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Managing Motorization

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MANAGING MOTORIZATION
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Abstract

The World Bank is now committed to helping its member countries prepare national *Comprehensive Development Frameworks* and municipal *City Development Strategies* to guide development efforts. These processes focus attention on issues that have broad impact on development. An issue of wide significance that raises many difficult dilemmas is that of Motorization – essentially, the spread of private motor vehicle ownership.

In the large majority of countries, motor vehicle drivers are paying for only small proportions of the costs that their activities, especially in cities, impose on others, notably through Accidents, Congestion and Pollution. The underpricing of transport, by omission of these externalities, combines with rigidities and distortions in land and housing markets to spread out cities more than would otherwise occur. This increases the need for arterial road construction and reduces opportunity for improvement of more central living areas that could gradually upgrade and grow vertically. Increasing proportions of the population are confronted with unacceptable alternatives: between very poor living conditions, at high cost, close to work, or journeys to work taking an hour-and-a-half, and more, each way – and often 20-30% of lower-income people's earnings.

From review of the experience to date around the world, this paper suggests six basic propositions whose exploration in city analyses and discussions should generate good guidance for public policies in these areas:

1. People's requirements for living and working space are so varied and so frequently changing that the only way to meet them efficiently is through open markets for land, housing and transport that convey as accurately as possible real costs (including externalities) in each.

2. As urban road space becomes congested, the best way to maximize the benefit it yields to society is to introduce time-varying charges for its use, and there are now proven techniques, of different degrees of sophistication, for doing this at reasonable cost.

3. These efficiency-inducing charges can generate rapidly rising revenues due to the difficulty of expanding road space in congested areas, and one high-priority use of that portion of the revenues that really represents rent for land used by road transport would be

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for public investment to help fill the backlog of inadequate infrastructure and services to deteriorated central areas.

4. Development, maintenance, updating and enforcement of a unique structure plan for a metropolitan area, using open participative processes and including all jurisdictions, are key to rational development of transport and the urban land market more generally.

5. Costs to society from road traffic accidents and pollution should be fully recovered from drivers, using combinations of targetted taxes, charges and fines that convey to them as closely as possible the marginal social costs of their activity and therefore provide common incentive to reduce such negative side-effects of transport.

6. Public transport services have a critical role to play in enabling cities to offer choices of living that can suit more people, and they should be fostered by encouraging more competition and innovation, and assigning them street-use privileges. Company financial subsidies should not be needed, with the possible exception of assistance for major new infrastructure, with grant of development rights for some contiguous lands then being the most promising formula.

MANAGING MOTORIZATION

I. INTRODUCTION

1. Governments apply a wide variety of policies affecting the spread of ownership and use of motor cars. Some are established mainly at the national level, such as import duties, engine emission and fuel efficiency standards, fuel taxes, home mortgage support and the priority assigned to investment in expansion of the road network. Others are often the responsibility of intermediate levels of government, such as driver licensing, vehicle insurance requirements and registration taxes, and maintenance of the regional road network. Yet others are mainly in the hands of local government, such as land-use zoning and controls, building-code requirements for provision of parking space, pedestrianization schemes and traffic calming measures, and support for public passenger services (priority in traffic, for example, in addition to frequent subsidization).

2. Despite this abundance of public policy instruments, the last few years have seen rising concern about dangers and problems that were foreseen twenty years ago and have now become much more real throughout the world, and especially in densely inhabited regions, whether in developing or developed countries. Around one million people die each year in road traffic accidents, many of them pedestrians. A stir was created in Europe in the middle 1990s by a publicized scientific finding that vehicular air pollution might be killing more people than accidents. In 1999, a trilateral Austrian-French-Swiss assessment of the health costs of traffic-related air pollution[1] concluded that premature mortality (in the long term as well as the short term) brought about by particulate emissions from vehicles in 1996 reached levels that are in fact equivalent to about twice these countries' current death rates from traffic accidents.

3. Downtown weekday traffic speeds now average 8 kph or less in cities as important as Seoul and Shanghai; 10 kph or less in Bangkok, Manila and Mexico; 15 kph or less in Jakarta, Kuala Lumpur, St. Petersburg and Tokyo; and only slightly higher in London and Sao Paolo. Of the sixteen developing-country cities of 4 million or more population which reported commuting time data to the UNCHS Global Urban Indicators Database established in 1998[2], five (Bucharest, Jakarta, Kinshasa, Lagos and Metro Manila) cited *average* journey-to-work time (one way) at more than one hour and a quarter, implying that a sizeable proportion of their citizens faced one-way journeys to work of around two hours. Surveys of Mexico City commuting have shown that 20% of workers spend more than three hours travelling to and from work each day, and 10% more than five hours.[3]

4. An important question for the coming years is how public policies can work more effectively to reduce the negative side effects of motor transport and improve its net contribution to socio-economic development, especially the reduction of poverty. Motorization – the spread of motor car ownership, essentially at the household level – is still at relatively early stages in the large majority of developing and transition economies, with less than 100 cars per thousand people in most and 100-200 in a few, compared with 400-500 in most Western European countries and

[1] Seethaler (2000).
[2] http://www.urbanobservatory.org
[3] quoted in Schwela & Zali (1999), p. 192.

Japan, and around 600 in U.S.A. Numbers are growing rapidly in many developing countries. Underlying demand is strong. But it is also not immutable, as demonstrated by trends in a wide variety of places: very limited fleet growth in densely populated island countries whose space limitations required strong public policies; much reduced use of cars for downtown trips in a number of cities around the world, especially in Europe; and indications of overall motorization rates topping out, possibly slightly receding, in a few European countries.

5. The purpose of this paper is to review the information currently available on the "externalities" of road transport (i.e., the costs road users impose on others, largely without compensation), and to propose the main elements of a conceptual framework for analyzing, assessing and improving policies affecting motorization. It does not deal with possible future fleet numbers, nor the amounts of investment that may be required for road construction, but rather with the framework of policies that will significantly influence those quantities, whether by adding restrictions on vehicles or, on the contrary, easing them as negative side effects are brought under control. The paper is intended to provide the basis for subsequent country- and city-specific discussions of potentials and policies.

6. Following this Introduction, the paper proceeds in six further sections. Section II, on the Scale of the Problem, presents and discusses a number of the comprehensive estimates of traffic externalities so far made for different countries and cities and reviews current motorization trends. The third section, on the Urban Spatial Context, presents a simple 'model' of cities' development over time and the role of transport, and identifies the main problems to which cars have given rise, on the one hand in richer (OECD) countries and on the other hand in the developing countries. Section IV discusses Potential Tools for Solution of the problems, including policies toward public transport. The fifth and longest section goes into more depth on each of the three main categories of externality – Congestion, Pollution and Accidents – reviewing how they may be measured, whether and what charges or regulatory interventions they should attract, and what use should be made of resultant revenues. Section VI, on Urban Land Use and Finances, deals with the management of motorization in support of cities' development and the actions needed from the city authorities. The seventh and last section draws overall Conclusions and recommends next steps in helping countries secure the best contribution from motorization to their overall development.

II. THE SCALE OF THE PROBLEM

7. The failure of drivers' costs to reflect the full social costs of their activity has been termed perhaps "one of the major mistakes of the twentieth century's adoption of automotive technology. It can be speculated that if costs were internalised from the early days of the automobile age , many of the problems encountered today could have been avoided."[4] Interest in more accurate charging for the costs involved in road use has also been increased by the advances in electronics that now make it possible for the first time to reflect time- and place-specific conditions in the charges levied. But pricing applications have not been the only purpose of efforts to quantify externalities. Since the time, about thirty years ago, that public concern about the negative side-effects of road transport began to emerge, attempts to put numbers on these effects have also been motivated by interest in establishing how important they

[4] Bovy & Salomon (1999)

really are, what might be the most important areas to address, and what allowances to make for them in analysis of potential government investments in transport.

8. A large amount of work has been done, but it is heavily concentrated in the OECD countries, especially North America and Western Europe. Only in the last five years have efforts begun to make comparable analyses for developing countries, with a path-breaking effort by Zegras and Litman for Santiago de Chile[5] four years ago still remaining the most thorough attempt at comprehensive assessment; all these efforts have been severely hampered by absence or poor quality of basic data. Even for the OECD countries, all authors would recognize the high degree of uncertainty about some of their economic valuations and lament the limited treatment they were able to give to such factors as water and wetlands pollution, and the disruption and severance of established communities. Nonetheless, analysts are now reasonably confident that they are capturing the most important effects not reflected in present pricing/taxing systems, and considerable progress has been made in understanding health effects of vehicle operation and the values consumers attach to them.

9. Studies done in the 1990s suggest that the externalities of road transport have been equivalent to as much as 5% of GDP in recent years in OECD countries (and possibly more), and that in some major developing-country cities they are at least as important and probably more so. Table 1.1 attempts to express the findings of some of the main studies done in OECD countries, and available estimates for developing countries and cities, in the common metric of percentages of GDP, national or, for cities, regional. Expression as a percentage of GDP should not be taken to imply that elimination of all the costs involved would add this amount to GDP; some of the costs (eg. pollution, pain and suffering) are not normally included in national income accounting. Nor should it be taken to mean that these amounts even could be fully eliminated or should necessarily be compensated by road users. It is intended rather to give a broadly meaningful indicator of relative orders of magnitude of different studies' findings as to costs imposed on the rest of society. Since the studies have generated – or assembled from others – monetary values for the different effects considered important in the local context, it is striking not only that the aggregate figures are of such very large proportions but that most of them tend to converge in regard to the aggregate net burden, as shown in column (xiv)[6]. A decade ago, such comprehensive assessments as had been done[7] yielded aggregates more in the region of 2-4%, reflecting especially the more limited understanding that then existed of the damaging effects of particulates on human health.

10. All the studies contribute usefully to an understanding of the costs that motor vehicles impose on others, whether road users or not, the principal interest of this report. But it should immediately be recognized that they differ significantly in conceptions, definitions and methods, and the rigor with which these are applied. Some are better described as studies to identify the full costs of the road transport sector as a whole; they generally disregard costs imposed on

[5] Zegras & Litman (1997), Zegras (1998).

[6] Results of the extremely thorough study of social costs of motor vehicle use in the U.S. that was undertaken in the middle 1990s by a team from the University of California at Davis headed by Mark Delucchi are not included in Table 1.1 because they are not readily available in the same breakdown. Available summaries - see Delucchi (1997) – suggest that the overall magnitude and distribution of the externalities found would resemble the USA2 line in Table 1.1 drawn from NRDC.

[7] A good review is provided in Bureau of Transport and Communications Economics and Environment Protection Authority (1994), *Victorian Transport Externalities Study*, vol. 1.

other road users but give full attention to costs to government (e.g., for road construction and maintenance). The Santiago study combines a 'full cost' methodology with partial coverage of costs within the sector, at the risk of a degree of double counting. Coverage for other developing countries is largely limited to Accidents, Congestion and Local Air Pollution, drawn sometimes from studies covering all three and, in other cases, assembled from independent analyses, as indicated in the notes to the table. The European studies give more emphasis than others to establishing Marginal Social Costs of driving. The more important methodological differences among the sources will be taken up in discussion of each of the main externalities in Section V below.

11. The figures given in Table 1.1 for the European Union have a special interest, not only because they summarize a huge amount of underlying work in many countries of the Union, but also because they result from an effort specifically to address the question of how much charges for road use would need to be adjusted to fully reflect externalities. The study is the product of a task force assembled from the various countries of the Union to advise on ways of actually implementing the commitment that the EU has already made in principle to internalize gradually all transport externalities. For this purpose, the group had not only to be cautious (to maintain consensus) but also to focus on establishing appropriate future prices – marginal social costs – reflecting changes in technology or behavior that would have occurred in the meantime. Comparison of the two EU lines in the table suggests that the group projected sharp interim improvements in vehicle emissions (the local air pollution column) and accident rates, and some increased efficiency in road network management.[8] With these improvements already underway (so that no further particular inducement was needed to bring them about), the task force reached the conclusion that full internalization could be achieved with an increase of only some 15-30% in the final price of transport services – some 15% for cars overall, but more in cities, and especially so at peak hours, and less in rural areas; and for trucks, some 18% in rural areas and 30% in urban areas. These increases, which were somewhat lower than what had previously been thought necessary to implement the principles adopted by the EU,[9] would reflect the many changes in taxation and charges for use of public infrastructure that would be necessary to reflect marginal costs.

12. Most of the country-level studies cited have been carried out at the national level, for road transport as a whole, and have given relatively little attention to the relative responsibility of freight, cars and other road services in the production of externalities; the same goes for the breakdown between rural and urban areas. Only broad estimates can therefore be given. In the OECD countries, the road freight sector probably generates some 20-30% of the externalities, reflecting notably the important contribution of heavy diesel engines to emissions of small particulates and also frequent failure of national tax systems to charge trucks adequately for the damage heavy axle-loads do to pavements. Bus services are generally small contributors, even in countries where they are numerous and widespread. Thus 70% or more of road transport externalities have resulted from the operation of cars and motorcycles. And of that amount,

[8] The task force took account broadly of congestion, and reflected the related pricing needs in its overall recommendations, but it did not go into depth on the subject nor estimate a 'total cost of congestion' since this was being handled at the time by another ECMT group. For the purposes of compiling Table 1.1 , we have therefore taken the figure for column (vi) from the report of that group, ECMT (1999), and retained it for both lines.

[9] See INFRAS (1999) and the work of the team that has been working over the last several years under Dr. Bruno De Borger of the University of Antwerp on model-testing, for Belgium, possible variants of EU pricing policies.

Table 1.1 Estimates of External Costs of Road Transport as % of national/regional GDP

Country/City	Year	Source	Road Costs	Land and Parking	Congestion	Accidents, net of insurance	Pollution				Subtotal	Revenue from road users	Net Subtotal	Others	Total
							Noise	Local air	GHG**a)**	Other					
(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)	(ix)	(x)	(xi)	(xii)	(xiii)	(xiv)	(xv)	(xvi)
USA1	1989	WRI	1.64**b)**	1.56	-	1.00	0.16	0.18	0.50	-	5.04	**b)**	5.04	0.46	5.5
USA2**c)**	1990	NRDC	1.25**b)**	0.43-1.74	0.19	1.71	0.05	2.09 - 3.83		0.07	5.69-8.84	**b)**	5.69-8.84	0.78-2.61	6.47-11.45
USA3	1991	Lee	1.76	2.41	-	0.24	0.19	0.73		0.26	5.59	0.88	4.71	0.87	5.58
EU1	Early '90s	ECMT	1.75	-	0.75	2.40	0.30	0.60	0.50	-	6.30	1.67	4.63	-	4.63
EU2	Early '00s	ECMT	1.49	-	0.75	1.20	0.30	0.15	0.47	-	4.36	1.67	2.69	-	2.69
UK	1993	CSERGE	0.24	-	3.03	0.46-1.49	0.41-0.49	3.12	0.02	-	7.28-8.39	2.60	4.68-5.79	-	4.68-5.79
Mexico City	1993	Ochoa		0.08	2.56	2.32**d)**		0.64			5.60		5.60		5.60
Poland	1995	ISD	1.14	-	0.30	1.60	0.10	0.30	-	-	3.44	2.81	0.63	-	0.63
Sao Paolo	1990	IBRD	-	-	2.43	1.11	-	1.55-3.18	-	-	-	-	5.09-6.72	-	5.09-6.72
Buenos Aires	1995	FIEL	0.73	-	3.42	0.5-2.00**e)**	-	0.97	-	-	5.62-7.12	1.01	4.61-6.11	-	4.61-6.11
Bangkok	1995	Misc.	-	-	1.00-6.00	2.33	-	2.56	-	-	5.89-10.89	-	5.89-10.89	-	5.89-10.89
Santiago	1994	Zegras	1.37	1.92	1.38	0.94	0.15	2.58	-	-	8.35	1.64	6.71	-	6.71
Dakar	1996	Tractebel	-	-	3.37	0.16-4.12	-	5.12	-	-	8.65-12.61	-	-	-	8.65-12.61

Sources: Author's calculations on the basis of:

USA1: Mackenzie, J.J., et al (1992)
USA2: Miller P. and J. Moffet (1993)
USA3: Lee, D.B. (1994)
EU1 & 2: European Conference of Ministers of Transport (1998)
UK: Maddison, D. et al (1996)
Mexico Metro Zone: Ochoa & Radian (1997)
Poland: Institute for Sustainable Development (1997)
Sao Paolo: World Bank (1994)
Buenos Aires: Fundacion de Investigaciones Economicas Latinoamericanos (1995), supplemented by current World Bank work on accidents
Bangkok: Lvovsky K. et al(1999); SweRoad (1997); Pendakur V.S.(1996) and Dowall, D.E. (1998)
Santiago: Zegras, C. (1998)
Dakar: SSATP (1999)

Footnotes:

a) GHG = Greenhouse Gases
b) Road costs given net of revenues from road users
c) Cars only
d) Gross of insurance compensation
e) Calculated on nationwide basis and gross of insurance compensation

around 66-75% occur in urban areas[10]. Thus, in the OECD countries, cars (and motorcycles) in towns account for some 50% or more of the total externalities imposed by road transport.

13. Compared with OECD countries, car ownership in developing and transition economies is usually more heavily concentrated in towns, and especially larger towns,[11] although it remains lower even there than in equivalent sized towns in the richer countries. The estimates assembled in Table 1.1 suggest that, even with their typically lower traffic levels, important developing-country cities may suffer road transport externalities of the same importance relative to GDP as OECD countries (though not necessarily OECD cities, for which separate estimates are not available). The different socio-economic structures may also make the consequences of unrecovered externalities more serious. Economic growth and efficiency in use of scarce resources are more urgently needed, to relieve widespread poverty, but are not well served by the underpricing of transport services that is implied by the existence of large externalities. The much more limited share of households owning vehicles means that the right to add to the externalities is more concentrated, in a situation where income and welfare inequalities need rather to be reduced. The tighter fiscal situation of the local governments means that the failure to discourage externalities, or recover their cost, has more serious effects on the general level of local public services that can be afforded.

14. That the problem of motorization in developing countries is mainly an urban problem is also suggested by examining the historical record of the last fifty years. Chart 1.1 relates motorization rates (measured as passenger cars/thousand population), on the y axis, to GNP per capita on a PPP basis, on the x axis. It shows the broad path traced since the 1950s by some of the countries which motorized most rapidly at that time, France, UK and Japan, and, more recently, Spain. Many other countries which have reached the stage where income levels permit wide motorization now fall at points within the broad track cut by those four countries. The principal countries which, in 1995, fell outside, or at the edges of, that track are mapped individually on the chart. Other than Argentina, Brazil and Mexico, almost all the countries with much higher motorization rates than attained by the Western European countries when their incomes were comparable are transition economies with a relatively strong inherited infrastructure and considerable income potential but, at the same time, difficulties – in some cases, great difficulties – in adjusting their economic structures to the new, market environment. On the other edge of the track already cut, with relatively low motorization for their income level, lie Thailand, Philippines, Chile and Korea, all home nonetheless to individual cities facing as great or greater motorization difficulties than the principal cities of Argentina, Brazil and Mexico. In many large Asian cities, rapid and wide spread of light motorcycles (not included in the chart) exacerbates the difficulties.

15. Thus current problems of motorization seem not generally to result from its occurring at lower per capita income levels, or more rapidly, than in the countries which coped with it reasonably satisfactorily in earlier years; it also grew very fast there for prolonged periods, especially in France (and Germany). The problems tend to be connected rather with the higher concentration of national population, economic activity and motorization itself in one or a very

[10] See estimates of Todd Litman for the United States 1994 quoted in Murphy and Delucchi (1998) and ECMT (1998) p. 32, allowing for ECMT's coverage of Congestion costs in the separate 1999 report.
[11] For example, some 75% of all Thailand's car registrations are in Bangkok, and 66% of the Philippines' in Metro Manila.

few major cities, at times when those cities are also increasing in size and population much more rapidly than was the case in Europe or Japan. Alleviating the problems of those very large cities is of great importance because they will remain key centers for their countries' economic development. But the types of solutions that they can find could also be of wider significance, to help larger numbers of cities, in their own countries and in other countries, achieve motorization in the coming years with less human sacrifice and stress than it has imposed in most large OECD cities.

III. THE URBAN SPATIAL CONTEXT

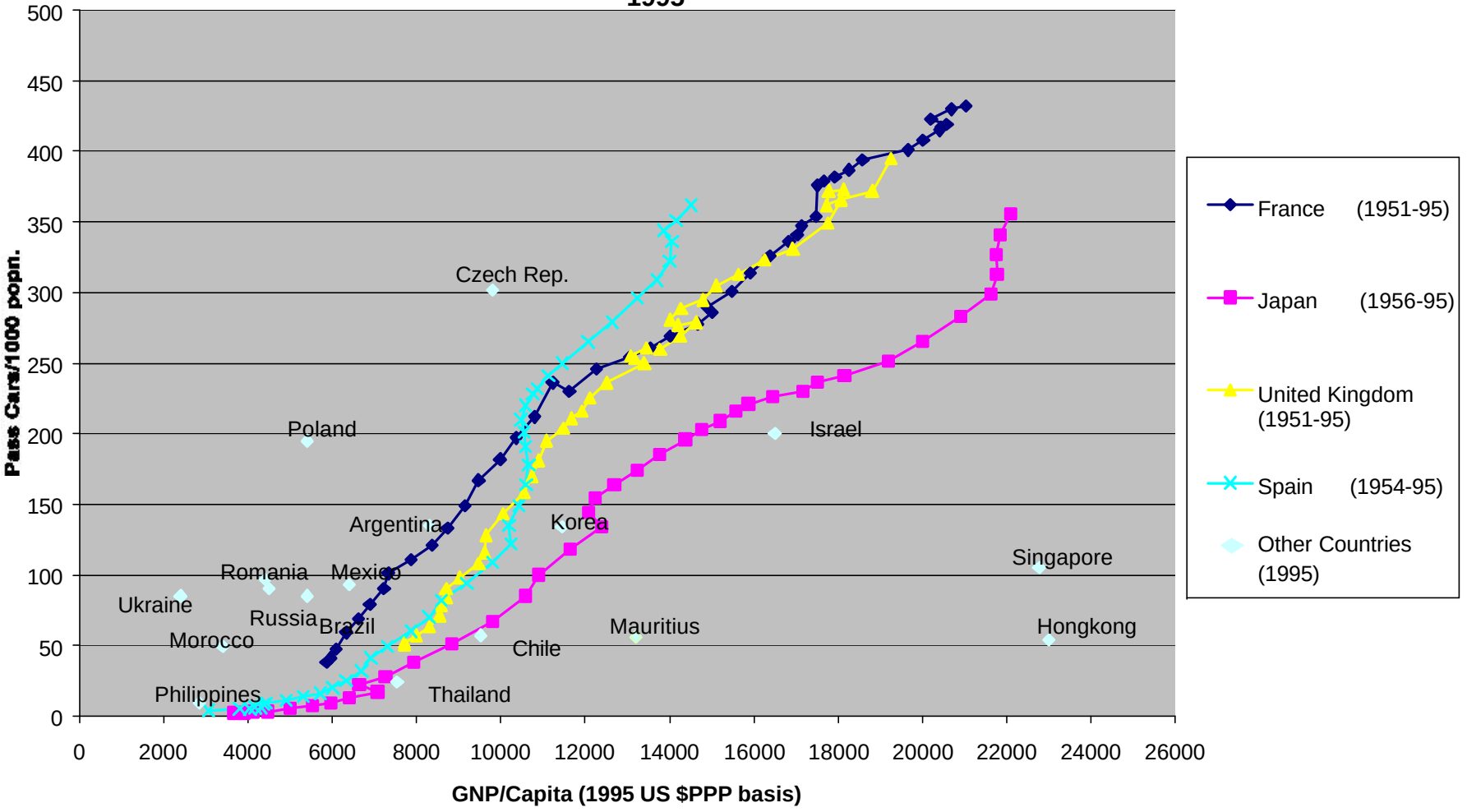
16. The process of motorization reflects the interaction of two major markets – that for transport or access and that for space, especially for living. Residential space and transport are by far the two largest land uses in most market-economy cities, and they are also the two largest items in household budgets – for instance, in the U.S. in 1997 on average, respectively 30% and 21% of total expenditure. Both markets are quite imperfect, as illustrated in Section II with respect to car users' coverage of the costs of their activity. These imperfections have been considered to justify extensive interventions of planning and regulatory nature. The relevant and appropriate objectives are clearly efficiency and equity, but assembling sufficient constituencies in support of specific expressions of these objectives, or particular means to reach them, is often a very difficult task. While the overall pace of motorization is governed mainly by income trends, the shape it takes and its effects on the city depend on practices and regulations often established with other main aims in view, rather than policies drawn up to induce the best contribution that motorization could make to a city's overall development.

17. The classical interpretation of city structure is in terms of land values and occupancy densities. These will tend to be highest at the point of greatest accessibility for the citizens, namely the center of the traditional monocentric city, and to decline steadily toward the periphery, where land value may be set rather by agricultural productivity. As population increases and incomes grow, expenditures on housing tend to increase from a minimum of 5% of household income (for a normal citywide minimum of about 5 square meters/person) to a maximum of some 30%, transport links are improved and more peripheral land is purchased for urban use. The predominant pattern, especially in the twentieth century, has been for the better-off to lead this process, thereby fulfilling their desire for larger and better living space while maintaining travel time (or, in some analyses, time and costs) to the city center (the site of employment) roughly constant. This has been possible thanks to use of improving transport technology that lowers the cost and/or increases the speed of movement.[12] But most cities, especially those with a well-maintained historical heart, will retain some high-income central areas, and in some these may be extensive enough that the central district continues to have the highest average incomes.[13]

[12] Ingram (1997). Vincent Fouchier, analyzing the results of a 1991 general travel survey for Paris and the Ile de France region, finds total daily travel (not only journey to work) increasing substantially in kilometers but declining slightly in time spent, the further the residence is from Paris, Parisians spending 89 minutes per day to travel 12 kilometers, while people in the outer areas of the overall conurbation spend 79 minutes to travel 30 kilometers. See Fouchier (1997).

[13] Brueckner, et al. (1999)

Chart 1.1
Motorization and Incomes: Growth of Cars vs Growth of Per Capita Incomes in France, Japan, Spain and United Kingdom (1950s - '95) and Relative Position of Selected other Countries in 1995



18. Dispersion of residences away from the center tends gradually to be followed by decentralization of employment, initially of direct services to the resettled population and then of manufacturing or back-office activities, seeking to take advantage of lower land values, easier availability of labor and possibly lower wage rates at the periphery. Over time, local concentrations of employment and commercial activity tend to emerge (or pre-existing small centers that were beyond the boundaries of the city get swallowed up in its expansion), and the polycentric city begins to take shape, with the corresponding more complex pattern of land-value and density gradients. Movement patterns become increasingly complicated, with declining significance of travel to the center, and many small flows arising among different suburban centers. Nonetheless a predominantly monocentric structure and pattern can normally be retained up to a total population of at least three million.

19. Large cities have remained dominant economic centers, even while secondary cities or smaller towns have been growing faster in terms of population in an increasing number of countries. The large, well established cities, whether monocentric or polycentric, offer unique advantages for easy face-to-face interaction among establishments such as company head offices, business and legal services, banks and financial institutions, upper levels of government, media, journalism and information services, etc.[14] Productivity and wage levels are typically significantly higher per person employed in these centers than in smaller towns. Some analysts have noted that prices in general, and rental-rates for office and residence space in particular, are correspondingly higher, and argued for government recovery of this windfall benefit from landlords by gradually increasing land tax rates.[15] Others have suggested that since some agglomeration economies are not internalized (they depend upon interaction of independent agents, as illustrated), the government should seek explicitly to increase the size of the local labor market and be ready to subsidize transport for this purpose.[16] Vickrey bridges these points, in arguing that, for a large city to remain dynamic, it must tax away the increase in land rents received by landowners and channel them into subsidies for public services that offer large scale-economies.[17]

20. In the OECD countries, the process of urban decentralization and suburbanization has been significantly accelerated by the artificial reduction of transport costs resulting from the failure to charge road users the marginal social cost of their activities.[18] Policies adopted for promoting home ownership have often worked in the same direction. Zoning arrangements sharply restricting mixed land use and requiring high minimum lot sizes have reinforced car dependence at the local level.

21. The overall urban settlement pattern that has resulted has well satisfied the large majority of its beneficiaries because enough was invested in public infrastructure to maintain a reasonable balance with the evolving preferences of residents and employment-providers. Housing standards have steadily improved. Residential space per person now averages 30/40 square meters or more in the major cities of OECD countries other than Japan (15 square meters in Tokyo). Travel surveys continue to show average journey-to-work time within a half-hour or so,

[14] Anas, Arnott & Small (1998)
[15] Hatta & Tabuchi (1995)
[16] For example, Prud'homme (1997)
[17] Vickrey (1977)
[18] Wheaton (1998), Lee (1999), p. 20.

with few exceptions such as Tokyo and London, and very little change over time for individual cities. Nonetheless recent years have seen the emergence of increasing concerns on several scores:

- Health impacts, from settlement patterns' discouragement of walking, the worrying recent findings about the serious effects of small particulates, and a rising concern, especially in Europe, about road transport noise interfering with daily life and especially with normal rest.[19]

- Fear – notably in England and the Netherlands, and spreading to an increasing number of densely populated areas in most OECD countries – that the battle against congestion, which has spread far beyond city centers to inter-suburban roads, is no longer winnable by road-building (in a system without pricing of road space) because capacity added is quickly absorbed by traffic demand previously suppressed by sheer lack of road space.

- Also a result of the underpricing of road space, but a byproduct of long efforts to keep up with the resultant demand: overinvestment in roads and parking facilities – and, particularly in the U.S., in mass transit systems – that are greatly underutilized, and, in some areas, related loss of historic buildings and precincts.[20]

- Difficulties for the poor, living in deteriorated areas or public housing projects in the central city, to access appropriate job opportunities now arising mostly in the suburbs, and the high share of family expenditures[21] - 25% and even up to 40% - that they have sometimes to devote to transport.

- Dependence on liquid fuels, and the difficulties in securing an adequate contribution from transport to the internationally agreed targets for reducing the risks of global warming, with its potentially dire consequences: worries alleviated by growing confidence that competitive alternative vehicle drives will be available at least by 2010 and could spread fast.

- Widespread perception (although efforts to generate really representative evidence have tended to yield conflicting results) that very dispersed settlement patterns often

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[19] On the noise problem, see Dora (1999) and Conseil National des Transports (1999) pp. 35-36. WHO estimated in 1995 that 65% of EU population was exposed regularly to sound levels of 55-65 dB that lead to serious annoyance, interference with speech, and sleep disturbance. In France the Serrou report found that 12% of the population are regularly exposed to more than 65 dB, and regular household surveys on living conditions have shown 56% of households in Paris complaining about noise.

[20] Douglass Lee, of the U.S. DOT Volpe Transportation Systems Center, comments, for example, with regard to U.S. experience: "A symptom of over investment in urban transportation is the cost per trip for the construction of many new facilities. Transit infrastructure costs of over $30 per passenger trip over the lifetime of the system, and highway projects that cost over $50 per vehicle trip of 3-4 miles suggest an overbuilt system. Users would not be willing to pay anything like these costs as prices, and justification in the form of external benefits would not be credible at even a much lower level of subsidy….. Removing the least-productive 75% of all highway mileage would affect (ie. cause a detour for) barely 13% of the traffic, yet this would reduce capital expenditures by over half. Most urban highways are not congested, and even congested ones are uncongested most of the time." See Lee (1999).

[21] For France and UK: Dupuy (1999), p. 55. For USA: Burwell (2000).

impose high public costs (e.g., for schools, utility services, and roads) which are not fully recovered from residents, and cause mobility-disenfranchisement of both those who cannot drive as well as those who are obliged to spend much time ferrying them.

22. Urban development patterns underway in the developing countries have also followed the broad lines identified in paras. 17-19, but with the key difference that virtually all the large cities have had, with very limited resources, simultaneously to cope with rapid influx of new migrants, on top of an already existing large housing backlog. Between 20 and 50% of their residents are housed in slums. In regard to travel, some are so poor that, as revealed by a recent survey of pavement dwellers in central Bombay, "… they were willing to live in congested dwellings without safety or security just so they could walk to work."[22] Much larger numbers have more permanent dwellings but are limited to walking for mobility because they cannot afford any transport fare. Results of a recent survey of travel habits in Dhaka, Bangladesh[23] suggest that the city's many female garment workers either spend some 15-20% of their US$30.00 monthly wage on acommodation in overcrowded central slums from which they can walk to work, or devote 25-30% of the wage (and considerable time) to travel from places elsewhere in the city, most of them at the periphery. More than 70% of the workers live in the central slums close to the garment factories, many seemingly reluctantly.

23. Another very important characteristic of major cities in the developing countries, especially in Asia, is that, in their central areas, not more than 12% of space[24] is devoted to transport (often less, in the range 5-8%), compared with the 20-25% common in European cities, and up to double those amounts in North American cities, say typically around 35%. Moreover, significant parts of that space is occupied by non-transport uses and by slow-moving non-motorized vehicles. Cities in the transition economies typically have transport space closer to the European levels and no slums, but a peculiar urban form – extensive central acreage still in the hands of declining or closed industrial enterprises, and high-density residential rings far from employment centers – resulting from past planning without regard for the costs of urban services.[25]

24. Most developing-country cities have not been able to maintain stable journey-to-work times, especially not for the majority of their population who remain dependent on public transport. The earlier cited UNCHS Database indicates that only 6 of the 16 developing-country cities of more than four million population that were covered have average journey-to-work times of less than 40 minutes. Fully reliable data on these matters are unfortunately very scarce because definitions differ and a tendency for survey respondents to exaggerate has been widely noted. But results are available in a few cases from well-designed surveys at different points in time. Surveys in Rio de Janeiro, for example, revealed a steady and substantial contraction over the years of the areas from which the city center could be reached by public transport within a given period of time.[26] The 1995 origin-destination survey showed average journeys to work in the metropolitan area of 83 minutes by bus and 50 minutes by car. Travel surveys of Shanghai indicate less than expected rise in overall average daily trip rate (including walking) from 1.79 in

[22] Survey conducted by Swayam Shikshan Prayog (SSP) quoted in Barter (1999) p. 147.
[23] Paul-Majumder & Shefali (1997)
[24] 11%, for example, in Bangkok and Calcutta; 12% in Singapore.
[25] Renaud and Bertaud (1997)
[26] Camara (1993)

1985 to 1.95 in 1995 and a small increase in average trip time from 33 minutes to 36, mainly reflecting increasing duration of public transport trips and increased use of bicycle for longer trips.[27]

25. In some cities, overall trip rates are actually declining, quite different from the experience in OECD countries and raising the threat of 'metropolitan disarticulation'[28] and loss of the urban and agglomeration economies which are a main advantage of large urban areas.[29] Although the broader economic implications remain unclear, significant drop in overall trip rates, gradually extending from the poor to the rich, appears to be clearly the case in Sao Paolo, one of the most highly motorized and best documented cities among developing countries. Table 3.1 summarizes main results from the systematic decennial origin-destination surveys undertaken.[30]

Table 3.1
Sao Paolo, Brazil: Average Trip Rates and Durations, 1967-97

	1967	1977	1987	1997
Metropolitan Area Population (mlns.)	7.1	10.3	14.2	16.8
Motorization (Cars/'000 popn.)	70	135	141	184
Trip Rates (trips/person/day)				
Motorized: Public transport	0.64	0.95	0.73	0.62
Private transport	0.37	0.58	0.58	0.61
Sub-Total	1.01	1.53	1.31	1.23
Walking	n.a.	0.51	0.75	0.64
Total	n.a	2.04	2.06	1.87
Total Daily Travel per Person (all modes)				
Kilometers	n.a	11.9	10.8	11.6
Minutes	n.a.	76	67	64
Motorized Trip Rates by Income Quartile				
Quartile 1	n.a.	0.92	0.66	0.64
Quartile 2	n.a.	1.25	0.97	0.95
Quartile 3	n.a.	1.56	1.35	1.29
Quartile 4	n.a.	2.08	2.07	1.90

The initial increase in overall trip-rates (1967-77) reflects mainly opening of the subway in this period, after central-city congestion had indeed become very serious during the 1960s. But since 1977, despite significant growth of incomes and large increases in the car fleet, overall trip rates have fallen and kilometers of travel per person have changed little. The big private investment in

[27] Ho (1999)
[28] McGee (1999)
[29] Vasconcellos (1999)
[30] CMSP (1999); Henry & Hubert (2000).

additional cars – seemingly in all income groups – must have added some speed and comfort to travel and no doubt increased flexibility, but has not brought the customary increase in general mobility. The experience seems to contrast with that of Mexico City, Latin America's other largest city, where available (but not very reliable) figures suggest an increase in the overall motorized trip rate from 1.15 in 1984 to 1.68 in 1994.[31] But it may parallel the experience of Metro Manila, where the figures from the recent Person-trip Survey seem to indicate a fall in average motorized trip rate from 2.00 in 1984 to 1.85 in 1996.

26. A principal question of interest is how trends of the type described above affect the poor: what is happening to their ability to access jobs and essential services ? Unfortunately there is little or no systematic empirical information available to permit a sound answer. Slowing public transport services, combined with the greater length of public transport journeys often undertaken by the poor,[32] would imply a more serious effect on the poor than the better off. Also, as Table 3.1 shows, by 1997 the motorized trip-rate of the lowest income quartile was only 70% of what it had been twenty years before and was lower relative to that of the rich than it had been then (34% now, 44% then). Thus there has been substantial relative deterioration of the situation for the poor, measured purely in terms of trip rates.

27. But these changes may reflect changing locations of housing and employment which are not only rational reactions to an evolving economic situation (large shift from manufacturing to service employment, greater use of telecommunications, heavily loaded transport infrastructure), but may possibly also provide some improvements in the combined space/access situation for many of the poor. Available figures clearly reflect the strong decentralization from downtown Sao Paolo that has been underway and show a significant improvement in the balance between jobs and housing in the metropolitan area's different sub-regions. The ratio of daily work-trips to jobs has fallen significantly. Also, between 1987 and 1997 average trip duration fell about 7% for the lowest income quartile, while rising about the same amount for the highest quartile. Sound assessment would require much more information than is available about trends in wage-rates in the different parts of the metropolis and in housing conditions, especially for the poor in the outer sub-regions that have been rapidly gaining population.

28. Thus, the questions meriting the most concern may be less ones of equity, more those of efficiency – and in particular two, one at the level of city structure, the other at the local, neighborhood level. As regards city structure, there is considerable evidence that imperfections in land and housing markets in the developing countries have tended to reinforce the excessive dispersion effect of underpriced transport and account for a significant part of the typically 5% p.a. increase in land area of major cities. These imperfections take different forms in different societies. One common one, visible for instance in China as well as several Latin American countries, is the tendency for migrants, and even new enterprises, to respond to cities' efforts to restrain growth by settling in neighboring jurisdictions, building within a few years settlements that are for all practical purposes part of the metropolis, but a bit more distant from the center

[31] Figures drawn from Cervero (1998) and Poole (1994). Ochoa (1999), estudio num. 1, p. 39, using a somewhat different definition of the metropolitan area, shows a more slowly increasing average daily trip rate, from 1.34 in 1976, to 1.51 in 1986, and 1.75 in 1996.

[32] Poole et al. (1994) p. 55 shows, for example, from the 1987 Sao Paolo survey that 51% of the public transport trips of the lowest income group took more than one hour, whereas this was the case for only 31% of the public transport trips of the richest group, and 41% of those of the next richest.

than they need to have been; such practices are often further encouraged by the surrounding jurisdictions themselves.

29. Another widespread problem is the setting of unrealistically low permitted Floor Area Ratios for extensive areas of the city, either automatically pushing new residential construction to the periphery or, if combined with effectively enforced green belt policies as in Seoul,[33] exerting strong upward pressure on the price of housing. A third factor, encountered in many countries but particularly important currently in some of the transition economies, is difficulty in releasing well-located but underutilized sites for redevelopment; underlying obstacles are of great variety: ineffective bankruptcy laws, absence of a normal land market (as in most of the Former Soviet Union), reluctance of municipal authorities to cede direct control, owners' hoarding traditions, bad titles and ownership disputes, environmental liability risks, and others.

30. The neighborhood-level problem is that, due to inadequate planning of local road networks and insufficient requirements on subdivision developers to provide for public space, or ineffective enforcement of these requirements, sections of main road come to be used for purely local trips, with serious effects on the capacity of the city's arterial road network. The efficiency of the trunk investments is compromised by the failure to provide adequate neighborhood networks of secondary and tertiary roads – which should be built at the expense of their direct beneficiaries. This has been an important contributor to the serious traffic problems of both Bangkok[34] and Mexico,[35] for example. Where street lay-out is suitable and main road capacity scarce, the reverse problem also arises, with the press of through traffic spilling over from the main road into parallel residential streets.

31. These inefficiencies, spreading the city out more rapidly than would be required with efficient operation of land and transport markets and increasing the amount of arterial road building required, do in turn have significant distributive effects. They further reduce the resources available for the badly needed extensions of local road and other infrastructure networks to slums, squatter settlements and legalized land invasions, and for assemblage of land and provision of basic infrastructure for new areas of settlement for the poor. Such investments, of great significance for reducing overcrowding and unhealthy living conditions in the areas affected, are nonetheless of interest only to the relatively small numbers of people directly affected by each scheme. Inevitably they take second place to works of interest to larger numbers of people and politically powerful groups. The slow progress of most developing country cities in making the contribution required of them for improvement of the living conditions of the poor is due in significant part to inefficiencies in the handling of motorization.

IV. POTENTIAL TOOLS FOR SOLUTION

32. The unsatisfactory side-effects of motorization result from a combination of underpricing of road use and excessive or ill-directed regulation of the urban land market. Such side-effects have been known for a long time, if less clearly and with less understanding of their magnitude than recent developments, and scientific study of them, have made possible. Were they easy to overcome, more action would already have been undertaken.

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[33] Dowall (1995)
[34] Dowall (1995), p. 8
[35] Cervero (1998), p. 388.

33. The principal obstacle is undoubtedly political, in the sense that almost any intervention to change existing arrangements will have distributive effects and likely negatively affect the perceived interests of certain groups. For quite understandable reasons, the family or individual car has enormous consumer appeal the world over, and the "car lobby" is correspondingly strong. Equally, very strong interests are involved in all issues connected with urban land development: "developer lobbies" and "home-owner lobbies" are also strong, if less unified. The most important practical criterion for judging the potential relevance of tools that could help solve the problems is therefore the likelihood that they could win wide enough understanding and support. For this, the significance of the particular problem addressed has to be clear, the remedy proposed has to be of convincing effectiveness, and the distribution of its effects tolerable. After more false starts than successes so far with the introduction of road pricing, for example, there are signs that constituencies are now gradually being built in some European countries, and professional consensus seems to be emerging that a key selling point, in the European conditions, will be to ensure that all net revenues would be used either for incremental improvement of the road network or, at the least, improvement of passenger transport more generally in the city affected – in either case, additional to what would otherwise have been done.[36]

34. Tools for solving motorization problems can be classified in different ways. The most useful classification for present purposes is into four groups: Regulatory, Planning (and Public Investment), Public Transport, Taxing and Pricing. The experience shows that measures are normally needed from all four categories to make a significant impact on the problem. The economic decision rule would be to pursue each of the selected measures up to the point where a resultant unit reduction in the problems has equal marginal social costs; this is relatively straightforward, for instance, in the case of air pollution problems.[37]

35. Simultaneous measures are usually needed not only from each of the four groups, but also to address both transport and space, or land-use, aspects. This is well illustrated by the interesting contrast that seems to have emerged over the last twenty years in the experience of three important Asian centers. Hong Kong has managed its transportation development efficiently and well, but has made much more limited progress in upgrading housing conditions;[38] partial indicators are the still low residential space per capita of less than 8 square meters, extensive overcrowded and deteriorating residential neighborhoods, and some transport difficulties for the poor from distant high-rise buildings in the new territories.[39] In Bangkok, quite efficient land and construction markets have helped improve the average level of accomodation (residential space per person is about 15 square meters), despite the huge population influx into the metropolitan area, but great weaknesses on the transport side have given rise to huge congestion problems and very long journeys to work for many.[40] Singapore, with per capita income much higher than Bangkok but about the same as that in Hong Kong, has achieved vast improvements in housing (residential space per capita averages about 20 square meters) and equally in transport, largely avoiding congestion and pollution problems. The issue at the microeconomic level was well put by the representative of the French government at a

[36] ECMT/OECD Workshop on Managing Car Use for Sustainable Urban Travel, Dublin December 1999.
[37] Eskeland & Deverajan (1996)
[38] Dimitriou and Cook (1998), especially Arnott (1998); and World Bank (1993), p. 26, making an interesting comparison with Athens.
[39] Lau (1997)
[40] Dowall (1995) and (1998), World Bank (1993)

recent conference on urban transport problems:[41] Might it not be preferable to divert some of the large funds now spent each year on subsidizing and extending the Paris transport network to assisting the purchase of central land for accomodating some of the less well off ?

36. **Regulatory measures** include all forms of physical restrictions and controls, and the policing systems to ensure their observance, such as exhaust emission standards and inspections, pedestrianization and traffic calming, speed limits, parking space required to be obtained before buying a car or to be included in a building's design, zoning restrictions and building codes, traffic management measures, and restrictions on vehicle purchase or access to particular roads or quarters of the town at particular times. Measures of these sorts have had clearly visible impact in reducing pollution and accidents significantly below the levels indicated by trends prior to their introduction. Their effectiveness stems from their rigidity, if honestly and effectively enforced, which also however makes them less suitable for situations demanding more variation (for different times or places) or more incentive to people to go beyond the standards laid down.

37. **Planning** may be of public investments or policies, or equally of the framework for private investments. Objects of planning may therefore be city hierarchies and overall population distribution, new towns and greenbelts, city conservation, national and regional road networks, ring roads, neighborhood networks for vehicles and for non-motorized transport, commercial establishments generating large quantities of traffic, or information systems to warn of congestion and enable better network utilization. Particularly important aspects are often coordination between different levels and departments of government, and communication to secure citizen participation in the planning process and to help build the consensus needed for new approaches. The contribution that planning has made to avoiding motorization problems is often considered weak and disappointing. It has frequently been hampered by conflicts between neighboring governments and by difficulties of maintaining commitment to plans through successive political administrations.

38. **Public transport** services, whether provided by public or private sectors, are clearly of immense importance to almost all efforts to improve the role of cars in development. They constitute the main alternative mode for the majority of passenger kilometers otherwise accomplished by car. Using figures from a variety of cities for which data of reasonable quality are available, Table 4.1 attempts to summarize the varied experience around the world regarding the role of public transport.

39. The table shows that, except in Shanghai (where cycling greatly increased its modal share in this period), public transport remains much more important in most major cities of developing and transition economies than in those of the OECD countries. In most, however, it has been losing share, and this is particularly true of mainline bus services, still the principal form of urban public transport, even in Moscow with its very extensive subway network. Such growth as there has been in public transport's role has tended to result mainly from the opening/expansion of rail subway services (notably, for example, in Hong Kong and Seoul, among the cities and time periods covered in the table) and from the rise of para-transit and taxi services (particularly in the cases of Manila and Mexico, among the cities in the table).

[41] Chantal Duchene, at above-mentioned ECMT/OECD Dublin Workshop.

Table 4.1
Evolution of Public Transport's Significance in Selected Cities

City	Earlier Year				Recent Year			
	Year	Popn. (mlns)	Pub. Trpt. trips/day	%of all trips	Year	Popn. (mlns.)	Pub. Trpt. trips/day	%of all trips
Hong Kong	1973	4.2	1.08	85	1992	5.6	1.65	89
Singapore					1999	3.9	1.28	71
Manila	1984	6.6	1.50	75	1996	9.6	1.45	78
Mexico	1984	17.0	0.92	80	1994	22.0	1.21	72
Moscow	1990	8.6	2.80	87	1997	8.6	2.80	83
Santiago	1977	4.1	0.95	70	1991	5.5	0.86	56
Sao Paolo	1977	10.3	0.95	46	1997	16.8	0.62	33
Seoul	1970	5.5		67	1992	11.0	1.51	61
Shanghai	1986	13.0	0.43	24	1995	15.6	0.29	15
Warsaw	1987	1.6	1.34	80	1998	1.6	1.20	53
Paris					1998	10.9	0.69	18

Note: Overall trip rates include motorized trips only, in the case of Hong Kong, Singapore, Manila and Mexico. For the other cities, they include also walking trips (variously locally defined). Public transport is defined, wherever possible, to include taxis and jitney services.

40. The relative decline of bus services is partly due to poor organizational frameworks for their provision, inadequate competition to promote new ways of responding to consumer demand, poor ticketing systems, and old-fashioned management and work rules. But underlying these problems are usually stronger forces directly connected with the rise of the car: inadequate privileging of buses, with their large passenger loads, in the use of scarce street space as private car traffic increases, and political reluctance to allow fares to rise in line with costs, especially when private transport and, in some cases, middle/upper-class housing too, are significantly subsidized. Consequent cash-flow shortages not only inhibit new service initiatives, but also often lead to inadequate equipment renewals and maintenance, gradual deterioration of service, and corresponding further loss of market share.

41. Analyses for OECD countries have suggested that operating subsidies of as much as 40-60% of total operating costs may be economically justified for major urban bus services, mainly to try to level the playing field with cars paying less than social marginal costs for their trips.[42] Such high numbers result above all from high marginal external costs of private motorized transport, and secondarily from a variety of other factors: low (though still of course positive) cross-price elasticity between private and public transport, existence of potential scale economies in public transport because of low existing frequencies, high value that public transport riders attach to waiting time, and a relatively low shadow price of public funds. The large majority of OECD countries, with the principal exception of Japan, do now subsidize urban public transport operations to the extent of some 40-70%.[43] Some in fact now give more emphasis to targetting public transport's share of the urban transport market (the last column in Table 4.1) than any particular financial performance.

[42] See notably De Borger and Swysen (1999), Else (1985) and Glaister (1984).
[43] Newman & Kenworthy (1999), p. 346 ff.

42. The high costs of these policies to overall economic efficiency have been brought out in a recent Belgian analysis,[44] which for the first time attempts to calculate, for a concrete case, how these costs compare with those of a pricing system (as now recommended by the European Union) in which each passenger or driver pays the marginal social costs of his or her trip. The analysis shows how the latter system would lead to major reallocations of passenger journeys to buses, and some to trains, at the morning and evening peak travel times, as well as postponement of some car trips to off-peak and abandonment of a few other existing trips. Overall welfare gain would be equivalent to several percentage points of regional GDP, of which only a tiny fraction can be gained by manipulations to the existing system of high implicit subsidies for cars and explicit subsidies for public transport. The analysis limited itself to the transport sector, but one may also question the land-use implications of the subsidies. Particularly since cross-price elasticity from private to public transport is so low, a larger impact of the public transport subsidies may often be to further stimulate spread and decentralization. If it is decided to subsidize highways and favor road transport, there is no clear economic rationale for introducing, in addition, distortions in public transport, inducing yet further overinvestment (for instance in fixed rail, as has occurred in several U.S. cities).

43. From the point of view of the developing and transition economies, there are additional problems with the high public-transport subsidy policies. They impose very heavy burdens on already inadequate city budgets – more than 30% of total city budget in many recent years in the case of Mexico city, for example, and payments by Moscow (for both investment and operating expenditures) equivalent to US$150 per year for each inhabitant of the city. They encourage inefficiently extensive spread of the city, more important than in the case of the OECD cities which have usually to accommodate much smaller numbers of new inhabitants each year. They also do little to cope with the problems of isolation that result for many from widely spread settlement patterns.

44. The measures that would thus do most to enable public transport to play its economically efficient role would be steady progress towards eliminating or internalizing the externalities of each mode. This would clarify public transport's market potentials and generate cash flow (from traffic transferring from increasingly costly private transport) to help respond to them. To help ease and accelerate this transition, particular attention should be paid to (a) improving the efficiency of public transport providers by generating a more competitive structure, (b) developing practical systems, such as already exist in some middle- and high-income countries, for equitable provision of assistance with travel costs to those who really need it (e.g., taking travel needs into account in calculation of general income supplements, or, in cases where social assistance management is not yet able to offer income support, purchasing and distributing subsidized passes or smart cards), and (c) prioritizing traffic management measures that recognize the higher value of a few minutes saved for a bus-load of peak passengers than for one or two occupants of the typical car.

45. If cities were to move in these directions, an important need could nonetheless still arise for major subsidy of transport systems that, due to lumpy technology, have initially to operate significantly below optimum scale. This might be a case of the type identified by Vickrey, as mentioned in para. 19, warranting subsidy out of the increasing land rents that property owners would be receiving as the city develops. In practical terms, it arises most particularly with Mass

[44] De Borger and Swysen (1999)

Rapid Transit (MRT) systems, with high capital costs and large scale economies. One way of partially implementing the Vickrey prescription is illustrated by Hong Kong. When its Mass Transit Railway Corporation was established in 1975 to build the railway, it was also endowed with access to land assembly powers and with property development rights. By 1995, 200,000m^2 of office space, 300,000m^2 of retail space, and more than 31,000 flats had been built over its stations and site depots by private development companies winning construction and lease contracts, which in turn had generated the substantial additional revenues needed to cross-subsidize railway operations.[45]

46. The principal danger of this approach is that the subsidy may be maintained beyond the stage at which major scale economies are being realized, and may lead to overoptimistic demand forecasts and excessive capacity provision, and/or the operational inefficiencies characteristic of most government-owned public transport undertakings. Some observers have been worried, for example, by Singapore's decision to increase the subsidy to the operator of its MRT system in 1996 when traffic was finally reaching originally projected first-year levels. The operating subsidy had always taken the principal form of relief from normal requirements to put aside money for depreciation and renewals of facilities. The 1996 change was to remove the company's need to provide for anything beyond historical cost depreciation of the rolling stock. Further change may perhaps be needed in coming years to prevent fares becoming unrealistically low as worldwide inflation continues, even at a slow pace. To avoid such problems with subsidies, many economists would recommend much caution in applying the "Vickrey subsidy", limiting it at most to an initial period of build-up in the scale of operations. They would counsel greater reliance on the Ramsey-Boiteux formulae for reconciling marginal cost pricing with financial equilibrium by application of two-part tariffs or other ways of raising greater revenues (in excess of marginal costs) from price-inelastic categories of demand.

47. **Taxing and pricing,** and fostering of the open market in which they can be most effective, constitute the fourth category of tools useful for helping to manage motorization. As with the other types of measures discussed, they apply equally to transport objects and to land, to vehicles but also to housing and commercial buildings. In connection with motorization, special interest attaches to taxes that can internalize externalities such as pollution, congestion and accidents, and costs not presently fully recovered from users such as those for parking, for neighborhood infrastructure in new sub-divisions, or for the above-average costs of utility connections to dispersed residences in newly settled areas. Taxes (and tax privileges) may be on acquisition, on ownership or on use; each will clearly have different incentive effects.

48. While houses and vehicles carry a variety of taxes in most countries, these taxes have seldom been designed to help manage motorization, although many developing countries did use high vehicle import taxes partly to discourage motorization. Now those high import duties have largely been abandoned in the interests of trade liberalization and domestic economic efficiency, and they were not replaced – a step now blamed in some cities for sharply accelerated rise of motorization in recent years. The broad idea has nonetheless been widespread that taxes should at least help to cover the costs of public infrastructure and services required to support an additional car or house. Taxes and tolls have been increasingly widely used to influence demand for parts of the service provided by a car: e.g. fuel taxes, partly to encourage energy saving; higher taxes on leaded fuel to encourage the shift to use of unleaded; and tolls and access

[45] Arnott (1998)

charges on individual roads (though these have usually been designed simply to generate revenues rather than to contribute to evening out demand).

V. THE MAIN EXTERNALITIES

Congestion

49. Congestion is the phenomenon with which everybody is familiar, especially in developing countries, when demand for a common service – whether the attentions of a doctor, access to a telephone or to the trunk system, or movement on a road or over a road network – rises toward or above capacity, and people have to wait for service. Few services are so inexpensive to provide that they can be made available in sufficient quantity to meet any foreseeable fluctuations in demand. The attempt instead is to provide for an optimum level of congestion, at which welfare gains from a marginal reduction in delays equal the marginal costs of making such reduction possible. Except at times of economic emergency, market economies have normally relied heavily on differential prices, in one form or another, to help in these scaling decisions. This has been particularly visible in recent times in the vast expansion of telecommunication services. More for reasons of tradition than anything else, roads have seldom been treated in the same way. Hence road congestion has mounted, especially in densely populated areas, and become a sensitive political issue in many countries.

50. While the common-sense meaning of road congestion is clear to all, there is no universally accepted way of measuring it, let alone of measuring its costs. This is clearly reflected in the particularly large variations among the externalities studies cited in Table 1.1 in the overall economic cost that they assign to congestion (column vi). Some, especially the earlier studies, from the U.S.A., largely exclude this item from their accounting, on the grounds that the costs of congestion may be external to the individual driver who joins heavy traffic and slightly slows all the other vehicles, but they are not external to the sector; the large majority of the costs involved are borne by other road users.[46] For present purposes, of trying to improve the impact of motorization on development, congestion is clearly a very important subject, perhaps in the medium run the most important externality insofar as it is much less susceptible than most others to reduction by technological advance.

51. Among the studies listed in Table 1.1, most of those dealing with individual cities in the developing countries cost congestion essentially by multiplying congested traffic volumes by the value of the extra journey time (and extra vehicle operating costs) that such traffic faces compared with free-flow or off-peak travel conditions. For the countries of the European Union as a whole, this was earlier estimated to amount to about 2% of GDP on average.[47] While this remains in many ways the most understandable measure of the costs of congestion, it also usually gives an exaggerated picture because, as pointed out above, no country could afford to provide free-flow traffic conditions to all traffics at all times – nor should it, from the point of view of economic efficiency. Thus, the figure included in Table 1.1 for the EU, 0.75% of GDP,

[46] Focussing his calculation of externalities specifically on the relationship between the highway system and the rest of the economy (including fiscal flows), Douglass Lee explicitly excludes all costs which represent transfers among users – not only those of congestion, but also the portion of accident risk and pollution damage that is suffered by other highway users – emphasizing that these should be dealt with by efficient pricing and operation within the system. See Lee (1997).

[47] European Commission (1995)

is the European experts' assessment of the "deadweight loss" presently borne by the member countries as a result of failure to reduce congestion to optimum levels, or, expressing it another way, the net economic gain achievable with an effective road pricing system. This figure would of course be higher for the areas well known to be suffering from the most severe congestion – such as UK, Netherlands, Belgium, parts of Germany and Athens – but not nearly as much higher as might be assumed from inspection of Table 1.1's figure for UK, which follows yet another definition (see Annex 1 for further clarification of these concepts).

52. Properly applied, these concepts of congestion should satisfactorily capture not only the delays experienced by the existing traffic on a road but also the effects borne by traffic that has been diverted or suppressed as a result of the poor traffic conditions. All should be reflected in the demand curve. On the other hand, it must be admitted that, if congestion is allowed to accumulate largely unresolved over a wide area, there can be 'network' effects of broader economic significance: general unreliability and uncertainty of travel times, so that people have to plan their schedules to allow for the possibility of long travel delays, face-to-face meetings are hard to organize efficiently, and more slack has to be provided in Just-in-Time delivery and production schedules.[48] To help avoid deterioration of this sort, the Dutch have developed procedures for systematic reporting of all traffic build-ups more than 2 kilometers in length that develop, and they have established targets, based on economic reasoning, regarding the maximum acceptable proportion of motorists running into such hold-ups on roads of different classes: for example, about 2% on the trunk road network, meaning, given typical peak-period traffic concentrations, that a person who regularly drives at the peak should not meet such a traffic hold-up more than once every two weeks.[49]

53. Disappointed by past experiences of road improvements quickly swamped by traffic growth, most city highway departments are being much more selective in applying to congestion the traditional response of simply adding road capacity, in many cases probably too cautious given that demand remains largely unpriced and grows commensurately. Greater attention is given first to the search for all possible network alternatives, such as traffic management improvements and facilitating better balance of traffic over different routes. New road additions or expansions have also to be scrutinized very carefully from the viewpoint of environmental and social impact. More attention is being given to efforts to coordinate land use (especially location of major traffic generators, such as shopping centers) with transport facilities and plans.

54. Some of the most thorough and successful efforts to avoid the build-up of congestion have been by relatively wealthy, smaller European cities, combining extensive physical limitations on downtown movement of cars with aggressive support for public transport and non-motorized transport alternatives. Downtown car use has thus effectively been made more expensive and less convenient than in other cities, mostly by physical restrictions, and the alternatives have been subsidized, both directly and also indirectly by assigning them strong street privileges.

[48] ECMT (1999), pp. 128 and 224.
[49] Bovy & Salomon (1999), pp. 130-31.

55. A leading example is Zurich[50] where popular referenda in the 1960s and 1970s firmly rejected major development of subways that had been proposed to improve public transport while leaving more of the surface for cars. Emphasis went instead to extensive upgrading of the old tram system, to maintain the traditional urban texture, height and form, and gradual extension of high-quality and frequent public transport for the wide region around the city, with stops convenient to all residential neighborhoods. Trams, buses and bicycles are heavily privileged on the streets and through the traffic light system, such that buses seldom have to wait for green and usually manage to achieve similar downtown travel times at the peak as off peak. Cars are clearly in second place on main city streets, restricted by exclusive lanes for public transport and by widespread turning restrictions. They are limited by traffic calming measures, street furniture and 30 kph speed limits in residential areas. Car parking space in the city center has been substantially reduced and prices increased, while public transport tickets have been heavily subsidized – and made more convenient for intermodal journeys, and for use in combination with non-transport services.

56. The public transport trip rate now averages 1.5/day, equally for the whole Zurich conurbation (1.2 million inhabitants) as for Greater Zurich (some 600,000 population). Work trips to central Zurich are more than 50% by public transport from outer areas, and 75% by public transport for residents of the city itself (some 330,000 population). Despite a car ownership level of 380/1,000 population, city residents make more than 60% of all their motorized trips by public transport. Car sharing has developed strongly with the aid of new techniques for assuring ready access by smart card, and had 20,000 subscribers by mid-1998. Congestion – except in the form of the planned slow movement of cars in the center – is quite limited.

57. The wide spread and low prices of public transport have clearly extended Zurich's region of influence and supported its development as a significant center of banking and business. Land values at the city center are some of the highest in the world, more than $150,000 per square meter. Unfortunately, review of the overall financial and economic costs and benefits of its transport and settlement pattern does not appear to have yet been undertaken. Developing and transition country cities interested in considering this type of model would also need to know much more about the large budgetary costs involved and how they have been financed.

58. The alternative approach to alleviating the congestion problem is to recognize that use of streets at times of congestion indeed costs society much more than their use at other times and to find ways of reflecting those higher costs to potential travellers, leaving the choice to them as to how to react. Like the Zurich model, it requires significant change in travel habits but, also as in Zurich, these can be brought about gradually over the years. It does involve noticeable increases in the cost of peak-period travel (some 100-150% of present user costs for a car-kilometer at the peak, according to two recent calculations[51]), but part of those increases can be returned to drivers through simultaneous reduction of other existing car taxes (fuel and registration). It is highly likely that the net costs to the road users will be less than the amount that has to be raised under the Zurich model from other revenue sources such as property and income tax. The fact

[50] See, for example, Cervero (1998) and FitzRoy & Smith (1993). Bratzel (1999) makes interesting comparisons with other European cities that have applied similar policies, and reviews the political processes that brought them about.

[51] Santos (2000) and personal communication from Gabriel Roth.

that this approach to greater efficiency of road use requires early selective increases in revenues from road users tends in fact to make it more feasible for the typically cash-strapped municipality in a developing/transition economy. It is also more apposite to their frequently greater shortage of street space relative to built area. Moreover, the political obstacles should be less insuperable than in more highly motorized societies since the proportion of the population who would be called upon for increased charges would be a minority, due to much lower car ownership, and, as high income earners, they have the most to gain from reduced gridlock and journey unpredictability.

59. Indications are, however, that a gradually increasing number of OECD cities will slowly find ways of overcoming the more serious political obstacles that they face to introduction of fairer charging systems for use of road space. Different societies attach different weights to the reasons for slowing the expansion of urban road networks – some stress sheer shortage of space, others local environmental concerns, others financial constraints, others conservation of historical monuments and settlement patterns, yet others global warming worries[52]. But the conclusion is the same, so that the effective limit to traffic will increasingly be congestion, and road users will demand a more efficient system for rationing road space and ensuring its availability when they really do need to make a rush trip.

60. The appropriate levels of congestion charge are determined entirely by the elasticity of demand and by short-run costs (Annex 1 elaborates). However, the decision by the road authority (whether a public authority seeking to maximize social welfare or a private entity working in competition with providers of potential substitute roads) as to whether and when to invest in expansion of the road must depend on the relationship between congestion-charge revenues and the costs of the expansion.[53] The revenues must cover all fixed charges, mainly non-use-related maintenance (generally assumed to be sufficient to preserve the road in perpetuity, so that no separate provision is needed for depreciation), rent of the land used, interest on the capital invested, and fixed charges of administration. Investment in expansion will become worthwhile when the projected congestion revenues, discounted in the normal manner, equal the time-discounted costs of the investment and non-use-related annual expenditures for its maintenance and operation. The relevant notion of rent for the land required for the expansion would be that which could be earned in the highest alternative use – i.e., a rate established by the market for adjoining land in commercial and residential use.[54] Since this rate is normally rising over time, as a result of agglomeration and urban economies attracting new businesses to the area, as explained in para.19, its projected level will have a significant bearing upon when the capacity expansion becomes justified. Thus it will also determine the level that traffic and corresponding congestion charges reach before the expansion investment is initiated.

61. Beyond these cases, allowing for the diseconomies of scale and long-run rising costs characteristic of the urban environment, it should also be expected that there will be an increasing number of instances where society simply rules out any additional road construction along a given route or even over a whole quarter of a city. In that case the pricing task is dominated by demand and the result determined entirely by willingness to pay.

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[52] See, for example, ECMT (1999) pp. 37, 114 and 140.
[53] Hau (1992) pp. 28-45, Mohring (1999), Roth (1996)
[54] Lee (1999), pp. 12 and 20.

62. Congestion charges can be collected through a variety of techniques, of different degrees of precision, sophistication and cost. With each technique, the charge can either be set centrally for each period of time that it is desired to distinguish (e.g. morning peak, evening peak), or alternatively be adjusted to reflect actual demand pressures, as in an auction. The first method has significant advantages of predictability for potential drivers, while the second could reflect better the fluctuations in levels of demand and possibly result in fuller overall utilization of the available capacity. Five principal techniques have been developed to date:

Parking charges clearly cannot cover persons driving through an area nor reflect much of the different distances or routes drivers take, but they can be varied over a city's space and over the course of a day in such a way as to capture a significant part of the congestion externality and encourage better spatial/temporal distribution of demand for movement over the roads.[55] Gradually increasing use of parking charges with these purposes in mind is quite widespread in European cities. U.K. and France are both debating taxation of privately owned commuter parking spaces.[56] Transferrable permits for a given number of available parking spaces would be a way of auctioning the right, for commuters for example, to drive to work.

Cordon pricing, or area licenses, can be applied, also without any very sophisticated technology, to charge for the right to access, or circulate within, limited geographical areas, with some degree of time differentiation. This technique cannot distinguish between heavy and light users of the controlled area's road network, and careful design is required to avoid congestion build-ups on the outside edges of the controlled area and at the shoulders of peak periods. Principal applications have been in downtown Singapore since 1975 and three Norwegian cities since the late 1980s.

Time-dependent tolling of individual roads or road lanes can charge for congestion on major highways and improve traffic flows on the affected facility (though not necessarily beyond it). Principal examples are HOT (High Occupancy or Toll) lanes on various North American expressways, most notably the privately financed HOT lanes opened in 1995 on the SR-91 in Southern California, and differentiation of Sunday afternoon and evening tolls on the A1 expressway between Paris and the English Channel.[57] The electronic equipment employed would permit pricing to fluctuate directly with traffic volumes, but has so far been used to charge different pre-fixed prices for travel in different time periods.

Electronic Road Pricing (ERP) enables more precise differentiation of charges by road, time of use and type of vehicle for whatever area is covered. Various appropriate technologies have been developed and several large test applications undertaken. The only system actually installed is that in Singapore, where it replaced the Area Licensing Scheme and tolls on a few major access roads in 1998 and is gradually being extended as needed.[58] The investment to create and install the system and equip all vehicles with transponders (into which the driver inserts a cash card, with the applicable toll being deducted from it

[55] Verhoef, Nijkamp & Rietveld (1995)
[56] Conseil National des Transports (1999), p. 106 and Department of Environment, Transport and the Regions (1998)
[57] Small & Gomez-Ibanez (1998)
[58] See Willoughby (2000) and the website of Singapore Land Transport Authority: http://www.lta.gov.sg

electronically upon passing a charging point on the road) was covered virtually entirely out of the government budget and amounted to some US$120 million equivalent, less than US$200 per vehicle in the country.

Fleet control, limiting the total number of vehicles (or of vehicles of certain classes) permitted to register in a region or a country, is obviously a much grosser, less focussed technique for coping with congestion, but it can contribute substantially to pricing for the use of road space. It has been employed in lieu of any other technique as well as in supplement to other techniques, and may come into wider use in areas where there is great reluctance to increase road space and the macroeconomic aspects of congestion (para. 52 above) become a dominant concern. Principal relevant experiences are those of Denmark and Hong Kong where acquisition taxes that approximately triple the cost of cars have been major factors limiting motorization (presently some 330 and 60 cars per thousand inhabitants, respectively)[59]; Singapore, introducing in 1990 an auctioning system for entitlement to own a motor vehicle (so-called Certificate of Entitlement or CoE) which, in combination with pre-existing taxes, resulted in new cars retailing at some four or five times their world market price; Tokyo, long requiring a prospective car purchaser to provide proof of having an off-street parking space; and various Chinese cities which have sold entitlements to register a motor-cycle and banned circulation within their precincts of motor-cycles registered elsewhere.

63. Fears about the direct effects of congestion charging on lower income groups, which have been a significant obstacle to its political acceptability in highly motorized societies,[60] are much less justified in developing-country cities, where most people remain dependent on public transport and, in some cases, non-motorized modes. Equity concerns have not been a major concern in Singapore's repeated raising of taxes and charges on motor vehicle ownership and use, and family budget surveys make it clear that the vast majority of these taxes and charges are paid by the 30% highest-income households. These households are in turn benefitting from ability to use their cars, and keep their appointments, more efficiently than in neighboring cities, while lower-income families also enjoy superior, and quicker, public transport services than available in most other countries. Equity issues could raise more concern in some of the rapidly motorizing major cities of Eastern Europe, which are still struggling to adjust personal incomes to levels adequate to pay for the housing and public services that were provided much below cost under the Communist economic regime. But those cities still offer, as an alternative, much more extensive and frequent public transport services than available in many of the western countries. Specific inequities which do arise in the shift to a fairer, more efficient system of charging for road use can also be compensated by provision of case-specific subsidies, such as free or reduced-price smart cards or stickers during a transition period.

64. It is widely recognized that the future of congestion charging will depend considerably on political acceptability of the proposed uses for the large revenues that will be generated. The emerging North Atlantic professional consensus, referred to at the outset of this section, that net revenues from congestion charging (after some reduction of other road user taxes in cases where

[59] Other countries too have sometimes justified new taxes on car acquisition as measures to ration access to road space, but the relatively low rates of the tax make it harder to identify specific impact. For the case of the U.K., see Newbery (1990).

[60] See, for example, Richardson & Bae (1998) and Jones (1998).

they are already high) should be devoted largely to transport improvements, reflects the results of public opinion surveys and the various efforts so far made to generate support for road pricing in particular cities. Various formulae have been proposed to combine transport service objectives with social/fiscal desiderata, so that the benefits of the scheme would be distributed as fairly as possible and would be seen to be so.[61] European discussions usually give particular emphasis to use of a significant portion of the revenues for support to public transport, partly on grounds that drivers in congested areas benefit directly (in respect of journey duration and operating costs) each time another driver decides to take the bus rather than to drive.

65. What is appropriate for a particular case has to be determined in light of local circumstances and local priorities, which are likely to be substantially different from those in the OECD countries. Reservation of the funds to the transport sector may not be so necessary; they have certainly not been so reserved in Singapore. A strong case can in particular be made for channeling the land-rent part of congestion revenues (ie., the portion which in fact reflects compensation for use of the urban land) to the municipal authorities without prior judgment as to how they might be used – possibly on accelerated transport improvements or, equally, on other needs of higher priority in the locality. This should be politically feasible, as well as economically more efficient, in developing and transition country cities moving towards appropriate charging for congestion.

Pollution

66. Pollution caused by motor vehicles is usually divided into the four categories that were used in Table 1.1. The most important category, which has attracted most study though it is still imperfectly understood, is pollution of the air in the immediate vicinity of the vehicle as a result of gaseous emissions, evaporation and dust diffusion. Second, noise pollution is often an important concern in the immediate neighborhood of vehicle operation. Third, and least studied, is pollution of soil, groundwater, lakes and natural habitats, whether by immediate run-off or at a greater distance, due, for example, to acid rain. Fourth is the contribution attributed to the so-called Greenhouse Gases towards the potentially extremely serious problem of global warming and climate change; carbon dioxide (CO_2) is the key concern here. Densely inhabited areas, where many people can suffer from these predominantly local effects, need most attention, and this is even more true in developing countries where vehicles are more concentrated in towns and cities, buildings are often closely packed together, and street life is much more active. Freight vehicles and buses are of course also important contributors to each type of pollution, but the evidence is that, in the large majority of existing situations,[62] more than half of the damage comes from cars and motorcycles, with the latter being an exceptionally serious part of the problem in an increasing number of Asian cities.

67. The different externality valuations summarized in Table 1.1 tend to show a rising trend over time in the case of local air and noise pollution, reflecting: increasing understanding of the phenomena; wide differences in respect of Greenhouse Gases because of the evolving state of

[61] Small (1992)

[62] An exception, for instance, is Hong Kong in regard to local air pollution. The most serious problem there is suspended particular matter (SPM), about 50% of emissions of which are attributed to motor vehicles. Of this, about 63% comes from freight vehicles, 17% from buses and only 20% from all vehicles under 5.5 tons, largely reflecting Hong Kong's low motorization rate of less than 60 cars per 1,000 population. See Schwela & Zali (1999) and Barron (1998).

study of climatic issues; and virtual absence of valuation efforts, with the exception of limited work in the U.S.A., on regional soil and water pollution. Thus, in regard to local air pollution, the carefully developed estimates for U.K., Bangkok and Santiago, amounting to some 2.5-3.0% of national/regional GDP (and still felt by their authors to err on the low side), reflect mainly the clearer and more serious health effects of small particulates identified by epidemiological research in the late 1980s and early 1990s. Most of the other studies cited, including the E.U. report, had to rely mainly on the results of the earlier generation of research.

68. As regards noise pollution, it has not been possible to find any estimates for developing/transition countries founded on empirical research. The figures cited in Table 1.1 for Poland and Santiago are based essentially on straight extrapolation of earlier research findings originating largely in U.S.A. The higher numbers given in the E.U. and U.K. assessments reflect research linking house prices and rents to ambient noise levels in various European locations – where indeed, as in Japan, considerably more people seem to be affected by road traffic noise than in the U.S., due to denser settlement patterns.[63] Since the global warming phenomenon, and the links between it and transport emissions, have been still at relatively early stages of understanding, the valuations cited – found only for OECD countries – reflect mainly the political commitment of the authors or their government rather than scientific research. This was a particularly important aspect of the E.U. report since all the member governments are highly concerned about fulfilling their Kyoto commitments, and it is a live political question in some countries whether they should try to go beyond them.[64]

69. The by-products of motor vehicle operation that are now of principal concern are lead (Pb), benzene, and oxides of sulfur (SO_X), and the largely secondary pollutants, small particulates (PM_{10} – i.e. those less than 10 microns in diameter – and even more the still smaller $PM_{2.5}$) and tropospheric ozone (O_3), all of which have been found to cause mortality, much the most emphatically in the case of lead and small particulates. Motor vehicle contributions to PM_{10} consist partly of direct emission of small particles, partly of secondary products from emitted nitrogen oxide (NO_X), sulfur oxide (SO_X) and hydrocarbons or volatile organic compounds (VOCs), and partly of dust from tire wear (which produces very small particles) and road surface. Recent research in the UK[65] finds 25% of ambient PM_{10} to come from road traffic, but 60% of $PM_{0.1}$. Since gasoline engines contribute a rather high share of these smaller particles, which health research has tended increasingly to find the most damaging, current preoccupation with exhaust from diesel engines may spread again to gasoline engines. Tropospheric, or 'ground-level', ozone is entirely a secondary pollutant, formed by the action of sunlight on nitrogen oxide, oxygen and VOCs. Other worrisome by-products of motor vehicle operation are butadiene and formaldehyde, both considered potential cancer-causing substances but without sufficient epidemiological evidence as yet to attribute specific effects to them.

70. Economic measurement of the health impact of motor vehicle air pollution is a complex process, now being made more readily applicable for decision-making purposes in developing countries. A useful step in this direction is work carried out over the last two years by the Bank's Environment Department to develop a rapid assessment methodology and apply it to six

[63] See the figures cited in Poole et al. (1994) p. 40-43 and in ECMT (1998) pp. 184-94.
[64] See, for example, INFRAS (1999).
[65] See internal World Bank note by Masami Kojima and Magda Lovei (1999), "Urban Air Quality Management: Transport – Environment – Energy Nexus".

cities.[66] There are six main stages to any such analysis for an area. Air quality data has to be systematically collected to identify those pollutants which are reaching worrying ambient levels. Second, an inventory is built up of all the major sources of emissions, and their approximate contributions, with particular attention to the quality of the fuels used and contributions to secondary as well as primary pollutants. Third, the dispersion of the pollutants from the various sources has to be modeled, reconciled with the recorded ambient levels, and related to the distribution of population in the area. Fourth, health impacts are calculated using dose-response functions, based on the most relevant available research results, that link variations in levels of key pollutants to human mortality and morbidity events. Fifth, the health impacts have to be valued, and this is best done using Willingness to Pay methodology,[67] which seeks to capture people's actual preferences, or, second-best, using Human Capital approach, which focuses on lost earnings; costs of treatment must also be added. Sixth, these economic values need to be related back to the different sources (e.g. different classes of vehicle) for purposes of economic analysis of different remedial measures and identification of those which would be most cost-effective in the particular circumstances.

71. Significant progress has been made in recent years in reducing motor vehicle air pollution in some of the worst affected cities of the developing world such as Bangkok, Mexico and Santiago[68] – mostly by regulatory measures, as in the OECD countries. Fuel improvement, especially reduction of lead and sulfur content, has often been an important contributor; Thailand phased out leaded gasoline over the course of five years, Bangladesh and El Salvador within a single year, and Mexico City has greatly reduced consumption. Most of the countries have followed, with some delay, the new vehicle emission standards set by OECD countries, such as the U.S. which gradually lowered allowed exhaust particulates, for example, from 0.37g/km in 1980 (the first time a limit was established, reacting to signs that particulates were damaging) to 0.05g/km for cars manufactured in 1989 and thereafter. In Mexico and Santiago, blocks of very old vehicles – particularly taxis in the former and buses in the latter – were phased out. Large numbers of taxis in Bangkok and Mexico were converted to use of LPG. Vehicle inspection requirements have been substantially tightened and their organization strengthened – for instance, in Mexico by direct centralization under government, with independent auditors present at each station to monitor integrity and quality. Santiago undertook an extensive paving program to reduce fugitive road dust. The combined result of such measures was a significant improvement in air quality in all three cities according to monitoring indicators, especially with regard to lead and carbon monoxide, and, in Mexico, sulfur dioxide and, in Santiago, PM_{10}.

72. But large problems remain, even in these cities which have given special priority to reducing automotive air pollution. The number of days that local ozone standards are infringed have continued to increase in Santiago and remain very high in Mexico (largely due to NOx emissions of petrol engines). PM_{10} levels in the latter are still generally about 30% over the current local standard. The very high cost to society of such problems, as demonstrated by the valuations cited earlier (para. 67), and the inevitably slow progress in their solution, indicate that the economic burden will remain important a long time into the future. Thus, more needs to be done to apply the widely accepted "polluter pay" principle – to compensate the rest of society for the damage drivers are doing, as well as to stimulate them to think twice about journeys and

[66] Lvovsky et al. (1999).
[67] Further discussed in paras. 81-84 below.
[68] Schwela & Zali (1999); Zegras & Litman (1997)

more often about vehicle maintenance and replacement. To be effective for these purposes, however, the charges need to be quite closely and transparently related to the damage done. That is difficult because the damage caused by different vehicles varies so substantially, depending on a wide range of factors: age of vehicle and adequacy of the maintenance it has received, type of fuel used and its quality (affecting the composition of emissions), annual kilometrage, location of use (densely populated areas or rural roads), winds and atmospheric chemistry, season of use (even in some cities facing serious air quality problems, the day of use), and the length of trips. A significant degree of averaging is inevitable.

73. Two charging mechanisms which could capture most of these factors and yet be relatively simple to apply unfortunately still seem slightly beyond the existing range of proven technology: mobile spot checking of pollution emitted by vehicles in motion, to identify those who should be fined for exceeding allowable limits,[69] and use of the annual emissions test to calculate a fee reflecting kilometers added to the odometer since last reading and the average pollution burden imposed by the vehicle.[70] Studies have repeatedly demonstrated that a relatively small proportion of total vehicles – generally the older or less well maintained ones – account for a very high proportion of total pollution. Practical realities continue to raise questions about the cost-effectiveness of universal periodic testing requirements under Inspection and Maintenance (I/M) programs; the experience recently noted from Wuhan in China, that roadside testing showed 93% of vehicles falling short of the standard even though 97% of those tested in the same period at the I/M station met it, seems far from unique.[71] Thus, wider use of spot-checking equipment capable of identifying main problems from any relevant vehicle-type, and of fixed I/M stations for more thorough examination and follow-up of vehicles so identified, holds promise of significant impact on the pollution problem; an appropriate system of fines, and controls thereof, could also make such system at least self-financing. Whether periodic tests could yield sufficiently reliable information on cumulative emissions to serve as part of the basis for a vehicle-specific pollution tax seems more uncertain.

74. As means of fair charging for pollution damage, however, the most serious deficiency of the systems described would be their inability to distinguish between vehicle useage in built-up areas, where the costly damage is caused, and that in rural areas, where the local damage from road transport is largely limited to some adverse effects on water bodies and soils. Where this distinction is important – as it is in the large majority of developing and transition economies – appropriate mechanisms for pollution charging have to be sought rather among those developed for dealing with congestion (para. 62 above). Electronic Road Pricing could clearly incorporate considerable spatial, as well as temporal, differentiation of charges, and also some broad distinctions between different vehicle classes.

75. In the interim, and especially for cities facing very serious road transport air/noise pollution problems, the tradeable permits system suggested for Mexico[72] is very worth considering, although it would need to be supplemented by measures of the type proposed in paras. 73 above and 77 below, to ensure that it does not merely encourage use of more highly polluting vehicles. It bears an affinity to Singapore's system for auctioning entitlements to own

[69] See, for example, Roth (1996), pp. 92-95.
[70] See, for example, Eskeland & Deverajan (1996), p. 33.
[71] Tian Xianmin, quoted in Zhou (2000); Roth (1996), p. 92.
[72] Goddard (1997).

a car, but takes off rather from the experience of those cities, such as Athens, Mexico and Santiago, which found it necessary to prohibit use of a proportion of the car fleet on pollution-prone days. Standing entitlements to drive in the area covered (probably, most appropriately, a wide version of the central city) could be issued free to all existing vehicle owners in the metropolitan area for, say, three out of the five week-days – or perhaps four, if Saturday also presents serious traffic pollution problems. A market would be encouraged to develop (much as has often occurred in Latin American cities for telephone connections, when their provision ran far behind demand), and entitlements would be tradeable freely, under government supervision to avoid cornering of the market, fraudulent certificates, etc. New first-time purchasers of vehicles might either have to buy entitlements from existing owners or, if some increase in the city's transport pollution load was deemed acceptable, the authorities could issue (and auction) limited numbers of new entitlements, in much the same way as in Singapore.

76. Emphasis has been given in recent debate on road user taxation, especially in Europe, to the alleged need for greater "variabilization", meaning a relative shift from fixed annual taxes to use-related taxes which will have greater impact on vehicle owners' trip decisions. Pending the availability of systems of the type discussed above and in the last section, this tends to mean in practice increasing the fuel tax.[73] But the general level of fuel taxes provides, on its own, no pollution-related incentive except to the extent that the global warming threat is deemed to require a general discouragement of fossil fuel use (to which emission of carbon dioxide is directly proportional). An additional problem in the case of the oft-targeted diesel fuel prices is that as much or more diesel fuel is often used, especially by the poor for non-transport purposes, in rural areas where adverse environmental consequences are minor.[74]

77. The most practical way then to align the tax system somewhat better than now with the need for pollution charging – and a poor third or fourth best compared with the 'new' taxing/pricing systems discussed above – is to differentiate fixed periodic taxes to a greater extent according to the level of damage caused by different vehicle categories, defined by criteria such as engine-size, fuel used and age-bracket. For the particular case of heavy trucks, which is sensitive because of the size of the tax increases required and the effects they can have on the industry's competitiveness, it is interesting to note that the increase required (per ton-kilometer) on pollution grounds for urban running may parallel that often required on grounds of damage to road surfaces, especially for extensive rural running; insufficient recovery of costs of the latter type is a problem common to many countries and is to some extent reflected in column (iv) of Table 1.1. An alternative for heavy goods vehicles, much closer to variabilization but largely independent of fuel tax, is a tax based on distance run or distance and weight; variants operate effectively in New Zealand and Sweden and are planned for introduction soon in Switzerland.

78. The discussion above has been conducted in terms of charging for air pollution damage, but it also applies to other forms of pollution. Noise pollution, which merits more attention than it has so far received in considering developing countries' urban transport problems, can be treated in much the same way as local air pollution. Greenhouse gas pollution, on the other

[73] This is reflected for instance in the recommendations of the EU study group on internalization. See ECMT (1998), p. 32.

[74] Lvovsky (1999) discusses this issue well for Asian countries. In OECD countries the problem is sometimes overcome by distinguishing among users in the tax rate applied; this is not yet normally practicable in the circumstances of developing and transition economies.

hand, requires a response that is both narrower and broader.[75] Narrowly, in regard to pricing, taxes on all fossil fuels should be adjusted upward in relationship with the seriousness of the global warming threat – just like other threats that have to be taken into account in determining fuel policy, such as possible supply instabilities or general world price rises. More broadly, and more importantly, the increasing worries about the adverse consequences of potential warming do add to the reasons why developing and transition countries would be well-advised to give more attention to management of motorization generally.

79. The purpose of charging for air pollution as close as possible to marginal cost is to provide a common incentive towards reduction and to raise revenues for compensation of victims. Neither purpose can be fulfilled very directly because price rationing will continue to play a role subsidiary to regulatory measures for improving air quality, and the suffering caused is too widespread and indirect, in the sense that an individual mortality/morbidity event can seldom be linked sufficiently conclusively to an event of transport pollution. But the revenues should cover the large public health costs incurred and support a wide range of initiatives that help to reduce the pollution threat to the general public, such as improved vehicle testing equipment and on-street monitoring programs, better policing of fuel adulteration, assistance to vehicle owners with retrofitting significant anti-pollution devices, incentives for scrappage of highly polluting vehicles that would otherwise be kept in operation for several more years, installation of quieter running surfaces and noise barriers along highways close to living/working quarters, and development of non-motorized transport networks located so as to well serve the poor. Finally, because the welfare effects are so widespread, the revenues could also appropriately be used to reduce rates of other taxes widely paid in the city, especially by those spending much time in or close to the streets.

Accidents

80. For many countries, accidents are almost certainly the most important single form of external costs imposed by the road transport sector. The externalities involved in traffic accidents are generally calculated as the difference between total social costs of accidents and the compensation paid by insurance companies. Consistency with the notion of marginal external costs would require a deduction for the private costs that all drivers have to accept, as a personal risk, in making the decision to drive and that is assumed to make them more careful than would be the case if all accident costs were indeed reimbursed.[76] This refinement is not normally attempted in studies for developing countries and is omitted even in the EU study discussed here. Social costs would include mainly the costs of emergency services provided, consequential traffic hold-ups, police and legal follow-up, medical treatment and property damage, plus the loss of earnings by (or contribution to production from) accident victims and family members who must care for them, and the burden of pain and grief borne by accident victims and their families. The more advanced a country's social system the greater the share in many of these costs that would be carried by the state out of general revenues. A significant omission from this accounting (similar to the case of congestion, as discussed in para. 52) is the cost of actions and sacrifices undertaken by people in response to the increased accident risk resulting from growth of motorized road users. Substantial reduction of walking in large cities, and greatly increased

[75] Schipper & Marie-Lilliu (1999)
[76] Discussion of this issue, albeit more relevant to OECD than to developing countries, is to be found in Gomez-Ibanez (1997) and Maddison et al. (1996).

delivery of children to school by vehicles, have been noted widely over the last thirty years, and a major factor is believed by most people to be unacceptable traffic risk.[77]

81. Dominating the total costs of accidents in the OECD countries are those of lost output and allowance, if made, for pain, grief and suffering. As traffic accidents rose in the decades after the second world war to become a major area of social concern, attention turned to the inadequate allowance public authorities were felt to be making, in their planning criteria, for the true costs of accidents. The so-called 'human capital' approach to valuation of lives destroyed or maimed – assessing discounted effects on national output – was felt increasingly to be unacceptable. Individuals and families, it was noted, were prepared to pay much more than this amount to reduce the risk of death or disability. Various techniques have been used to estimate this 'Willingness to Pay', but the one generally considered most satisfactory is the Contingent Valuation Method, applied through carefully designed social surveys posing questions about how much people would be prepared to pay to reduce such risks by various amounts. Assessments of the costs of accidents in OECD countries would now normally include allowances, based on these concepts, for pain grief and suffering, especially that involved in loss of a human life (the Value of a Statistical Life, or VOSL) or serious incapacitation (usually as a ratio to the VOSL).

82. The valuations of external costs that were given in Table 1.1 treat these matters in various different ways. Most of them are re-presented, along with traffic fatality rates for approximately the same base years in the different cases, in Table 5.1. Traffic fatalities are taken as the most appropriate physical indicator of accidents because they are the most reliably recorded and appear anyway to account often for around one-half of total accident externalities, at least in middle- and higher-income countries. The left-hand side of the table presents figures for the OECD countries in the early 1990s and shows the country basis of the 2.40% of GDP calculated by the EU task force mentioned in para. 11. The group's final conclusions regarding the absolute values of externalities for each country have been recalculated for the table in relation to each country's GDP, and the countries are listed in ascending order on this indicator.

83. The underlying methodology[78] was to take the average of the officially recognized VOSL values for the five European countries which had accepted a Willingness to Pay approach (1990 US $1.8 million equivalent) and to adjust that to each EU country on a Purchasing Power Parity (PPP) basis and assuming an income elasticity for this good of 0.3, as suggested by a number of related researches. Values for non-fatal accidents were calculated in a similar way. Table 5.1 shows that the percentages of GDP correlate quite closely with the figures for fatalities per million population, as would be expected, while the variations must be explained, under the methodology used, mainly by differences among the countries regarding recorded non-fatal accidents. The very high percentages of GDP shown for Greece and Portugal reflect partly those countries' higher accident rates and partly the high VOSLs (relative to these poorer countries' incomes) that resulted from the methodology described.[79]

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[77] see, for example, Maddison et al. (1996) pp. 134-135; and Burwell (2000).
[78] ECMT (1998) pp. 173-183.
[79] For their assessments of pollution externalities in developing country cities, as discussed in the previous section (para. 70), Lvovsky et al. also had to extrapolate from VOSL estimates in OECD countries, but they used what amounted to more cautious formulae, converting incomes at market exchange rates and assuming income elasticity of 1 for pollution avoidance.

Table 5.1
Estimates of Accident Externalities and Fatalities for Selected Countries/Cities

Selected OECD Countries, Early 1990s				Selected Developing/Transition Countries, Middle-Late 1990s			
	Ext'ties (%GDP)	Traffic Fatalities per: mln. popn.	10,000 vehicles		Ext'ties (%GDP)	Traffic Fatalities per: mln. popn	10,000 vehicles
U.S.A.	1.71	154	2.08	Poland	1.60	163	6.30
				Warsaw	n.a.	106	2.30
Sweden	0.92	86	1.91	Brazil	n.a.		20.00
Denmark	1.15	117	3.16	S. Paolo	1.11	232	5.10
Finland	1.23	126	2.89	Argentina	2.00	188	7.34
Holland	1.46	86	2.08	B. Aires	n.a.	80	
Lux'burg	1.81	208	3.73	Thailand	3.41	283	13.30[a]
U.K.	1.97	81	2.06	Bangkok	2.33	167	4.00[a]
Italy	2.10	136	2.33	Chile	n.a.	126	23.00
France	2.22	183	3.60	Santiago	0.94	72	7.80
Ireland	2.29	126	4.40	Senegal	n.a.	97	69.00
Germany	2.43	130	3.12	Dakar	0.2/4.0	81	26.00
Austria	3.05	210	4.69	Dhaka	n.a.	47	20.00
Belgium	3.19	186	4.20				
Spain	3.46	223	5.45	Other Comparators, late 1990s			
Greece	4.44	195	7.60				
Portugal	9.54	357	12.95	Japan	n.a.	86	1.56
				Tokyo	n.a.		1.10
All E.U.	2.35	145	3.36	U.S.A.	n.a.	158	2.08
				N.Y.C.	n.a.		1.60

84. The figures on the right-hand side of Table 5.1 relate largely to developing and transition countries and cities. They permit a number of conclusions:

A. Relative to recorded fatality rates, the estimates of externalities as a percentage of GDP appear generally reasonable, although on the low side, by comparison with the calculations for the OECD countries. This applies equally in cases (e.g. Santiago) where no allowance was made for the pain, grief and suffering as in those (e.g. Argentina) where such provision was included, and in others (e.g. Thailand) where standard percentage adjustments were applied in lieu of a separate calculation. The figures cited for Dakar are illustrative of the difficulties of finding a methodology fully appropriate to the poorer countries, the very low 0.2% GDP emerging from application of a 'human capital'

[a] Because they loom so large in the total vehicle fleet, and as causes of accidents, in Thailand, motorcycles are included in the denominator of these ratios for this country, unlike the other countries in the table.

approach and the very high 4.0% GDP being the estimated result of a 'Willingness to Pay' methodology.[80]

B. Despite the high share of the national vehicle fleet in the large cities, the accident problem is nationwide rather than metropolitan, strongly contrasting in this respect with the other major externalities already discussed. Indeed the figures indicate that, at least in the few countries covered, fatality rates in the larger cities are normally much below the national averages, probably reflecting in part the slower speeds imposed by denser traffic.

C. The strongest contrast between the OECD and other countries is with regard to the fatality rates per vehicle, which are often many times as high (up to well over 50 times, though the largest range among the countries covered here is 36 times, between Senegal and Sweden). The only reason the fatality rates relative to population are more comparable to those in the OECD countries is the lower level of motorization in the poorer countries. Wherever relevant figures are available, they indicate that about 60% of urban traffic accidents involve cars and similar light vehicles, even in cities such as Dhaka where much transport is by non-motorized vehicles.

85. One important reason why the value of accident externalities is probably underestimated in most developing countries is the poor recording, especially of non-fatal injuries. Table 5.2 presents comparative numbers for a variety of countries. The block of numbers for the EU is taken from the European Traffic Safety Council,[81] indicating that, in these countries as a whole, actual cases of serious injury are about eleven times fatalities, and light injuries sixty-six times, but that there is much under-reporting even for serious injuries. The U.K. and U.S. recorded numbers support, and probably form part of the basis for, the 11 and 66 ratios. The Brazilian numbers cited represent reported accidents but adjusted upwards, partly on the basis of hospital records regarding serious traffic injury victims.[82] The Chilean figures are those officially reported, probably of better quality than in most developing countries but still considered by the local authorities serious underestimates in regard to injuries.[83] The numbers for Argentina, Mexico City and Dhaka, based on official reports (whose coverage has greatly improved in the latter case in recent times), must still represent gross underestimates.

86. Over the course of the 1990s much progress has been made in many of the European countries in bringing down the high accident rates reported in Table 5.1 For instance, already by 1995 fatalities per million population were 20% or more lower in several of the countries where the rates were low in 1991 (e.g. Sweden and UK) as well as those with high rates at that time (e.g. Portugal and Spain).[84] Continuation and spread of such progress must be the principal basis for the EU task force apparently assuming a halving of the accident externality to 1.20% of GDP for the EU as a whole (see Table 1.1) soon after 2000. Most of this progress has resulted from strong popular pressure, leading to coordinated efforts by the entities, both public and private,

[80] It is somewhat surprising that none of the studies reviewed appear to have tested the Disability Affected Life Years System (DALYS) elaboration of the 'human capital' approach, as outlined in World Bank (1993) and Murray and Lopez (1996). It might help to generate sounder estimates that would also be more comparable for countries of widely different income levels.
[81] European Traffic Safety Council (1997)
[82] Vasconcellos (1997).
[83] Zegras & Litman (1997).
[84] Conseil National des Transports (1999), p. 40.

Table 5.2
The Annual Toll of Road Traffic Accidents: Injuries relative to Fatalities

	Fatalities (Number)	Serious Injuries		Light Injuries	
		Number	Ratio to Fatalities	Number	Ratio to Fatalities
EU – Reported	45,000	355,000		1,180,000	
Non-reported		145,000		1,770,000	
Est. total	45,000	500,000	11.1	2,950,000	65.6
U.K. (1993)	3,814	45,009	11.8	257,197	67.4
U.S.A. (1993)	40,115	---------3,125,000		77.9 ----------	
Brazil (c. 1990)	35,000	350,000	10.0	n.a	
S. Paolo (c. 1990)	2,800	14,000	5.0	47,600	17.0
S. Paolo (1995)	2,278	9,000	4.0	58,700	25.8
Chile (1994)	1,762	----------41,646		23.6----------	
Santiago (1994)	394	3,130	7.9	12,876	32.7
Mexico C. (1993)	2,179	----------4,671		2.1----------	
Argentina (1996)	6,710	14,762	2.2	53,009	7.9
Dhaka (1998)	420	1,001	2.4	135	0.3

Note: "Medium injuries", where separated (as in Santiago), have been included with Light injuries for purposes of this table.
Sources: USA: Transportation Statistics Annual Report 1995; EU: European Transport Safety Council; U.K.: Maddison et al. (1996); Brazil: Vasconcellos (1997, 1999); Chile: Zegras & Litman (1997); Argentina: World Bank current work; Dhaka: Bangladesh Police (1999); Mexico: Ochoa & Radian (1997).

from the many sectors that have to help – e.g. education, police, road authorities, insurance, urban and transport planners and managers, etc. One supportive factor has been large increase in most countries in officially accepted VOSL, which has significantly strengthened the weight attached to safety aspects in planning roads, managing traffic, setting speed-limits, etc.[85]

87. In the developing countries, reduction of the accident scourge is still currently the most important single problem to be addressed in managing motorization. This is certainly true outside the major cities, and even within them it is often of roughly equal importance with the problems of congestion and pollution. Yet progress in most countries seems to be limited. There are probably two overriding reasons, one sociological and the other organizational. The sociological factor is widespread lack of confidence that man (or woman) can control the phenomenon, exacerbated in many traditional societies by low regard for the weak and the poor.

[85] Maddison et al. (1996), pp. 129 and 137-138. Conseil National des Transports (1999) p. 39 also stresses the significant potential effect of further increases in the VOSL used in France.

The motor vehicle easily becomes an instrument of inequity.[86] Some 60% of those killed in traffic accidents in major cities of the developing world are pedestrians or NMT riders, predominantly poor.[87] The organizational factor is the difficulty observed in virtually all societies of organizing initiatives that require great inter-agency coordination, a requirement key to sustained progress in this area, as mentioned from the experience of OECD countries. Police, judiciary, roads department, media, schools, developers, planners, traffic managers and others have to be brought together to work out, sustain and monitor a well-prioritized program of actions, and that is only possible with strong political leadership.

88. Charging road users the full external costs of traffic accidents obviously cannot fully resolve these problems, but it can make a signal contribution. Moreover, with the exception of clear cases of irresponsible action by the roads department or other public authority, it is very hard to conceive any reason why any of the costs of accidents should be borne by society generally or by public revenues rather than by road users, particularly those who cause the accidents. Thus, the state, the police and the judiciary should seek to ensure that accident victims do all receive full compensation for the damages inflicted, including for pain, grief and suffering according to locally established standards. Second, insurance companies, which would be called upon to pay the large majority of these compensations, should be encouraged to differentiate their premiums more strongly among classes of driver according to the results of systematic analysis of their proneness to risk. Introduction of a tax on insurance companies for each fatality for which their clients are found responsible[88] may also be useful in some countries, to help focus company attention to the reduction of fatalities and to raise funds for safety-increasing investments.[89]

89. Third, a safety levy on fuel has merits to cover part of insurance premia and most public sector costs in coping with accidents – provided that its introduction is accompanied by the other measures mentioned that distinguish more strongly among drivers according to the extent to which they are liable to cause accidents. The specific composition and rates would need to be determined on a country-specific basis according to the extent to which they needed (a) to respond to widespread failure of drivers to purchase insurance, (b) to cover the compensation of victims of 'hit-and-run' drivers, and (c) to introduce more differentiation among properly insured drivers for the distances they cover in a year.

90. Full recovery of accident externalities from road users by joint action of the insurance companies and the government, using the methods described, would help to build a wider appreciation of the value that society attaches to all its citizens. It would also help to generate the relatively small but critically required funds for effective coordination and implementation of

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[86] Vasconcellos (1996), p. 266.

[87] Vasconcellos, for Sao Paolo, and the Dhaka traffic safety studies both indicate about 60% pedestrian share smong traffic fatalities. In Indian cities 45% of traffic accident victims are pedestrians and 19% cyclists, while in Beijing the corresponding numbers are respectively 15 and 39% (Dimitriou, 1998). In Mexico City, in 1993, 53% of recorded fatalities were pedestrians (Ochoa & Radian, 1997).

[88] As proposed, for example, in INFRAS (1999).

[89] A number of countries have been securing much increased financial contributions from insurance companies towards the costs of safety measures. This is the case, for instance, with the government-owned insurance companies in British Columbia in Canada, and Victoria in Australia. The insurance companies operating in Fiji have also accepted a voluntary levy of 10%, on aggregate third party insurance premia, to be applied to safety programs.

action planning, including dimensions that are often underfunded such as police vehicles and traffic control equipment, small re-arrangements of side-walks and street crossings at accident black spots, serious enforcement of regulatory measures of recognized value (such as observance of red lights, stop signs and speed limits, motor-cycle riders' use of crash helmets, use of seat-belts in cars), and preparation of effective media programs.

VI. URBAN LAND USE AND FINANCES

91. Gradual implementation of the regulatory and pricing measures already discussed for motor vehicles and public transport would, over a period of years, have significant effects. Much evidence exists that demand for cars and car use is quite responsive to prices, especially in urban areas.[90] A thorough recent survey of research from a variety of OECD countries, for instance, concludes that short-term (less than one-year) price elasticities of vehicle travel[91] are in the range –0.6 to –1.0, while long-run (5-10 year) elasticities are about double, in the range of –1.0 to –2.0. Thus, with serious moves to fuller cost recovery[92] from road users and the accompanying measures already recommended, car commuting would fall, especially in peak hours, public transport would improve and attract more patronage, average travel time would drop slightly (mainly as a result of less obstructed bus flows), and pollution and accident externalities would be less. Higher out-of-pocket costs of transport would set in train some pressures toward reconcentration of activities in the city center and at subsidiary nodes.[93] And the municipal authorities would be receiving additional revenues, their volume depending on the degree and extent of congestion that had previously built up.

92. Such measures would no doubt be useful and the resultant trends desirable. But such a heavily technical approach, largely limited to the road transport sector alone, is not consistent with the gravity of the problem in major urban areas, nor with the interdependencies that surround it. Moreover, it is probably politically unrealistic to suppose that transport measures can advance in isolation. Earlier parts of this paper, especially Section III, suggested that whether the situation of the poor is deteriorating as a result of motorization of their societies remains to be proven, but that motorization is unquestionably a major part of the increasing space-access problems confronting almost all income classes, and especially the poor, in the large urban areas. And those problems are of major proportions, such as widespread two-hour one-way commutes (and the even more unattractive conditions for living in the central areas that such commuters must be rejecting as an alternative), unacceptable housing conditions for 40% or more of the population, and decaying efficiency of the whole agglomeration as a productive apparatus.

93. Thus the political profile of the issues connected with motorization needs to be heightened and broadened, and the regulatory and pricing measures proposed need to be developed and introduced simultaneous with complementary action in four key broader areas: Land Market,

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[90] Lee (2000), Goodwin (1992), Eskeland & Feyzioglu (1997), and Dargay et al. (2000).
[91] The focus was to vehicles rather than people, because the general problem is one of excessive numbers of vehicles, not of people, on the roads. Lee (2000).
[92] whether Marginal Social Costs, as normally recommended in European literature (eg., EU), or Full Costs, as recommended by some leading North American authors (eg., Lee), recognizing the merits of short-run marginal cost charging but assigning even higher priority to enterprise budget balance as an efficiency-stimulating device and therefore stressing recourse to Ramsey/Boiteux pricing when necessary.
[93] Lee (1999)

Structure Planning, Infrastructure for the Poor, and Municipal Finance. This section deals with each of these in turn.

Land Market

94. For more realistic pricing of transport to make the needed contribution to the city's performance, land and housing markets need also to be operating effectively, so that dwelling-place choices by households, construction decisions by developers and new initiatives by employers can respond flexibly. Optimization of housing/transport combinations for large numbers of households of varied and constantly changing sizes, needs and tastes is a far too complex problem to be solvable by other than market interactions. Hence the key issue is to improve the functioning of the markets concerned, reducing government interventions in their day-to-day operation. In most developing and transition economies, improvement is needed on many dimensions and it can normally only be brought about gradually.

95. Four main lines of action normally deserve priority, as listed and illustrated, below:[94]

1. **Increasing liquidity of real estate, to accelerate demand-driven land use change:**

- Clarification and recording of property rights, to generate security of tenure, provide a base for investments and borrowing, and enable efficient transfers of property from one owner or use to another. Improvements needed are different in different countries. In cities still dependent on the informal sector for much housing provision and development, high priority attaches to accelerating procedures for adjudication of land invasions and similar informal acquisitions, and for assignment of property rights. In many of the ex-Communist countries the main need is to replace the various existing types of title, providing only restricted rights, with a full ownership title recorded in a single, open registry containing full information about liens, mortgages, easements, etc.

- Converting existing land use controls to a transparent system sensitive to demand signals. Detailed, time-consuming site and building controls need to be replaced by broader zoning regulations that provide for extensive public consultation in their conception and initial application, and facilitate gradual change in response to changing needs, but insist on transparency to avoid manipulations. Zoning classifications need to be realistic in regard to population pressures and market possibilities, and minimally restrictive, so as to avoid the subsidies often given to the better-off when the use of land is limited by law to low-density residential occupation.

- Overcoming the variety of obstacles to recycling of urban lands**.** Too often local governments are part of the problem rather than of the solution. The issue is particularly important in most of the ex-Communist countries, where large areas of industrial land are involved, often in prime locations, and enterprise managers and local government officials combine to prevent reassignment. For the particular problem of polluted lands, raising liability risks that frighten away private purchasers, government investment in clean-up may often be the only solution. (At a national scale, the U.K. Government has

[94] Elaborations on many of these points are to be found in World Bank (1993), Dowall (1995, 1998), World Bank (1998).

recently raised from 50% to 60% the share of all new residential development that should take place on re-used urban land.)

- Broadening and deepening financial markets' support for housing**.** This is an appropriate object of banking and taxation policy, but it is important to ensure that measures taken do not inadvertently privilege detached suburban housing (as in the U.S. through standards set for onward sale of mortgage packages and, to a lesser extent, generous tax deductibility of mortgage interest) and that the benefits reach, in first priority, the groups who would otherwise barely be able to own/rent appropriate accommodation.

2. Avoiding distortion of land use through excessive regulations and poor pricing/taxing practices:

- Legally required standards for building and site development need to be adjusted to income levels, and then firmly enforced**.** In many countries, required plot widths are too wide, block lengths too short and street widths too generous. In others, well-chosen standards are ignored by developers, with the result that development becomes haphazard and expensive to serve. A widespread problem is grossly excessive requirements for provision of parking space, especially at office and commercial establishments but also in residential design, wasting space and giving a further implicit stimulus to reliance on private transport.[95]

- Avoiding market distortions resulting from excessive inter-jurisdictional competition**.** In areas, such as land and housing, where efficiency of supply depends on an integrated market spanning the whole of a metropolitan area, central governments should set standards to limit local government interventions through granting of special favors (such as tax remissions or exceptional relaxations of regulations) to attract investors away from other jurisdictions in the area.

- Sales and leases of lands owned or developed by public authorities should always be at full market value, and equally public utilities should set connection charges reflecting actual costs rather than systemwide averages**.** Singapore has always used transparent, competitive procedures for such transactions, but urban development authorities in many other countries have sold lands at prices at best reflecting historical costs, thus undercutting what the private sector would have otherwise been able to do, depleting their own financial resources, and hence severely limiting the land that could be developed/redeveloped.

3. Ensuring inclusion of infrastructure cost into land price through transparent impact fees or in-kind obligations:

- Promoters of new subdivisions must pay for the expansions of infrastructure and public services that their projects require rather than leave these as a charge on the broader community**.** Developers should be required to cover the costs of neighborhood infrastructure and whatever expansions of public facilities are needed to maintain service

[95] Shoup (1999)

levels in fields such as fire and police stations, storm-water infrastructure, schools, roads and bus-stops. Recent research in the U.S. suggests that, where they have existed, local governments' Adequate Public Facilities Ordinances (APFOs), spelling out such requirements, have probably been the most effective means of limiting excessive urban sprawl there.[96]

4. Acquiring primary rights of way or easements therefor:

- Clarity for all parties about the broad future shape of the city. The public authorities need to acquire rights of way, or define precise easements, for the intended future extensions of main arteries. Without such transparency in regard to the future spatial macro-structure (see paras. 98-99 below), it is difficult for either the land market or actual land-use patterns to develop rationally.

96. The central thrust of all these measures is to increase supply of housing and working space by creating a firm but fair framework for all participants in the market. Introduction of the recommended transport measures in a context where these issues were gradually being taken care of would tend to make demand more elastic and so to stimulate a reshaping of the city. If congestion pricing was seriously applied in one form or another, the city would evolve towards a more compact form, with more mixed land use, less resources devoted to spread of the road network into surrounding areas, and more funds available for upgrading infrastructure in the already urbanized area.[97]

Structure Planning

97. In addition to bringing about the market environment that can enable land and transport to interact effectively, government has a crucial planning role at the interface between the provision of public infrastructure (whether provided by public or private entities) and private investment in buildings. Such interface arises at macro and micro levels. Both demand effective planning actions by the public authorities, leading participative processes that maintain a broad consensus and respond to changing needs and opportunities. The macro level, of choosing and following an overall structural design that will guide the evolution of land use across an expanding metropolitan area, is the more difficult. Being far-sighted enough is one difficulty, normally dwarfed, however, by the difficulties of securing consensus among contiguous jurisdictions and maintaining it through changing political administrations.

98. Singapore and Curitiba, Brazil, the two developing-country cities widely considered to have best managed their motorization, have benefitted immensely from gradually elaborating and implementing long-term structural plans set decades ago. In the case of Singapore[98], it was a plan drawn up over the decade following achievement of self-government in 1959 (partly reacting to a more conventional plan prepared by the colonial authorities), envisaging the island's development pattern resembling the shape of a lotus flower seen from the side; transport arteries have been steadily developed along the lines of both outer and inner petals, and settlements located along them. In the case of Curitiba, it was a plan drawn up in 1965, benefitting from space-reservation under a 1943 technical assistance plan but using the space in a

[96] Pendall (1999)
[97] Lee (1999), Wheaton (1998).
[98] Chua (1997)

completely different way, to accommodate high-density settlement and public transport routes along a few selected radii from the center.[99] Important details of both plans' implementation – excessive depopulation of old, central Singapore and too distant location of some of the new housing estates, too abrupt decline of densities around Curitiba's center and along the edges of the radii and inadequate incorporation of new immigrants – can appropriately be criticized. They resulted mainly from excesses of government involvement in plan implementation. But they do not alter the debt that citizens of both places owe to those who conceived the plans and developed over the years numerous imaginative elaborations to realize more fully their basic objectives.

99. A well-chosen and readily accessible long-term structural plan is crucial for maintaining the possibility of a substantial role for public transport as an alternative to the private car. As pointed out in para. 38, the possibilities for managing motorization effectively are severely restricted unless public-transport alternatives are available. The structural plan permits rational procurement of lands, or easements, for future rights of way for main arteries. It also allows rational development of population densities, higher in proximity to the rights of way, whether aided by zoning and permitted Floor Area Ratios or left more to market forces. Mainline public transport services cannot normally be economically feasible if the neighborhoods alongside them do not have densities of at least 50 persons per hectare. The Singapore and Curitiba structural plans were particularly crucial in enabling the steady development of the high-quality public transport services both cities provide. Singapore finally decided to construct its MRT system only in 1982, but it faced no delays on land acquisition because the right of way had been reserved under the 1960s structural plan. It was also able to provide good service to a considerable proportion of the population right from the opening of the first stage in 1988 because high-density housing estates had been built in proximity to that right of way. Curitiba was able to respond effectively to different traveler preferences by developing an increasing variety of bus services, some stopping and some express with accelerated boarding arrangements, because so much of the demand was concentrated on the main routes defined by the five gradually extended radii. In both cities more than 60% of downtown trips use the public transport services.

100. Establishing and enforcing planning standards for the micro-level interface between trunk infrastructure and local developments is equally important. City planning staff must play a key role in maintaining balance between provision of private parking facilities and the capacities of the street network,[100] in locating high trip-generators (such as shopping centers) in places conveniently accessible by public transport, and in ensuring that new subdivisions provide public space for movement consistent with the needs of contiguous areas and broader networks. While great care has to be taken, as emphasized in para. 95 (point 2), to avoid the excessive subdivision standards that are often currently imposed, it nonetheless remains important to insist upon the minimum necessary to permit development of adjoining land parcels and to keep purely local traffic off main streets.[101] Proper provision also needs to be made for pedestrian movement. A principal conclusion from a recent large comparative study even of London, New York, Paris and Tokyo was the overriding importance of building neighborhoods to be walkable.[102] The

[99] Cervero (1998)
[100] Monheim (1996)
[101] Dowall (1995, 1998)
[102] Carolyn Konheim, presenting at the January 2000 TRB meetings the main results of the study, Focas (1998).

physical environments built by the private sector affect the safety of people passing through and may have implications beyond the immediate area. For instance, in societies not yet widely using private motorized transport, residential environments suitable only for access by private vehicle will likely further push the process of motorization.

101. Development of processes for discussing, choosing and eventually sustaining skeletal plans for a city's macro-structure is of particular importance for the 'second cohort' of major cities, those which have been much smaller than a country's existing main centers but show signs of very rapid forthcoming growth (para. 19). Cities which have already grown to large sizes without an effective guiding plan still usually have scope for some improvements and rationalizations in future development, even though they may have lost the opportunity of major structural measures. Cities which are not yet on the verge of rapid growth could surely benefit from consideration of alternative possible future structures (note the importance of decisions in the 1940s and 1950s for the good development of Singapore and Curitiba in the 1980s and 1990s), but ability to do such work will depend on resources available.

Infrastructure for the Poor

102. The pressures set up by motorization have been one of the reasons for the deterioration of the housing standards of many of the urban poor, as pointed out in para. 31. While only the market is capable of responding efficiently to the variety of people's changing needs, it also has to be recognized that markets have to respond in the main to monetized demand, which gives less weight than most societies desire to attach to the needs of the poor. Government therefore has a crucial role to play in helping to organize and meet the needs of the poor, and this can have a large influence on their living conditions and transport requirements.

103. Adjusting building standards to realities, and stimulating competitiveness in the housing market, along the lines outlined in para. 95, can improve the housing prospects of some of the poor – as it did, for instance, in Bangkok[103] - but many will still need further help. Curitiba built accommodation for some 20,000 low-income households on lands that the state acquired early at low prices,[104] but this was very small compared with the needs that eventuated, and the large majority of migrants from the rural areas had to settle outside the city boundaries or even move to other towns and cities.[105] It would probably have been able to serve larger numbers if households had been given a freer hand on where to use the housing subsidy – probably more would have chosen locations closer to the center – and on when to sell on to others as their own needs evolved.

104. When Singapore achieved self-government in 1959, improvement of housing was a politically non-deferrable top priority, and the new government organized a massive public housing construction program. Because the program was very efficiently executed, and the need, though large, was limited by the island's fairly small population (there was not the almost uncontrollable volume of urban immigration characteristic of cities with large rural hinterlands), the worst of the problem was largely solved within a decade. Rapid progress in upgrading housing conditions was sustained throughout the 1960s and 1970s, although at the cost of

[103] Dowall (1994), Setchell (1995), Yap (1996)
[104] Rabinovitch (1996)
[105] These points are partially covered in Smith & Raemaekers (1998)

excessively wide dispersion of population and separation from jobs, mainly due to prolonged neglect of market considerations (consumer preferences) in management of the housing programs. The resultant problems were only gradually overcome through release of restrictions on purchase and sale of house leases, thus permitting people to move in response to changing job locations, and massive transport investments. By the 1990s Singapore had brought about one of the most impressive improvements in the general living conditions of the poor in a single generation that has been accomplished anywhere in the world.

105. The wider solution to the problem of housing for the poor, more relevant to the vast majority of developing country cities, is to help them gradually upgrade their existing quarters, whether in overcrowded and deteriorating downtown tenements, in centrally located slums or in recent or new shanty-towns at urban peripheries. But action is usually needed for very large numbers, and therefore has to be carefully chosen. Once the owners of space in these areas have security of tenure, they can be expected to contribute to local improvements and also to accept some longer-term reimbursement responsibilities, while retaining of course the right to sell their interest in the scheme to others when a change in their situation requires them to move. What is needed from local government is help in organizing for such works, up-front financing for the public share of the costs of the schemes, and extension of trunk infrastructure – of paved roads, NMT tracks, storm drains, water supply lines and sanitation facilities – to serve these often previously neglected areas. Public finance is often also needed to help with assemblage of lands for redevelopment, to remove major environmental hazards, and to provide basic infrastructure to areas capable of accommodating the often large annual inflow of new migrants to the urban area.

106. Programs of this sort are severely constrained in most cities by financial stringencies. They could evidently benefit substantially from the compact city's lower needs for road-building **and** from availability of part of the financial flows to the government that are a by-product of mechanisms to secure a more efficient use of congested road space. As pointed out in para. 65, a significant part of these flows really correspond to rent for the public land that is dedicated to space for vehicle movement and parking. Recognizing a broad housing-transport link, some cities have already channelled some of the tax receipts from vehicles into support for housing programs; for instance, Buenos Aires has an old 'Vivienda Popular' tax on motor fuel sales.[106] Taxes of the types proposed in the present paper would contribute more effectively to relieving congestion and also generate larger revenues for resolving the housing problem.

Municipal Finance

107. The flows of funds that would be appropriate in any given metropolitan area can only be determined in light of the specific conditions regarding road space congestion and priorities for incremental public spending in that area. But it is clear that potential revenues from more adequate charging for use of the land devoted to roads and parking are often considerable. Different authors have treated the subject in different ways, many North Americans focussing explicitly on identifying the subsidy drivers enjoy from free parking and roads, Europeans concentrating more attention on estimating appropriate levels for congestion charges, of which a part would be returns to land.

[106] Fundacion de Investigaciones Economicas Latinoamericanas (1995)

108. These differences, no doubt reflecting differences among countries in the problems that have been of most concern, are visible in Table 1.1. For instance, the study of Santiago, applying largely North American methodology, estimates the unpaid externalities for land and parking at nearly 2.0% of regional GDP. Official estimates for the Netherlands indicate a subsidy on public parking alone of 0.2% of national GDP.[107] Application of a rationalized approach to public and on-street parking in the U.S.A., by setting variable fees at whatever level is necessary to maintain approximately 15% vacant spaces[108] (and adjusting the supply of parking spaces to yield a normal return on the investment) would generate additional revenues of at least the same proportion of GDP. As for the congestion approach, Newbery's estimates for the U.K. have indicated total congestion charge revenues approximately equivalent to (and taking the place of) total revenues[109] from all existing, fairly high road user charges (fuel taxes, vehicle acquisition and registration taxes, net of V.A.T.), equivalent to 2.3% of GDP. He also showed that these revenues would adequately cover, inter alia, rental of the land area devoted to the national highway network. The portion of the congestion revenue specifically attributable as land-rent in cities would need to be calculated on the basis of GIS data summarizing current land values (in areas defined by concentric circles at different distances from city centers and subsidiary nodes) and square meters of road in the same areal categories.

109. Sound management of motorization in a metropolitan area thus requires a more systematic accounting of road user charge revenues than usual in the past. Many governments still relate such revenues essentially to the annual recurrent and capital expenditures of the roads department, expecting in addition to receive from road users at least a traditional, substantial contribution to general government income. This paper has shown that the charges need to be designed in such a way as to reflect as closely as possible the marginal social costs of alternatives (routes, vehicles, fuels, timings, etc.) among which potential road users can choose. And the resultant revenues need to be directed to agencies responsible for corresponding services to road users and those affected by their activities – and, in the important specific case of land rents, to priorities selected on a broader base. Table 6.1 summarizes some of the main financial flows that might be foreseen for a metropolitan area (abstracting, for the sake of clarity, from the issue of different levels of government involved).

110. The revenue assignments are not intended to reflect a rigid system of earmarking, but rather to capture the relationship between what users pay for a service and what public authorities spend to provide it, however the government may please to channel funds. The 'Roads Department' is envisaged to be run on a largely commercial basis, and it might even be imagined that it would be paying the Health Department or Police for services rendered (last column), but the purpose of the table is not to show more than that users would be paying and relevant department of government would be providing. The 'Finance Department' (which might possibly receive all the revenues in the first round) is envisaged here more as agent for compensating externality victims and, more importantly, for decision regarding uses of the substantial land rent expected and other general revenues, including (not listed explicitly in the

[107] Verhoef et al. (1995)
[108] Shoup (1999)
[109] Newbery (1990). Taxes charging vehicles for the marginal costs of the damage they do to road surfaces would not be replaced under Newbery's proposal and indeed represent an important area for improvement in the management of many countries' road systems, as noted in para. 77. We skip over this point in the present context because the revenues involved are much smaller, and have no bearing on the issue of interest here.

Table 6.1
Proposed Sources/Uses of Revenues from Road Users in a Metropolitan Area

Source	to Roads Department	to Finance Department	to Other Departments
Congestion & Parking Charges (paras. 60 - 62)	- Interest on total past investment - Maintenance and management of metropolitan network - Contribution for use of road network elsewhere in country	- Land rent from metropolitan network and public parking space	
Pollution-Based Fines & Charges (paras. 75 - 78)	- Pollution-reduction expenditures (e.g. noise barriers, vehicle testing, NMT networks)	- General revenue contribution from "polluter pay" rationing - Reduction taxes on persons working/dwelling close to roads - Subsidies for vehicle retrofitting and scrapping	- Public Health Department for anti-pollution measures related health services
Accident Related Taxes & Charges (paras. 88 - 89)	- Safety improvements to structures (street layout, etc)	- Compensation for victims of uninsured or "hit-&-run" drivers	- Police, prevention/ emergency services - Public Health Department, emergency services

table) proceeds from V.A.T. on the different inputs into motor transport and from any luxury taxes that it is decided to retain on it. These funds would provide the source for the proposed investments in infrastructure services to low-income settlements or for any subsidies that it was envisaged to offer to other transport modes.

111. One important outcome of application of the policies proposed in this paper will be to increase the demand for public transport services. In a few cases, this would revive demand for services that have been losing traffic and have spare capacity. In many other cases, it will be a matter of creating renewed demand for bus services, to which the private sector should be able to respond effectively provided that a fair, competitive framework for its participation in public transport services has been established. But in an increasing number of cases it should be expected that major investments will be required in bus-ways, light rail transit (LRT) and mass rapid transit (MRT), whether above or below ground. Especially in the case of MRT systems, the recent evidence is that only in the direst of transport situations (eg., Bangkok) can they be expected to be financially viable in their early years of operation. Moreover, as pointed out in para. 45, there is some justification in economic theory for provision of limited public subsidy to services that can be shown to be economically justified for investment now but can only gradually attain adequate scale to be financially viable; the subsidy should not be in excess of the amount that would be needed to enable fares to be set at short-run marginal costs. While such subsidy was provided in the case of Singapore's MRT by government financing of all the capital costs of the system, it would represent a financial burden in excess of what many other governments could bear.

112. A solution that should be particularly applicable in developing and transition countries, where transport networks remain much more limited than in most OECD countries so that individual improvements can dramatically affect accessibility, is to mobilize the interest of potential or existing users of lands that would particularly benefit, as was done in Hong Kong. There are various ways of doing this:[110]

- build/operate/transfer (BOT) schemes, incorporating special provision for the private transport developer and operator to receive not only fare-box revenues for a fixed period but also revenues from exploitation of development rights on specified contiguous lands: this is probably the surest, soundest approach;

- the concept of 'planning gain', under which developers benefitting from improved accessibility are required to contribute financially or to build parts of the transport facility;

- land development taxes or other forms of betterment fee, with the levy from the beneficiaries paying directly for the transport investment;

- direct increases in property taxes on landowners benefitting, and hypothecation of the resultant revenues to the transport agency to cover debt-service, etc. on the transport investment made.

These represent different ways of mobilizing growing land rents (on lands not used directly for transport) to provide support for accomplishment of transport investments offering substantial scale economies. Their use also permits a more equitable allocation of the costs and benefits of such schemes than frequently occurs when the investment is financed largely by sources from outside the metropolitan area.

113. Combined application of the transport, housing and land-use measures outlined in this paper is both a necessary and, in most circumstances, sufficient condition for overcoming the more extreme problems that motorization is giving rise to in large urban areas of the developing world. Beyond the initial changes in transport patterns mentioned in para. 91, they would bring about a gradual reallocation of dwelling and working activities' location in such a way as to achieve the combinations of space and access that can best satisfy the city's inhabitants within the constraints of the area's resources and geography. The pace at which improvement can be made clearly depends on broader trends in the region's development as well as on actions in the specific fields focussed here. But there is every reason to expect that, in particular, the proportion of people living in hopeless slums could be vastly reduced; journeys to work, if not at the half-hour maintained in most of the OECD countries, should be able to be cut to within 45 minutes; and the integrity of the agglomeration as a large market with wide choices for labor, production and consumption would be enhanced.

[110] Arnott (1998)

VI. CONCLUSIONS

114. Cars and other motor vehicles have made a very large contribution to economic development during the twentieth century, but they have also had major negative side effects. By integrating them better with general development patterns, their net contribution can be vastly increased. This is largely a matter of public policies affecting cars and settlement patterns, most particularly those determining the relationship between prices and costs. Pricing policies that are essential for increasing efficiency in use of road and other space are also essential for greater equity in housing and transport provision. The broad lines of needed policy improvement are now clear, and a variety of instruments have been developed and applied.

115. It is particularly urgent for large cities throughout the developing world, and for middle-income countries more generally, to develop explicit policies on these matters, appropriate to their particular situation:

- Significant proportions of their citizens are already facing far more serious problems, which are largely side-effects of motor vehicles, than have been experienced in the OECD countries – very long journeys to work (or extreme overcrowding close to work) and serious health impacts (pollution, accidents, noise) on the large numbers living/working in or close to the street,

- Motor vehicle parks are growing extremely rapidly, at sustained rates of often 10-15% p.a., and sometimes more,

- The share of householders who have private vehicles and therefore might have to adjust travel habits in response to more adequate pricing of vehicle use remains a minority, still seldom more than 30%,

- The great diversification and improvement of telecommunication services that is continuing means that they will play a steadily increasing role in substitution and complementarity to physical travel, so that pricing principles applied in transport need not only to ensure fair competition between modes as in the past, but also between physical movement and telecommunications alternatives,

- The rapid urban development in prospect over the next forty years may well prove the last phase of fast demographic growth, so that it offers a last main opportunity to avoid the unsatisfactory, excessively car-dependent urban form that many OECD cities feel they are stuck with.

The combination of these factors means that developing and transition countries would be wise to take measures in this area with much more alacrity than the OECD countries.

116. Regulatory, planning and pricing policies all have an important part to play and need to be used in mutually supportive packages. But all need to be conceived within a framework that seeks to improve the operation of the market for space and for access, conveying to economic agents the real costs (including external costs) of alternative possible combinations of space and access. Regulatory policies selected within such a framework – ie. wherever the marginal costs

they impose are less than those of alternative measures for reducing a negative side-effect of car use – can be expected to continue to reduce the overall burden of externalities. But a large residual will remain which needs to be charged back to operators. Such charging will not eliminate the externalities but it will reduce them to the level at which the gain to society from further reduction would be less than the value to its members of the journeys that they make. In the particular case of congestion, which is likely to grow increasingly important among externalities as pollution and accident-rates are reduced through technological advance and behavioral adjustment, the required charges are likely to generate substantial revenues. A significant part of these revenues could be devoted to providing the public contribution that is essential to make sizeable impact on the large infrastructural backlog that underlies the housing problems of the poor. The policy packages and programs would clearly need to be drawn up specifically for each particular case. But an indication of what should be possible may be given, using the broad orders of magnitude suggested by research to date, and the discussions of appropriate policy responses in Sections IV and V.

117. Thus, for example, if the current burden of externalities is equivalent to 5% of the region's annual GDP, and identified regulatory measures could reduce it over 5-10 years to say 3.5%, it would be reasonable to expect that a gradually escalating series of pricing measures could cut it in half, to 1.7%, while generating revenues equivalent to perhaps 4% of GDP, of which 2% may be in replacement of existing, less apposite taxes on road users, 1% for compensatory and preventative expenditures for pollution and accidents, and the other 1% available for broader purposes – including the attack on slum housing conditions. (Net government revenues from road users in Singapore rose from about 2.5% of GDP in the early 1980s to 3.5% in the late 1980s, before the stronger price restraints were introduced in the early 1990s; by 1993 net revenues were equivalent to nearly 5% of GDP.) While these numbers illustrate the potential direct fiscal implications for the government, the changing relative prices resulting from the market improvement process in transport and in housing would be expected gradually to bring about even more significant changes in the region's economy, reducing distances that people need to travel, securing a more efficient disposition of the space available to the city, and hence enhancing its competitiveness vis-à-vis other economic centers.

118. Past World Bank lending activity most relevant to the issues of motorization has been the extensive support provided for reform and reorganization of urban public transport – both bus and rail – in many countries, some support for urban road building, and loans to a few cities in support of programs for reduction of air pollution. IFC has also been involved in a few BOT projects in urban public transport and in urban road building. Through policy dialogues surrounding broader highways lending, required studies, and commitments under highway loans, the Bank has also contributed in many countries to strengthening highway safety programs, and to increasing recovery from highway users at least of the costs that they impose for maintenance and reconstruction of the highway network. More specifically focussing on motorization, the Bank in the late 1980s and early 1990s devoted serious attention, without eventual success, to interesting Bangkok and Kuala Lumpur in application of some of the techniques applied in Singapore for reducing traffic congestion. In the middle 1990s, it produced very thorough studies of urban transport problems in the rapidly motorizing cities of Poland,[111] recommending gradual transition to electronic road pricing, and it organized a major seminar on motorization

[111] World Bank (1995)

and urban transport development in China.[112] In the late 1990s it began, through the Sub-Saharan Africa Transport Program (SSATP), a program of studies and seminars on urban transport issues, and management of cars in towns, in Africa.

119. Sufficient experience has now been accumulated around the world, as illustrated in this report, that the Bank should be prepared to respond substantively to cities seeking international advice on broader policies affecting cars, for instance within the framework of preparing their City Development Strategy – or in contributions to the broader, national Comprehensive Development Framework. Such advice would need to be based principally on an on-site assessment of both efficiency and equity aspects of the current operation of the transport and land-use/housing markets, as presented in Sections IV-VI of this report. An important lesson from countries' past experience in this area is that explicit analysis of the problems and possibilities, and bold experimentation followed by any needed adjustment, give much superior results to leaving the problems to fester.[113]

120. With the Bank focussing more on helping countries, and their outside supporters, to develop promising solutions, feasible at the national scale, to the major problems faced by poor people, the general space/access issues raised by motorization and related developments should be receiving much more attention from the Bank than in the past. Also, in the search for local funds to finance efforts targeting reduction of urban poverty, it will not be possible to neglect the much increased revenues that it would be economically efficient to collect from cars nor the savings on road building that should be possible with a more compact city. Thus the Bank should maintain ball-park estimates and breakdowns of the amounts of taxes and charges that it believes should be collected from main vehicle classes, even if such numbers have long to be used only as reminders to all of what would be desirable. At the same time, for the short term, the Bank should be enthusiastically encouraging and promoting every even small step in the right direction that societies begin to find feasible. And pending countries' adoption of more rational pricing structures, particular attention must be given to avoiding the risk of over-investment, in excess infrastructure.

121. To enhance the feasible quality of outsider advice to a country, and – probably more importantly – to spread local understanding of motorization issues, the Bank should seek all means to encourage and assist development of local capacities in its member countries for assessing road transport externalities.[114] The Bank has made significant contributions to the development and application of methodologies for assessing local air pollution externalities, especially in a number of Asian, Latin American and West African cities. It has also promoted assessments of road accident externalities in many countries, work which will no doubt be further stimulated by the Global Road Safety Partnership. Comprehensive studies of road transport externalities are currently under preparation by a few cities and countries, including Abidjan and the Republic of South Africa. The Santiago study referred to in this report provides a valuable example, and useful compilations and assessments of methods have now become available.[115] In some countries, such work may best be done, especially in the first instance, by

[112] Stares & Zhi (1996)
[113] Gorham (1998), Willoughby (2000).
[114] Continuous work in this area is already standard practice in many of the European countries. For the case of France, for example, see Conseil National des Transports (1999) passim and the recommendations on p. 104.
[115] See Litman (1999), and Gomez-Ibanez (1997).

environmental NGOs with trained economic staff, since they would foster the development of lively local debate about the issue, helping to generate the base of popular understanding for subsequent political action. In other cases, the work may be done in an interested government department, such as that responsible for Environment or for Urban Development. But in either case the focus should be on developing standing capacities for preparing such assessments, carrying out research to strengthen their foundations, disseminating the results, and bringing them to bear in discussions of local development priorities.

122. Another important technique for gathering information and developing public understanding is the execution of well-designed surveys of people's experience and opinion about travel and housing. These may be done by the same institutions just mentioned, by professional public opinion research entities or by the newsmedia. Such surveys are now regularly conducted in most European countries and are an important means of educating public opinion and informing politicians. In Europe they tend quite often to suggest that public opinion is more ready for additional restrictions on downtown car usage than most politicians perceive.[116]

123. The World Bank Institute (W.B.I.) could evidently play a useful role in helping to lay the foundation for constructive policy reform in this area of day-to-day concern to so many hundreds of millions of people. A short course should be mounted either directly by W.B.I., or jointly with a transport/environment research institute or university department, addressed specifically to people from developing-country NGOs or government departments who would be working on assessment and valuation of transport externalities, organizing public opinion surveys of the type just discussed, and generally promoting serious public discussion of urban transport questions. Second, Singapore might be prepared to organize a High-Level Policy Seminar for Mayors of developing/transition country cities seriously thinking about applying some of the non-conventional policies toward cars that have been developed there. W.B.I., which is already developing collaboration with Singapore (including on a forthcoming general urban development seminar), would probably be able to contribute usefully to design of curriculum and recruitment of participants. It would be important to include in the delegation for a city also one or two senior representatives of concerned central government departments.

124. The Bank's sectoral Networks could make valuable contributions to improve countries' ability to assess motorization externalities, particularly by policy/research work to clarify some important issues of economic valuation. There would seem to be need for the Human Development Network to work with the Environment Department and the Infrastructure Department to agree common standards and methodologies for valuing human lives; at present the Bank appears to be in transition towards applying Willingness to Pay methodologies, with the result that health-related initiatives (such as measures to reduce air pollution and accidents) are sometimes proposed to countries on inconsistent bases, making it more difficult for countries to try to ensure sound allocation of available funds among all the different ways of saving lives. It would also be highly desirable to enable the Environment Department to organize further work to alleviate the extreme shortage of high-quality research on pollution dose-response and on noise valuation in the circumstances of developing-country cities.

[116] See, for example. Conseil National des Transports (1999), p. 96; Rietveld & Verhoef (1998); and Suchorzewski (1999)

125. In addition to this important work to spread and deepen appreciation of motor vehicles' externalities, some further research would be very useful, along the lines opened up by this report, with regard to evolving urban form and the role played by cars, and policies toward them, in shaping cities. Such work would seem to be most suitable for support by an independent foundation interested in environmental and urban development issues, including in developing and transition countries. Some city assessments have already been done, some of them referred to in the course of this report, but very few deal simultaneously with consumer preferences and costs; rather, they tend either to emphasize correspondence of interesting urban forms with apparent consumer preferences without reference to costs, or to emphasize certain aspects of costs without reference to consumer preferences. What is needed is comparative analysis of selected cities' development experience, covering both space and access (housing, employment and transport) and how they were and are paid for, with special attention to the evolving situation of the poor. Studies of this nature, including for a number of the cities touched on in this report – such as Zurich, Singapore, Sao Paolo and Curitiba – could make an invaluable contribution to helping developing-country cities improve management of their motorization process and achieve a better development pattern for all their citizens.

126. As the foundations of knowledge on management of motorization are strengthened over the next few years by the actions discussed above, it may become appropriate for the aid community to organize an informal Partnership drawing together the wide variety of interested parties from the aid community itself, from developing/transition countries and cities, from foundations/universities, and from companies interested in areas such as public transport and real estate development. That would enable high-quality advice and assistance to cities and countries as they confront the difficult decisions that growth of motorization will inevitably pose.

ANNEX 1

Note on Measuring and Pricing Congestion

A1. The different concepts applied in the externality studies listed in Table 1.1 which did try to estimate total costs of congestion can be explained most clearly with the aid of the conventional diagram for analyzing congestion's microeconomic costs. This is shown in Chart A1, which converts the engineer's traditional speed-flow curve, relating traffic flow to speed on a given stretch of road, into a cost curve relating traffic flow to the time-cost involved in traversing one kilometer. This is shown as the AVC (Average Variable Cost) curve, while the SRMC (Short Run Marginal Cost) curve is the derivative of total costs, showing the incremental costs incurred by all users combined as the traffic flow increases. If drivers are not made aware of the congestion costs they are imposing on others, traffic will expand to the inefficient equilibrium level shown by Qnow, where the demand curve cuts the AVC curve which also reflects *private* marginal costs. AB, the difference between marginal costs and average costs at this traffic level measures the cost that each additional vehicle adds to the costs of others at this level of traffic flow. The most efficient level of traffic would be at Qopt, where the demand curve cuts the SRMC curve, but getting there would require imposition of a congestion charge CE, raising the cost of the journey to the individual driver from Average Variable Costs to the SRMC level. This would generate substantial revenue to the road authority, cause a small proportion of the drivers to abandon their trip (mainly transferring to other vehicles by ride-sharing or use of bus, or adjusting timing), and marginally reduce travel time for remaining road users.

A2. The studies dealing with individual cities in developing countries normally cost congestion essentially by multiplying existing congested traffic volumes by the value of the extra journey times (and extra vehicle operating costs) that such traffic faces compared with free-flow or off-peak travel conditions. This corresponds to the area FBJH in the chart. It is the amount that was earlier estimated for the European Union as a whole at 2% of GDP.

A3. Though more difficult to calculate, the most accurate concept of the costs of congestion, within this microeconomic framework, is the so-called 'deadweight loss' that it imposes, as measured by the triangle ABC in Chart A1, reflecting costs that the users who are responsible would not be prepared to pay even if asked. It is equal to the delay costs to "old" travellers (rectangle FGEx) minus the incremental consumer surplus (triangle CBx). This is the amount which (as reflected in column vi of Table 1.1) has been estimated by a group of European specialists[117] as averaging about 0.75% of GDP for the countries of the European Union.

A4. The much higher figure cited from the U.K. study included in Table 1.1 results, however, from use of another concept – essentially multiplying the line AB in the chart by total traffic – in order to give an indication of the marginal costs presently caused by traffic, and to raise the question whether *all* journeys are really of such great value to those who undertake them. Yet another concept of the costs of congestion, sometimes used though not in the studies covered here, is the total revenue that would be generated by congestion charging (i.e. line CE in the

[117] ECMT (1999)

chart, multiplied by total traffic). On normal assumptions about cost curves and demand elasticities, it would likely be about three times the deadweight loss from not correcting the excess congestion, and somewhat greater than the simple measure of congestion costs (area FBJH) discussed in para. A2.[118]

A5. As a basis for considering the prices that might be charged for use of congested roads, Chart A2 builds on the static picture previously discussed to depict different congestion situations on a given section of road over the course of time. It incorporates the assumption of diseconomies of scale and long-run increasing costs, because that best captures the typical situation in developing countries' major cities, but the implications would not be significantly different with constant returns to scale. The left-hand side of the chart gives the short-run average and marginal costs curves for an existing road, as in Chart A1, while the right-hand portion shows the same curves for a substantially expanded and upgraded version of this road. The demand curves D_1-D_6 reflect the expansion of demand for use of the road over the course of time, say twenty years, and the vertical lines Q_1-Q_6 show the optimum traffic for each level of demand and, by the thick part, the size of the congestion charge (in, say, $ per car per kilometer) needed to limit traffic to this level.

A6. D_1 and D_2 stand for the early years of normal traffic growth well within the capacity of the road, provided that adequate congestion charges are levied. D_3 represents higher levels of demand, much closer to, or above, the maximum capacity of the road, when congestion charges *may* have the effect of *increasing* traffic flow as well as its speed. While the optimum level of traffic implied (Q_3) is considered to be an unstable equilibrium, very susceptible to renewal of gridlock, with traffic and speed both falling again, there is general recognition of the appropriateness of congestion charges to help correct such a situation.[119] D_4 stands for the years of traffic growth well within the capacity of the expanded road. D_5 depicts, for the larger road, return of the situation described for D_3.

A7. D_6 shows the situation when no further expansion of the road is possible despite continuing growth of potential traffic demand. Insofar as expansion is already considered unacceptable for many urban roads, whether in developed or developing countries, this case may have wide relevance; in other words, not a few urban roads may already be now at the D_5-D_6 situation, unable to expand further.[120] Empirical estimates of appropriate congestion charges so far made for developing country cities usually assume that the situation they are dealing with corresponds to D_1 (or D_4), but since the results have not been applied in practice, it is unclear whether these assumptions were correct. The countries that have used pricing most seriously to cope with congestion, most notably Singapore, have tended to make the opposite assumption, that their situation was more akin to D_6; hence the combination of pricing constraints they have used.

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[118] see calculations in Newbery (1990).
[119] See, for example, Gerondeau (1999), in ECMT (1999).
[120] There is, of course, almost always the possibility of building an underground tunnel, but this so raises investment costs as to be of very limited relevance to developing countries.

Chart A1
Congestion Equilibirum at a Single Point in Time

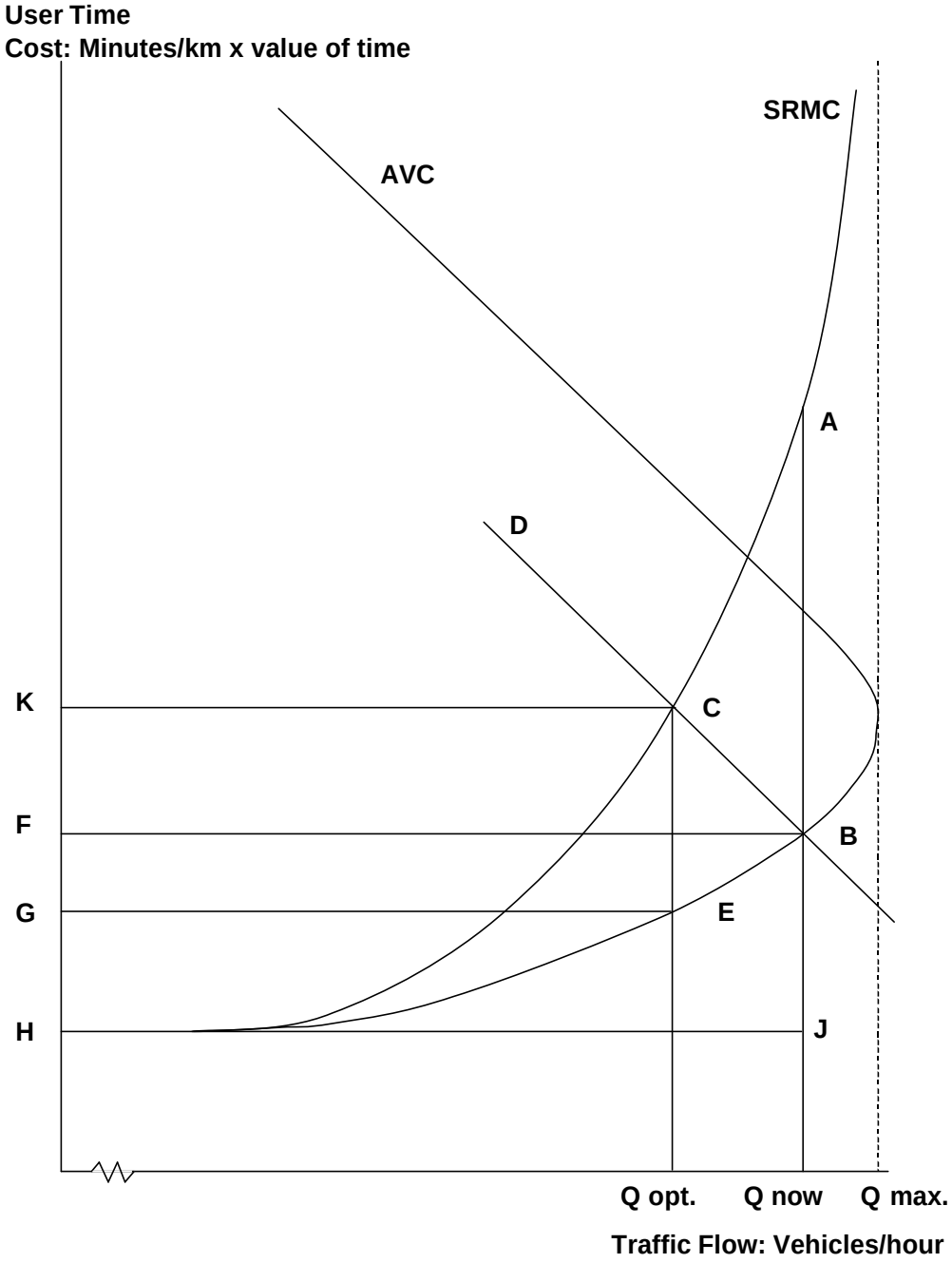
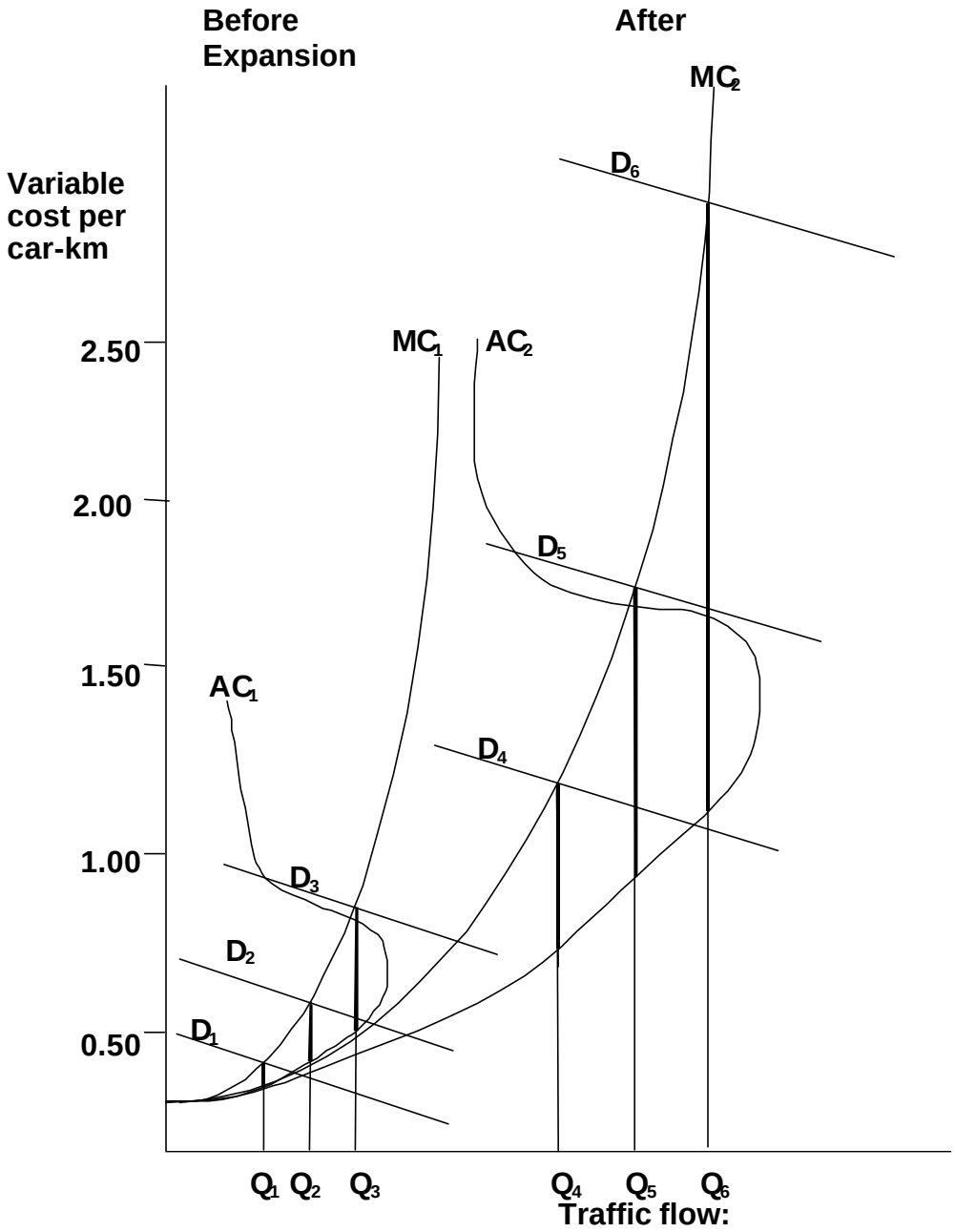


Chart A2
Evolution of Congestion and its Costs over Time



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