PUBLIC TRANSIT FARE AND SUBSIDY POLICY IN GREATER VANCOUVER, 1970-1983: EFFICIENCY AND EQUITY IMPLICATIONS

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ABSTRACT

This thesis studies the consequences for efficiency and equity of the fare and subsidy policies for public transit in Greater Vancouver from 1970 to 1983. Efficiency is defined as revenue passengers carried per revenue vehicle kilometre and equity is defined in terms of progressive, proportional and regressive net incidences of subsidies.

By analysing revenue and cost data from suburban and inner city transit depots, it is shown that the net incidence of operating subsidies in 1980 tended to be regressive on a per capita basis.

It is shown that the efficiency of transit in Greater Vancouver could be increased by adopting a differentiated fare structure.

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CHAPTER 1

INTRODUCTION

This thesis is prompted by concerns about productivity and income distribution in financing the operation of public transit in Greater Vancouver. The period analysed will be 1970 to 1983.

Productivity is defined as the number of revenue passengers[1] carried per revenue vehicle kilometre[2,3] and income distribution is defined in terms of progressive, proportional or regressive net incidences of subsidies.

It is argued that productivity and income distribution are functions of the operational criteria and the organisational structure of a transit system (Gwilliam: 1978). The operational criteria can be influenced by the provincial operating subsidy formula. For example, a subsidy formula that is based on the number of revenue passengers carried carries an explicit message to the operator to maximise revenue passengers. The organisational structure refers to the government bodies responsible for transit planning and the balance of political power within them. For example, a regional government with a large suburban representation can introduce fare and subsidy policies that benefit the suburbs over the inner city. Therefore, both the operational criteria and the organisational structure will determine the choice of transit system provided, its productivity and the distribution of income associated with financing it.

The majority of the work undertaken on the impacts of operating subsidies on transit system productivity and income distribution (Frankena: 1973, 1981 and Nash: 1978, 1982) completely neglects organisational issues. This thesis represents a small attempt to consider economic and political determinants of transit productivity and income distribution.

Between 1970 and 1983, transit operating deficits were covered initially by B.C. Hydro's profits from the sale of electricity and then from provincial general revenues and finally, by the province and Greater Vancouver Regional District jointly. Transit planning was variously the responsibility of B.C. Hydro, the Bureau of Transit Services in the Ministry of Municipal Affairs and the Greater Vancouver Regional District.

It is hypothesised that the operational criteria and the organisational structure of transit in Greater Vancouver from 1970 to 1983 led to:

- a decline in the level of system productivity
- an economically sub-optimal fare structure
- a regressive distribution of income.

Chapter 2 will discuss some concepts relating to fare and subsidy policy. It will be shown that different subsidy formula produce different types of transit systems and that the flat fare structure is sub-optimal on revenue raising, marginal cost pricing and social policy grounds.

Chapter 3 traces the evolution of fare and subsidy policy in Greater Vancouver from 1970 to 1980. Over this period, system productivity fell, the fare structure became gradually undifferentiated and subsidies led to a regressive distribution of income. It is shown that by re-adopting a differentiated fare structure the productivity of the Greater Vancouver Transit System would increase.

Chapter 4 sets out the conclusions of the study.

NOTES TO CHAPTER 1

[1]A revenue passenger is a single passenger who rides a transit vehicle and has paid a fare, either by cash, ticket, token or pass for that trip. (excludes transfers or non-revenue rides).

[2]Revenue vehicle km is the movement of a transit vehicle a distance of one kilometre in a regular passenger service.

[3]Ideally, the measure would be revenue passenger kms. per revenue vehicle km. but reliable data on transit trip lengths are not available.

CHAPTER 2

FARES AND SUBSIDIES - CONCEPTS

There are as many ways of financing transit as there are views on what transit is, it could be free[1] or it could be completely unsubsidied, even profit making. It is rare to find a public transit system, in the developed world, that relies exclusively on either fares or subsidies for its revenue.[2] Instead, they rely on a combination of fares and subsidies, although the mix varies greatly.

TABLE 1: TRANSIT PHILOSOPHIES

Implicit view of transit	Ethos	Urban Area	% costs covered by fares
Utility	"Transit as a right"		0
Social Service	"A loss is no sin"	Greater Vancouver	35(1982)
Subsidised business	"Try and break even"	Greater London, U.K.	65(1975)
Business	"Make a profit"	Bogota	100

If transit is free then it is a public utility with no user charges and, like sewerage disposal, it is entirely funded out of tax revenue. Transit is defined as a social service if the system is not expected to break even or make a profit. An example of this is the flat fare charged in Greater Vancouver. London, England is an example of transit as a subsidised business because London Transport is expected to at least try and break even. Finally, transit is a private business when it receives no government subsidy, and makes a profit.

It is necessary to distinguish between the fare level and the fare structure (Grey: 1975). The fare level is the monetary cost of a trip, the fare structure is the way, if any, that the monetary cost of a trip varies. For example, the fare may vary by distance travelled, by time of day, type of service, by the user or day of the week. Another way of explaining the fare structure is in terms of the degree of fare differentiation - some systems' structures are highly differentiated, others are not. A transit system may differentiate fares in none, some, or all of the ways shown in Table 2 but, generally, the amount of differentiation tends to increase as the percentage of costs that must be covered from fares increases.[4]

Fare differentiation is justified on three grounds: increasing revenue, efficient pricing and social policy.[5] As a way of raising revenue, it is possible because of the heterogeneous nature of the transit market. There are two basic markets: the captive user and the choice user, the former has no option but to use transit (the captive can, of course, walk or not make the trip at all). The choice rider could use a car.[6] The transit market may be further disaggregated by age, sex, income, trip length, and trip purpose, each with a particular aversion to or predilection for using transit, measured in terms of their elasticity of demand.

The effectiveness of fare differentiation depends on the degree to which these markets can be isolated given the operational constraints. The majority of fares are collected 'on-board' therefore an upper limit on the amount of differentiation exists otherwise unacceptably long boarding times result.[7]

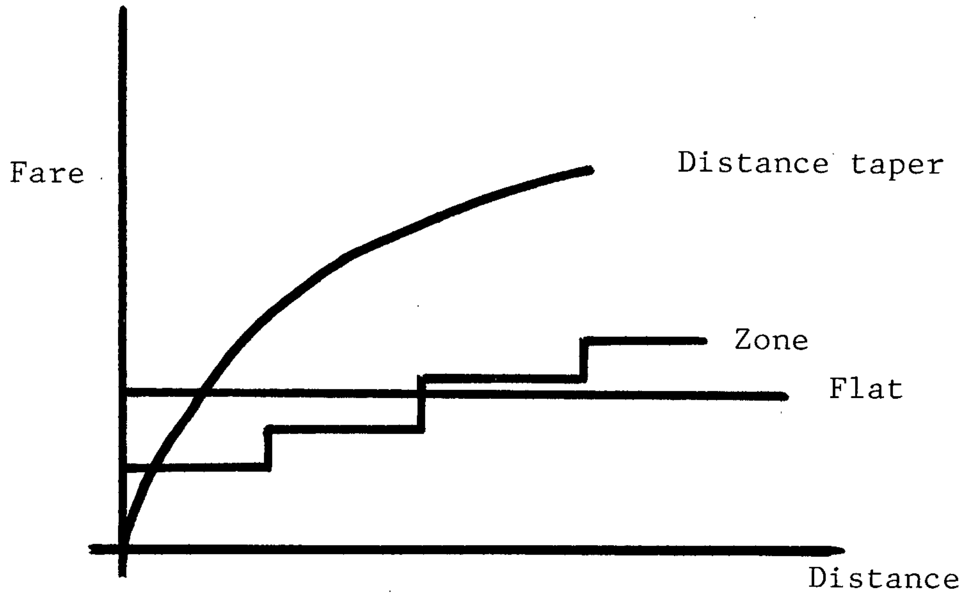
TABLE 2: FORMS OF FARE DIFFERENTIATION

Form of differentiation	Examples	Cities
Distance[1]	Zones distance taper[2]	Greater Vancouver Pre-1981 London, England
Time of day	Peak/Off-Peak	West Vancouver
Service	Express/Local	Ottawa Greater Vancouver (Proposed in 1982)
	Subway/Bus	London, England
User	Senior citizen School student	Greater Vancouver
Intensity of use	Farecard	Greater Vancouver
Day of the week	Sunday	Greater Vancouver

1. A graphical representation is given in Figure 1.
2. For a definition, see figure 1 overleaf.

FIGURE 1:

FARE DIFFERENTIATION BY DISTANCE



1. Distance taper: the cost per km. declines as the length of trip increases. This fare structure is common in transit systems in the U.K.

2. Zone fare structures may be 'coarse' or 'fine', i.e. few or many zones, respectively. Greater Vancouver moved from a fine to a coarse zone structure in 1976.

3. Flat fare structure: no fare differentiation by distance.

The concept of elasticity refers to the sensitivity of a dependent variable (ridership) to changes in an independent variable (fare and service level). Demand is elastic if the percentage change in the dependent variable is greater than the percentage change in the independent variable. Demand is inelastic if the percentage change in the dependent variable is smaller than the percentage change in the independent variable.[8]

The concept of fare elasticity is important because it shows the impact of changes in fare on revenue. When demand is elastic, a percentage rise in fare produces so large a percentage fall in ridership that total revenue falls. When demand is inelastic, a percentage rise in fare produces so small a percentage fall in ridership that total revenue increases (Samuelson and Scott: 1980).

The concept of elasticity must, however, be treated with circumspection. It assumes the shape of the demand curve and that everything except the two variables remain constant, but, as Kemp (1973) states:

> ".... as long as one is prepared to talk in very approximate terms, one often finds sufficient pattern or 'constancy' in empirically determined values of elasticity to be able at least to distinguish between high and low elasticity commodities."
>
> (pp. 27-28)

The elasticity of demand for transit is a function of the desire to travel and the desire to use transit. As a general rule, the more discretionary the trip, and the greater the choice of mode, the more elastic the demand will be. Table 3 gives an idea of the likely elasticities for various trips.

TABLE 3: EXPECTED ELASTICITIES OF DEMAND BY TRIP PURPOSE

Trip purpose	Desire to travel	Desire to use transit	Expected elasticity
Work	Strong	Strong	Low
Personal business	Medium	Medium	Medium
Sports	Medium	Weak	High
Convenience shopping	Weak	Medium	High

Source: Kemp (1973)

The fare elasticity of demand for transit is generally inelastic because, by and large, people do not use transit unless they have to. Most empirical work puts the fare elasticity of demand at between -0.1 and -0.5 (Nash: 1982). Canadian estimates are -0.33 (Frankena: 1978)[9] and -0.44 (Gaudry: 1975).[10] Service elasticities of demand are also inelastic but less so than the fare elasticities. Lago et al. (1981a) estimate the average bus and commuter rail headway elasticity (all hours) to be -0.47.[11,12]

The demand for peak trips is more inelastic than for off peak trips. Kraft and Domencich (1972) put them at -0.19 and -0.32 respectively[13] providing a rationale for a higher peak fare. The demand for short trips is more elastic than for long trips because walking is an option. Fairhurst and Morris (1975) estimate the fare elasticity of demand for trips of less than one mile to be -0.55 and -0.29 for trips of between one and three miles. There is rationale for a lower fare for short trips.[14]

The second rationale for fare differentiation is efficient pricing, which requires that the fare equal the marginal cost of carrying the rider. If fares are set below marginal cost, an inefficient number of riders are carried because riders who do not value their trips at their marginal cost are using the system.[15] Resources are being wasted on them. Fares set above marginal cost are also inefficient because riders who are prepared to pay the marginal cost of their trips, but not more, are lost.

The application of efficient pricing to transit is necessary because of the nature of its output.[16] Transit's output is not storable - if there are empty seats on a bus but there are not riders to fill them, the seats cannot be stored until the demand is there (Nash: 1982). Secondly, transit's output is indivisible. When the bus is full and a rider is left at the stop, all the rider wants is a seat but since seats do not come along individually, another bus must be provided. Therefore, the marginal cost is either zero (when the bus is not full) or very high (when the bus is full).

Pure marginal cost pricing is not possible because the fare structure cannot change momentarily, but the principles are important.[17] Since the marginal cost of carrying a rider on a bus that is not full is zero (in the

TABLE 4: RATIONALES FOR FARE DIFFERENTIATION

Form of Differentiation	Increasing Revenue	Efficient Pricing	Social Policy
Distance e.g. higher fare for longer trips	Short trips are more elastic than long trips	Short trips use capacity inefficiently during peak	Higher income groups more likely to make longer trips
Time of day e.g. lower fare in off peak	Off-peak trips are more elastic than peak trips	MC in off-peak is zero, MC in peak is high	Off peak users less likely to be in the labour force
Service e.g. higher fare for express services	Demand for express service is inelastic especially during peak	MC for peak express service is high	Higher income groups more likely to use premium services
User e.g. reduced fares for senior citizens	Off-peak only	Off-peak only	Senior citizens have lower than average incomes
Intensity of use e.g. farecard	Guaranteed revenue in advance	Encourages off-peak trips	Users making many trips e.g. captives, pay a lower average fare per trip
Day of week e.g. lower fare on Sundays	Sunday trips are elastic	MC is zero on Sunday	Sunday riders are more likely to be captives

off-peak for example), fares should be reduced. This policy is consistent with the evidence that the fare elasticity of demand is more elastic in the off-peak. Since off-peak services should be provided (to provide a minimum level of service and to utilise the buses efficiently i.e. not have them idle between the peaks) any revenue that does not add to costs should be sought.

A higher peak fare is justified because the marginal cost of carrying peak trips will be higher. Buses may only make one trip carrying a small number of riders who were crowded off other buses. A higher peak fare is also supported by the elasticity evidence, in addition to reflecting, crudely, the externalities riders impose on other riders during congested periods (Mohring and Turvey: 1975).

The third and final rationale for fare differentiation is on social policy grounds, the most common examples being reduced fares for senior citizens and school students. The limitation on this form of differentiation (i.e. by user) is that the beneficiary must be clearly identifiable (Nash: 1982). Short of issuing passes to everyone listing age, sex, income, and car ownership, thereby incurring long boarding delays and massive administrative costs, the potential for this form of differentiation is low.

In conclusion, fare differentiation is justified because it increases revenue, the marginal costs of trips vary and, certain groups are worthy of subsidy. The degree of fare differentiation is a function of the community's policy toward transit, operational constraints i.e. the ability to distinguish between the markets that exist for transit.

Each fare structure favours certain users and disfavours others, for example, the flat fare structure favours long distance riders over short distance riders. Each fare structure is a trade-off between three groups: the user, the operator, and the community and will, similarly, favour or disfavour them as the case may be. The user is concerned about the cost of the trip being made and the quality of service. The operator is concerned about the amount of work and policing involved in any fare structure. The community is concerned about the tax burden of the system subject to certain social policy considerations e.g. cheap fares for seniors. Using these assumptions Table 6 shows the three perspectives on common forms of fare differentiation. For example, the distance taper structure is good for short distance riders because the fare is in rough proportion to the distance travelled.[18] From the operator's point of view it is bad because it involves more work and more policing. It is good for the community because it raises revenue.[19]

Each fare structure implies a subsidy structure - they are two sides of the same 'revenue coin'. Two categories of subsidy exist: exogenous and endogenous. Exogenous subsidies are paid by the government to the user, the operator or both.[20,21] Endogenous subsidies are the cross-

TABLE 5: USER, OPERATOR AND COMMUNITY VIEWS ON DIFFERENT FARE STRUCTURES

Fare Structure	User Perspective	Operator Perspective	Community Perspective
Zones	Short distance, one zone: GOOD Short distance, two zone: BAD Long distance: ACCEPTABLE	ACCEPTABLE	ACCEPTABLE
Distance taper	Short distance: GOOD Long distance: ACCEPTABLE	BAD	GOOD
Flat	Short distance: BAD Long distance: GOOD	GOOD	BAD
Peak/Off-peak	Peak user: BAD Off-peak user: GOOD	BAD	ACCEPTABLE
Express/Local	Express user: ACCEPTABLE[1] Local user: GOOD	ACCEPTABLE[2]	ACCEPTABLE
Senior citizen discount	GOOD	ACCEPTABLE	GOOD
Amount of use	GOOD	GOOD	ACCEPTABLE

1. Depends on the degree to which the user perceives the service to be worth the extra fare.

2. Depends on the degree of separation between the two services e.g. a service which is part express and part local will require more policing and, therefore, be bad.

subsidies that exist in any fare structure and are 'paid' from user to user. Table 5 above gave an impression of which riders benefit and lose under the types of fare differentiation shown.

Exogenous subsidies are justified on social policy grounds. The riders with the lowest elasticities of demand are the captives, e.g. senior citizens and low income groups. If fares were set according to elasticities, (i.e. maximising revenue generation) those least able to pay would be charged the highest fares (assuming that the transit system is a monopoly). This has proved to be unacceptable.

Exogenous subsidies are also justified on marginal cost pricing and social policy grounds. The long run marginal costs[22] of a trip to the operator falls as the total number of trips on the system increases i.e. economies of scale with respect to ridership volume exist.[23] If marginal cost pricing is employed, revenue will never cover costs because the long run average cost curve will always be above the long run marginal cost curve. Why do long run marginal costs fall? Mainly because higher ridership volumes allow larger vehicles to be used (articulated buses for example).[24] Economies of scale with respect to ridership volume accrue to riders because as ridership increases so will headways and route coverage, therefore, average walking and waiting time will be reduced.[25]

Each combination of subsidies that the government chooses (i.e. user-side vs. operator-side, proportions of capital and operating costs covered) will produce a different type of transit system.[26] This, in turn, is a matter of public policy, therefore it is essential that the objectives of the transit system be chosen and then the appropriate subsidy 'tools' be selected.

Nash (1978) argues that there are two feasible objectives for a transit system - maximising vehicle kilometres or maximising passenger miles/ridership both subject to a budget constraint. The problem with maximising vehicle kilometres is that the rider does not demand vehicle kilometres. A transit system with this objective will have a large service area and a higher average fare level. It is a supply-side objective because the operator is not so much required to carry riders as to run buses. The alternative is to maximise ridership but the problem with this approach is that low ridership areas will receive a low, if any, level of service. It does make the operator consider demand however and provides a superior performance incentive i.e. 'carry riders'.

Frankena (1981) analyses three subsidy formulae (lump sum, cost, and ridership) to determine their appropriateness for a given objective. He shows that if the objective is to maximise ridership then a lump sum and a ridership subsidy will have the same effect. A cost subsidy, at the same cost to taxpayers, will produce a smaller reduction in fares, more service but lower ridership.

Given that the choice is between these two objectives,[27] there are three operating subsidy formulae which are consistent or inconsistent with each of the objectives. Operating costs may be subsidised on a percentage basis,[28] a fixed amount per rider[29] basis or a fixed lump-sum amount. If the objective is to maximise vehicle kilometres, the lump sum and the percentage cost formulae are equally effective. If the objective is to maximise ridership, then the lump sum and the 'per rider' formulae are equally effective (Frankena: 1981). Each subsidy formula is of equal cost to the taxpayer.

TABLE 6: TRANSIT OPERATING CRITERIA AND OPTIMAL SUBSIDY FORMULAE

	OPERATING SUBSIDY FORMULA			
Objective	Lump sum	%	Per rider	Fare and service level
Max. vehicle km.	Effective	Effective	Ineffective	High
Max. ridership	Effective	Ineffective	Effective	Low

Source: derived from Frankena (1981)

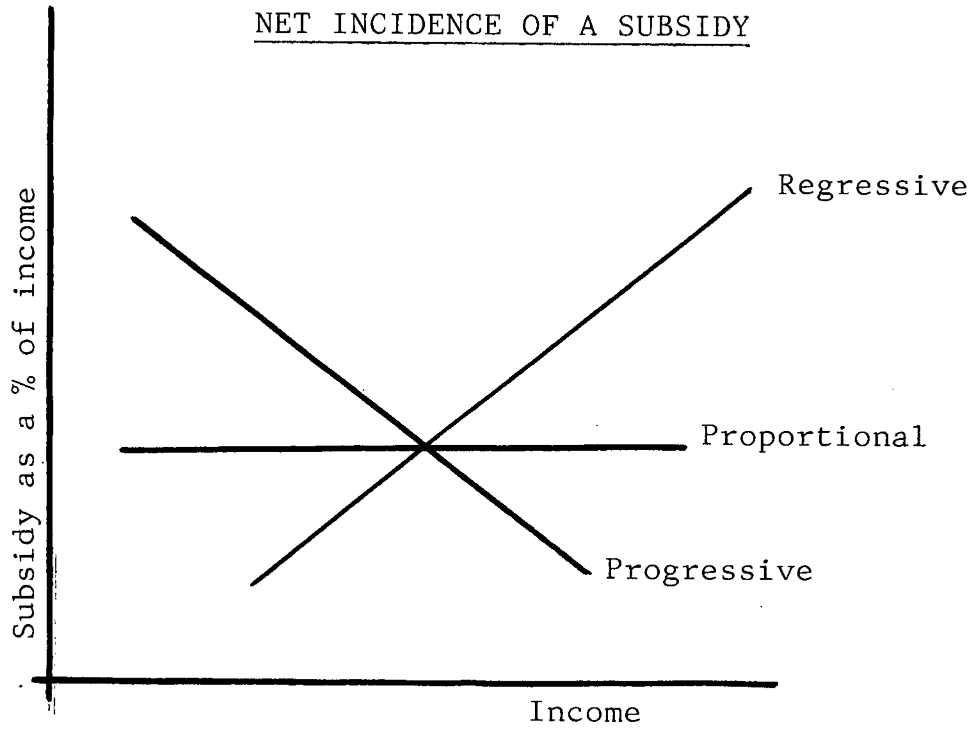
Exogenous subsidies must be paid for and there are four sources of revenue from which they come: general provincial revenues, property taxes, gasoline taxes and hydro surcharges.[30,31] Each source of revenue will favour or disfavour certain groups. In other words, taxes and subsidies exhibit distributional characteristics. The net incidence of a subsidy (the average subsidy received minus the average tax burden as percentages of income) is either progressive, proportional, or regressive (Frankena: 1973).

Exogenous subsidies redistribute income from the community to the user. Frankena (1973) shows that in Ontario, the largest subsidies go to transit systems used by higher income groups i.e. commuter rail and dial-a-ride systems. Cevero (1982) argues that in the U.S. exogenous subsidies are, overall, progressive.[32]

Endogenous subsidies redistribute income from user to user. Cevero (1982) concludes that the incidence of these subsidies are mildly regressive because, under the flat fare structure, low income captive riders subsidise higher income choice riders.

FIGURE 2:

NET INCIDENCE OF A SUBSIDY



In the past, public transit deficits have been financed from profits on public utilities (this was the case in Greater Vancouver until 1976). Frankena (1973) states that this is very regressive because the demand for electricity is inelastic with respect to income. Statistics Canada's Urban Family Expenditure Survey in 1978 shows that families in the $6000 - $7999 bracket spend 2.2% of their income on electricity while families in the $25,000 - $29,999 bracket spend 1.1% of their income on electricity.

In conclusion, fare differentiation can increase revenue, lead to a better utilisation of capacity and meet social policy objectives.

The characteristics and performance of a transit system is a function of the subsidy formula which, in turn, is a question of public policy.

Subsidies have distributional characteristics which may be progressive, proportional or regressive.

The next chapter will analyse the evolution of fare and subsidy policy with respect to public transit in Greater Vancouver between 1970 and 1980. It will be shown that by 1980 transit in Greater Vancouver had an undifferentiated fare structure compared to the structure in 1970, operated under a percentage costs subsidy formula, and that this produced:

- a greater percentage increase in inner city fare levels compared to suburban fare levels,

- high subsidies per passenger in low ridership areas, and
- higher subsidies per capita in higher average income areas, producing a regressive net incidence of subsidy.

Finally, it is shown that the re-introduction of differentiated fares would increase ridership, revenues and productivity.

NOTES TO CHAPTER 2

[1] As an idea, free transit enjoyed some popularity in the 1970's but it has never been systematically implemented for a long period of time. It was rejected because the absolute cost and the opportunity cost is high (Nash: 1978). If the objective is primarily to help low income groups, free transit is clumsy because higher income groups would also be subsidised. If the objective is to reduce auto congestion, free transit is equally inappropriate as Lewis (1977) comments that "during peak periods .... service level changes are calculated to be twice as important as fares in determining mode choice."

[2] Unsubsidised and/or profit-making transit is common in less developed countries.

[3] Meaning the fare does not vary with distance travelled, time of day or quality of service.

[4] Highly differentiated fare structures increase the costs of collecting the fares and the costs of policing the system and may outweigh the revenue gains from them. These costs fall to the operator and to the user in the form of longer boarding times leading to lower vehicle productivity and longer journey times. Quarmby (1973) shows that total bus journey time per mile (in seconds) rose from 334 under a 'no change' flat fare structure to 359 when the fares varied by distance and the driver made change.

[5] Table 4 summarises these three rationales by type of fare differentiation.

[6] Car ownership rates per household are not particularly good indicators of the captive/choice market split. Households with more members than cars contain captives.

[7] Inter city travel operators are able to differentiate fares to a far greater degree because they are collected 'off-board'.

[8] When the percentage change in both variables is equal, elasticity is unitary.

[9]28 Canadian cities.

[10]Montreal

[11]67 cities, mainly in the U.S.

[12]Choice riders are more sensitive to service levels than captive riders. Even 'dial-a-ride' services which eliminate walking and waiting time by picking up the passenger at home have not discouraged auto use. Button (1977) states that a dial-a-ride system in Harlow, England only diverted 2% of its riders from the car. Out of vehicle time elasticities are -0.59 as opposed to -0.29 for in-vehicle time elasticities (Lage et al.: 1981a).

[13]Reflecting the fact that most peak trips are to and from work. Data from Boston, Mass.

[14]Both the distance taper and flat fare structures charge a higher rate per km. for short trips however. Operators may want to discourage short trips because they are an inefficient use of space, especially in peak periods.

[15]When fares are below marginal cost, riders who would be prepared to pay a fare equal to marginal cost are enjoying consumer surplus, i.e. the difference between what they are paying and what they would be prepared to pay. The transit system is forsaking revenue therefore.

[16]Frankena (1979) argues that since automobile use is not priced efficiently, then, on grounds of second-best, transit fares below marginal cost are justified. The theory of second best is that when efficient pricing cannot be achieved in all sectors of the economy, it should be pursued in none.

[17]If average cost pricing principles are followed, a lower fare will be charged in the peak and a higher fare in the off-peak. Nash (1982) argues that this is incorrect but has "the superficial appearance of being more equitable and may as a result command political support."

[18]In terms of cost per km. the distance taper structure is better for long distance riders, but it is good for short distance riders relative to the flat fare. The ratings in the table are not absolute but relative to the other forms of differentiation listed.

[19]Quarmby (1973) showed that if London Transport's distance taper structure was replaced by a flat fare structure, with no change in average fare level, then an 8% loss in traffic and a 16% loss in revenue would occur.

[20]User-side subsidies usually take the form of reduced rates for transit by means of special passes and/or discounts on transit tickets.

[21]Kirby and McGillivray (1976) argue that user-side subsidies are more flexible and effective if the objective is to help certain targeted groups.

[22]The discussion of marginal cost pricing earlier referred to short run marginal costs, i.e. inputs are fixed, in the long run they are variable.

[23]Increasing the revenue per unit cost.

[24]When the marginal cost is defined to include the fare and the monetary value of walking and waiting time.

[25]Frankena (1979) comments that if capital costs are subsidised to a greater percentage than other costs then operators will be encouraged to provide a capital intensive system.

[26]The potential for economies of scale with respect to fleet size are very limited because labour costs are the largest component of total costs - 60%

[27]The choice is not likely to be mutually exclusive. The 'kilometres' objective will usually be accompanied by a requirement to raise a certain amount of fare revenue. The 'ridership' objective will probably have a clause stipulating a basic level of service in all areas.

[28]Pucher (1982) comments: "... most transit subsidy programs in the U.S. simply cover costs - whatever they happen to be - without regard to any index of goal achievement, (so) there is not much incentive for transit systems to use subsidies efficiently."

[29]Saskatchewan uses this formula.

[30]Frankena (1973) shows that the incidence of provincial taxes are proportional and the incidence of property taxes is very regressive. Gasoline taxes and hydro surcharges were not studied.

[31]There are also many other types of special assessment.

[32]This is mainly because the U.S. Government plays a far larger role in funding transit than the Government of Canada. The Government of Canada's role in transit is limited by the Constitution Act to transfers to the Provinces for capital improvements under the Urban Transportation Assistance Act of 1977.

CHAPTER 3

FARE AND SUBSIDY POLICY IN GREATER VANCOUVER 1970-1980

From 1970-1980, the transit system in Greater Vancouver was operated by a provincial crown corporation, B.C. Hydro. In 1970, there was a four zone fare structure, the system served the inner municipalities and 77% of costs were covered by fare revenue (including a $2 million p.a. lump sum subsidy from the provincial government to cover reduced fares for senior citizens). The remaining 23% of costs were paid for out of profits from B.C. Hydro's other activities. With limited subsidies available, a high percentage of costs had to be covered by fares, therefore service was confined to high ridership areas of the GVRD with a fare structure that increased revenue.

Between 1973 and 1976, B.C. Hydro expanded the service area under the direction of the Ministry of Municipal Affairs. The number of revenue vehicle km. supplied increased by 72% between 1970 and 1980. The number of revenue passengers only increased by 40% over the same period resulting in a drop in productivity from 2.3 revenue passengers per revenue vehicle km. in 1970 to 1.8 in 1980. In addition, the cost per revenue passenger increased by

TABLE 7: EVOLUTION OF TRANSIT FARE AND SUBSIDY POLICY, 1970 TO 1983

DATE	TRANSIT PLANNING AGENCY	TRANSIT OPERATING AGENCY	% COSTS COVERED BY FARES	SUBSIDY SOURCE	SUBSIDY FORMULA	SUBSIDY AMOUNT	FARE STRUCTURE	FARE LEVEL, $	REV.PASS. /REV. VEH. KM.
1970–1973	B.C.Hydro	B.C.Hydro	77%	Province lump sum $2M p.a. cross subsidy from B.C. Hydro operations			4 zones	A:0.25	2.3
1973–1976	Province	B.C.Hydro	50%				12 zones	A:0.25 B:0.40 C:1.00	
1976–1980	B.C.Hydro	B.C.Hydro	36%	Province	% costs	100% of deficit	2 zones	A:0.50 B:0.50 C:1.00	2.1
1980–1983	Province/ GVRD	M.T.O.C.	35%	Province/ GVRD	% costs	65%/35%[1] of deficit	Flat fare	A:0.75 B:0.75 C:0.75	1.8
1983 –	Province	?	?	?	?	?	?	?	?

A = Within City of Vancouver
B = Coquitlam to Downtown Vancouver
C = White Rock to Downtown Vancouver
[1] This ratio varied over the period 1980-83.

352% over the same period while the revenue per revenue passenger only increased by 106%. By 1980, 35% of costs were covered by fare revenue.

It was decided that subsidies should be paid on a percentage costs basis. From 1976 to 1980, the province paid for the operating deficit in full, and from 1980 to 1983, the deficit was shared by the province and the GVRD with 35% of costs to be raised from fare revenue. Since the subsidy formula was based on percentages of costs there was little incentive for B.C. Hydro to minimise costs or to maximise ridership. For example, in 1970, the cost per revenue vehicle kilometre was $0.58 while in 1980 it was $1.92 - a 23.1% p.a. increase compared to a 8.2% p.a. inflation rate, and productivity, with no change in service area, fell from 2.1 revenue passengers per revenue vehicle km. in 1976 to 1.8 in 1980.

The decision to finance transit primarily from subsidies, and the subsidy formula that was adopted, removed the need for a differentiated fare structure on revenue raising grounds. In 1976, a twelve zone fare structure that had evolved along with the service area expansion was replaced by a two zone structure. Since only 2% of all trips crossed the zone boundary, it was, in effect, a flat fare structure.

It was decided that there should be no variation in fare by distance travelled although the distance that it was possible to travel had increased greatly. It was further decided that the fare should not vary by the quality of service consumed although between 1970 and 1980 there was a widening differential in service quality. For example, a network of suburban express routes and a ferry service across the Burrard Inlet were inaugurated.

The reason behind the deteriorating system and fiscal performance of the Greater Vancouver Transit System was because the service expansion of the 1970's was into low density, suburban areas with a progressively undifferentiated fare structure. The expansion would not have been possible without a subsidy formula that is only indirectly related to ridership. Table 10 shows the lower patronage and productivity levels of suburban services. It is possible to distinguish them from inner city services because data on costs, revenues and revenue vehicle km. operated are available by transit operating centre, of which there are five, each serving a well defined part of the region. Figures 3 through 7 show the services operated out of each centre, and it may be said that the service areas of each centre are as follows:

FIGURE 3:

OAKRIDGE OPERATING CENTRE SERVICE AREA

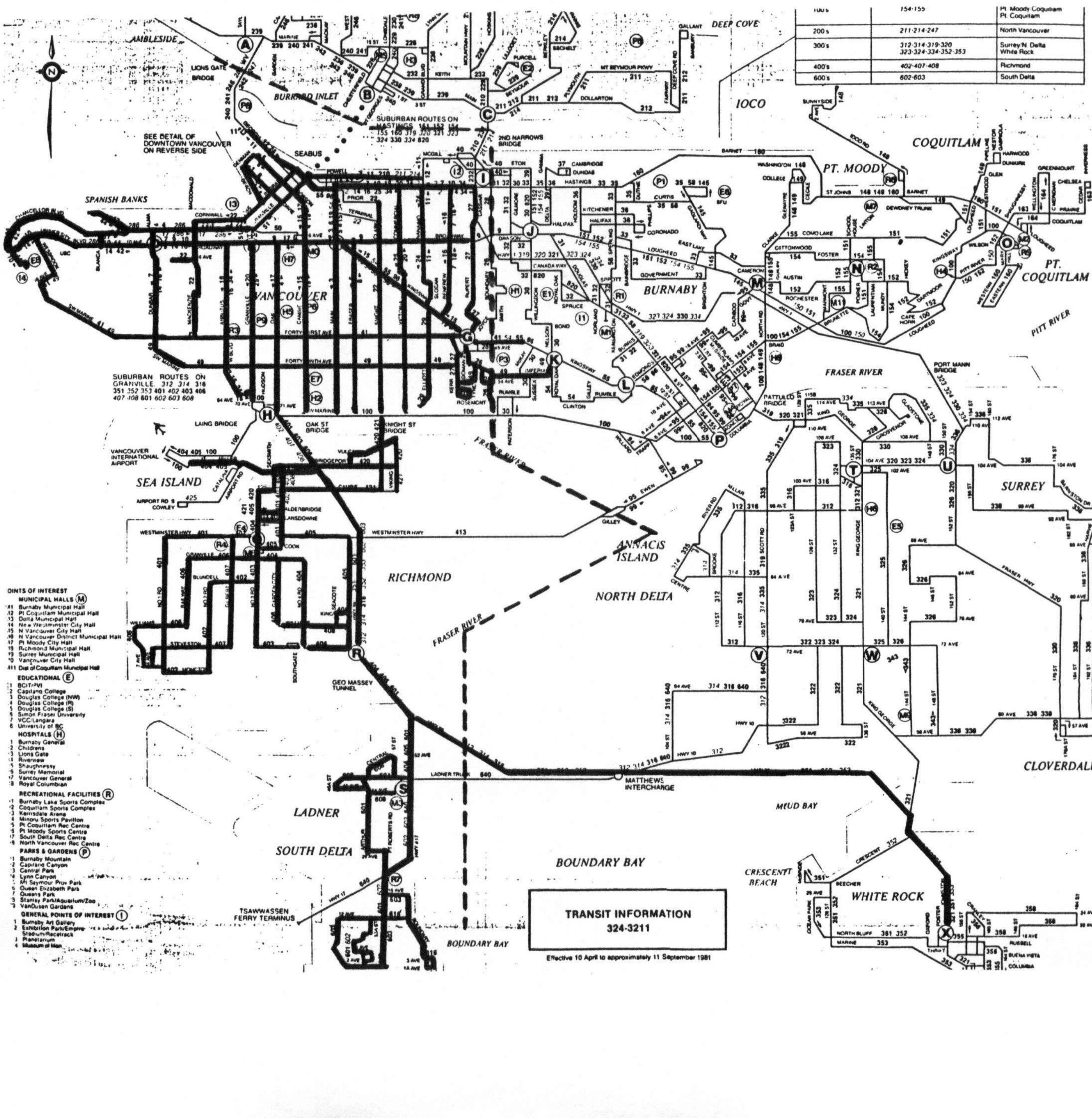


FIGURE 4:

NORTH VANCOUVER OPERATING CENTRE SERVICE AREA

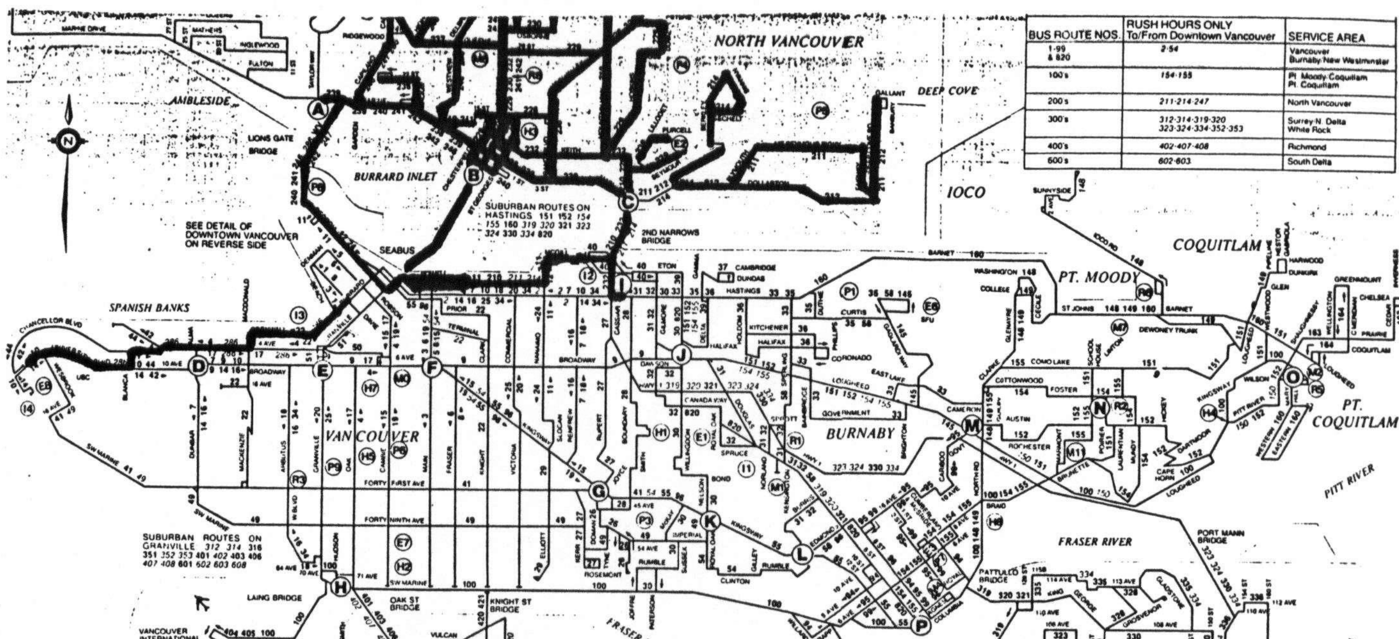


FIGURE 5:

KENSINGTON OPERATING CENTRE SERVICE AREA

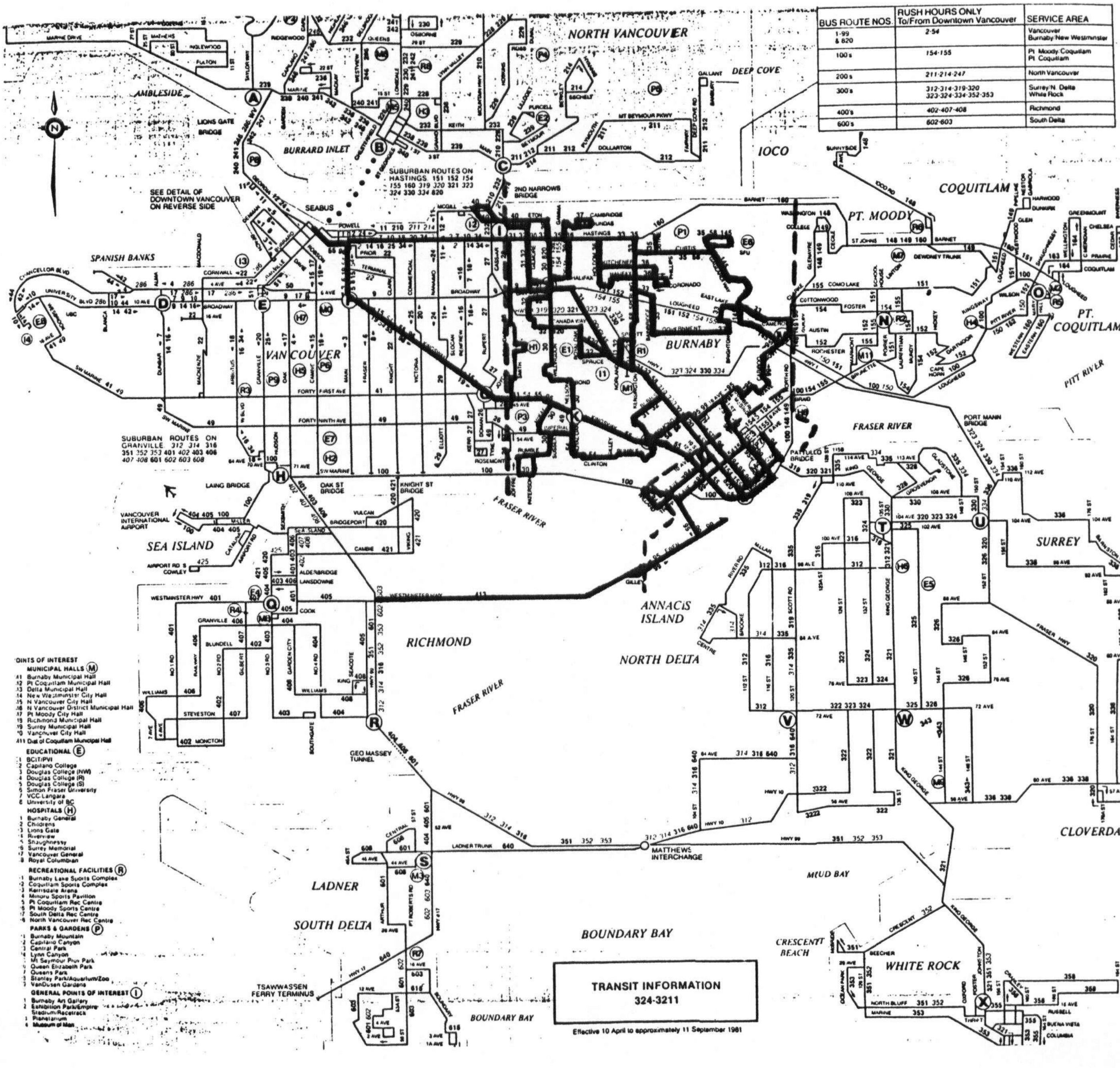


FIGURE 6:

PORT COQUITLAM OPERATING CENTRE SERVICE AREA

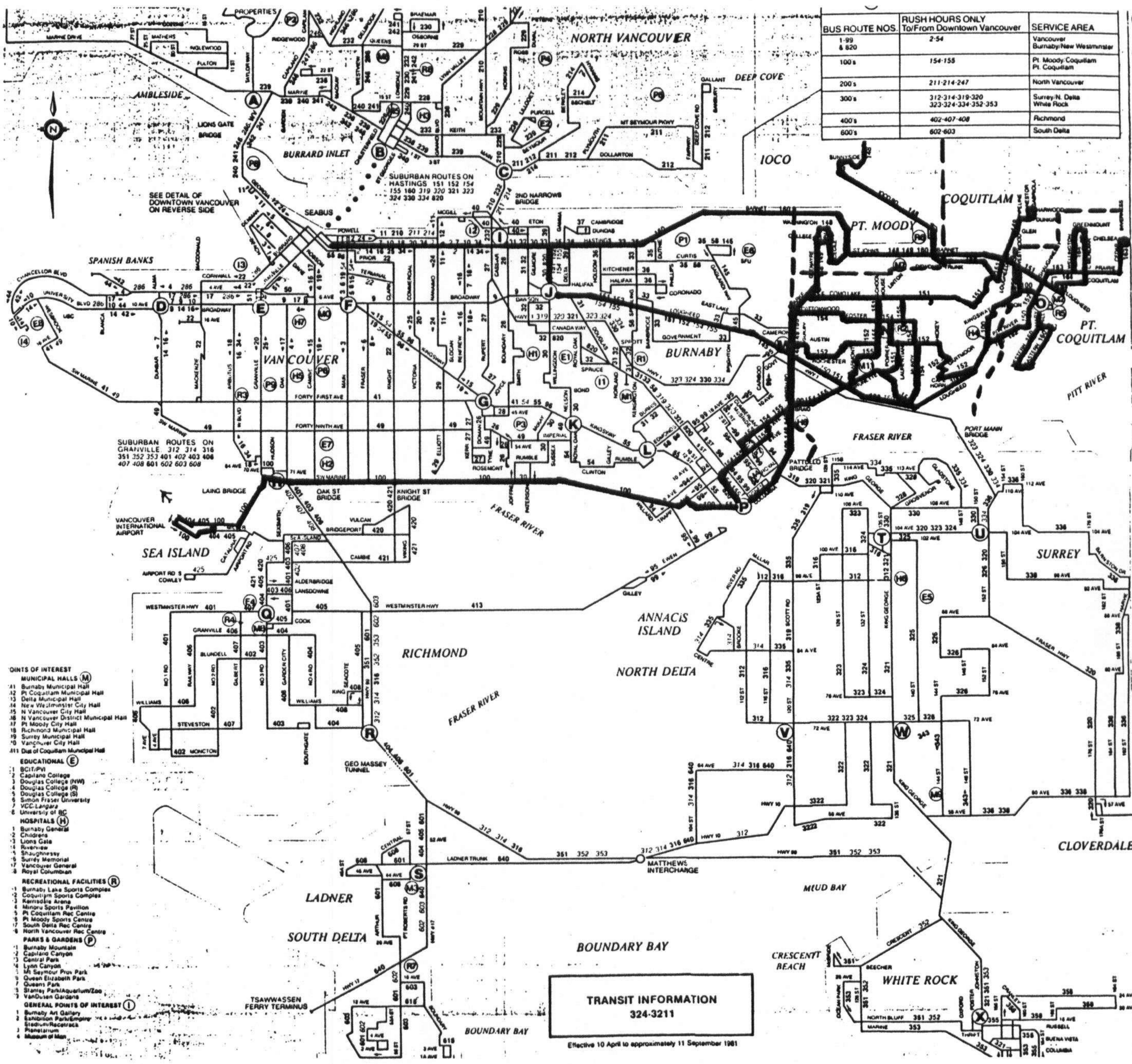


FIGURE 7:

SURREY OPERATING CENTRE SERVICE AREA

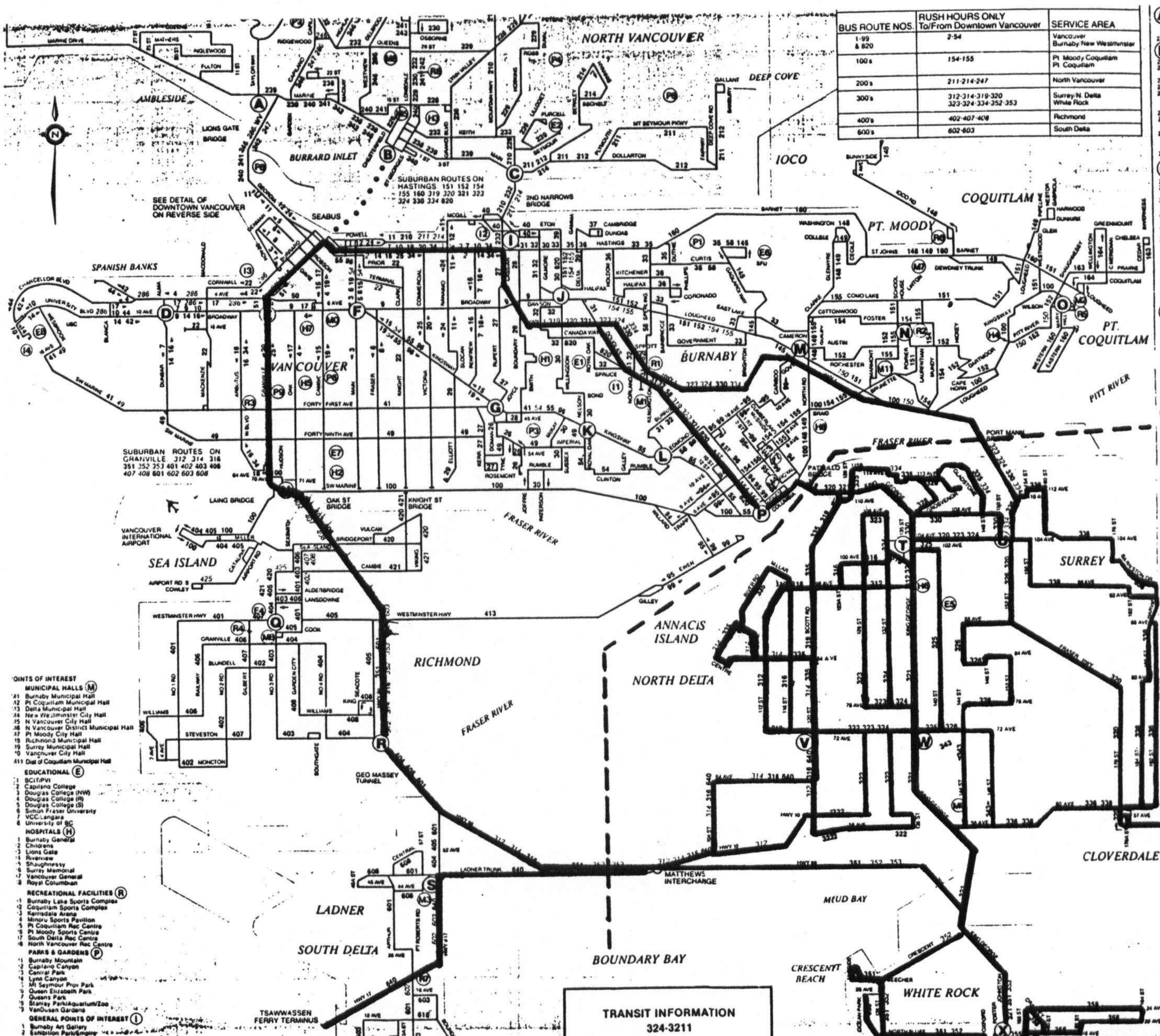


TABLE 8

OPERATING CENTRE SERVICE AREA CHARACTERISTICS, 1981

OPERATING CENTRE	SERVICE AREA	POPULATION 1981	POPULATION PER RESIDENTIAL HA. 1981
Oakridge	City of Vancouver, Richmond, South Delta	540,391	54.9
North Vancouver	City of North Vancouver, District of North Vancouver	99,319	49.3
Kensington	Burnaby, New Westminster	175,044	57.9
Port Coquitlam	Port Coquitlam, Coquitlam, Port Moody	103,526	36.8
Surrey	Surrey, North Delta, White Rock	205,424	14.8

Notes: Population data are from the 1981 Census of Canada. Residential density data are from the GVRD.

Figures 3 through 7 show that North Vancouver, Kensington, Port Coquitlam and Surrey Centres operate services to and from the City of Vancouver. Since these services do not permit trips entirely within the City to be made on them, it is unnecessary to include the City's population in their service areas.

TABLE 9

POPULATION DENSITY, REVENUE-COST RATIOS AND PRODUCTIVITY BY OPERATING CENTRE, 1980-81

Operating centre	Pop. per residential ha. 1981	Rev. pass.[1] per rev. veh. km. 1980-81	Revenue-cost ratio, 1980-81
Oakridge	54.9	2.3	0.40
North Vancouver	49.3	1.8	0.24
Kensington	57.9	1.5	0.26
Port Coquitlam	36.8	1.0	0.20
Surrey	14.8	0.8	0.17

Sources: Census of Canada, GVRD Planning Dept. 1981 Land Use Map and Metro Transit Operating Co. Annual Operating Agreement, 1980-81.

Notes: Revenue passengers per centre is obtained by dividing total revenue by the average fare in 1980-81 ($0.40). Cash fares and pass revenue is between 94% and 96% of total revenue. This assumes that the ridership profile is the same in all centres. It is unlikely that this is the case since some centres may have a higher proportion of senior citizens or school students in their service areas.

Revenue vehicle km. are obtained by multiplying the total revenue vehicle km. per weekday, Saturday, Sunday/Holiday as set out in the Annual Operating Agreement and multiplying them by the number of such days in a year (250 weekdays, 52 Saturdays and 62 Sundays and Holidays).

Revenue-cost ratio is total centre operating cost plus the percentage of system overhead costs equal to the percentage of system revenue vehicle km. operated by the centre divided by total revenue.

The revenue passengers per revenue vehicle kilometre measure is biased against those centres that operate long hour routes (e.g. Surrey) since there is no distance component in the numerator.

It is clear that productivity and revenue-cost ratios are directly related to population density.

A percentage costs subsidy formula, because it is unrelated to ridership, allows the expansion of service into low ridership areas therefore increasing system costs. However the fare level from 1980 or had to be set so that 35% of system costs are covered by fare revenue. Under a flat fare structure, this has resulted in greater percentage increase in the fare level for an inner city trip than for a suburban trip as shown in Table 10.

TABLE 10

CHANGE IN FARE LEVEL BY TRIP LENGTH, 1975 TO 1982

	% change in fare level p.a.
Trip within the City of Vancouver	+28
Trip from White Rock to Vancouver	-3.5
Trip from Coquitlam to Vancouver	+12

Under the flat fare structure and the percentage costs subsidy formula the largest subsidies per revenue passenger go to the areas with the lowest revenue-cost ratio.

TABLE 11

SUBSIDIES PER REVENUE PASSENGER BY OPERATING CENTRE, 1980-81

Operating centre	Revenue-cost ratio	Subsidy per[1] rev. pass. $
Oakridge	0.40	0.59
North Vancouver	0.24	1.23
Kensington	0.26	1.15
Port Coquitlam	0.20	1.47
Surrey	0.17	1.79

Source: MTOC Annual Operating Agreement

Notes: Subsidy per revenue passenger is derived by dividing total cost minus total revenue by total revenue divided by average fare.

[1]GVRD and Provincial subsidies.

If, on average, the income of transit riders is the same throughout the region, in other words, ignoring possible distributional consequences then it is much more expensive to carry riders in the suburbs than in the inner city. Policies such as service expansion and the flat fare which encourage a dispersal of transit users are costly.

On a per capita basis, the largest subsidies go to the areas with the highest average incomes. The fare and subsidy policy in Greater Vancouver is therefore regressive.

The variations in subsidy per capita is accounted for by variations in productivity and revenue-cost ratios which, in turn, are functions of population densities and

TABLE 12

SUBSIDIES PER CAPITA AND AVERAGE INCOMES BY OPERATING CENTRE, 1980-81

Operating centre	Subsidy per capita[1] $	Average income, 1980 $	Subsidy as a % of av. income, 1980-81
Oakridge	66.11	14,316	0.046
North Vancouver	106.06	16,194	0.065
Kensington	61.71	14,797	0.041
Port Coquitlam	83.49	15,664	0.053
Surrey	49.75	14,885	0.033

Source: Census of Canada 1981, MTOC Annual Operating Agreement and Revenue Canada Taxation Statistics.

Notes: Income data in lieu of Census data was obtained from Revenue Canada which is in the form of the number of all returns in 1980 (taxable and non-taxable) by income group by municipality. Average incomes are mid-point averages. A return is not synonymous with an individual since spouses with an income less than $3000 do not file a separate return. However, since the relative differences in average income between service areas are of interest, it is not important. According to Frankena's definition of net incidence, taxes should be deducted. This has not been done because the hydro surcharge and the gas tax are extremely small percentages of annual income and provincial income tax only varies by 0.2% over the range of average incomes shown above.

[1]GVRD and Provincial subsidies.

monitoring device for the operator in terms of cost minimisation and ridership maximisation.

To what extent is the poor condition of the Greater Vancouver Transit System a result of the fare policies that have been pursued over the last ten years as opposed to the subsidy formula.

Table 8 clearly shows that the fare structure of the Greater Vancouver System became progressively undifferentiated between 1970 and 1983. Button and Navin (1983) have developed a model to predict the impact of fare structure and fare level on the revenues and ridership of the Greater Vancouver Transit System. Assuming a 1% p.a. increase in population, a 1% p.a. increase in real incomes, a 0.5% increase in car ownership and constant transit service levels up to 1990, Table 14 summarises the implications of four fare structure and fare level changes, including retaining the flat fare. It is clear that the re-adoption of a differentiated fare structure would improve productivity, ridership and revenues.

The most striking comparisons are between retaining the flat fare structure and a peak/off-peak structure with off-peak fares held at $0.75 and between the flat fare structure and a distance based structure. In the first case, an extra 10 million rides would be generated and only $1 million in revenue lost by 1990, with productivity rising to just under 2.0 revenue passengers per revenue vehicle km. In the second case, an extra 8 million rides would be generated but revenues would icnrease by $4 million, in addition to an increase in productivity.

TABLE 13: REVENUE, RIDERSHIP AND PRODUCTIVITY IMPLICATIONS OF DIFFERENT FARE STRUCTURES IN GREATER VANCOUVER UP TO 1990

Fare Structure	Fare level increase 1981-1990	Riders (000) 1990	Revenue ($000) 1990	Riders per rev. veh. km.[1] 1990
Flat Fare	6% p.a.	94,332	79,785	1.77
Peak/Off Peak	10%/0% p.a.	104,856	78,213	1.96
Peak/Off Peak	10%/5% p.a.	96,446	86,078	1.81
Distance Short/Med/ Long	0%/5%/10% p.a.	102,954	83,987	1.92

1. 1981 service level = 53 million rev. veh. km. For graphical representations of these data see Appendix A.

Therefore it can be concluded that the expansion of service into suburban areas caused a certain decline in productivity but that this was exacerbated by abandoning the differentiated fare structure.

CHAPTER 4

CONCLUSIONS

There is nothing wrong with the expansion of public transit services into suburban areas *per se*. What is wrong, in the case of Greater Vancouver, is that they are not charged for in a more efficient and equitable way. Not only would a differentiated fare structure improve the revenues of the Greater Vancouver Transit system but it would also increase ridership. Why, then, was a differentiated fare structure abandoned.

Between 1976 and 1980 it would seem that the reason was the generosity of the subsidy, 100% of the operating deficit. While not quite a licence to print money such an open-ended formula would inevitably encourage a laxidaisical attitude towards raising revenue and encouraging productivity in any organisation. Secondly, but not analysed in this thesis, is the opposition of drivers to differentiated fare structures and the erosion of management's bargaining position when in receipt of a generous subsidy. It is difficult for them to claim that their resources are finite when the subsidy formula explicitly stakes that they are not.

Between 1980 and 1983 the peculiar nature of the organisational structure responsible for transit can be held to account for the introduction of the flat fare. Clearly, the flat fare was in the best interests of the suburban municipalities who had the majority voting strength on the GVRD board. Greater Vancouver was unique among Canadian metropolitan governments in having direct control over transit fare policy combined with regional government on a ward-system model.

In 1983, the Greater Vancouver Regional District was relieved of its duties towards fare policy. The reasons for this are sufficient for another thesis but suffice it to say that it was not primarily because they adopted the flat fare. While there has been a loss of local political control over what is a local service to the provincial level, the balance of political power that perpetuated an undifferentiated fare structure has been removed and there is some hope that a more rational fare structure will now be put in place.

A further reason for the abandonment of differentiated fares is the somewhat naive desire not to do anything that could possibly discourage a person from using transit. For some reason a simple fare structure is viewed, in some circles, as promoting ridership, by virtue of its simplicity. The proponents of this position forget that the same riders easily cope with differential rates for telephone calls, by time of day and distance. At a more fundamental level, it suggests a misunderstanding of the role of public transit in the wider scheme of urban transportation policy since it is premised on the belief that riders should be carried at any cost.

It is clear, then, that a differentiated fare structure will raise revenues, in all but one case, and ridership in all cases examined. However, differentiated fares are necessary but not sufficient. The long term results of a transit system is dependent upon urban planning that encourages high density employment nodes and, where appropriate, high residential densities.

BIBLIOGRAPHY

Button, K.J. 1979. "The Economics of Urban Transport". Saxon House, Farnborough.

Button, K.J. and F.D. Navin. 1983. "A Public Transport Demand Forecasting Model for Vancouver". Traffic Engineering and Control. Vol. 24. pp. 27-31.

Canadian Urban Transit Association. Unpublished data.

Cevero, R. 1982. "Transit Cross Subsidies". Transportation Quarterly. Vol. 36. pp. 377-389.

Fairhurst, M.H. and P.J. Morris. 1975. "Variations in the Demand for Bus and Rail Transport up to 1974". Economic Research Report R210, London Transport Executive, London.

Frankena, M.W. 1973. "Income Distributional Effects of Urban Transit Subsidies". Journal of Transport Economics and Policy. Vol. 7. pp. 215-230.

Frankena, M.W. 1978. "The Demand for Urban Bus Transit in Canada". Journal of Transport Economics and Policy. Vol. 12.

Frankena, M.W. 1979. "Urban Transportation Economics". Butterworths, Toronto.

Frankena, M.W. 1981. "The Effects of Alternative Urban Transit Subsidy Formulas". Journal of Public Economics. Vol. 15, pp. 337-349.

Gaudry, M. 1975. "An Aggregate Time Series Analysis of Urban Transit Demand: The Montreal Case". Transportation Research. Vol. 9. pp. 249-258.

Germane, G.E. 1974. "Subsidy Mechanisms - The U.S. Experience" in K.M. Ruppenthal ed. "Transportation Subsidies - Nature and Extent" Centre for Transportation Studies, UBC, Vancouver.

Glaister, S. and D. Lewis. 1975. "An Integrated Fares Policy for Transport in London". Journal of Transport Economics and Policy. Vol. 9. pp. 341-355.

Greater Vancouver Regional District 1983. "Land Use in Greater Vancouver" (Map), Vancouver.

Grey, A. 1975. "Urban Fares Policy". Saxon House, Farnborough.

Gwilliam, K. 1979. "Institutions and Objectives in Transport Policy". Journal of Transport Economics and Policy. Vol. 13, pp. 11-27.

Hazard, H. 1979. "Technocrates in Transition: The Changing Role of the Transportation Planner". Transportation Paper 5, University of Toronto/York University Joint Program in Transportation, Toronto.

Kirby, R.F. and R.G. McGillivray. 1976. "Alternative Subsidy Techniques for Urban Public Transportation". Transportation Research Record 589, Transportation Research Board, Washington B.C.

Kemp, M.A. 1973. "Some Evidence of Transit Demand Elasticities". Transportation. Vol. 2, pp. 25-52.

Kraft, G. and T.A. Domencich. 1972. "Free Transit" in M. Edel and J. Rothenberg eds. "Readings in Urban Economics". Collier-MacMillan, New York.

Lago, A.M., P. Mayworm and J.M. McEnroe 1981. "Transit Service Elasticities - Evidence form Demonstration and Demand Models". Journal of Transport Economics and Policy. Vol. 15. pp. 90-119.

Metro Transit Operating Co. Annual Budget 1980-81. Unpublished.

Lewis, D. 1977. "Estimating the Influence of Public Policy on Road Traffic Levels in Greater London". Journal of Transport Economics and Policy. Vol. 11. pp. 155-168.

Nash, G.A. 1978. "Management Objectives, Fares, and Service Levels in Bus Transport". Journal of Transport Economics and Policy. Vol. 12. pp. 70-85.

Nash, C.A. 1982. "Economics of Public Transport". Longman, New York.

Navin, F.D. 1981. "Urban Public Transit Subsidies in Canada". Canadian Transportation Research Forum. Charlottetown, P.E.I.

Pushkarev, B. and J.M. Zupan. 1977. "Public Transportation and Land Use Policy". Indiana University Press, Bloomington.

Pucher, J. 1982. "Effects of Subsidies on Transit Costs". Transportation Quarterly. Vol. 36. pp. 549-562.

Quarmby, D.A. 1973. "Effects of Alternative Fare Systems on Operational Efficiency: The British Experience". Symposium on Public Transport Fare Structure. Transport Road and Research Laboratory Supplementary Report 37UC, Crowthorne, UK