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**E C L A C**

**Economic Commission for Latin America and the Caribbean**

**THE TRANSPORT SYSTEMS OF  
LATIN AMERICAN CITIES:  
How they might better serve  
the needs of the poor**

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### **Explanatory notes**

A point (.) is used as a decimal separator.

A dash (-) between years –as in 1985-1986– indicates that both are included in the period.

The word “tons” means metric tons, and the word “dollars” refers to United States dollars, unless otherwise indicated.

The following conventions are used in tables:

- three dots (...) indicate that data are lacking or not separately reported;
- a dash (—) indicates that the quantity is less than one half of the least significant digit in the respective column

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## A. HOW DO THE URBAN POOR TRAVEL?

### 1. An Overview

In general, the urban poor of Latin America spend a great deal of time travelling, but they make few trips. Their usual mode of transportation is the bus, at least for trips to and from their place of work. In some cities, the middle class has a social aversion to using buses, so that the vast majority of all bus trips are effectively made by poorer people. Caracas is one such city, and Lima is another. The poor also spend a great deal of time walking. In certain corridors of a few cities, they may travel on low-cost, low-quality suburban trains. Their use of the metro (in those cities that have such systems) is limited, since this mode tends to cater to riders in a better economic situation. The bicycle is significant in only a few specific cases.

A survey conducted recently in a poor neighborhood to the east of Santiago, Chile, found that 75% or more of work trips are made by bus, 15% by bicycle and only 7% on foot.<sup>1</sup> Even so, long distances are often covered in walking to the boarding point, either to save paying an extra fare or because bus service is scarce. As detailed in table 1, between the late 1970s and the end of the 1980s, the proportion of the minimum family wage represented by 50 bus fares per month increased from approximately 3% to over 20%. This stimulated the use of walking instead of an access bus leg. The case of Santiago and other Chilean cities is extreme, but similar although less spectacular cases can be found in other Latin American cities.

Table 1

**SANTIAGO, 1977-1987: PERCENTAGE OF MINIMUM FAMILY INCOME REPRESENTED BY 50 BUS FARES PER MONTH**

Year	Percentage
1977	4.24
1978	2.93
1979	3.04
1980	4.12
1981	4.35
1982	6.26
1983	10.36
1984	15.20
1985	17.73
1986	21.82
1987	20.80

*Source:* ECLAC, based on data from the National Statistical Office of Chile, and Dirección General del Metro, *Metro de Santiago*, Santiago, 1986.

Because they have little money for travel, poorer families order their budgets by giving priority to the trip to work of the bread winner. Moreover, they sometimes spend 20% or more of their incomes on basic urban transportation and hence must ration their travel. Time savings must be traded for money savings, with the result that up to two hours or more can be spent in travelling between home and work in the larger cities such as São Paulo. The poor cannot afford to live in suburbs with good accessibility due to the prevailing high property values. Thus they congregate on the edges of cities, a long way from many of the places to which they might wish to travel. The relative inaccessibility of these locations not only increases the time the poor spend making each trip, but also tends to reduce the number of trips they make and limits their opportunities for social advancement.

## 2. Overall modal split

The meaning of the term "bus" varies from one city to another. Indeed, in many Latin American cities, the populace does not normally use the word, or reserves it for the interurban context. However, if a bus is defined as *a road-borne self-propelled vehicle for public transportation with a capacity of at least 20 seated passengers*, then this is the most-used form of transport in almost all Latin American cities with a population of more than approximately half a million.

Table 2 shows sample modal splits in capital and other principal cities. Note that, apart from extracting walk-mode trips in those cases where they were originally included, no attempt has been made to normalize the information in this table for the different cities.

There are exceptions to the "rule" that the bus is the primary mode of transportation used by the urban poor. They occur principally in a few individual cities with relatively high car ownership –the most notable being Brasilia– and in various cities in countries with high car ownership, such as Venezuela. In Caracas in the mid-1980s, buses accounted for only 18% of all trips made, while private cars performed 49% and *por puestos*, which were then mainly U.S.-style passenger vans, performed 29%, i.e., more than half as much again as the buses.

Low bus usage in Caracas is not due only to high car ownership, but also to a possibly unintentional tendency of the authorities to promote the supply of *por puestos* relative to buses. The situation in Caracas is now somewhat different, due to growth in the unit size of the typical *por puesto*, so that it is now included within our definition of a bus. Nonetheless, in other Venezuelan cities, notably Maracaibo, *por puestos* are still much smaller in terms of unit passenger-carrying capacity. The characteristic of public transport management in Caracas to favor the growth in the fleet size of smaller vehicles, as opposed to buses, is also reflected in some other cities such as La Paz, Bolivia, where it is possible that the smaller *trufibuses* have now displaced larger vehicles as the dominant mode.

In many cities, the bus is not just the most important mode, but also performs more than half the total number of trips made. For instance, in Santiago, Chile, towards the end of the 1980s, 65% of all mechanized trips were made by bus, in Santa Fe de Bogota 75%, in greater Buenos Aires 58%, and in Havana as much as 86%, which proportion has probably since increased even more. These figures are approximate, since definitions and dates vary. Nonetheless, it is obvious that even where comprehensive metro or suburban rail networks exist, the bus predominates.

Table 2

**MODAL SPLIT FOR TRIPS MADE BY MECHANIZED MEANS  
IN LATIN AMERICAN CITIES**

City	Year	PERCENT OF ALL TRIPS BY MECHANIZED MEANS USING:					
		Car	Individual taxi	Collective taxi	Bus	Rail	Others
Santa Fe de Bogota	1980	14	1	0	80	0	5
Santa Fe de Bogota	1988	8	2	2	82	0	6
Buenos Aires	1970	21	incl in Bus	0	62	13	4
Buenos Aires	1980	18	7	0	63	13	-
Buenos Aires	1986	28	incl in Bus	0	58	10	4
Brasilia	1988	47	4	0	49	0	0
Caracas	1975	53	...	23	24	0	-
Caracas	1978	47	...	23	23	0	7
Mexico	1972	11	...	3	76	10	-
Mexico	1983	19	...	8	44	29	-
Mexico	1989	14	...	21	46	19	-
Rio de Janeiro	1980	24	2	2	62	11	1
San Jose, Costa Rica	1980	29	5	-	63	-	3
San Jose, Costa Rica	1987	30	incl in Collect. taxi	11	62	-	3
Santiago, Chile	1980	16	1	2	76	5	-
Santiago, Chile	1988	18	incl in Collect. taxi	5	65	12	-
São Paulo	1980	32	3	-	54	10	1
São Paulo	1988	40	1	-	38	14	7
Tegucigalpa	1990	14	1	4	80	-	1

**Sources:** (i) City case studies conducted for ECLAC as part of the project on "The Impacts of Subsidies and Different Forms of Control and Organization of Urban Public Transport Systems in Latin America," (ii) national presentations in the First Seminar of the Central American Urban Transport Commission, Guatemala City, October 1991, and (iii) the following:

- Edgar Días A., *Experiencia en el subsidio del transporte remunerado de personas en la ciudad de San José de 1980 a 1987*, paper presented in the Second Latin American Meeting on Urban Transport, Mar del Plata, Argentina, November 1987;
- Celia Benchimol A., *Sistema de transporte público de Caracas: Integración metro-metrobús*, paper presented in the Second Latin American Meeting on Urban Transport, Mar del Plata, Argentina, November 1987;
- Carlos Román, *La liberalización del transporte urbano en Santiago de Chile*, paper presented in the First Latin American Meeting on Urban Transport, Brasilia, October 1985;
- Coordinación General de Transporte del Departamento del Distrito Federal de México, *Reestructuración del transporte público en la Ciudad de México*, paper presented in the First Latin American Meeting on Urban Transport, Brasilia, October 1985;
- *Urban transport: A World Bank policy study*, International Bank for Reconstruction and Development, Washington, D.C., 1986.

**Note:** The figures presented in this table should only be considered a general guide. The sources are heterogeneous, and are not always explicit or consistent about the definitions they use. It is unlikely, for instance, that the share of the metro in the number of trips made in Mexico City rose to 29% in 1983 and then fell back; much more probable is a change in definition regarding the way to count trips made by metro with a transfer between lines. In some cases, trips by chartered bus are include in "others," but elsewhere they are counted with "buses." In certain cities such as Mexico, the mean size of vehicles counted here as collective taxis has been growing to come within the definition of a bus.

In some other cities the bus dominates without reaching a 50% share, such as in the metropolitan area of Mexico City, where the bus share of all trips is estimated to have been approximately 46%, or in São Paulo, where buses carried 38% of all trips. Cities where the bus does not attain a 50% share tend to be larger and richer ones, with high car ownership and significant passenger-carrying rail networks. However, the bus share can also fail to reach 50% in smaller cities with less than half a million inhabitants where no serious attempt is made to impede the development of services offered by vehicles of lesser carrying capacity than the standard bus defined above.

The quality and quantity of information on urban transport in Latin America is directly related to the size of the city. This implies that comparatively little is known about transport patterns in smaller cities, but it is probable that in Chilean cities with populations of 50,000 to 200,000 people (such as Calama, Copiapo, Los Andes, or San Fernando), shared taxis carry more people than do buses.

Urban Latin Americans are not generally noted for their propensity to ride bicycles. Nonetheless, the use of this mode is important in a few smaller cities, principally in the south of Brazil. For example, in 1983, in the southern Brazilian town of Campo Bom, which then housed some 35,000 people, 33% of all trips were made on foot, 20% each by bus, bicycle and car, and the remaining 7% by unspecified means. In Cuba, the government reacted to the fuel crisis which hit the country in 1990, when the Soviet Union decided to cut back on its exports of subsidized petroleum, by withdrawing one third of urban bus services and importing large number of Chinese bicycles, which it sold to the public for approximately USD 100 each. The bicycle population of Havana increased from 70,000 in December 1990 to 450,000 ten months later. This may have resulted in an increase in the bicycle share of all trips made from approximately 2% to 15% or 20%. However, this experience has no parallel in other parts of the region.

### **3. Walking as a transport mode for the poor**

Walking is already an important mode for the poor, and it seems to be getting more so all the time. In São Paulo, a walking trip has been defined for survey purposes as one of any length made on foot for work or educational purposes, or one of at least 500 meters for other purposes. So defined, walking trips increased by 82% between 1977 and 1987, from 5.2 million to 9.5 million a day, while the Metropolitan Region's population increased by only 56%. In 1987, 36% of all trips in São Paulo were made on foot.

Definitions of what constitutes a walking trip vary between surveys and cities, although the most usual one is any trip of more than 500 meters (or five blocks) made on foot. Relatively recent survey data give as 9% the proportion of all trips made on foot in Santa Fe de Bogota, while in greater Buenos Aires the proportion is 6%. One can be reasonably certain that the vast majority of these walking trips are made by poorer citizens. Information on walking is often nonexistent or inexact, partly because a trip which involves a bus or train line-haul leg plus a long walk as access is often classified just by the former. Another reason for the relative ignorance on walking trips is that, for many years such trips did not interest transport planners and engineers very much.

### **4. Who travels by suburban train?**

Few Latin American cities have important suburban rail systems. Only in Buenos Aires, Rio de Janeiro, São Paulo and Valparaiso/Viña del Mar can they be termed significant, although rail services of some kind exist in and around Recife, Lima, Fortaleza, Santiago, Porto Alegre, and a few other cities. Where they do exist, they are often used mainly by the poorer classes. In Brazil, in São Paulo and even more

so in Rio de Janeiro, suburban rail fares are set low with the declared aim of helping the urban poor. This calls for large subsidies and reliance on nonpassenger revenue to finance investment, which is often not made to the degree required to avoid deterioration of service quality. This is a matter to which we shall return later — i.e., that fares set at less than cost can in the long run harm the very people they are intended to benefit in the first place.

Apart from cases such as the *Trensurb* system in Porto Alegre and *Metrobel* in Belo Horizonte, which are more akin to metros than traditional suburban rail systems, Latin American suburban rail networks have been in existence for upwards of 50 years, and occasionally more than 100. Some once catered to high-income people living away from the city itself, but the urban sprawl later expanded to encompass these locations. Competition from other modes —trams and buses in the cities, and buses and trucks on interurban hauls— hit railway finances hard. This set in motion a steady trend towards investment allocations to the suburban rail network that were inadequate to cover the needs of depreciation and modernization. In São Paulo and Rio de Janeiro, as well as on some of the Buenos Aires network, electrification took place, but even so, service degradation occurred. Lower service standards lost the railways their high-class clientele, and the relative income levels of their passengers dropped steadily.

## 5. Who travels by metro?

The same process affected, to a limited extent, the 80-year-old Buenos Aires Underground system, which also came to suffer from underinvestment. Many of its riders were, and still are, rail commuters who switch to it at mainline railway stations to continue their journeys into the city center. Therefore, to a certain degree it experienced the same change in the relative social status of its passengers as happened on the suburban railways. However, the change was less marked in the case of the Underground, which also caters to trips within central areas unconnected with railway stations, and to the relatively high-income people who work in the city center. In Rio de Janeiro, São Paulo and Santiago, Chile, the income level of the average metro passenger is probably quite high, as shown in table 3 for the case of São Paulo some years ago, when only the north-south line was operating.

Table 3

SÃO PAULO, 1977: ESTIMATED RELATIVE FAMILY INCOME  
OF USERS OF DIFFERENT TRANSPORT MODES  
(*Bus only = 100%*)

Mode	Relative income (%)
Bus only	100
Car only	181
Taxi only	165
Metro only	161
Suburban rail only	71
Bus + bus combination	90
Bus + metro combination	113
Bus + suburban rail combination	90

*Source:* ECLAC, based on data from the Empresa Metropolitana de Transportes Urbanos de São Paulo.

Cities build their first metro lines in corridors where traffic flows are highest, in part as a measure to alleviate congestion. The first line almost always leads from a suburb, sometimes one with relatively high car ownership, to the city center, where workers receive incomes higher than for the city as a whole. Therefore, it is to a certain extent inevitable that metros in cities with small networks cater to people whose mean income level is quite high. If the network continues to grow, as it has in Mexico City, the mean income level of metro users tends to fall as it reaches people in steadily lower income brackets.

In Latin America, where all but one of the networks are less than 50 km long, metros on the average cater to middle-class citizens, whereas suburban railways concentrate on lower income groups. Table 2 showed that the mean income level of those who benefit most from the metro, i.e., those who use it without having to change to or from another mode, have incomes more than 40% above those who do. Nonetheless, property owners probably gain more than anyone else from the building of metros.

## **6. Marginal transport in marginal zones**

In almost all Latin American cities, the bus route structure is highly regulated, and only concession holders are officially allowed to offer services. Where the regulation process is not dynamic enough to respond to the growing transport needs of the city, incentives exist for informal or unauthorized services to spring up. This happens especially in rapidly-developing outlying communities where lower-income families live, unless the enforcement of regulations is strict enough to prevent it. Such informal transportation, being not officially authorized, has no legal right to exist, which dissuades the operators from investing in order to improve the services they offer. Instead, they frequently rely on well-worn, unkempt, and badly maintained passenger-carrying vans. They charge fares that are not subject to official control and can be much higher than those for authorized bus services.

Informal services can also appear on routes which regular buses cannot serve for physical reasons, such as steep grades or sharp corners, or where their owners are unwilling to operate them because of inadequate security. In the hilly parts of Caracas, for instance, where routes to marginal suburbs are very steep and inadequately policed, service is provided by jeep-type vehicles with long chassis. On the routes they serve, they are the only form of public transportation available. No other vehicles have the adherence and power-to-weight ratio needed to climb the hills fully loaded. For security reasons, however, they do not operate after nightfall. In 1975, the latest year for which data are available, they performed 11% of trips made in the city.

Due to the very nature of informal services, information on them is lacking. Nonetheless, there is no doubt that the poor in the outlying districts of many Latin American cities depend on them. In so doing, they suffer the perverse consequences of public transportation policies that attempt to regulate services for the public benefit: they are left with no viable alternative to relying on expensive, unsafe, and unreliable services outside the scope of the regulations in force.

## **7. The trip-making propensity of low-income families**

Trip making is highly correlated with car ownership, which in turn is directly related to income. The Latin American poor do not own cars, and as a result, make comparatively few trips. The trip generation rate of the least well-off is also reduced by their not having enough money to buy more than a minimum number of regular bus fares. See table 4, which presents some illustrative trip generation rates for the

case of Salvador, Brazil. Although these rates are to some extent influenced by the unusual geography of the city, the same overall trend can be observed in other cities as well. In general, for lower levels of family income, fewer family members travel on any given day, each member who travels makes fewer trips, and the total distance covered by the sum of these trips is less.

Table 4

## SALVADOR, BRAZIL, 1975: FAMILY TRIP STATISTICS

Family income (cruzeiros/mo)	Persons/ family	Family members traveling/day (%)	Trips/day/ family	Km/family/ day
0 - 417	4.45	31	4.1	25.5
417 - 834	5.22	34	5.4	39.4
835 - 1 251	5.58	39	6.6	48.0
1 252 - 2 085	5.99	45	8.9	61.0
2 086 - 3 336	6.12	47	10.4	72.8
3 337 - 4 587	6.18	50	11.2	78.7
4 588 - 5 838	6.32	51	12.8	87.0
5 839 - 8 340	5.51	58	13.8	83.2
8 341 - 12 510	6.21	56	16.1	105.0
Over 12 510	6.48	59	18.6	114.4

*Source:* Economic Development Institute of the World Bank.

As already mentioned, in many parts of Latin America the poor tend to congregate in low-class housing on the periphery of cities, from which they have to travel relatively great distances to get to work places and other potential destinations. In spite of this, distance traveled per family is positively correlated with family income. Clearly, lower income families are to some extent trapped in their unfortunate predicament. They are unable to travel to inaccessible jobs which might pay higher wages than ones that can easily be reached, and they may find it very difficult to attend courses which might train them for better-paid occupations. They also have limited opportunities to take advantage of entertainment or recreational facilities that are provided publicly free of charge or at low cost, such as parks, museums and zoos.

## B. THE BASIC PROBLEMS AND HOW THEY MIGHT BE DEALT WITH

### 1. What are the basic problems?

The previous section discussed how the urban poor travel in Latin America. It also noted that they do not travel very much, due to limited accessibility arising from the relatively high cost and sometimes restricted supply of basic public transportation. But what are the basic causes of their plight? Leaving aside the fundamental problem that they have little money, there are other problems attributable to the transport system itself. These problems may be grouped into two categories, which might be termed *internal* and *external*. Internal problems are those directly caused by the way the transport system is planned and administered, and their solutions depend essentially on transport planners and administrators. External problems must be faced by transport planners and managers but are not essentially caused by them, at least not in the short run.

The following are internal problems:

- (i) Excessive control over fares, intended to reduce transport costs for low-income people, tends to discourage investment in the supply of transport services, which aggravates travel conditions for those same people. Moreover, it can have the perverse effect of increasing the fares the poor must pay, by reducing the availability of services subject to fare control and thereby contributing to the establishment of informal services not subject to fare control.
- (ii) Excessive regulation sometimes restricts the penetration of bus services into rapidly-expanding marginal communities on the outskirts of cities.
- (iii) Publicly-owned bus companies, many of which include among their specific objectives the provision of basic mass transportation for the poor, are often inefficiently managed. This manifests itself in various ways, such as low vehicle availability.
- (iv) Large proportions of capital and current public expenditures available for urban transportation are sometimes channeled into schemes such as metros and urban freeways that are of little benefit to the poor. Some public transport subsidy schemes are also wasteful, in that they provide help to people who do not need it, thereby reducing the amounts available to those who really do.
- (v) Some of the benefits from schemes to give priority to buses, such as bus-only lanes on streets, are usurped by bus operators rather than passed on to passengers. Bus companies have also been found to lie to fare-fixing authorities about costs and ridership, thereby transferring resources to themselves from passengers who are called upon to pay fares that are higher than necessary. Bus drivers and fare collectors are sometimes involved in fraudulent activities that lead to fares being higher than they should be.
- (vi) Traffic congestion reduces bus productivity and raises operating costs.
- (vii) The Latin American norm of city-wide route-specific flat fares has disadvantages for the lower income classes, because it dissuades bus operators from providing adequate services on longer routes with relatively high operating costs per passenger.

The following are external problems:

- (i) The Latin American urban poor often live in outlying communities where land values are low, but where accessibility is also low. To get to desirable destinations, they may have to make one or more transfers, each of which costs time and –what is even more important– money.
- (ii) Urban transportation is influenced by general economic policy decisions, which rarely take the interests of the transport sector adequately into account.
- (iii) Demand peaking reduces bus productivity and contributes to congestion. Demand peaking is to some extent caused by the concentration of particular social classes in specific geographical zones.

This list is not complete. Factors such as high fuel costs or city size and territorial extension could be added, but they are essentially outside the purview of transport system planners and administrators, and will not be dealt with here.

The rest of this section will deal in turn with each of the problems listed, and suggest possible ways to solve them.

## 2. Repressive fare control

If any market (be it for urban bus transportation, telephone services, water supply, or whatever) is controlled by regulations which confer semimonopolistic privileges upon operators, or if, in the absence of such regulations, operators engage in collusion, price control is necessary to guarantee that they cannot exploit the situation for their own benefit. Fare control is thus necessary under regulation and may be desirable even if supply is deregulated. In either case, the justification for fare control would be to make sure the market produces that combination of service quality and user cost which the population, via its elected representatives, prefer.

The history of Latin American urban transportation abounds with examples of fares that have been fixed, not using technical or economic criteria, but rather in an attempt to assist lower income groups or for political convenience. Helping the poor and political convenience can amount to the same thing, since the voice of the lower income groups weighs heavily in election results. In a bid for popularity, local or national governments often fix fares at levels so low they make it impossible for operators to cover long-run costs at reasonable occupancy factors. There is no such thing as a Latin America-wide fare level which permits the long-term stable growth of urban bus services. Nonetheless, it is obvious that city-wide flat fares as low as the USD 0.07 charged in Lima or the USD 0.05 charged in Quito during the late 1980s were insufficient to cover the long-run marginal costs of bus operators.

Fare setting must be taken out of the political arena. Technical formulae should be devised and applied by nonpolitical bodies. This is easy to say, but difficult –although not impossible– to do. It requires the establishment by law of independent tribunals, well-defined cost estimation formulae, and periodic surveys to count the number of passengers each bus carries.

If fares fall relative to bus operating costs, service quality will fall as well, unless operators' revenues are augmented by compensatory subsidies. The reverse is true if fares increase. If fares are low, operators can only cover costs by carrying a large number of passengers per bus, which implies overcrowded conditions and infrequent service. If fares are high and entry into the business is not blocked by excessive regulation, occupancy factors will tend to fall until each bus owner earns just normal profits. In cities where fares are fixed, the respective authorities should be made fully aware that fares and service

quality are directed related, so that they can choose from a continuum of different fare and quality standards. Where personal income levels are low and public funds are insufficient to finance subsidies, low fares and low service levels may be the preferred option. In high-class suburbs, people may prefer to pay high fares for premium service.

In certain cities in certain periods of time (Rio de Janeiro in the middle 1970s, Santiago in the 1970s, Buenos Aires and Santa Fe de Bogota in 1992), the authorities have fostered the provision of two or more types of bus transportation. One type is basic, cheap and of low quality, being aimed at lower income groups. Another offers higher quality service at considerably higher fares. This is an interesting and attractive policy option that reflects the need for Latin American cities, with their wide income distributions, to provide different qualities of service for differing demands. It should not be applied, however, without sufficient attention being given to the following considerations:

- (i) If an existing one-class bus service is split into parallel high quality/high fare and low quality/low fare services, the frequencies offered by each of the latter will necessarily be less than those of the former, if all other conditions are equal.
- (ii) If one type of service is more profitable than the other, investment will be channelled into whichever has better returns, possibly by diverting resources from the other type of service. Since the authorities would be under pressure to apply stricter fare controls to the basic low-quality service, this is the one that is normally liable to underinvestment.
- (iii) Experience has shown that operators of high-quality services, provided exclusively for seated passengers, give in to the temptation to carry standing passengers, while still charging the higher fare (until the authorities become aware what is going on).
- (iv) Creating two categories of services can aggravate congestion, albeit marginally, by lowering the average number of passengers per bus, and hence requiring more buses to carry a given number of people. However, this effect can be counterbalanced if the higher quality service succeeds in attracting passengers who would otherwise travel by automobile.

If sufficient attention is paid to these points, the creation of different qualities of service is well worth considering. It would be fair to state that by creating service differentiation, the middle class stands to gain more than the poor. The major benefit to the poor is that the government can direct any subsidies designed for their benefit directly at the basic service category, leaving the middle class to cover whatever costs are needed to finance the superior-quality service. In this way, the funds available for subsidies benefit only the people who need them, avoiding the waste of subsidizing others who have no such needs.

### 3. Excessive regulation

Latin American cities traditionally grow rapidly, and the fastest-growing parts are the outlying suburbs in which migration of low-income families from the countryside is concentrated. To legally serve these peripheral zones, bus operators have to obtain some kind of license, concession, or permit. The granting authorities are often encumbered by bureaucratic procedures that adversely affect their ability to efficiently authorize new services with the necessary rapidity. Moreover, from the operators' point of view, extending an existing route to serve recently-developed outlying marginal zones may not be commercially attractive. On the one hand, there is a significantly greater risk of vandalism to vehicles and theft of fare-box takings. On the other hand, due to the flat fares normally applied in Latin American cities, the entire amount of extra revenue needed to cover the costs of the increased route length must be earned by carrying a greater number of passengers. Nothing can be expected from higher unit fares. Consequently,

authorized bus services are often not provided, or at least not provided quickly enough or on the necessary scale. One of two situations can then result: (i) little or no authorized service is provided and the populace of the marginal zones has to walk to an existing terminal, or (ii) services provided by informal and technically illegal operators are set up to fill the demand. Having to walk is obviously undesirable. Having to use informal services is also undesirable, for the reasons previously explained. The solution to this problem is regulatory reform, necessarily comprising the first of the following elements and preferably the second as well.

**(a) Simplify the procedures necessary to obtain official authorization to establish or extend routes**

Ideally, no quantity restrictions of any kind should be applied to limit the capacity offered, but minimum quality controls on the technical condition of the vehicles and their drivers should be reinforced. Quality control should not be overdone. Vehicles must be safe, but there is little sense in requiring –for instance– that they conform to particular design norms developed for higher income environments, that they be newer than a specified maximum age limit, etc. By imposing such stringent conditions, costs are unnecessarily increased.

**(b) Encourage operators to serve outlying marginal zones without charging excessive fares**

Unfortunately, the practical measures to do this all involve the intervention of public authorities, and therefore conflict with the need to minimize the amount of regulation. Various alternative measures suggest themselves, all of which have disadvantages. Perhaps the least unattractive is a version of a procedure developed in the United Kingdom whereby local authorities are empowered to invite bids for the operation of socially necessary but commercially nonviable bus services. They are obliged to accept the bid of whichever operator requires the lowest subsidy, provided the conditions stipulated in the bidding documents are satisfied (which in the Latin American environment would include the fare to be charged). The major problem associated with this system is that a public body, quite probably lacking adequate resources for the purpose, would have to decide what zones need additional bus service, to where and at what times of the day or week.

Another option would be to apply a system similar to the *vale transporte* widely used in Brazil, whereby low-income wage earners receive vouchers from their employers for a minimum amount of urban bus transport. However, to be fully effective in low-income peripheral zones, the scheme would have to include the unemployed looking for work and people employed in the informal sector. This would convert an already administratively complex scheme into a bureaucratic nightmare.

#### **4. Publicly-owned bus companies**

Bus companies such as *EMTA* in La Paz, *Ruta-100* in Mexico City and *ENATRU* in Peru include among their basic objectives the provision of essential transportation for low income citizens. The main trouble with these companies is that they tend to be very inefficient, with high costs, excess staff, and low vehicle availability. See table 5. It is not impossible to run a publicly-owned bus company efficiently, but all the evidence suggests that doing so in Latin America is very difficult. It is equally difficult to avoid arriving at the conclusion that they should be liquidated, perhaps by transferring their assets to their employees in place of part or all of the latter's severance payments. This was successfully done in Buenos Aires some 30 years ago.

Table 5

LATIN AMERICA: BASIC OPERATING DATA FOR  
URBAN BUS COMPANIES, 1988-1989<sup>a</sup>

City/Company	Buses in fleet	Buses in oper- ation	Bus-km/ month	Passen- gers/month (millions)	Number of em- ployees	Percentage of drivers	Percentage of fare collectors	Percentage of maintenance workers	Mean model year
<b>São Paulo</b>									
• Private <sup>b</sup>	5 982	5 408	35 253 579	112.67	29 790	38	41	12	1983.6
• <u>CMTC</u>	3 519	2 829	16 700 000	47.58	24 351	34	33	5	1983.1
<b>La Paz</b>									
• EMTA	94	31	147 235	0.39	166	45	...	28	1984.0
• S. Bolívar	...	71	135 879	0.90	...	...	...	...	1977.8
• V. Victoria	...	145	329 502	1.94	...	...	...	...	<i>idem</i>
• P.D. Murillo	...	49	94 897	0.61	...	...	...	...	<i>idem</i>
• E. Avoroa	...	176	325 123	2.26	...	...	...	...	<i>idem</i>
• San Cristóbal	...	178	343 533	1.92	...	...	...	...	<i>idem</i>
• Litoral	...	210	717 037	3.21	...	...	...	...	<i>idem</i>
<b>Santiago</b>									
... <sup>c</sup>	131	83	627 561	1.19	284	92	0	...	...
... <sup>c</sup>	362	...	...	2.75	733	95	0	...	...
<b>Lima</b>									
• ENATRU	638 <sup>d</sup>	523	3 939 835	19.52	4 500	...	...	...	1981.2
• San Miguel	25	22	186 846	1.02	130	26	29	27	1960.2
• San Judas	24	20	168 000	1.01	127	34	45	...	1979.6
• Lima Metro.	150	130	1 040 000	2.99	746	...	47	26	1982.6
• SOTISA	63	61	366 000	1.23	217	35	57	— <sup>e</sup>	1970.9
<b>Havana</b>									
• Emp. Omn. Urb.	2 325	1 567	11 360 000	104.63	12 159	34	2	48 <sup>f</sup>	1985.4
<b>Brasilia</b>									
• ICB	354	...	1 998 214	3.63	1 430	40	25	14	1978.0
• Viplan	444	...	2 876 251	4.02	2 451 <sup>g</sup>	38	38	15	1985.3
• Pionera	539	...	3 247 845	5.71	2 560 <sup>g</sup>	42	42	10	1985.5
• Alvorada	201	...	1 432 270	3.57	1 228 <sup>g</sup>	38	38	15	1986.1
<b>Mexico</b>									
• Ruta-100	7 200	3 024	26 762 000	204.67	22 896	51	...	23	1983.0

Continues

Table 5, concluded

City/Company	Buses in fleet	Buses in operation	Bus-km/month	Passengers/month (millions)	Number of employees	Percentage of drivers	Percentage of fare collectors	Percentage of maintenance workers	Mean model year
<b>Bogota</b>									
• La Nacional	534	...	...	...	...	...	...	...	1975.9
• Copenal	365	...	2 059 498	7.10	...	...	Data not comparable	...	1973.0
• Sidauto <sup>h</sup>	1 036	...	2 512 148	6.71	...	...	Data not comparable	...	1975.4
• Sidauto <sup>i</sup>	259	...	735 884	1.57	...	...	Data not comparable	...	1982.4
• Cooptrans.	680	...	5 344 976	...	...	...	Data not comparable	...	1982.6
• Unión Com.	557	...	1 382 810	7.80	...	...	Data not comparable	...	1974.2
<b>Quito</b>									
• Alborada	26	23	65 156	0.38	52	88	...	...	1971.2
• Car-Tarq.	88	80	482 144	1.50	190	93	...	...	1983.9
• Sae Sur	25	19	134 400	0.40	47	85	...	...	1977.2
• Libertad	119	101	382 946	2.69	223	95	...	...	1973.0
• Municipal	9	7	34 960	0.32	65	46	5	15	1983.7
• Municipal <sup>k</sup>	70	54	459 000	1.80	350	50	...	...	1988.7
<b>Buenos Aires</b>									
• Nuevos Rumbos	82	...	482 565	2.40	236	75	...	11	1984.3
• San Vicente	229	226	1 954 747	3.91	616	81	...	9	1982.3
• Micro Omn. Norte	392	361	3 590 264	6.51	1 364	79	...	12	1984.1
• San Lorenzo	30	28	198 536	0.54	105	68	...	18	1981.0
• T.A. Plaza	47	43	262 882	1.17	144	76	...	9	1981.9

Source: Case studies performed for ECLAC.

<sup>a</sup> Bus companies whose names are underlined are publicly owned.

<sup>b</sup> City-wide data for all private-sector buses.

<sup>c</sup> Data not made available by the associations. Bus owners are responsible for maintenance, i.e., the associations do no employ maintenance workers

<sup>d</sup> Excludes 582 buses officially considered to be under repair, but in fact probably waiting to be scrapped or sold.

<sup>e</sup> Bus owners are responsible for maintenance.

<sup>f</sup> Data include employees assigned to repair work (as opposed to maintenance).

<sup>g</sup> Data refer, so far as possible, solely to regular bus services — i.e., they exclude charter operations, in which all four companies were heavily engaged in until 1990. For statistical purpose, the private companies Viplan, Pionera, and Alvorada apparently attribute to regular services personnel who actually perform charter services, as a means of pressing for higher fares.

<sup>h</sup> Data refer to regular-size buses.

<sup>i</sup> Data refer to smaller-size buses.

<sup>j</sup> Bus owners are responsible for maintenance.

<sup>k</sup> Data are for 1991.

The most efficient way to provide basic transportation for lower income groups is via competitive bidding along the lines suggested above. Services would be relet every so often, with no unfair preference being given to the incumbent operator. Normally, only legally constituted, bus-owning, companies would be allowed to submit bids, although it is feasible (although not necessarily desirable) to adopt tendering while doing nothing to change organizational structure of the traditional route associations which operate so much of Latin America's urban public transport. The people or companies which participate in the tendering process would make arrangements with individual bus owners to operate a route, should their bid be successful. In Santa Fe de Bogota, most bus transport is provided by companies which sign up different bus owners in order to operate the route for which the companies hold concessions.

## 5. The use of public funds available for urban transport

Both in Latin America and in other parts of the world, a great number of investment projects in urban transportation have been inadequately evaluated. As a result, projects not really viable in socioeconomic terms have occasionally been implemented. To some extent, this stems from the use of inadequate analytical tools. Another fundamental cause is political expediency, whereby governments find it easier to borrow money for large investment projects, leaving it to another government years later to worry about where to find the money to repay the loan, rather than adopt alternative measures which would improve the utilization of existing infrastructure. By doing the latter, some inconvenience is likely to be caused to politically influential sectors of the population, such as high income car commuters.

There are various reasons why urban transport investment projects of dubious worth sometimes come to be implemented, but space precludes us from explaining them in the present paper.<sup>2</sup> The end result might be, for instance, the construction of urban freeways which increase congestion by causing trips to be switched from off-peak to peak periods, or encourage extra travel, or transfer bottlenecks from one node to another, etc.. Metros are another case in point, because they consume vast amounts of resources to solve problems that can sometimes be solved much more economically by other means.

Metros seduced Latin American politicians in the 1960s and 1970s. They provided shiny new transport capacity of great benefit to the masses travelling along high-demand corridors, without disturbing those who wished to drive their cars on city streets. The Caracas metro, for example, was constructed at a cost of well over USD 100 million per kilometer, without serious attempts having been made to improve public transportation through less-expensive measures such as bus lanes, and certainly with no thought of liberating road space for buses and other public transport vehicles by imposing restrictions on car usage in central areas. The World Bank was instrumental in having an urban road pricing study carried out for Caracas at the beginning of the 1970s, but the Venezuelan government never attempted to implement the proposed measures.

There is no doubt that expensive investment projects are sometimes worthwhile. But there is also no doubt that it is normally worthwhile to first examine less expensive measures to alleviate problems and to maximize the productivity of existing infrastructure before resorting to investment projects. Among the policy options that are available but have not been taken advantage of in Latin American cities, either at all or to the required extent, are:

- strict controls over parking in city centers;
- charging the users of congested road space appropriate tolls for the scarce resource they consume;
- exclusive bus lanes, and;
- computerized area traffic management combined with parking control.

Such measures can often be shown to generate positive benefits for the community as a whole. They also benefit bus passengers in particular. Some of them, such as urban road pricing or taxes on parking, can even generate revenue which might be used for improving public transportation.

Quite apart from investments of dubious worth, vast sums have also been channeled into subsidizing the operation of urban transport, often in wasteful ways such as subsidies for inefficiently-run publicly owned bus companies (e.g. Mexico), subsidies which encourage inefficiency among private operators (e.g. Bogota), or travel subsidies for everybody, including many who do not require them (e.g. Guatemala).<sup>3</sup> Important economies can be made in terms of the volume of resources needed, without affecting the poor and needy, by modifying the basis on which subsidies are assigned. Examples of models used in the United Kingdom or in Brazil for this purpose have already been presented in section 3 above.

## **6. Resource transfers away from low income bus passengers**

When bus priority measures such as exclusive bus lanes are introduced, there are normally two categories of beneficiaries. Firstly, users benefit, since they reap time savings. Secondly, the bus operators benefit, since higher operating speeds translate into savings in terms of the number of vehicles and staff required. However, fare-setting mechanisms rarely include any provision to transform the higher profitability of bus operations into lower fares for users.

Bus operators do not have to wait until a bus priority scheme is introduced to lay claim to resources which rightfully belong to bus passengers. It is often suspected, and has sometimes been proven, that bus companies mislead fare-setting tribunals by overestimating bus operating costs or underestimating ridership. By so doing, they try to obtain unjustifiable fare increases. Any fare higher than necessary to attract sufficient capital to bus operation amounts to a transfer of money from bus passengers to the companies or individuals which provide the services. To a certain extent, the attempts of bus companies to mislead the fare-setting bodies stem from suspicions by the former that the latter distort their estimating procedures for political reasons, thereby making the resulting fare too low to cover costs.

The ideal would be to get fare setting out of the political arena and place it in the hands of competent technicians and economists. But this may not be possible, for someone has to select the preferred point on the spectrum between high service quality/high fares and low service quality/low fares, which has already mentioned in section 2. Although theoretically that point could be determined by maximizing a welfare function, this is more a transport economist's dream than a real-world possibility. In practice, the elected representatives of the people should decide. However, they should not do so without being adequately aware of the costs of providing bus service.

Another kind of fraud is that perpetrated by bus drivers and fare collectors, who often pocket some of the money they receive, rather than passing it on to their employers. There is little doubt that, in general, such fraud raises fares and hurts bus passengers in general. However, the situation is complex. Sometimes passengers consciously pay the appropriate fare directly to the driver (or conductor) without demanding a ticket in exchange, knowing perfectly well that the money goes straight into the driver's pocket. They justify this on the grounds that the driver is much poorer than the owner of the bus company, whom passengers suspect of committing the kind of fraud mentioned in the previous paragraph. At other times, an obviously destitute individual may ask to be allowed to ride for less than the official fare. The driver sometimes has compassion and lets the individual get on board, but cannot issue a ticket since the individual does not pay the full fare. Whatever the individual does pay thus goes straight into the driver's pocket. Such cases make it plain that not all fraud is harmful to the poorer classes. However, most of it certainly is, and the poor stand to gain if it is reduced.

Sophisticated electronic ticketing schemes, with entry and alighting controlled by turnstiles or similar equipment, can solve most of the problem. However, simpler and cheaper measures can also be very effective. One ingenious scheme, devised by the general manager of a publicly-owned bus company in Cochabamba, involves selling return tickets at a heavy discount relative to one-way fares. Upon boarding a bus in the morning, the passenger requests a cut-rate return ticket, in order to avoid having to buy another expensive single ticket in the evening. Private-sector bus operators in Chile sometimes launch what are essentially lotteries, with bus tickets as entry coupons, which have similar effects to the Cochabamba system in encouraging passengers to ensure that they receive tickets.

## 7. Traffic congestion

Most urban traffic congestion is caused by cars. Each bus has a greater disturbing influence on traffic than each car, but there are normally many more cars than buses in the traffic stream. This is not always true on certain city-center streets in some Latin American capitals. Buses are also capable of generating their own congestion and getting caught in it, especially if there are many of them and they are confined to specific lanes. Nonetheless, it can be shown that cars do the most harm. In a typical urban situation, each car occupant causes 15 times as much congestion as each bus passenger, who is the primary victim of the situation. A previous paper studied the effects of urban congestion on bus fares, and the extent to which fare reductions can be expected from measures introduced to restrict car traffic.<sup>4</sup> The probable amount by which fares will be reduced depends to a large extent on the characteristics of the particular case in question. One critical variable is the route length, since over longer distances, increases in bus speeds resulting from decreases in the volume of car traffic still will not enable many buses to make an extra peak-direction trip within the peak period. However, a four percent fare reduction is attainable in most situations, and up to six percent in some.

Exclusive bus lanes, streets reserved solely for buses, bus-activated traffic signals, and other bus priority measures can be effective in alleviating the problems that car-generated congestion causes for buses. Still, they do not solve the basic problem of congestion itself, which can be most efficiently dealt with through road pricing. Although there is no obligation to use revenues generated by such a measure to improve public transportation, this is normally proposed as a way to soften the blow to car users priced out of their automobiles. This use of revenues can be justified on grounds of economic efficiency, since by providing car users with a reasonable alternative, the price elasticity of demand for car travel is reduced in absolute terms, which in turn makes road pricing schemes more viable socioeconomically. Even if revenues are not so used, market mechanisms should result in some improvements to public transportation anyway, since providing an alternative to expensive car travel would become profitable. Evidently, if public transportation is improved, the poor stand to benefit. The direct beneficiaries of urban road pricing are bus passengers, together with some affluent commuters who continue to travel by car who value their trip-time saving more than the amount of the toll they are required to pay.

Other measures to reduce traffic congestion are less attractive from the standpoint of economic efficiency. Still, they are usually preferable to doing nothing, and they benefit the poor by enabling buses to move more freely. These measures include strict control of on-street parking in congested areas, general restrictions on both on- and off-street parking in zones to which cars travel over congested streets, and maybe even crude number-plate-based bans on car usage in city centers. Options which involve rationing through user charges are preferable to those based on physical restrictions, since pricing is an efficient rationing mechanism and the revenues generated can be used to improve public transportation.

## 8. Route-specific flat fares

If a flat bus fare is set for the city as a whole, operators will naturally prefer short routes with relatively high revenue to cost ratios. They will also favor routes with high passenger turnover. To some extent, the tendency to operate short routes can be countered by certain forms of regulation, such as assigning companies balanced packets of short and long routes, but the preference for concentrating resources on shorter routes would still exist. If  $n$  buses are required to operate two routes, one long and one short, and only  $n - 1$  are available, the operator will reduce frequencies on the longer route. The poor often tend to make disproportionate use of longer routes, where the fare paid per kilometer may be low, but where frequencies and general service quality are also likely to be low. Nevertheless, the scope for assigning one operator a packet of routes is limited within the context of individual bus ownership and route associations which prevails throughout much of Latin America, although this can be achieved via rotating buses among routes, as happens in La Paz or Quito.

Route-specific fare regimes are another possibility. However, they require passengers who switch from one line to another to pay again. The poorer classes are especially subject to multiple payments, by because they tend to live on the outskirts of cities, and not work in the center where most routes converge.

Workable solutions to the problem of flat fares are few in number, taking into account the often limited technical, financial, and administrative resources available to most municipal supervisory agencies. One which might work successfully in some of the region's cities involves bus tickets valid not per ride but per day. They would be sold wholesale to newspaper stand operators, companies maintaining ticket vending machines, long-distance telephone call centers, and similar points of sale, which would resell them to the public. A passenger would have to possess a valid ticket prior to boarding a bus. Preferably, the ticket would be magnetic or at least punch-coded. Upon boarding, the passenger would insert it into an inspection machine, in order to pass through a turnstile if it were verified as valid. Alternatively, the holder would show the ticket to the driver, who would check it. Revenues from wholesale ticket sales would be distributed among bus operators in proportion to daily mileage weighted by bus type.

The greatest difficulty with applying this system lies in determining real daily mileage per bus. In Curitiba and a few other Brazilian cities, revenues are pooled and then distributed according to bus-kilometers operated. But there, buses are run in a professional manner by a reduced number of genuine companies, and routes are planned, authorized, and inspected by a municipal agency. In the typical environment of route associations and inadequate route planning, efficient administration of such a system would be much more difficult.

## 9. Spatial distribution of the urban poor

As already mentioned, in many parts of Latin America, the urban poor tend to concentrate in peripheral zones, from which travel distances to desirable destinations such as reasonably well-paid jobs tend to be high. In the industrialized countries, the relatively affluent normally live furthest from the city center, while the poor congregate in decaying inner areas where environmental conditions may leave something to be desired, but accessibility is normally adequate. In our region, rings around the central areas of cities such as Bogota, Caracas, and Lima house some low-income families. However, such inner zones have insufficient space to accommodate large numbers of migrants from rural areas. For such housing to be provided, high-rise apartment blocks would have to be built, which the would-be residents are in no position to finance. Solutions to this problem involve long-term urban planning and renewal. All that

transport planners and administrators can do is alleviate its adverse effects on the poor by applying measures such as those suggested in section 3 above.

## **10. The subservience of urban transportation to general economic policy**

Urban transportation only receives attention from economic policy makers when a crisis demands immediate political action. In normal times, it is subject to the influence of –but has little influence on– overall economic policy. Transport ministers do not rank very high in the cabinet hierarchy. One example of this occurred in Chile in 1987, when a decree signed by the minister responsible for transport reintroduced an element of regulation to Santiago's bus transportation. This decree was overturned a few months later by another decree emanating from the Ministry of Finance, which referred specifically to urban bus transportation but which the minister for transport was not even required to sign. In Ecuador and Peru towards the end of the 1980s, bus fares were fixed at very low levels by government authorities. Operators could only hope to renew their fleets if they were allowed to import used buses or conceded low-cost financing to buy new ones, but these options were denied them by the ministries responsible for economic policy. In Jamaica in the 1980s, economic activities considered to be foreign-exchange earners –mainly tourism and certain agricultural and industrial sectors– were allowed access to low-cost credit and given other advantages that were denied to the urban public transport sector, which was considered to be a consumer rather than a generator of foreign exchange.

With the general adoption of neoliberal economic models, such practices are tending to disappear, yet there is no guarantee that neoliberal thinking will endure forever. Moreover, urban bus transportation is still sometimes discriminated against, with consequent regressive effects on income distribution. In many countries, imports of new buses continue to be strictly controlled to protect the domestic assembly industry, while used buses are excluded altogether.

## **11. Demand peaking**

Demand peaking is a feature of modern urban life. The productivity of a city depends to some extent on most people being at work during the same hours. But changing the working or school hours of some people can often yield net benefits in the form of reduced transport costs made possible by spreading out peak demand. A few cities such as Curitiba have attempted to introduce such changes, but resistance is often encountered from some sectors of the population when the way society functions conflicts with rescheduling. As an example, many Latin American fathers drop their children off at school on their way to the office. If either school or office hours were changed, families would have to find other means of transport for their children.

Nevertheless, scope for changing working hours exists. For instance, there is little sense in having stores in the city center open at more or less exactly the same hours as downtown offices, if their potential clients are the workers in those offices. In such cases, stores might be open from perhaps 11:00 until 21:00 hours, while office hours remained the usual 09:00 to 18:00 or 18:30 with a break for lunch. It might also make sense for some shops to open on Sundays, when the whole family is free to frequent them, and close on Monday. Banks might open half an hour earlier than factories and offices, so that employees could conduct their business before starting work.

From the point of view of the transportation system, the advantage of changing working hours is to reduce costs. Rescheduling automatically reduces congestion by spreading a given number of trips over a greater period of time. However, for rescheduling to have the maximum benefit for bus passengers, the following aspects should be borne in mind:

- (i) Even without alterations in bus speeds, peak spreading can reduce costs per passenger if the given number of trips can be performed by fewer vehicles, thereby permitting capital-cost savings and reductions in operating crews. Spreading is more likely to happen if routes are short and adjustments in working hours are significant.
- (ii) Most rescheduling schemes suppose that each type of activity will have its own working hours, which are different from those of other activities. Thus, construction work might start at 07:00, factories at 08:00, offices at 09:00, banks at 10:00, etc. To obtain any significant reduction in operating costs under such a scheme, buses must be allowed to switch between routes. For example, demand for a bus on a route to an industrial zone will be minimal once all the factory workers have clocked in. That vehicle should be permitted to transfer to a route serving the downtown area, so that it can carry a load of office workers.

It must therefore be concluded that the benefits to bus passengers of rescheduling working and school hours is greater if routes are short and regulation is not oppressive.

## C. THE INTERFACE BETWEEN THE ENVIRONMENTAL IMPACT OF URBAN TRANSPORT AND THE POOR IN LATIN AMERICA

### 1. Some problems usually overlooked

In a short paper such as this, it is impossible to do justice to the matter of the general environmental impact of urban transport in Latin America. Fortunately, this will no doubt be the subject of other studies motivated by the 1992 *World Environment Conference* in Rio de Janeiro. The treatment here will thus be limited to a brief review of some little-mentioned aspects of the overlap between poverty and the environment, within the overall context of urban transportation.

### 2. Environmentally innocuous energy sources for public transport

In certain Latin American capitals, notably Mexico City, Santiago, and São Paulo, diesel-powered buses are very important sources of air pollution, especially nitrogen oxides and inhalable particulate matter. In Santiago, Chile, for instance, diesel-powered vehicles in general are responsible for 71% of particulate matter in suspension.<sup>5</sup> The contribution made by buses and other diesel-powered vehicles to the amount of particulate matter in the air is often misunderstood and, consequently, underestimated. Particulates emitted by diesel motors are very small and correspondingly light. Because they are small, they are especially harmful to human health; because they are light, they remain suspended in the air much longer than heavier particles. Table 6 compares the participation of various sources in the generation of particulates with the contribution of each source to airborne particulate matter suspended at any given moment. Diesel-powered vehicles have a modest 19% share in the former, but a dominant 71% share in the latter. Means proposed for alleviating this problem include electrification of public transportation through constructing metros or light rail transit (LRT) lines, though these are also claimed to be further justified by having higher capacities than systems based on buses. Electrification without capacity increases can be achieved by installing trolleybuses networks. A further alternative to diesel propulsion involves the adoption of internal combustion motors which use liquified natural gas or other nonpolluting fuels.

Trolleybuses have essentially the same capacity as diesel buses, and are frequently thought of as being quieter and cheaper to operate, nonpolluting, and not dependant on nonrenewable sources of energy. However, the World Bank estimates that they actually cost 20% more,<sup>6</sup> and cost was the reason given for São Paulo's discontinuance of its trolleybus program. If a cost surcharge must be paid by users, the income effect will be regressive. Moreover, even though trolleybuses have no capacity advantage over diesel buses, the higher initial investment required by electrical substations and overhead wires means that trolleybuses are more likely to be operated on routes in higher-demand corridors. As demand starts to drop off towards the suburbs, the trolleybus route often ends. Passengers who wish to continue their journey must then purchase a new ticket in order to transfer, which is unfair to low-income families who live in outlying areas. If trolleybuses are operated, their extra costs should not be paid by the poor through fare-box revenues, but by the community as a whole.

Table 6

**SHARE OF DIFFERENT SOURCES IN THE GENERATION OF PARTICULATE MATTER  
IN THE AIR OF SANTIAGO, CHILE, VERSUS THE PROPORTION OF SUCH MATTER  
IN THE CITY'S AIR WHICH IS ATTRIBUTABLE TO EACH SOURCE**

Source	Share of generation of particulate matter (%)	Proportion of particulate matter in the air attributable to indicated source (%)
Housing	7	2
Industry	20	6
Gasoline-powered vehicles	5	6
Diesel-powered vehicles	19	71
Natural dust	49	15

*Source:* A. Cofré, *La locomoción colectiva en Santiago: Un enfoque de organización industrial y su participación en la contaminación atmosférica*, presented in the Fifth Latin American Congress on Urban and Public Transport, Santiago, Chile, November 1992.

One clear advantage of trolleybuses is that they do not pollute directly, since their motive power comes from electricity generated in a central power plant. Although this plant may be located far from the city where the effects cannot be seen, it will still produce some air pollution if it burns coal or petroleum. However, the amount is likely to be less than that produced by the equivalent number of diesel buses, whose emissions are more difficult to control than those of a large, static generator. Still, coal and petroleum are fossil fuels, and under those circumstances, it can hardly be said that the trolleybus does not depend on nonrenewable energy sources.

In many parts of Latin America, the prevailing source of electricity is water power, which does not produce air pollution. Nonetheless, hydroelectric plants do have serious environmental consequences. In Chile and elsewhere, planned hydroelectric projects are being threatened on environmental grounds. Furthermore, water is not always available when needed. Over the past few years, a number of Latin America countries—including Chile, Ecuador, and Peru—have suffered serious droughts that have affected their electric generating capacity. In Chile, this caused the curtailment of operating hours on the electrically-powered Santiago metro, as well as the use of diesel locomotives to pull long-distance trains over electrified tracks. Quito is considering installing a trolleybus system through the historical center of the city, but if this system had been operational in the early months of 1992, its use would probably have been confined to peak hours only in order to save electricity.

It would be unwise and probably incorrect to say that trolleybuses have an overall adverse environmental impact. However, it is true that they entail costs which must be weighted against their undoubted benefits. How does this affect the urban poor? They often live in areas of unpaved roads where the background level of particulate matter in the air is much higher than in the areas where the more well-to-do live, so that replacement of diesel buses by trolleybuses has a less-noticeable impact on the poor than on other groups.

Natural gas has also been proposed as an environmentally friendly fuel for buses in various Latin American cities. Natural gas is additionally attractive in countries such as Argentina, Brazil, or Chile, whose domestic reserves of this fuel are relatively more plentiful than those of petroleum. Yet to date, progress in converting to natural gas has been limited, and in—for example—Brazil, only one half of one percent of the nationwide fleet of urban buses was powered by this fuel in 1989.<sup>7</sup> Although engines powered by natural gas have significantly lower particulate emissions, specific fuel consumption is increased, especially in congested conditions. Depending on fuel-tax policy, higher consumption might

raise bus operating costs. Another problem is that the operating range permitted by the gas cylinders is normally only barely sufficient for a day's usage. Range can be extended by installing more cylinders, but this implies a penalty in terms of vehicle weight and passenger capacity. Further difficulties are the need to set up gas distribution systems, and the increasing scarcity on the market of high-cubic-capacity engines appropriate for burning gas. All this translates into extra costs that, as in the case of the trolleybus, the poor should not be called upon to finance.

### **3. Exposure of the poor to traffic-generated air pollution**

A feature of urban life in Latin America is the congregation of low-income informal workers at traffic intersections, where they sell newspapers, roses, oranges, windshield-wiper blades, chocolates, ice cream, balloons, and other items to drivers held up at stoplights or caught in the general congestion. Such locations are precisely where traffic-generated air pollution is most severe. Moreover, the delaying effect of a vendor trying to convince a housewife to buy a bag of oranges, of finding coins as change for a bill used to pay for a newspaper, or of children in the back seat trying to decide which flavor of ice cream they prefer has a substantial impact on intersection delays and hence air pollution. Vendors also pose an accident risk.

As far as is known, no study has been made in this area. Little action is normally taken against such vendors, and were it to be taken, the efficiency gains would be difficult to weigh against the losses suffered by the vendors. The same kind of exposure to air pollution also affects low-income workers in the formal sector, such as street cleaners, on-street car parking attendants, and kiosk operators.

### **4. Air pollution and income distribution**

Generally speaking, diesel-powered vehicles are the main causes of nitrogen oxide emissions, as well as of particles suspended in the air. Volatile organic compounds and carbon monoxide are attributable principally to gasoline motors, with taxis seeming to have higher pollution indexes than private cars.<sup>8</sup> This is probably due to taxis having inferior maintenance, higher mileage, and worn piston rings.

A pertinent question to ask is, who stands to benefit from measures taken to restrict vehicle-generated air pollution? When considering air-pollution controls, there is a tendency to speak of tons of pollutants, regardless of whether they are tons of carbon monoxide, nitrogen oxides, or whatever. Equal disregard is given to where the pollutants are discharged, whether there is a strong wind, etc. This is almost certainly senseless, but carrying on with the same convention, each person-km in Santiago, Chile, by private car produces 19 grams of carbon monoxide, nitrogen oxides, volatile compounds, and particulate matter. Each person-km by bus causes approximately 0.55 grams.<sup>9</sup> Were a tax applied to pollutants on a unit-weight basis, car travel would be much more affected than bus travel. The volume of car use would be reduced and modal split would shift in favor of the bus. This change would encourage service improvements of benefit to captive bus travelers, unless bus service is split into two types, a basic service and one of superior quality aimed at would-be car users.

If vehicles are not taxed on the basis of air pollution, car users force social costs upon the community to a much greater extent than do bus passengers, just as they do regarding traffic congestion. By not taking measures to control air pollution, governments discriminate against the poorer classes just as they do by being inactive regarding congestion.

## NOTES

<sup>1</sup>Jakeline Jaramillo, *La movilidad urbana en las estrategias de sobrevivencia de la población de menores recursos*, presented in the Fifth Latin American Congress on Urban and Public Transport, ECLAC, Santiago, Chile, November 1991.

<sup>2</sup>See, for instance, I. Thomson, "Los metros sudamericanos: Un análisis de su evaluación económica," in Institute for Urban Studies, *EURE*, Catholic University of Chile, August 1985.

<sup>3</sup>See ECLAC, *El efecto de los subsidios, la reglamentación y las diversas formas de propiedad en la calidad y eficacia operativa de los servicios del transporte urbano en América Latina*, (LC/L.675), Santiago, Chile, 16 March 1992.

<sup>4</sup>I. Thomson, "Urban transport in Latin America," in ECLAC, *CEPAL Review*, Santiago, Chile, August 1982.

<sup>5</sup>A. Cofré, *La locomoción colectiva en Santiago: Un enfoque de organización industrial y su participación en la contaminación atmosférica*, presented in the Fifth Latin American Congress on Urban and Public Transport, Santiago, Chile, November 1992.

<sup>6</sup>Alan Armstrong-Wright, *Urban Transit Systems*, World Bank Technical Paper No. 52, Washington, D.C., May 1986.

<sup>7</sup>R. Filho and W. de Almeida, *Uma análise comparativa da utilização dos ônibus a gas natural e a óleo diesel*, presented in the Fifth Latin American Congress on Urban and Public Transport, Santiago, Chile, November 1992.

<sup>8</sup>See I. Thomson, "Investigación sobre algunos aspectos de la influencia que ejerce el automóvil privado en la sociedad latinoamericana," in O. Sunkel and N. Gligo, ed., *Estilos de desarrollo y medio ambiente en la América Latina*, Fondo de Cultura Económica, Mexico, 1981.

<sup>9</sup>Using data taken from A. Cofré, *op.cit.*