pass onto households.

Clearly it is a useful simplification to allocate proportions of total discounted costs to relative income groups. It may be possible to adopt this approach also for costs incurred by property owners (e.g. losses of dividends, landholder surpluses and noise costs). We then face two questions. How are relative income effects converted into absolute income effects ? And how do we deal with situations, notably concerning air travellers, when this simplifying procedure may not apply ?

In order to predict the absolute income effects in say 1985, it is necessary to forecast the real income range corresponding to each relative income group. For example, the forecast income range of the second poorest income group in 1985 might be $9,200 to $13,300(1). The costs borne by this relative group in 1985 might then be distributed to households in the absolute income groups of say $0 to $9,999 and $10,000 to $14,999. Computationally it is simplest to assume that the distributions of incomes in the relative income groups are rectangular, although this might be slightly inconsistent with the assumption that income distribution does not change. Ideally this procedure is repeated for each relative income group for each cost area and for each year. But such an elaborate procedure is expensive and it may be desirable to seek a simplifying algorithm based on the incidence of costs in key years. For example, suppose that half the discounted government costs were predicted to occur between 1980 and 1989, a quarter between 1990 and 1999, and a quarter between 2000 and 2010. It would be reasonable, although approximate, to say that half the costs would be borne by households on 1985 level incomes, a quarter by households on 1995 incomes, and a further quarter by households on 2005 incomes.

With regard to the costs of air travellers, it may be necessary to allow for some increase in the proportion of air travel by the relatively less well off. In this case it is necessary first to predict the proportion and magnitude of costs which will be borne each year (or for selected key years) by households according to their real income groups. These estimates are then converted into amounts borne by the corresponding relative income group.

4. INTERPRETATION OF THE RESULTS

At this stage the analyst may possess a great deal of data. In the MANS study estimates were made of the initial incidence of costs

1. The forecast rate of growth of incomes would presumably be consistent with the growth rates implicit or explicit in the forecasts of air travellers.

for 9 social groups and for residents of local government areas (Tables 2 and 3). Alsó the final incidence of costs was estimated for Australian households according to 5 relative and 5 real income groups (see Tables 4 and 5). In each case estimates were made for 33 sets of assumptions but for the purposes of illustration, only half are shown here. The three main ways to use this data are well known. They are (i) to use equity weights to estimate a revised NPV or net cost figure, (ii) to interpret the results simply as they stand and (iii) to estimate switching values - the weights necessary to make an option equal to the best as determined by the NPV or net cost criterion.

The case for and against equity weighting has been widely argued (UNIDO Guidelines 1972, Harberger 1974) and there is no need for more than a brief statement here. Weights enable the analyst to estimate a single measure of the worth of a project which represents a compromise between pure efficiency and equity. A positive weighted NPV does not mean, however, that the project is necessarily good from an equity viewpoint because it is not inconsistent with a situation in which the rich could gain and the poor lose. Also, not all distributional effects are included in a weighted NPV. But probably the greatest defect of weights is that they have no objective, scientific basis. It is therefore our belief that the disadvantages of the use of weights outweigh the advantages.

In order to draw conclusions from the estimated distributional effects it should be noted first that the results for alternatives should be compared only when they are derived from a similar set of assumptions. The distributional consequences of an option with medium air traffic forecasts cannot be compared with those of an option with high traffic forecasts, for example. Nor can the results with medium and high traffic forecasts be combined because there is no agreed unit of incidence. Second, the analyst who is unwilling to make value judgments can declare that one site is better than another only if it is better or at least as good for all social groups. Thus on the basis of the assumptions made in the Sydney study it was possible to claim that the total costs of each of the 5 relative or real income groups would be minimised by the selection of the lowest total cost site. However in the limit, as we noted above, a household is a social group and it was certainly not possible to claim that the costs of all households in all areas would be minimised by the least cost site.

It must be stressed therefore not only that the analyst can draw few conclusions without making value judgments, but also that the way in which he/she presents the results (especially with respect to the choice of social groups) reflects value judgments about the relative importance of the various findings. Needless to say the calculation of switching values, helpful as this may be, does not get us over these problems. We should add, however, that we see these problems as things which the analyst should be aware of when he presents his results to the decision makers rather than as a fundamental criticism of the worth of the distributional analysis.

Table 2. **INITIAL INCIDENCE OF COSTS.**

All figures in 1977 Dollars (Millions)

Discounted at 10 percent per annum to 1976

RUN DESCRIPTION* \ INITIAL INCIDENCE CATEGORIES	C'wealth	State	Public Enterprise	Aust. Business	Foreign Business	Foreign Leisure	Aust. Leisure Travellers	Aust. Business Travellers	Australian** Residents	Total	
(1) 203.04/K/M-G/S-W-4/WSRW/–/–/	23	34	579	311	95	59	278	256	584 (193)	2219	(1)
(2) 208.06/K/M-G/N-I/WSRW/–/–/	23	34	579	311	95	59	278	256	586 (193)	2221	(2)
(3) 203.03/K/M-G/S.W-4/WSRE/–/–/	23	34	574	323	90	59	280	253	584 (194)	2220	(3)
(4) 207.04/S/M-G/S.W-4/WSRW/–/–/	23	34	584	311	95	59	278	256	584 (193)	2224	(4)
(5) 207.03/S/M-G/S.W-4/WSRE/–/–/	23	34	580	323	90	59	280	253	584 (194)	2226	(5)
(6) 205.01/K/M-G/N-I/EXSTG/1995/–/	32	41	591	360	89	60	304	258	567 (191)	2302	(6)
(7) 202.05/K/M-G/S.W-4/EXSTG/1995/–/	30	42	588	379	90	60	302	264	581 (192)	2336	(7)
(8) 208.01/K/M-G/N.-I/CSPE/2001/–/	28	37	636	371	89	59	293	257	567 (189)	2337	(8)
(9) 203.01/K/M-G/S.W-4/CSPE/2005/–/	26	37	630	381	92	59	291	263	578 (191)	2357	(9)
(10) 207.06/S/M-G/N-I/CSPE/2008/–/	27	36	659	385	95	62	294	265	581 (193)	2404	(10)
(11) 205.02/S/M-G/N-I/EXSTG/1995/–/	31	44	681	384	97	81	338	262	592 (187)	2510	(11)
(12) 206.05/S/M-G/S.W-4/EXSTG/1995/–/	27	46	669	392	100	85	348	270	618 (186)	2555	(12)
(13) 209.01/K/H-G/S.W-4/EXSTG/1985/–/	55	63	736	558	108	79	482	423	798 (212)	3302	(13)
(14) 209.04/K/L-G/S.W-4/EXSTG/2006/–/	22	34	495	297	79	47	234	210	499 (183)	1917	(14)
(15) 206.01/S/M-G/N.W.-I/EXSTG/1995/–/	165	47	667	394	99	89	360	268	618 (187)	2707	(15)
(16) 220.01/K/M-G/S.W-4/EXSTG/–/Base Case 1/	64	41	373	700	125	319	982	244	559 (197)	3407	(16)

* **LEGEND: RUN NUMBER / ROLE / FORECAST / SSA SITE / KSA RUNWAY LAYOUT / OPENING OF SSA / OTHER CONDITIONS /**
RUN NUMBER: No. given by Schedule Selection Model
ROLE: K = All international flights at KSA; S = All international flights at SSA if opened.
FORECAST: H = high; M = medium; L = low; G = General Aviation; C = commuting; I = non-jet intrastate
KSA RUNWAY LAYOUT: EXSTG = existing runway; CSPE = close spaced parallel east runway; CSPS = close spaced parallel south runway; WSRE = wide spaced runway east; WSRW = wide spaced runway west; H.C. = High capacity
OPENING OF SAA: Predicted year of SAA opening
OTHER CONDITIONS: N.A.C. = no attainable capacity at KSA; H.A.C.C. = High access capital costs; Base Case: No SSA development; No KSA development; 1990 or 1995: constraint on KSA development to these years.

** Figures in bracket refer to estimated noise costs borne by residents.

Source: MANS Study Summary of Incidence Analysis prepared for Department of Transport by Planning Workshop Pty. Ltd., 1978.

Table 3 **Initial Incidence Costs Attributable to Residents of Local Government Areas* ***

All figures in 1977 Dollars (Millions)

Discounted at 10 per cent per annum to 1976.

LOCAL GOVERNMENT AREAS / RUN DESCRIPTION*	SYDNEY	NORTH SYDNEY	SOUTH SYDNEY	WOOLAHARA	WAVERLY	RANDWICK	BOTANY	MARRICKVILLE	LEICHHARDT	DRUMMOYNE	ASHFIELD	BURWOOD	CONCORD	STRATHFIELD	CANTERBURY	ROCKDALE	KOGARAH	HURSTVILLE	SUTHERLAND	BANKSTOWN	AUBURN	HOLROYD	FAIRFIELD	LIVERPOOL	CAMDEN	CAMPBELLTOWN	PENRITH	WINDSOR	BLACKTOWN	PARRAMATTA	BAULKHAM HILLS	HORNSBY	RYDE	HUNTERS HILL	LANE COVE	WILLOUGHBY	KU RING GAI	WARRINGAH	MANLY	MOSMAN	WESTERN	NORTHERN	SOUTHERN	NON-SYDNEY
(1) 203.04/K/M-G/S-W-4/WSRW/–/–/	17	15	7	16	8	30	28	73	21	9	10	4	2	3	13	56	5	21	19	12	4	7	9	9	10	17	8	5	5	13	20	24	9	2	8	11	39	31	9	5	1	12	15	195
(2) 208.06/K/M-G/N-I/WSRW/–/–/	17	15	7	15	8	30	28	73	21	9	10	4	2	3	13	56	5	21	19	12	4	7	9	9	10	17	8	5	5	13	20	24	9	2	8	11	39	31	9	5	1	12	15	195
(3) 203.03/K/M-G/S.W-4/WSRE/–/–/	17	15	12	15	8	35	39	61	25	12	4	4	2	3	12	47	5	21	18	12	4	7	9	9	10	17	8	5	5	13	20	24	9	2	8	11	38	31	9	5	1	12	15	194
(4) 207.04/S/M-G/S.W-4/WSRW/–/–/	17	15	7	16	8	30	28	73	21	9	10	4	2	3	13	56	5	21	19	12	4	7	9	9	10	17	8	5	5	13	20	24	9	2	8	11	39	31	9	5	1	12	15	195
(5) 207.03/S/M-G/S.W-4/WSRE/–/–/	17	15	12	15	8	35	39	61	25	12	4	4	2	3	12	47	5	21	18	12	4	7	9	9	10	17	8	5	5	13	20	24	9	2	8	10	38	31	9	5	1	12	15	194
(6) 205.01/K/M-G/N-I/EXSTG/1995/–/	17	16	6	16	9	32	32	47	21	9	4	4	2	4	12	64	5	26	19	12	4	7	9	10	11	22	10	4	5	12	17	23	9	2	19	12	38	32	9	6	2	12	16	194
(7) 202.05/K/M-G/S.W-4/EXSTG/1995/–/	17	16	6	16	9	32	33	47	21	9	4	4	2	4	12	64	5	26	19	12	4	8	9	10	9	17	8	5	6	13	20	25	9	2	19	11	40	32	9	6	1	12	15	202
(8) 208.01/K/M-G/N.-I/CSPE/2001/–/	17	16	7	16	9	17	24	99	38	18	4	3	2	4	12	31	5	10	19	12	4	7	9	10	11	22	9	4	4	12	17	22	9	2	10	11	38	32	9	6	1	12	16	194
(9) 203.01/K/M-G/S.W-4/CSPE/2005/–/	18	16	7	16	9	17	25	101	39	19	4	4	2	4	12	31	5	10	19	12	4	7	9	8	9	18	8	5	4	13	21	25	9	2	10	11	40	32	9	6	1	12	15	198
(10) 207.06/S/M-G/N-I/CSPE/2008/–/	18	16	7	17	9	18	27	99	39	16	4	4	2	4	13	34	5	10	19	12	4	7	9	9	10	18	8	5	5	13	20	24	9	2	10	11	39	31	9	6	1	11	15	206
(11) 205.02/S/M-G/N-I/EXSTG/1995/–/	21	19	7	20	10	39	35	51	21	8	5	4	2	4	14	70	5	26	21	12	4	7	9	9	11	22	9	4	6	12	15	21	9	2	9	13	36	33	10	7	3	10	17	207
(12) 206.05/S/M-G/S.W-4/EXSTG/1995/–/	21	19	7	20	10	39	35	51	21	8	5	4	2	4	13	69	5	26	20	12	4	8	9	8	9	17	8	5	7	13	21	25	10	3	9	13	41	35	11	7	3	12	14	211
(13) 209.01/K/H-G/S.W-4/EXSTG/1985/–/	26	24	7	24	12	44	37	57	26	11	6	5	3	5	16	74	6	32	25	16	6	10	12	14	15	29	12	7	7	18	32	37	14	3	12	17	61	47	13	9	3	18	22	297
(14) 209.04/K/L-G/S.W-4/EXSTG/2006/–/	14	13	6	13	7	29	31	44	20	8	3	3	2	3	11	60	4	24	16	10	4	6	8	8	8	14	6	4	4	11	16	20	7	2	17	9	32	26	7	5	1	9	12	164
(15) 206.01/S/M-G/N.W.-I/EXSTG/1995/–/	18	17	6	18	9	37	33	50	23	9	4	4	2	4	13	64	5	27	20	14	5	8	10	11	11	22	7	6	7	14	24	26	10	2	9	12	43	35	10	6	5	14	17	213
(16) 220.01/K/M-G/S.W-4/EXSTG/–/Base Case 1/	16	14	6	15	8	31	33	48	21	9	4	4	2	3	12	65	4	26	18	12	4	7	9	9	9	16	7	4	5	13	19	23	8	2	18	10	38	30	8	5	1	12	15	165

* LEGEND: RUN NUMBER / ROLE / FORECAST / SSA SITE / KSA RUNWAY LAYOUT / OPENING OF SSA / OTHER CONDITIONS /

RUN NUMBER: No. given by Schedule Selection Model
ROLE: K = All international flights at KSA; S = All international flights at SSA if opened.
FORECAST: H = high; M = medium; L = low; G = General Aviation; C = commuting; I = non-jet intrastate
KSA RUNWAY LAYOUT: EXSTG = existing runway; CSPE = close spaced parallel east runway; CSPS = close spaced parallel south runway; WSRE = wide spaced runway east: WSRW = wide spaced runway west; H.C. = High capacity
OPENING OF SAA: Predicted year of SAA opening
OTHER CONDITIONS: N.A.C. = no attainable capacity at KSA; H.A.C.C. = High access capital costs; Base Case: No SSA development; No KSA development; 1990 or 1995: constraint on KSA development to these years.

Source: MANS Study Summary of Incidence Analysis prepared for Department of Transport by Planning Workshop Pty. Ltd., 1978.

Table 4. **FINAL INCIDENCE OF COSTS – BY RELATIVE INCOME DISTRIBUTION OF AUSTRALIAN HOUSEHOLDS**

All figures in 1977 Dollars (Millions)

Discounted at 10 per cent per annum to 1976

RUN DESCRIPTION* \ RELATIVE INCOME GROUPS	1 0 – 20 Lowest Incomes	2 21 – 40	3 41 – 60	4 61 – 80	5 81 – 100 Highest Incomes	TOTAL AUSTRALIAN	TOTAL FOREIGN	
(1) 203.04/K/M-G/S.W-4/WSRW/–/–/	211	327	417	470	684	2109	111	(1)
(2) 208.06/K/M-G/N-I/WSRW/–/–/	211	327	417	470	684	2109	111	(2)
(3) 203.03/K/M-G/S.W-4/WSRE/–/–/	211	327	417	470	686	2111	108	(3)
(4) 207.04/S/M-G/S.W-4/WSRW/–/–/	211	328	417	471	685	2112	111	(4)
(5) 207.03/S/M-G/S.W-4/WSRE/–/–/	212	328	418	471	687	2116	108	(5)
(6) 205.01/K/M-G/N-I/EXSTG/1995/–/	221	339	431	486	717	2194	108	(6)
(7) 202.05/K/M-G/S.W-4/EXSTG/1995/–/	223	344	437	493	730	2227	108	(7)
(8) 208.01/K/M-G/N.-I/CSPE/2001/–/	225	346	437	494	728	2230	108	(8)
(9) 203.01/K/M-G/S.W-4/CSPE/2005/–/	226	348	441	498	734	2247	110	(9)
(10) 207.06/S/M-G/N-I/CSPE/2008/–/	231	355	449	507	748	2290	113	(10)
(11) 205.02/S/M-G/N-I/EXSTG/1995/–/	241	369	466	527	781	2384	126	(11)
(12) 206.05/S/M-G/S.W-4/EXSTG/1995/–/	244	374	474	536	796	2424	131	(12)
(13) 209.01/K/H-G/S.W-4/EXSTG/1985/–/	317	485	621	701	1045	3169	133	(13)
(14) 209.04/K/L-G/S.W-4/EXSTG/2006/–/	183	283	360	406	596	1828	91	(14)
(15) 206.01/S/M-G/N.W.-I/EXSTG/1995/–/	268	400	501	563	842	2574	133	(15)
(16) 220.01/K/M-G/S.W-4/EXSTG/–/Base Case 1/	334	453	588	678	1292	3344	63	(16)

* LEGEND: RUN NUMBER / ROLE / FORECAST / SSA SITE / KSA RUNWAY LAYOUT / OPENING OF SSA / OTHER CONDITIONS /

RUN NUMBER: No. given by Schedule Selection Model

ROLE: K = All international flights at KSA; S = All international flights at SSA if opened.

FORECAST: H = high; M = medium; L = low; G = General Aviation; C = commuting; I = non-jet intrastate

KSA RUNWAY LAYOUT: EXSTG = existing runway; CSPE = close spaced parallel east runway; CSPS = close spaced parallel south runway; WSRE = wide spaced runway east; WSRW = wide spaced runway west; H.C. = High capacity

OPENING OF SAA: Predicted year of SAA opening

OTHER CONDITIONS: N.A.C. = no attainable capacity at KSA; H.A.C.C. = High access capital costs; Base Case: No SSA development; No KSA development; 1990 or 1995: constraint on KSA development to these years.

** Figures included in these columns are Australian Business & Leisure traveller costs, Noise & Commuting costs & Losses of Household surplus

Source: MANS Study Summary of Incidence Analysis prepared for Department of Transport by Planning Workshop Pty. Ltd., 1978

Table 5 **FINAL INCIDENCE OF COSTS – BY REAL INCOMES OF AUSTRALIAN HOUSEHOLDS**

All figures in 1977 Dollars (Millions)

Discounted at 10 per cent per annum to 1976

RUN DESCRIPTION* \ REAL INCOMES	1 0 – 9,999	2 10,000 – 17,999	3 18,000 – 23,999	4 24,000 – 29,999	5 30,000 & OVER	TOTAL AUSTRALIAN**	TOTAL FOREIGN	
(1) 203.04/K/M-G/S-W-4/WSRW/–/–/	255	525	446	351	530	2107	111	(1)
(2) 208.06/K/M-G/N-I/WSRW/–/–/	255	526	447	352	531	2111	111	(2)
(3) 203.03/K/M-G/S.W-4/WSRE/–/–/	261	537	451	351	511	2111	108	(3)
(4) 207.04/S/M-G/S.W-4/WSRW/–/–/	256	527	448	352	529	2112	111	(4)
(5) 207.03/S/M-G/S.W-4/WSRE/–/–/	261	536	450	351	517	2115	108	(5)
(6) 205.01/K/M-G/N-I/EXSTG/1995/–/	265	544	464	367	554	2194	108	(6)
(7) 202.05/K/M-G/S.W-4/EXSTG/1995/–/	267	546	468	372	574	2227	108	(7)
(8) 208.01/K/M-G/N.-I/CSPE/2001/–/	271	551	468	371	569	2230	108	(8)
(9) 203.01/K/M-G/S.W-4/CSPE/2005/–/	274	559	473	374	566	2246	110	(9)
(10) 207.06/S/M-G/N-I/CSPE/2008/–/	277	563	479	379	591	2290	113	(10)
(11) 205.02/S/M-G/N-I/EXSTG/1995/–/	265	533	478	394	715	2382	126	(11)
(12) 206.05/S/M-G/S.W-4/EXSTG/1995/–/	282	569	499	404	670	2424	131	(12)
(13) 209.01/K/H-G/S.W-4/EXSTG/1985/–/	364	750	648	530	878	3170	133	(13)
(14) 209.04/K/L-G/S.W-4/EXSTG/2006/–/	230	473	395	308	424	1828	91	(14)
(15) 206.01/S/M-G/N.W.-I/EXSTG/1995/–/	313	632	538	430	662	2575	133	(15)
(16) 220.01/K/M-G/S.W-4/EXSTG/–/Base Case 1/	326	578	582	535	1323	3344	63	(16)

LEGEND: RUN NUMBER / ROLE / FORECAST / SSA SITE / KSA RUNWAY LAYOUT / OPENING OF SSA / OTHER CONDITIONS /

RUN NUMBER: No. given by Schedule Selection Model
ROLE: K = All international flights at KSA; S = All international flights at SSA if opened.
FORECAST: H = high; M = medium; L = low; G = General Aviation; C = commuting; I = non-jet intrastate
KSA RUNWAY LAYOUT: EXSTG = existing runway; CSPE = close spaced parallel east runway; CSPS = close spaced parallel south runway; WSRE = wide spaced runway east;
WSRW = wide spaced runway west; H.C. = High capacity
OPENING OF SAA: Predicted year of SAA opening
OTHER CONDITIONS: N.A.C. = no attainable capacity at KSA; H.A.C.C. = High access capital costs; Base Case: No SSA development; No KSA development; 1990 or 1995: constraint on KSA development to these years.

** Due to rounding these totals are sometimes very slightly different from the totals shown in the corresponding Relative Income table.

Source: MANS Study Summary of Incidence Analysis prepared for Department of Transport by Planning Workshop Pty. Ltd., 1978.

5. CONCLUSIONS

The purposes of this paper were to illustrate some problems in distributional analysis and methods of meeting them. Firstly, the problem of selecting social groups, which is basic to distributional analysis, is often under-estimated. The results of the analysis may appear quite different according to the nature and size of the groups selected. Secondly, a considerable amount of data in addition to the NPVA data is required to predict even the initial incidence of costs. This is partly because some costs, such as transfer and secondary effects, are relevant to distributional analysis but not to NPVA. But the main reason is that more detailed data, for example on the division of costs between foreign and local airlines or between employer and employee, is required for distributional analysis than for NPVA. Thirdly, quite complex models and heroic assumptions are needed to estimate how costs are borne finally by households according to their income levels.

Finally, the results of distributional analysis rarely yield unambiguous answers concerning the relative distributional merits of alternatives. This does not mean that distributional analysis is without worth. To the contrary, we believe that it is an important part of any project evaluation. It means, however, that distributional analysis, like net present value analysis, is no substitute for tough political decisions.

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