INVESTMENT IN LOCAL GOVERNMENT ROADS IN TASMANIA
A PUBLIC CHOICE MODEL

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ABSTRACT: *The object of this paper is to develop a public choice model that will explain Local Government road expenditure. The model, which will be developed in this paper, treats Local Government roads as public goods and views public choice as the outcome of majority voting at the municipal ballot box.*

The effect of intergovernmental grants and the difficulty of measuring the output of roads necessitates considerable modification of the traditional voting model found in the public finance literature.

At this stage no estimations have been undertaken. However, it is hoped that the model will explain annual road expenditures rather than the overall size of the road network and develop estimates of the price elasticity of roads.

* This is a part of the author's dissertation for the Degree of Master of Transport Economics at the University of Tasmania. I wish to thank Dr. M.A. Brooks for introducing me to some of the public finance theory developed in the paper.

INTRODUCTION

Most economic analysis of road investment in Australia has centred around the use of Cost Benefit Analysis. This was the basis for determining the optimum allocation of road investment in the three reports by the Commonwealth Bureau of Roads (1968, 1973, 1975), and also by the Bureau of Transport Economics (1979). However, the actual allocation of funds to Local Government roads and especially to local rural roads has consistently been far higher than that recommended by these major cost benefit studies. In 1979 the Bureau of Transport Economics (BTE) reported (BTE 1979) that, in Tasmania, spending on rural local roads had exceeded by 3,300% that justified in the 1973 Commonwealth Bureau of Road's report.

Starkie (1981) and Stanley and Starkie (1982) discuss the divergence between the allocation of investment funds and the 'optimal allocation' determined by cost benefit studies. In the two papers they trace the history of the cost benefit studies and the way in which the methodology was amended to take account of secondary benefits, following criticism by a number of State Road Authorities that the studies consistently under-estimated the required level of investment in this class of roads. Stanley and Starkie (1982) suggest that local roads may be a form of quasi-public good. In support of this argument they cite the case study of Gunning Shire undertaken by the BTE (1982). This study showed that there was a pronounced hierarchy of access which did not fit well with the conventional economic assumption implicit in cost benefit analysis that the principal benefits of road expenditure are the reduction of road user costs through the savings in vehicle operating costs and in vehicle occupants time. As Starkie (1981) has shown these two categories make up over 75% of the benefits measured by cost benefit analysis.

This paper will take a different approach to most of the previous literature in this field. It will propose a model for the demand for local roads on the basis that this is a political process where the level of local road expenditure is decided at the municipal ballot box. The voting model, which will be developed in this paper, views public choice as the outcome of majority voting where voting is a procedure for arriving at a collective decision when voters have different tastes or different endowments and their individually preferred fiscal policies are likely to differ. This form of approach has been extensively developed in the public finance literature. (For a review of this literature see Atkinson and Stiglitz (1980)). Subject to a number of caveats this approach will allow a model of the electorate's demand function to be determined. Such a demand function might then be used to examine how far conventional cost benefit analysis succeeds in modelling political behaviour.

THE VOTING MODEL

The conventional model of consumer demand behaviour portrays a rational selfish man purchasing goods in a competitive market and attempting to maximise his utility so that at the margin the benefit obtained from the purchase of the goods just equals the cost of their purchase. In this model of democratic behaviour the competitive market is replaced by the ballot box and the voter is assumed to cast his vote on two factors - the amount of benefit that he will receive from a given output of public goods and the amount he will pay for that output in taxes. The level of utility of the voter will depend only on his disposable income and the level of spending on public goods.

The municipal council that is elected will have a platform closest to the desires of the majority of the electorate. Figure I shows the individual decision process. In Figure 1 the individual has an income OA and his budget line, the locus of all possible combinations of his expenditure on private and public goods is AB. Thus at OB the individual would devote (be taxed) all his income to the output of public goods. The individual voter maximises his combination of private and public goods at public good output OG. In the lower part of the figure this is represented as the maximum utility he can obtain for his given budget.

If everyone had the same preferences as the individual in the diagram and the same income then there would be unanimity over the level of public expenditure. The dashed lines in Figure 1 show alternative preferences held by other members of the electorate. Since there can only be one decision to be decided by the majority the combination of preferences adopted by the community will be those of the decisive voter, see Barlow (1970), who in the case of simple majority voting will be the median voter.

The median voter model makes strong predictions but at the expense of some heroic assumptions. In particular there are very strong information requirements as the voter has to be able to assess the benefits from public spending and the implications for taxation. It would be necessary to separate out roads from the other goods and services provided by the municipality. Further, it would be necessary to show that those elected are principally concerned with expenditure on roads rather than on other competing issues.

The difficulties caused by these assumptions require that in order to model local road investment satisfactorily the basic model will need to be considerably expanded. The investment in local roads depends not only on the contribution from rate income, but also on the level and form of assistance from State and Commonwealth Governments. The next section will consider the impact of such grants on the costs of roads as perceived by the voter. There are difficulties in determining what the output of roads is and in what terms it can be measured and this is dealt with in the section after next. The third extension of the model is to encompass all other goods and services provided by the municipality so that the final model measures the utility of all expenditure by Local Government, while identifying the demand for road expenditure separately. While the final model is both modified and greatly expanded in scope, the concept of a model based on the democratic process is maintained.

THE EFFECTS OF INTERGOVERNMENTAL GRANT

For a voter to make rational decisions at elections he must know the amount of benefit he will receive and the amount he will pay for that benefit. The effect of intergovernmental grants is to alter the link between rates collected for roadworks and expenditure on roadworks. If there were no intergovernmental grants a voter could reasonably expect that a 10% increase in the road rate would result in a 10% increase in roadworks. However, if road expenditure is partially funded from road rates and road grants, together with loan funds in some instances, then this will not be the case.

This section will examine the effect of intergovernmental grants on Local Government expenditure. It will be shown that the effects of these grants vary, depending on whether they are matching grants or lump sum grants. A theory will be developed to show how Local Government expenditure is expanded by the effect of intergovernmental grants.

Most of the literature dealing with the effects of grants is concerned with determining which is the more efficient form. Much of the following discussion is taken from Bradford and Oates (1971) and Nitzan (1977), who were both concerned with the relative efficiencies of the two grant forms. The effects of combining matching and lump sum grants is discussed in Slack (1980).

Matching grants are provided for road sealing on a dollar for dollar basis. Lump sum grants are provided for all forms of roadworks. Matching grants operate in a different way to lump sum grants in that they lower the tax price of the goods attracting the grant. Lump sum grants do not affect tax prices but make more income available to the community.

The effect of a matching grant is shown in Figure 2 taken from Bradford and Oates (1971). The pre-grant budget line is AB. This changes to AE after the provision of the matching grant. If the slope of AB is S then the slope of AE is $S(1 - mp)$ where mp is the rate of subsidy provided by the intergovernmental grant. p is the proportion of roadworks eligible for grant. In Tasmania only road sealing is eligible so p is the proportion of road sealing in the roadworks budget of the local authority. m is the proportion of that eligible output provided by the intergovernmental grant.

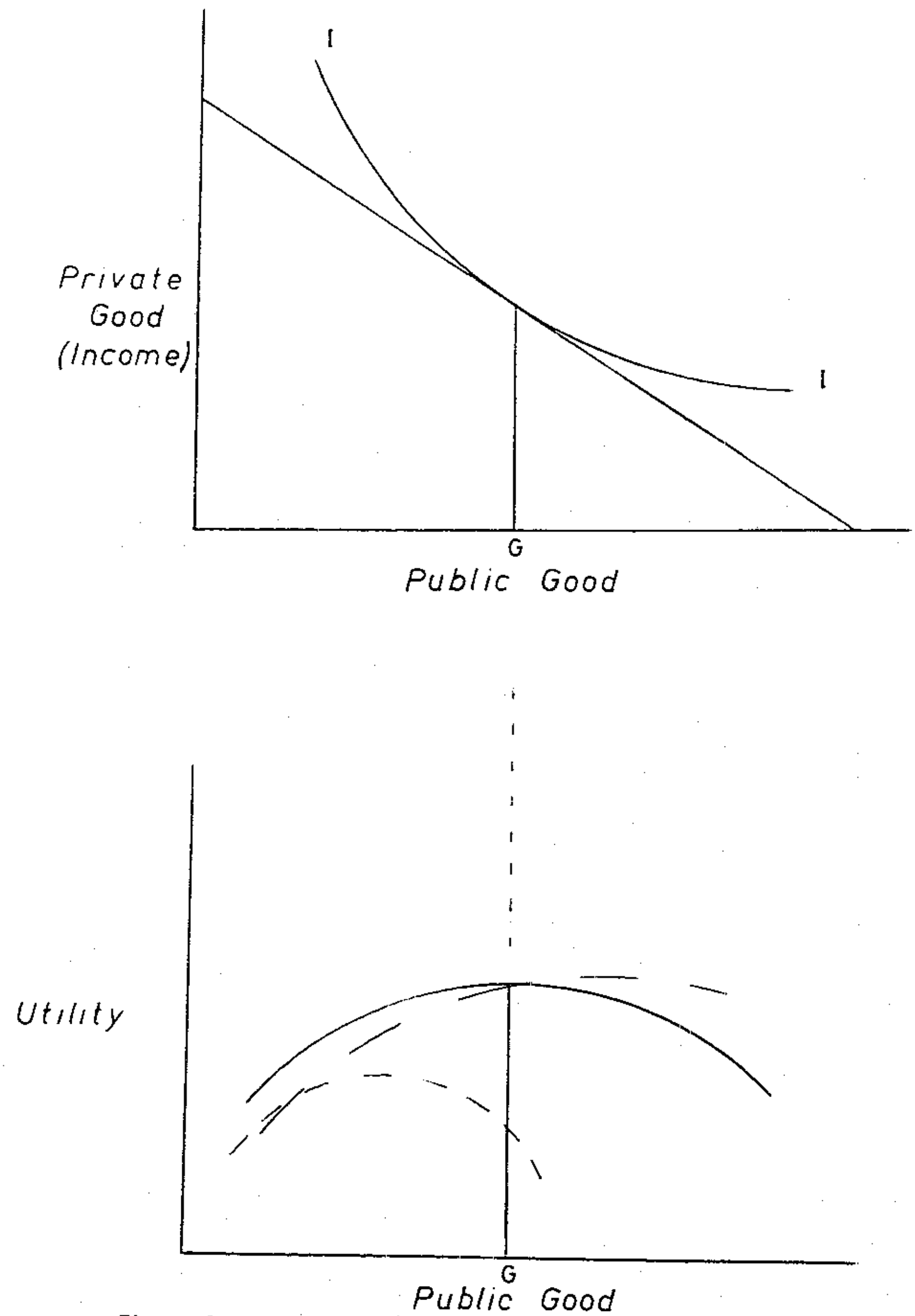

Figure 1 : Determination of Optimum Output of Public Good

Clearly the matching grant cannot be exchanged for other goods. Ihe matching grant will have the effect of lowering the tax price needed to produce the same output of roads.

Lump sum grants do not affect the price of Local Government output. The effect of intergovernmental lump sum grants is shown in Figure 3. The pre-grant budget line is AB and this line represents the trade-off between the individual's private goods (income) and public goods. The provision of a lump sum grant AC does not alter the tax price of the public good given by the slope of the budget line S but only increases his income. Thus the post-grant budget line is CD.

Before the grant is awarded output will be at G_R. If the local authority maintains its expenditure on public goods and does not use the grant to reduce the level of its own taxes output post-grant will be G_G. The maximum effect of the lump sum grant will be to increase output by the amount of the grant multiplied by the slope of the budget line S.

In Iasmania road grants are hypothecated for roads so that roads grants cannot be spent on other goods and services. An examination of the accounts of Iasmanian municipalities (excluding the cities of Hobart and Launceston) confirm that no such transfers are made.

It is possible that the provision of lump sum grants has the effect of lowering tax rates. In Tasmania local authority rates are stuck before the State Budget is handed down. However, local authorities, through consultation with the Department of Main Roads and on the basis of allocations from previous years, have a reasonable expectation of the level of intergovernmental grant. Accordingly, the processes of determining grants and Local Government rates are considered to occur simultaneously.

Matching Grants

Ihe effect of matching and lump sum grants can be represented in mathematical terms.

If S is the tax price without any intergovernmental grant then -

$$S = \frac{CX}{N} \tag{1}$$

Where C is the average cost ofproducing output X
X is the output of roads by Local Government
N is the population of taxpayers

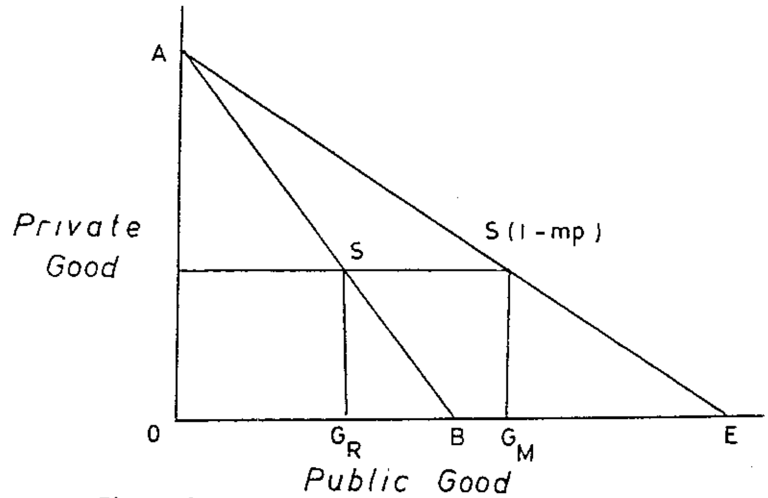

Figure 2 : Effect of Matching Grant on the Output of Public Goods (Source: Bradford and Oates (1971))

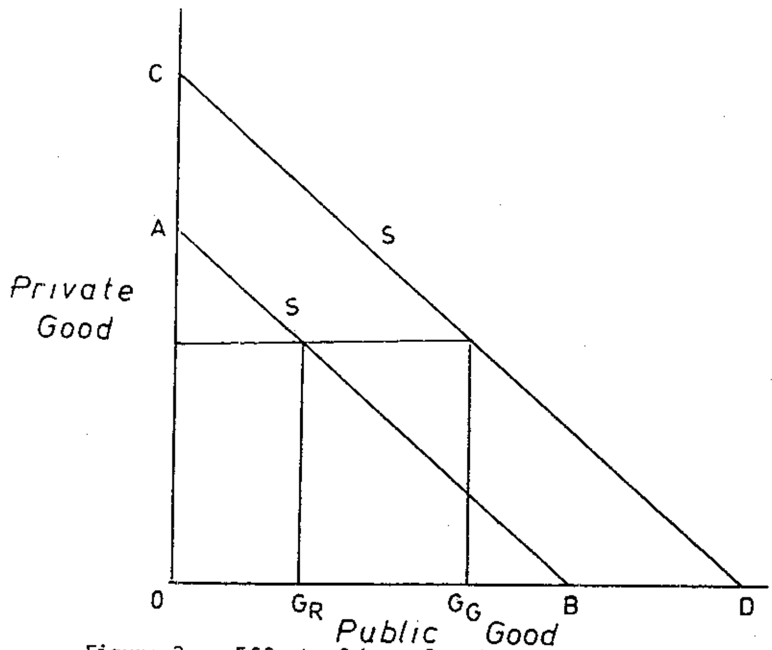

Figure 3 : Effect of Lump Sum Grant on the Output of Public Goods (Source: Bradford and Oates (1971))

If δS is the change in tax price due to a matching intergovernmental grant -

$$\delta S = mp\,\frac{CX}{N} \qquad (2)$$

Where m, p, C, X, N are defined previously

$$\text{i.e.} \quad S - \delta S = \frac{CX}{N}(1 - mp) \qquad (3)$$

Lump Sum Grants

The effect of lump sum grants is to increase the income of the municipal electorate. This results in an expansion of output δX.

$$\delta X = GS \qquad (4)$$

where G is the amount of intergovernmental lump sum grant

The increased output $X + \delta X$ will still cost the ratepayer the same tax price S since the grant does not affect the price of roads. However, the apparent tax price perceived by the voter has been lowered. He now receives output $X + \delta X$ while he pays the same amount of tax. The income effect can be translated into a pseudo price effect.

Figure 4 illustrates this point. Using the same notation as Figure 3 the effect of the lump sum grant is to expand output from G_R to G_G. To the voter it appears that he faces a tax price AF rather than AB before the grant.This is a pseudo price since if equation (4) is combined with equation (1) then -

$$X + \delta X = \frac{SN}{C} + SG = S\left(\frac{N}{C} + G\right) \qquad (5)$$

If the electorate wish to increase output still further they would face tax price S the slope of the pre-grant budget line rather than the pseudo tax price the slope of AF in Figure 4.

At output G_G equivalent to $X + \delta X$ the apparent effect of a lower tax price can be expressed mathematically as -

$$S^1 = \frac{CX}{N}(1 - g) \qquad (6)$$

where S^1 is the apparent tax price
g is the subsidy rate per head $\left(\frac{G}{N}\right)$

The effect of matching and lump sum grants can be combined. The matching grant will act on all road expenditure, both that provided by the ratepayer and that provided by the lump sum grant. Combining equations (3) and (6) we derive and equation for the price of roads P_R -

$$P_R = \frac{CX}{N}(1 - g - mp) \qquad (7)$$

MEASURING THE OUTPUT OF ROADS

There is a major problem in defining the output of road investment. Physical measures such as the length of the road network or the length of sealed road vary relatively little from year to year and do not correlate well with expenditure.

Stanley and Starkie (1982, 1983) develop and estimate a model relating the physical output of roads to a variety of soci-economic parameters. This explains how the road network came to be the size and type that it is. It does not model the variation in road output from year to year because the variation in these physical measures need not correlate with expenditure on roads.

This problem of measuring road output is most acute with Local Government roads because so much of the expenditure is on maintenance or a form of maintenance. It is meaningless to physically measure the number of potholes filled or the length of road re-graded even if such statistics could be obtained. Even such works as road sealing are not simply described. For example, on the same sealing project one section might require extensive drainage works, the provision of a good road base and the improvement of superelevation on corners while another section may require little or no extra work. Roads constructed by Local Government are built to widely differing standards of width and depth of pavement. The length of roads within a municipality does not give an accurate measure of the output of roads.

Accordingly, it is assumed that the output of a road is equal to the sum of the inputs measured in terms of expenditure. This makes the assumption that municipal councils have efficient cost minimising technology directed toward the maximum benefit of its electorate. The use of expenditure as a measure of output overcomes the problems of defining a physical output for roads.

However, the use of expenditure rather than a physical output prohibits the use of a direct demand function. This can be overcome by using the dual of the demand function, the expenditure function.

THE MODEL OF LOCAL GOVERNMENT EXPENDITURE

This section will develop a model of Local Government expenditure based on the political process and taking into account the problems of intergovernmental grants and the measurement of road ouput discussed in earlier sections.

The model will assume that the utility of the voter can be measured solely in terms of two outputs, road and other goods and services. Utility will be measured by the total expenditure of the municipality on all goods and services. Since there are no physical measures for roads or for other goods and services it is not possible to use a direct demand function as both dependent and independent variables would be measured in expenditure terms. Accordingly, the model of Local Government expenditure will use the expenditure function.

The expenditure function is the dual of the conventional demand function. Rather than maximising utility subject to a constant level of income the expenditure function minimises expenditure while holding utility constant. This function has had widespread use in the public finance literature, see Diamond and McFadden (1974).

The starting point of the model is the assumption of a Cobb Douglas utility function for the output of roads and other goods and services :

$$U = A \text{ Roads}^{a} \text{ Other Goods}^{b}$$

subject to an income constraint

$$I = \text{Price of Roads} \times \text{Output} + \text{Price other goods} \times \text{Output}$$

In mathematical terms -

The utility function

$$U = AR^{a}Q^{b} \qquad (8)$$

where

U = Utility
R = Output of roads
Q = Output of other goods
A, a, b are co-efficients

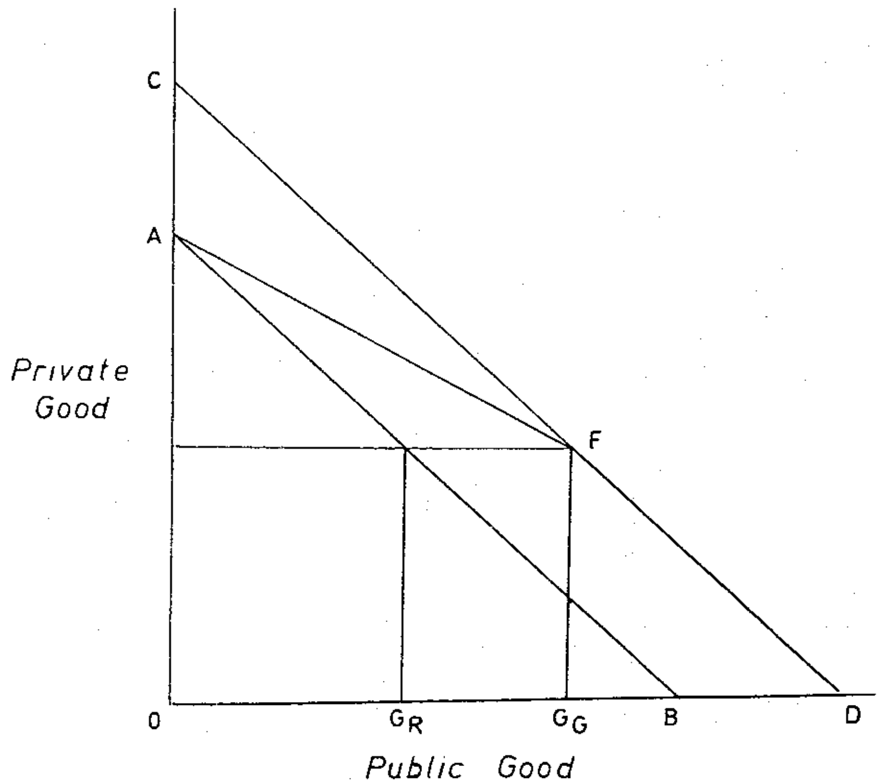

Figure 4 : The Pseudo Price Effect of a Lump Sum Grant

and the

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where

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utility

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and the income constraint is given by

$$I = RP_R + QP_Q \tag{9}$$

where

I = Iotal private income
P_R = Price of roads
P_Q = Price of other goods
R = Output of roads
Q = Output of other goods and services

Following the procedure in Diamond and McFadden (1974) the indirect utility function is derived.

$$R = \frac{a}{a+b} \frac{M}{P_Q} \tag{10}$$

where M is the total expenditure by Local Government

$$Q = \frac{b}{a+b} \frac{M}{P_Q} \tag{11}$$

Substituting back into (8)

$$U = A\left(\frac{a}{a+b} \frac{M}{P_R}\right)^a \left(\frac{b}{a+b} \frac{M}{P_Q}\right)^b \tag{12}$$

$$U = AM^{a+b} \left(\frac{1}{a+b}\right)^{a+b} \left(\frac{a}{P_R}\right)^a \left(\frac{b}{P_Q}\right)^b \tag{13}$$

$$M^{a+b} = \frac{U}{A} (a+b)^{a+b} \left(\frac{P}{a}R\right)^a \left(\frac{P}{b}Q\right)^b \tag{14}$$

$$M = \left(\frac{U}{A}\right)^{\frac{1}{a+b}} (a+b) \left(\frac{P}{a}R\right)^{\frac{a}{a+b}} \left(\frac{P}{b}Q\right)^{\frac{b}{a+b}} \tag{15}$$

Ihis is the first equation of the model. It is now necessary to define P_R and P_Q to complete the model

THE DETERMINATION OF TAX PRICES FOR ROADS AND FOR OTHER GOODS AND SERVICES

Intergovernmental grants are given to local municipalities for roads through the State Department of Main Roads. For other goods and services grants are allocated principally through the State Grants Commission, and also through the agency of a number of State Government Departments. In addition to these grants, the State Government has allocated Loan Funds from its allocation for both roads and other goods and services. The purpose of this section is to derive mathematical expressions for the tax price of roads P_Q and the tax price for other goods and services P_R. The equations so derived will form together with the expenditure function eq. (15) the complete model of Local Government expenditure.

The expression for the tax price for roads is given by equation (7). The equation for the tax price for other goods and services is analogous to this. However, since only roads attract significant matching grants, the equation has been simplified.

$$P_Q = \frac{Q}{N}(1 - q) \qquad (17)$$

Where q is the lump sum intergovernmental for other goods and services per taxpayer.

Intergovernmental grants for roads are distributed by the State Road Authority, the Department of Main Roads. The method of allocation is detailed in ACIR Report <u>The Provision of Roads</u>, ACIR (1981). The allocation of grants is a function of area, population, road length and sealed road length. It has been assumed that there is a linear relationship between these variables and the allocated grant.

For the purposes of the model, it is assumed that loan funds are allocated on a similar basis to that used for grants. Thus, g + mp, the grant per head allocated to each municipality, is given by :-

$$g + mp = c_1 + c_2 \text{ population} + c_3 \text{ area} + c_4 \text{ road length} + c_5 \text{ sealed road length} \qquad (18)$$

Grants for other goods and services are principally allocated through the State Grants Commission so as to provide a reasonably comparable standard of facilities across municipalities. These grants are also based on the population and area of the municipality, together with the length of the road network and the length of sealed road. In addition the Commission also takes into account the indebtness of the municipality, the level of health and welfare services and the provision of services to non-residents, (State Grants Commission Annual Report (1979)). There are also a number of smaller grants from the State Government for a wide range of projects, but the determinants of these grants are similar to Grants Commission grants.

The grant per head for other goods and services q is given by :-

$$q = d_1 + d_2 \text{ population density} + d_3 \text{ road length} + d_4 \text{ sealed road length} + d_5 \text{ indebtness} + d_6 \text{ welfare} + d_7 \text{ services to non-residents} \quad (19)$$

Equations (7) and (18) and (17) and (19) are combined to give expressions for P_R and P_Q.

$$P_R = 1 - (c_1 + c_2 \text{ population} + c_3 \text{ road length} + c_4 \text{ sealed road length}) \quad (20)$$

$$P_Q = 1 - (d_1 + d_2 \text{ population density} + d_3 \text{ road length} + d_4 \text{ sealed road length} + d_5 \text{ indebtness} + d_6 \text{ welfare } d_7 \text{ services to non-residents}) \quad (21)$$

ESTIMATING THE COMPLETE MODEL

At this point three equations have been derived. The first equation (15) is an expenditure function for Local Government in terms of the price of roads and the price of other Government goods and services. The second equation (20) seeks to explain the price of roads in terms of a number of socio-economic parameters of the municipality and the third equation (21) explains the price of other goods and services in similar terms.

The determination of grants by the State and Commonwealth Governments and the striking of the municipal rate are considered in the model to be a simultaneous process. In Tasmania local authority rates are struck before the State Budget is handed down. However, local authorities, through consultation with the Department of Main Roads, and on the basis of allocations from previous years, can reasonably estimate the level of intergovernmental grant. Hence the assumption of simultaneity is considered to be satisfied.

The three equations that make up the model must be estimated simultaneously using three stage least squares. The first stage is to estimate P_R, then P_Q and finally M the total municipal expenditure.

DISCUSSION OF THE MODEL

The aim of this paper has been to develop a model of the demand for expenditure on Local Government roads. The final model of three equations defines the demand for roads in terms of price and a number of other socio-economic parameters. The equations will explicitly model the political process and implicit in that are the income transfers generated by that process.

There are three advantages of this model over regression models that estimate physical parameters of the road system as a function of a number of socio-economic variables. Firstly there is an underlying theoretical justification based on the political process. Secondly, the model attempts to explain expenditure rather than the road network. This allows the determination of price elasticities for roadworks. Thirdly, the model will yield interesting information about the production of goods and services by Local Government both on the relative price elasticities between roads and other goods and services and also on the level of scale economies of municipal size.

The model is capable of handling time series data and this may yield further useful information. Initially only cross-section data will be employed as there are considerable problems in evaluating the many technical changes that have occurred in Local Government finance in the past few years. These include the revised Commonwealth tax sharing arrangements between 1976 and 1980, a change in the policy of administering road grants to municipalities introduced in 1981 and the provision of Australian Bicentennial Roads Grants in 1982.

The model is founded on a number of assumptions which may easily be found to be untrue or only partially true in practice. Two of the larger problems are the existence of public goods other than roads competing for the vote of the electorate and that of fiscal illusion where the voter is uncertain or deceived as to the price he is paying for a given output.

At this stage no model estimations have been undertaken. It is proposed, however, to use three data sets and compare the results between them. The first data set will include all Tasmanian municipalities. The second and third data sets are sub-sets of this. The second will encompass all local authorities that receive rural local road grants of whom there are some thirty-four municipalities and third data set will comprise all those municipalities who spend more than 50% of their total revenue on roads and who have no major output other than roads. This third data set includes twenty-five municipalities.

The comparison between the co-efficients for price and the socio-economic parameters will give a valuable insight into the demand for local road investment. It is hoped that the estimates obtained will explain the apparent overspending on rural roads reported by the BTE (1979) in its report on the Australian road network.

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