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Motor vehicle taxes as an environmental management instrument: the case of Singapore

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Abstract Being geographically small, land scarcity poses a potential constraint for economic growth in Singapore. Restraining car ownership and car use through motor vehicle taxes is part of the land-transport policy to ensure smoother traffic flow. This paper analyses the use of motor vehicle taxes in Singapore as an environmental management instrument. It evaluates the effectiveness of ownership and use taxes as instruments to internalise congestion and environment externality. Economic issues relating to the use of such taxes are also highlighted. It concludes that motor vehicle taxes offer Singapore a double dividend.

Key words Congestion externality · Double dividend · Environment · Motor vehicle taxes · Ownership and use tax

1 Introduction

Economic growth with rising incomes leads to an increase in the demand for cars and roads to transport goods and people. In many developed countries the rate of transport growth has roughly paralleled the rate of gross domestic product (GDP) growth; but for developing countries and many rapidly emerging economies transport growth rates are around two to three times that of the GDP (Orfeuil 1996, p. 163). In many developing countries the growth in car population has outstripped economic growth (Bahl and Linn 1992, p. 191).

Growth in road transport has many economic, social, and environmental impacts. Rapid growth in car population and car use leads to an increase in

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demand for road space. If this demand is not adequately managed, road congestion sets in, which brings about productivity loss because of the time lost in transit. Hewitt (1987) estimated the economic cost to be £15 billion a year for Britain. Lomax and coworkers (1988) estimated that for the city of Los Angeles alone economic loss amounted to US$6 billion a year or about US$3 a day per vehicle on the road. Studies by the Organisation for Economic Cooperation and Development (OECD 1994) put estimates of economic loss due to time lost in transit at about 2%–3% of the GDP, noise costs at about 0.3%, accident costs at about 1.5%–2.0%, and local environment pollution at about 0.4%, putting the total cost at 4%–6% of the GDP.[1] These figures imply that significant gains can be achieved if the motoring externalities are internalised through some forms of Pigouvian taxes (Pigou 1920), or green taxes, as they are now popularly known.

Repetto and colleagues (1992) suggested that green taxes, such as congestion tolls, are effective in achieving environmental goals and may deliver multiple dividends. Many OECD countries, especially the Scandinavian members, have actively undertaken environmental tax reforms to coordinate the environment and tax policies. In the OECD 1995 survey, green taxes[2] were seen to be gaining importance, on average accounting for 7.0% of the total tax revenue, varying between 3.8% and 11.2%, with almost two-thirds of the revenues arising from taxes on petrol and diesel fuel (OECD 1999). Taxes alter the relative prices to ensure that economic agents take into account the external cost of transport. Tax instruments are better than command and control measures; they are self-regulating because, once implemented, they allow market forces to operate and regulate.

Although Singapore does not have an explicit environmental tax policy, the scale and scope of motor vehicle-related taxes are both extensive and comprehensive. These taxes, which are part of the land transport policy, comprise about 20% of the government operating revenue (Chia 1998). In April 1998 changes were made to rationalise the two-decades-old motor vehicle tax structure, restructuring it to one based on use rather than ownership. Does this change also imply that the policy, which has arisen as part of the land-use policy, has now been shifted to one based on environmental considerations?

Although private cars are not the only contributor to motoring externalities, they are singled out in most motor vehicle tax policies. In terms of energy use, private cars are the least efficient, consuming more coal per passenger kilometre than other forms of transport, such as long distance jet, intercity rail, urban rails, and buses (Baron 1980). Furthermore, cars (though they have a capacity for four or five people are often occupied by one only) use one-

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[1] The environmental consequences of transport were well documented by Britain's Royal Commission on Environmental Pollution (1995).

[2] This includes taxes on energy and motor vehicles, which have environmental dimensions as well.

third to one-half the road space of a bus or a minibus with larger passenger capacity.

2 Car ownership and car use management in Singapore

Singapore is a small country (area 641 km^2 only) with a per-capita income of US$23000. With 220 vehicles per kilometre, it has one of the highest vehicle densities in the world, after Thailand (260 vehicles per kilometre), compared to Britain (67/km), Canada (17/km), and the United States (34/km).[3]

In the area of transport policy, Singapore's policymakers are willing to experiment with and implement innovative fiscal and regulatory measures to restrict car ownership and car use. Ownership taxes (e.g., the one-off sales and excise taxes on new vehicles) have more indirect impact on the environment, whereas use taxes (e.g., fuel tax and road pricing scheme) affect car use behaviour and hence have a direct effect on the environment.

2.1 Car ownership restraints

Ownership taxes include (a) one-off tax on sales or initial registration of motor vehicles and (b) annual or recurrent taxes on registration.

2.1.1 One-off sales tax Table 1 indicates the types of motor vehicle-related taxes currently administered in the OECD countries. Generally, the one-off sales tax on motor vehicles is higher than the sales tax on other goods or is imposed in addition to the general sales tax (or both). This one-off ownership tax can also take on environmental dimensions. For example, some OECD countries (Denmark, Finland, Germany, The Netherlands, Norway) introduced motoring taxes based on the "environmental" attributes of the vehicle. They include differentiated taxes on car types, depending on whether they are equipped with catalytic converters (which convert carbon monoxide and hydrocarbons to carbon dioxide and water and reduce nitrogen dioxide to elemental nitrogen and oxygen). The United States has a "gas-guzzler" tax, ranging from US$1000 to US$7700 per car, which is added to the sale of any new car with above-average fuel consumption (i.e., with fuel efficiency less than 22.5 miles per gallon). In January 1992 Austria introduced a new tax on car registration with an explicit environmental consideration, with the tax rates depending on the average petrol consumption and using the selling price of the car as the base.

Singapore, though not unique in using the one-off ownership tax, administers such a tax with more breadth and depth than that found in OECD countries, as seen in Table 2. Ownership taxes in Singapore include an import duty, a lump sum registration fee, an additional registration fee, an annual road tax, and certificate of entitlement (COE) premiums under the vehicle quota system (VQS).

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[3] Calculated from "Living with the car," *The Economist*, December 6, 1997.

Table 1. Environmentally related taxes and charges in OECD countries

Environmental tax measures	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y
One-off vehicle ownership taxes																									
Sales/excise/Registration tax differential (cars)			×	×	×	×			×	×	×	×			×	×		×	×		×	×	×		×
Road/registration tax Differential (cars)			×	×	×			×		×	×	×	×		×	×		×		×	×	×	×		
Motor fuels																									
Leaded/unleaded (differential)	×		×		×	×	×	×		×	×	×		×	×	×	×	×	×	×	×	×	×	×	
Diesel (quality differential)					×	×												×			×				
Carbon/energy taxation					×	×										×		×			×				
Sulphur																		×			×				
Other excise taxes (excluding VAT)	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
Other energy products																									
Other excise taxes	×	×	×		×	×	×	×	×		×	×	×	×	×	×		×		×	×	×		×	×
Carbon/energy taxation					×	×										×		×			×				
Sulphur tax					×		×											×			×				
NOx charge							×														×				

Source: Adapted from OECD (1996)

OECD, Organisation for Economic Cooperation and Development

A, Australia; B; Austria; C, Belgium; D, Canada; E, Denmark; F, Finland; G, France; H, Germany; I, Greece; J, Iceland; K, Ireland; L, Italy; M, Japan; N, Luxembourg; O, Mexico; P, The Netherlands; Q, New Zealand; R, Norway; S, Portugal; T, Spain; U, Sweden; V, Switzerland; W, Turkey; X, UK; Y, US

Table 2. Motor vehicle ownership tax and charges in Singapore

1. One-off vehicle ownership related tax
   - Customs duty: 31% of open market value (OMV), which also includes cost insurance freight (CIF), handling, and other incidental charges paid
   - Good and services tax: 3% CIF plus customs duty payable
   - Registration fee (RF): S$140

2. Additional registration fee (ARF): 140% of the open market value of cars
   Scrappage bounty—preferential additional registration fee (PARF)
   - To offset the discouragement effect on new car ownership arising from ARF, scrappage bounty was introduced in December 1975.
   - Car owners registering a new car could use PARF benefit to offset the ARF, RF, and certificate of entitlement (COE) premiums of any new car if they would scrap (or export) an old car, which must not be more than 10 years of age.
   - The PARF benefits vary with the age of the vehicle at deregistration.

Age of vehicle at deregistration	*PARF benefit (% of OMV)*
<5 Years	130%
<6 Years	120%
<7 Years	110%
<8 Years	100%
<9 Years	90%
<10 Years	80%

   Imported cars are not eligible for PARF benefits.

3. Annual road tax
   - Levied progressively based on engine capacity as follows:

Engine capacity (EC)	*Road tax formula*
EC ≤ 600 cc	$500 (flat rate)
600 < EC ≤ 1000 cc	S$500 + 0.25 × (EC-600)
1000 < EC ≤ 1600 cc	S$600 + 1.0 × (EC-1000)
1600 < EC ≤ 3000 cc	S$1200 + 1.8 × (EC-1600)
EC > 3000 cc	S$3720 + 2.5 × (EC-3000)

   - Road tax surcharge for vehicles over 10 years, at 10% surcharge for each additional year

4. COE under the vehicle quota system (VQS)
   - A motor vehicle quota system was implemented on May 1, 1990. To register a new car, the car buyer must bid or tender for a license or COE, under the appropriate vehicle category. There are seven vehicle categories. Tender is held monthly. [See Table 4 in Chia (1998) for an example of a tender result.]
   - The number of new vehicles allowed for registration is predetermined annually, taking into account the road capacity, traffic conditions, and number of vehicles deregistered during the last calendar year to allow the vehicle population to grow at an annual rated of 3%.
   - The price of the COE depends on demand conditions, and the successful bidder pays the lowest successful price instead of the bid price.
   - Owner of a 10-year-old vehicle who wants it to remain on the road for another 10 years has to pay the prevailing quota premium.
   - Company-registered cars and heavy vehicles pay double the quota premiums.

An import duty of 31% is levied on the open market value of cars in addition to the 3% goods and services tax. Since 1980 the lump sum registration fee was kept at S$1000; but as of April 1998, as part of the vehicle tax rationalisation, the fee was reduced to S$140 to reflect the administrative cost of vehicle registration. The up-front cost of car ownership, however, is still inflated by the additional registration fee (ARF), which is levied at 140% of the open market value (OMV). Compared to countries with the one-off sales tax, the ARF in Singapore is high. Among the OECD countries, The Netherlands has the highest one-off tax at 45.2% sales tax on net values operating on top of the 17.5% value-added tax (VAT), and Japan has the lowest—an automobile acquisition tax at 5% of the purchase price levied on top of the 3% consumption tax.

2.1.2 Recurrent or annual ownership tax The recurrent or annual ownership tax commonly takes the form of an annual car licence or road tax. Environmental considerations can be incorporated into these charges: for example, by setting charges according to vehicle engine size or other factors affecting fuel use, such as cylinder capacity. In Germany the annual road tax is based on cylinder capacity, with the rates depending on the dates of registration, pollution emissions, and engine type (petrol engine versus diesel engine). These taxes are likely to affect the types of car ownership but unlikely to affect the marginal cost of car trips. In Britain, however, the annual car licence is a flat lump sum of £135, which does not distinguish between cars of different size.

All registered cars in Singapore are subject to the annual road tax, which is levied progressively according to engine capacity (see panel 2 of Table 2). This progressivity not only reflects the principle of social equity but also has environmental implications because large engine capacity vehicles, which tend to contribute more to the urban air pollution, are taxed at a higher rate. The road tax structure also acknowledges the higher pollution contributions by older cars. Thus, cars more than 10 years old are subject to an annual road tax surcharge of 10% for each additional year; for example, a 13-year old car faces a surcharge of 30%.

Table 3 compares the motor vehicle tax reliance with the conventional tax reliance for Singapore and some selected OECD countries. The importance of the ownership tax in Singapore is evidenced from the revenue collected: 17% of the total operating revenue.

2.1.3 Vehicle quota scheme Table 4 shows the various adjustments on ownership taxes over the period 1970–1996. Despite these changes, the car population grew at an annual rate of 7.3%. Phang and Chin (1989) attributed this to the strong income effect arising from the double-digit economic growth during the 1980s, which offset the price effect due to fiscal measures. This suggests that policies targeting the up-front cost of car ownership may not be adequate. In May 1990 an important instrument, a vehicle quota system (VQS), was introduced to regulate the quantity of automobiles directly.

Table 3. Motor vehicle tax reliance relative to conventional tax reliance for selected OECD countries and Singapore

Country	Year	One-off vehicle tax	Motor fuel tax	Income tax	Value-added tax
Australia	1992/1993	1.6	0	72.2	10.4
Canada	1991/1992	0.1	0	58.6	13.3
Denmark	1993	4.3	0	45.3	28.2
Finland	1994	1.8	0	31.6	28.9
Netherlands	1993	3.0	3.4	33.5	15.0
Norway	1993	3.2	4.7	19.7	26.4
Singapore	**1995**	**17.4**[a]	**3.4**[a,b]	**41.5**	**32.9**
Sweden	1993	1.8	9.2	7.1	25.7
UK	1993/1994	1.7	0	37.5	20.8
US	1993	1.2	1.9	54.4	NA

Source: Data for OECD countries are compiled from OECD (1995) and IMF (1997). Data for Singapore were compiled from Accountant-General of Singapore and Chia (1998)
NA, not available
[a] Percent of operating revenue includes both tax and nontax revenues. Collections from the ARF and COE premiums (ownership tax) are classified as nontax revenues
[b] Include also other taxes and charges relating to car use, such as congestion tolls and traffic fines

Under the vehicle quota scheme, every buyer of a new vehicle must first bid for a certificate of entitlement (COE). The tender is held monthly. The Land Transport Authority (LTA)[4] predetermines the yearly quota, which allows the vehicle population to grow at an annual rate of 3%. The number of COEs available depends on road capacity, traffic conditions, and the number of vehicles deregistered during the last calendar year. With a preset quantity (the supply), through the bidding mechanism (the strength of demand), a market-clearing price (the quota premium) is determined. The successful bidder pays the lowest successful price, instead of the bid price.

The VQS has limited the car ownership growth in Singapore. Using elasticity estimates from an econometric model, Chin and Smith (1997) projected that the number of private automobiles registered in 1993 would have been 7.4% higher if the VQS had not been implemented.

Although there was some public unhappiness that led to several rounds of fine-tuning, the quantity-rationing scheme is considered acceptable by the public (Phang et al 1996). The government sets the quantity with the quota premium depending on how prospective car owners bid. Although the "tax burden" on the individual has increased, it is regarded as a direct outcome of the market mechanisms.

[4] The LTA is a statutory board under the Ministry of Communications set up in September 1995. It integrates several government agencies involved in land transport and administers all demand management schemes such as congestion pricing and the VQS.

Table 4. Changes in car ownership taxes in Singapore, 1968–1998

Parameter	1968–Oct '72	Oct '72–Dec '73	Jan '74–Mar '75	Mar '75–Dec '75	Dec '75–Feb '80	Feb '80–Oct '83[a]	Oct '83–Oct '84	Oct '84–Nov '88	Nov '88–Nov '90	Nov '90–Feb '91	Feb '91–May '97	May '97–Mar '98	April 1998
Import duties (% of OMV)	30	45	45	45	45	45	45	45	45	45	41	41	41
Registration fee (S$)	15	15	15	15	15	1000	1000	1000	1000	1000	1000	1000	140
Additional registration Fee (% of OMV)	15	25	55	55	100	150	175	175	175	160[a]	150	150	140
Annual road tax (cents/cc)[b]													
Up to 1000 cc	10	10	14	20	35	40	52	60	70	70	70	70[c]	$500 + 0.25(EC 600)
1000–1600 cc	10	12	15	25	40	50	65	75	90	90	90	90[c]	$600 + 1.0(EC 1000)
1601–2000 cc	10	15	2	30	45	60	78	90	105	105	105	105[c]	$1200 + 1.8(EC 1600)
2001–3000 cc	10	20	25	40	50	70	91	105	125	125	125	125[c]	$1200 + 1.8(EC 1600)
>3000 cc	10	30	60	65	80	100	130	150	175	175	175	175[c]	$3720 + 2.5(EC 3000)

Source: Phang (1993), Registry of Vehicles, Land Transport Authority (1997)

This road tax structure took effect in September 1998, when electronic road pricing (ERP) replaced the manual road pricing schemes, the ALS and RPS. The annual road tax is a flat $500 for engine capacity smaller than 600 cc. Road-tax rebate of $200 is given for every car, with annual rebates expected for several years

OMV, open market value; EC, engine capacity; ALS, area licensing scheme; RPS, road pricing scheme

[a] With the introduction of the car quota system in May 1990, the additional registration fee was reduced

[b] From 1975, company cars were subjected to 200% of private car road tax. From September 1, 1998, both company and private car pay the same rate

[c] In a move toward charging according to car use under the road pricing scheme, a rebate on the annual road tax was introduced in May 1997, with rebates of $60 for cars or commercial vehicles, $20 for motorcycles, and $10 for weekend/off-peak cars

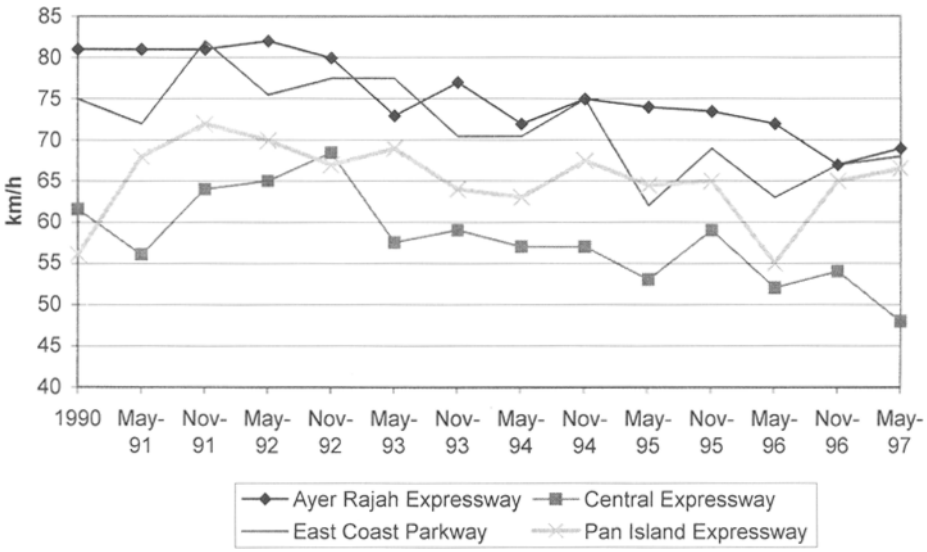

Fig. 1. Average traffic speed (morning peak) on major expressways. In June 1995 the road pricing scheme (RPS) was introduced on the East Coast Parkway for the morning peak hours. In May 1997 the RPS was extended to the Pan Island Expressway and the Central Expressway. Source: Land Transport Authority (1997)

2.2 Car use restraints

For three decades the design of motoring taxes had placed a heavier burden on car ownership than on car use so motorists face a high, fixed, up-front cost and lower variable-use cost. Thus, for a typical medium-size car, ownership cost (includes the OMV, custom duty, ARF, road tax, and COE) comprises about 70% of its overall cost (add fuel, parking, insurance, and road pricing charges).

Although economic instruments targeting car ownership have somewhat controlled the car population growth, congestion externality has not been fully addressed. When the VQS was introduced in May 1991, the average traffic speeds during the morning peak hours improved for all expressways except one (Fig. 1). However, after the motorists had adapted to the VQS, road use surged again; and by May 1995 traffic speeds for all expressways were in fact slower than the pre-VQS traffic speeds.

To address motoring externality directly, motoring taxes must be restructured toward taxing car use. In March 1998, as part of the motor vehicle tax rationalisation, ownership taxes were decreased and use taxes were increased. The annual road tax was reduced, ARF was lowered from 150% to 140%, and an electronic road pricing (ERP) scheme was phased in. By intensifying the scale and scope of use taxes, LTA hopes to maintain motoring fixed and use costs at 50:50.

From an economic efficiency point of view, taxing car ownership does not address the motoring externality, as it is not the stock of cars but car use that leads to congestion and environmental pollution.[5] Ownership taxes, particularly the vehicle quota system, check only on the growth of the "stock" of private automobiles. Use taxes encourage more discriminating use of cars. Car use taxes thus adhere more closely to the "polluter pays principle" and more closely represent an eco-tax because the tax paid bears a direct relation to the environmental costs imposed by the journey. However, a first best tax is one that charges according to the amount of pollutants actually emitted.[6] The incentive instruments used to restrict car use include (a) fuel taxes, (b) parking charges, (c) road-congestion pricing, and (d) the off-peak car scheme.

2.2.1 Fuel tax The fuel tax is a more direct form of eco-tax, as the tax varies with the amount of fuel consumed, which in turn affects the amount of vehicle emissions. Compared to ownership taxes or other charges, such as parking charges, the fuel tax targets motoring externalities more directly. Fuel consumption tends to be higher in congested urban traffic where there are more stops and starts, resulting in higher pollutant concentration. It is also simple to administer, is difficult to avoid or evade, and can be modified easily. Road users may respond by reducing the number or the length of trips, switching to more fuel-efficient vehicles, or driving in a more fuel-efficient way. Most OECD countries have fuel taxes (Table 1). It is recognised, however, that fuel taxes are not enough to internalise the motoring externalities (OECD, 1998, Part II).

The fuel tax may have limited effect on car use in Singapore. Ang (1989) concluded that the demand elasticity of petrol in Singapore was price-inelastic. This is not surprising because with high up-front ownership cost the fuel cost is a small proportion of the total monetary cost; hence the fuel tax is likely to have a small price substitution effect. To be effective, a fuel tax must be complemented with regulatory policy to inhibit cross-border topping up (Table 5, panel 1).

The fuel tax is less effective as an eco-tax than congestion tolls. The fuel tax, being a flat rate tax, does not give consideration to the different extent of environmental damage between peak and nonpeak use and between more and less congested localities. It is, however, possible to implement a quality tax differential in favour of unleaded petrol as an incentive for using less environmentally damaging fuels. As reflected in Table 1, some Scandinavian countries also introduced separate carbon and sulphur taxes on motor fuels as part of their environmental tax measures.

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[5] Chia et al (2001) used a simple general equilibrium model to compare full internalisation of congestion externalities to optimal tax outcomes for ownership and use taxes. The numerical simulation result shows that use tax restores Pareto optimality, whereas ownership tax only partially internalises the motoring externality.

[6] The German Council of Environmental Advisors has put forward proposals for a system of charges that would be directly related to quantities of pollutants emitted. Data on the use of a car during the year would be stored in an electronic engine management system, read out as part of the annual test on emissions, and passed on to the tax authorities.

Table 5. Motor vehicle use taxes and charges in Singapore

1. Fuel taxes
   - Differential tax for leaded and unleaded petrol
     Unleaded petrol tax: 60 cents per litre; leaded petrol: additional 15 cents per litre
   - Differential tax rate for petrol and diesel: diesel tax: 7 cents per litre (scheduled public buses exempted from diesel taxes)
   - "Three-quarter tank" rule was introduced to restrict cross-border topping up so it is an offence for a Singapore-registered car to enter Malaysia with less than 3/4 tank of petrol

2. Parking fees
   - The rates charged by the two main public sector operators of car parks are
     Within CBD: 90 cents per half-hour 8:30 am to 5:00 pm
     45 cents per half-hour 5:00 am to 10:0.0 pm
     Outside the CBD: 45 cents per half-hour 8:30 am to 10:00 pm

3. Congestion tolls
   a. Area licensing scheme (ALS)
      - All vehicles must pay for a license to gain entry into the restricted zone
      - Initiated in 1975 and had gone through many rounds of fine-tuning, which include
        May 1975—applied to morning peak hours (7:30–9:30), fee at $3 per car
        August 1975—morning peak extended to 7:30–10:15 am
        August 1977—fee adjusted to $4 per car
        June 1989—evening peak introduced 4:30–6:30 pm
        May 1997—whole-day ALS implemented with two types of licenses: a part-day license for off-peak hours (9:30 am to 4:30 pm on weekdays) and a whole-day license for peak hours (7:30 am to 7:00 pm on weekdays) and vary for different vehicles

        ALS license fees differ for different vehicles.

Vehicle	*Part day*	*Full day*
Motorcycles	S$0.70/day	S$1/day
	S$14/month	S$20/month
Private cars and other vehicles	S$2/day	S$3/day
	S$40/month	S$60/month
Company cars	S$4/day	S$6/day
	S$80/month	S$120/month

      - Vehicles entering the restricted zones are closely monitored for valid licenses; a hefty fine of S$70 for not displaying the license is implemented

   b. Road pricing scheme (RPS)
      - RPS is a expressway congestion pricing introduced June 1, 1995. It was initially applied to two points of the East Coast Parkway (ECP) during the morning peak (7:30–8:30 am).
      - May 5, 1997, RPS was extended to the Pan Island Expressway (PIE) and the Central Expressway (CTE). The peak hours were extended to 7:30–9:30 am.
      - Motorists using these three highways leading to the city during morning peak must purchase and display an RPS license. The license has a similar fee structure as the part-day ALS.
      - RPS license can be used for entering the CBD as an ALS license during the off-peak period. Except for the north–south CTE, a valid ALS license can also be used as an RPS license for the other two east–west highways, the ECP and the PIE.

   c. Electronic road pricing (ERP)
      - First phase was introduced April 1, 1998. In September 1998, the ERP replaces all manual road pricing schemes and the off-peak car scheme.
      - Electronic tolls vary by the time and location of travel and the road space occupied by moving vehicles.

Table 5. *Continued*

- ERP charges at the ECP from April 1, 1998 for the different vehicle types are as follows (PCU, passenger car unit).

Vehicle type/time period	*7.30–8.00*	*8:00–9:00*	*9:00–10:00*
Motorcycle, scooter (PCU 0.5)	\$0.50	\$1.00	\$0.50
Car (PCU 1)	\$1.00	\$2.00	\$1.00
Taxi (PCU 1)	\$0.35	\$0.70	\$0.35
Light good vehicles (PCU 1)	\$0.25	\$0.50	\$0.25
Heavy good vehicles, bus (<30 seats) (PCU 1.5)	\$0.40	\$0.80	\$0.40
Very heavy good vehicles, bus (>30 seats) (PCU 2.0)	\$0.50	\$1.00	\$0.50

- The manual RPS allows unlimited passage through the gantries with a single license, whereas under the ERP motorists are charged for each passage.

4. Off-peak car
   - Introduced in October 1994 as the revamped version of the weekend car scheme. Off-peak cars are identified by a red number plate, which is required to be welded onto the vehicle and sealed by an authorised inspection centre.
   - Buyers of off-peak cars enjoy tax rebates of S\$17 000 on car registration fee and import duty; and a flat discount of S\$800 on the annual road tax. Buyers have to bid in the same COE category as those buying cars for normal use and pay the same COE price.
   - Use of off-peak cars are restricted to Sundays and public holidays and during off-peak hours (between 7 pm and 7 am on weekdays and after 3 pm on Saturday). A day license at ≤20 to be displayed on the windscreen is required if the car is used outside the permitted hours. Five free day licenses are given for each year.
   - The penalty for using an off-peak car outside the permitted time and without proper license is a fine equal to half the annual road tax for an equivalent normal car for a first offence. For second and subsequent offences, the fine is equal to the full annual road tax for an equivalent normal car. The penalty for tampering with the number plate of the weekend car is a fine equal to twice the annual road tax for an equivalent normal car.

2.2.2 Parking fees The parking fee differential is used to reflect the geographical distribution of congestion. Within the central business district (CBD), hourly-rate charges are used to favour short-term parking (e.g., by shoppers or commuters) and against all-day parking (e.g., by workers in the CBD). However, whether high parking fees deter car use depends on the cost of parking relative to the total cost of operating a car.

2.2.3 Road pricing schemes Road pricing or congestion pricing is a direct solution to congestion. In principle, roads can be priced not only to reflect congestion costs but also to give a broader indication of environmental costs in certain areas (mainly, but not exclusively, urban areas) and at particular times. Compared to increasing road capacity to cope with demands, congestion pricing is more cost-effective because it shifts demands to other periods or to other modes of transport. Furthermore, many economists[7] believe in the fundamental law of traffic congestion: "On urban commuter expressway, peak-hour congestion rises to

[7] Example: Repetto et al (1992).

meet maximum capacity" (Downs 1962). It is believed that there are some "latent demands" for highway travel, so whenever road capacity increases extra drivers appear to fill the new capacity and congestion sets in again.

Singapore is the first city in the world to experiment with road-pricing schemes. As early as June 2, 1975, a congestion zone-pricing scheme for the city centre under the area licensing scheme (ALS) was introduced. The ALS is a manual, simple, low-technological scheme under which a single charge is levied for vehicles entering the restricted zone (RZ), which is a well-defined area of 720 hectares with 27 entry points. About 70% of jobs are concentrated within the RZ. All cars (including taxis) are required to display a paper licence on the windscreen. Panel 3a of Table 5 shows the fee structure of the ALS and how the ALS was fine-tuned over the two decades of its use.

In 1995 the road pricing scheme (RPS) was introduced to relieve congestion on specific stretches of the expressways and to distribute traffic to other time periods and to alternative routes. It also helps prepare motorists for more road pricing under the electronic road pricing scheme (ERP). The RPS was levied during the peak morning hours on three major expressways for stretches leading to the city centre (see panel 3b of Table 5).

In April 1998, with the implementation of the ERP, the scale of the use tax increased. Singapore is again the first city to introduce an electronic toll that varies according to the time and location of travel and the occupation of road space. The RPS points on the East Coast Expressway were replaced by the electronic toll in April 1998. More recently, in September 1998 the ERP replaced the manual ALS in the city centre and all remaining RPS points, and it is expected to extend to other choke points on the expressways and arterial roads. For now, those who do not value their time as much have the alternative to take the more congested, nonpriced routes.

The ERP system utilises a sophisticated technology combining radiofrequency, optical detection, imaging, and "smart card" technologies.[8] The ERP technology allows roads to be priced to reflect both the direct and indirect environmental and economic costs of driving. Roads are priced according to the time of travel, with higher rates for travel during the "peak within a peak" period (i.e., from 8 am to 9 am). To spread this peak and to smooth peak traffic flow to ensure better utilisation of the expressways, shoulder pricing is used. Lower shoulder rates apply to travels done during the less congested hours of the morning peak. The ERP charges also vary according to the passenger car unit (PCU) ratings of the

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[8] The ERP system consists of three main components: the in-vehicle unit (IU), the gantry, and the central computer system. All vehicles are fitted with the IU, which is an electronic smart card reader, on the windscreen. The IU has an LCD screen that displays the stored-value balance and confirms every transaction with a beeping sound. The ERP gantries work in pairs in two zones. The first antenna at the first gantry checks the validity of the stored-value smart card and executes debiting instruction. The second antenna in the second gantry deducts charges and photographs the rear licence plate of violating vehicles (no smart card or an insufficient balance on the smart card) and transmits the record to the Central Computer System in the ERP Control Centre in the LTA office.

various categories of vehicles. The PCU is the amount of space a moving vehicle takes up. Panel 3c of Table 5 shows the charges for two major expressways.

Unlike the existing manual ALS system, the ERP technology allows charging different rates for different expressways and for different entry gantries into the city centre. The toll is ≤3 per entry for the most congested and $0.50 for the least congested corridors. The price differentiation is likely to have an impact on the modes and time of travel. The Singapore ERP is unlike the dynamic road pricing on the 13-km stretch of I-15 in San Diego California, which fluctuates directly with the actual traffic volumes. The LTA administers the road charges, conducts regular reviews of traffic conditions, and adjusts charges every 3 months to achieve targeted speed ranges of 45–65 kph for expressways and 20–30 kph for arterial roads (for the latest rate, see http://www.lta.gov.sg).

2.2.4 Impacts of road pricing on traffic volume and traffic speed The experience of Singapore shows that tolls may be the most effective way to deal with peak hour congestion, but they must be fine-tuned periodically as new information becomes available. Figures 2 and 3 show the impact of ALS on traffic volume into the city centre. When it was first implemented, traffic volume into the city centre reduced by more than half, but by May 1976 traffic volume into the RZ started creeping up. Even with an increase in fee to $4 from $3 in 1977, traffic volume continued to increase. It seems that the income effect (from strong economic growth) had offset the substitution effect. Menon and Lam (1992) found that not

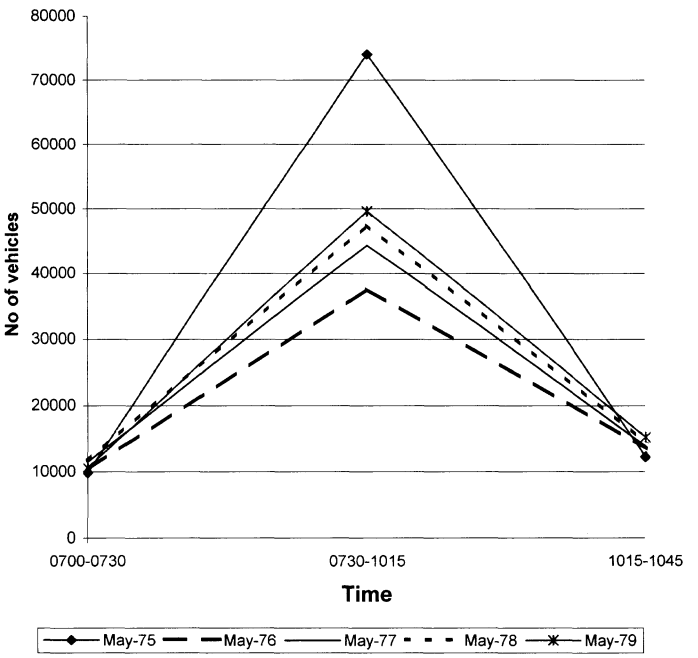

Fig. 2. Impact of ALS on traffic volume in the restricted zone (RZ), 1975–1979. Source; data presented by Seah (1980)

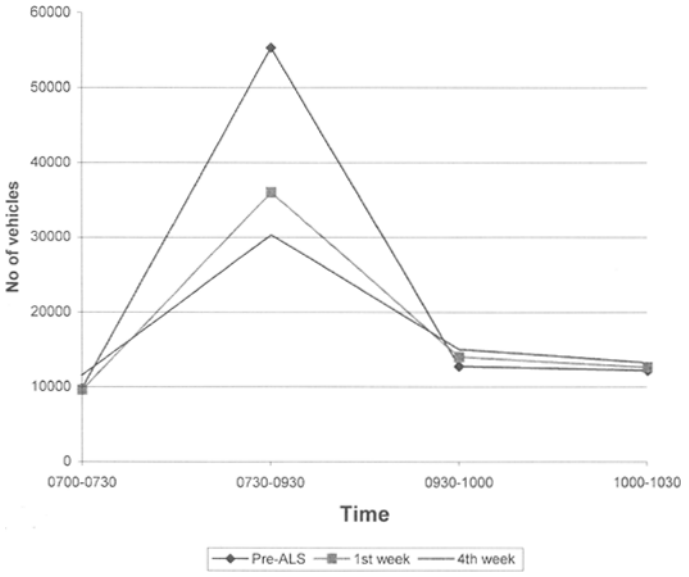

Fig. 3. Initial impact of ALS on traffic volume in the RZ. Source: Watson and Holland (1978)

only had peak hour traffic volume increased, traffic volume into the RZ during the pre- and postrestricted time had also increased. To smooth traffic flow, in June 1989 the congestion toll was extended to the evening peak hours.

The ALS had ensured satisfactory traffic flows during the morning and evening restricted hours. During the nonrestricted hours, however, there was an increase in traffic volume and a fall in traffic speed so the average traffic speed in the RZ during peak hours was higher than during off-peak hours. In January 1994 the ALS was changed into a "whole-day" ALS, which marked the start of a more extensive use of road pricing to regulate traffic by using differential pricing for different time periods (see panel 1a of Table 3). The implementation of whole-day ALS reduced traffic in the city area by 9.3%.

Similarly, when the RPS was introduced, traffic volume dropped by almost 40% and traffic speed improved from 40 kph to 67 kph (Land Transport Authority 1997, p. 12).

Traffic monitoring after introduction of the ERP indicated a fall in overall traffic volume on the East Coast Parkway by 15% (from 16000 to 13000 vehicles). Average speeds have increased to 50–60 kph during the peak hour, which is considered respectable for expressways during peak hours. Motorists are also taking advantage of the reduced shoulder rates during the periods 7:30–8:00 am and 9:00 am–9:30 am so that average traffic volume is reduced by 22% for the peak-within-peak hour, thus helping to spread the peak hour traffic.

2.2.5 Off-peak car scheme Singapore implemented an off-peak car scheme in October 1994 as a regulatory measure to restrict car use to nonpeak hours and

Table 6. Air quality before and after implementation of the ALS

Substance	Pre-ALS April (morning peak)	Post-ALS June (morning peak)
Total nitric oxide	167 μg/m^3	144 μg/m^3
Average level of carbon monoxide	7 ppm	4 ppm
Smoke level	189 μg/m^3	172 μg/m^3

Source: Anti-Pollution Unit, Annual Report 1975

weekends only. Tax concessions through savings in the ARF, custom duties, road tax, and lower COE premiums made the scheme highly attractive as they lower the up-front cost of car ownership. Car use restriction was enforced with stiff penalties imposed on violators (see details in Table 5, panel 4). In principle, the scheme reduced peak period congestion and therefore effectively checked on pollutant concentration during the peak hours. The off-peak car scheme has now been replaced by the ERP.

3 Environmental impact of motor vehicle-related taxes

The design of motor vehicle taxes in Singapore, though an outcome of land-use policy, has direct impacts on air quality. The OECD (1997) reported that in the OECD transport accounted for 20% of carbon dioxide emission in 1995 compared to 14% in 1980. The major culprit was energy transformation activities, which accounted for 40% of total carbon dioxide emissions compared to 35% in 1980. However, in Singapore, Kahn (1994) estimated that automobile emissions accounted for about 65% of the air pollution in Singapore; power generation and industry contributed 25% and 10%, respectively.

As in many OECD countries, there is a shortage of data when it comes to evaluating the effects of transport taxes on air pollution. Evaluating green taxes is also complicated by the fact it is difficult to isolate their impacts, as they are generally applied simultaneously with other instruments (e.g., regulations). We can only estimate the environmental impacts indirectly via the impact on traffic flow. Restricting car use and, to a certain extent, reducing car ownership have reduced pollutants from mobile sources. The various road-pricing schemes have distributed traffic away from the congested places and times and lowered the peak-hour pollutant concentration.

When the ALS was introduced in 1975, changes in the ambient air quality were monitored. The ALS resulted in a 45% reduction in traffic volume during the morning peak hour. Table 6 shows that a lower level of nitrogen oxides was registered, although the reduction in carbon monoxide and smoke levels was marginal.[9]

Congestion tolls cause commuters to reschedule trips or change their mode of transport (or both). Between 1990 and 1996, the average weekday ridership on

[9] Since then, no follow-up measurements have been undertaken.

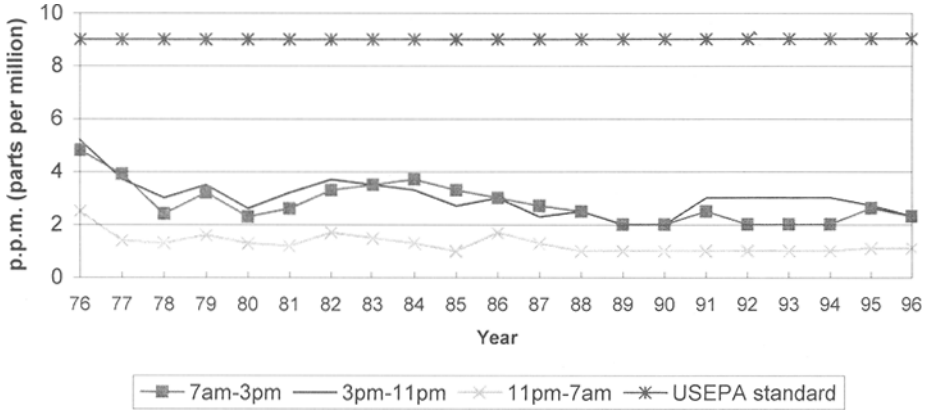

Fig. 4. Ambient carbon monoxide level in an urban area. Source: Anti-Pollution Unit, Annuals; Pollution Control Departments, Annual Reports and Department of Statistics, Yearbook of Statistics

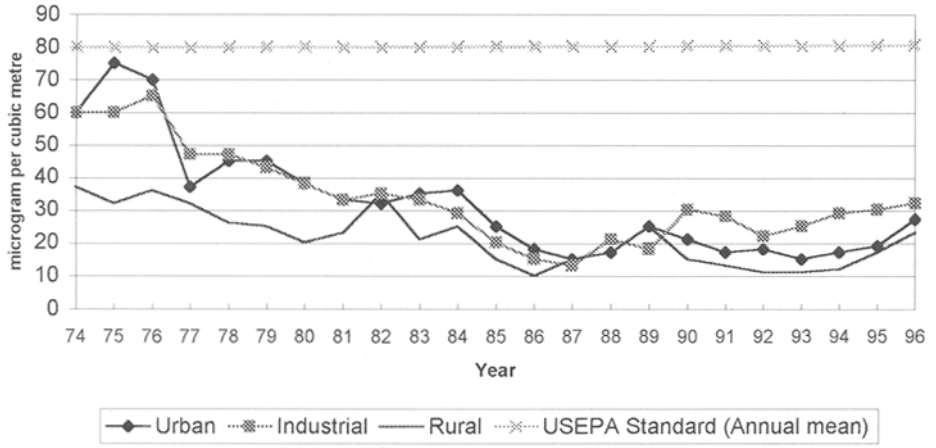

Fig. 5. Annual average levels of sulphur dioxide, 1974–1996. Source: Antipollution Unit Annuals; Pollution Control Departments Annual Reports and Department of Statistics, Yearbook of Statistics

the Mass Rapid Transit (MRT) increased by 41% for the three major stations within the central business district: Orchard, Raffles Place, and City Hall (Department of Statistics 1996). The reduced traffic volumes and increased traffic speed imply fewer stops and starts and lower pollution concentration.

Figures 4–8 show the extent of air pollution in Singapore. The levels of carbon monoxide, sulphur dioxide, nitrogen oxide, smoke, and average lead concentration in Singapore are well within the World Health Organisation (WHO) and U.S. Environmental Protection Agency (USEPA) standards.

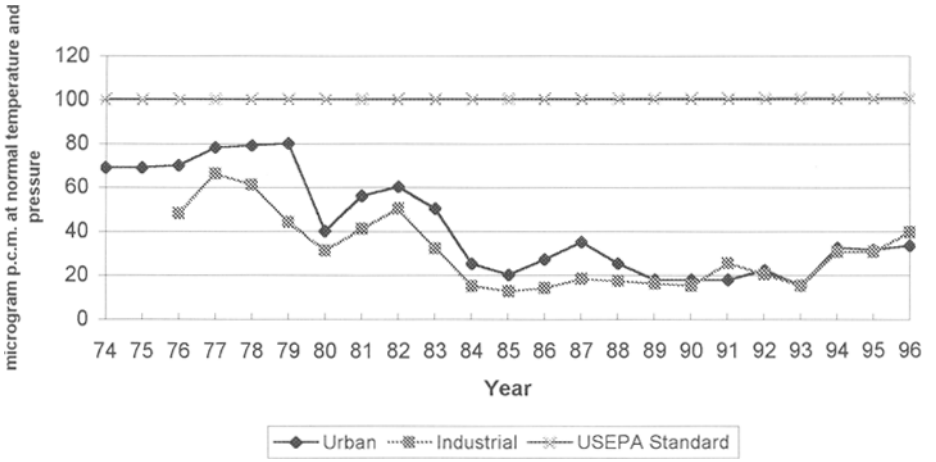

Fig. 6. Annual average levels of nitrogen dioxide, 1974–1996. Source: Anti-Pollution Unit, Annuals; Pollution Control Departments, Annual Reports and Department of Statistics, Yearbook of Statistics

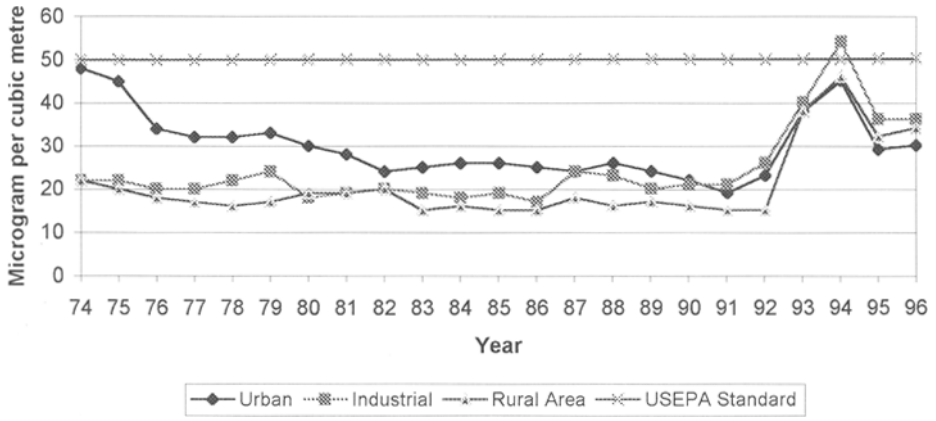

Fig. 7. Annual average levels of respirable suspended particles (PM10). Source: Anti-Pollution Unit, Annuals; Pollution Control Department, Annual Reports and Department of Statistics, Yearbook of Statistics

Figure 4 shows that the ambient carbon monoxide level in the urban area of Singapore has fallen significantly since 1976. The roadside levels of carbon monoxide are low. The 8-hour average levels are within the WHO's long-term goal and within the USEPA standard of 9 parts per million (ppm).

Figures 5–8 show that after 1992 air pollution from sulphur dioxide, nitrogen oxide, and particularly smoke has worsened. This is due to cross-border externality from the forest fires in Indonesia. The proportion of "good" days [with pollutant standard index (PSI) readings of 0–50] has dropped compared to

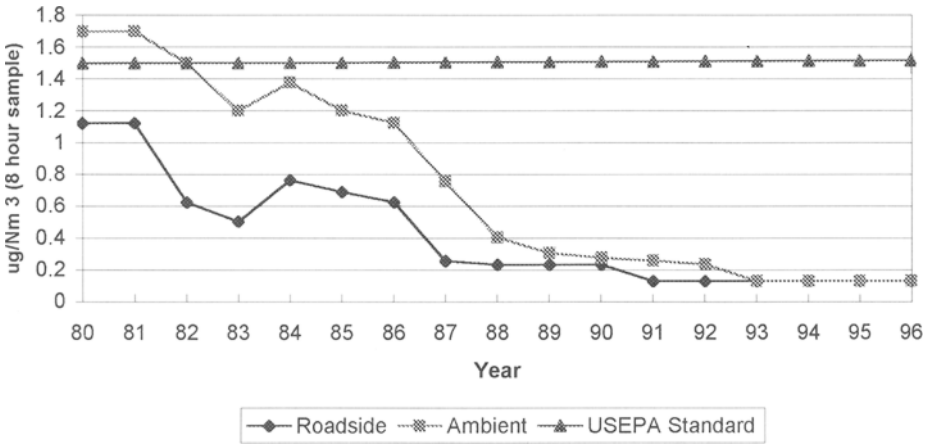

Fig. 8. Average lead concentration, 1980–1996. Source: Pollution Control Unit, Annual Report, various years. In June 1987 lead in petrol was 0.4–0.15 g/l. Unleaded petrol was introduced in Januray 1991

"moderate" days (PSI 51–100). In 1996 there were fewer "good" days (64% vs. 77% in 1992) and more "moderate" days (36% vs. 23% in 1992).

3.1 Other regulatory policies

Economic instruments via tax instruments help restrain car ownership and car use, but they must be complemented by other command and control policies that regulate vehicle emissions directly. These two sets of policy instruments reinforce each other. In the United States, although the EPA lobbied for "more stringent limits on gasoline volatility, control hydrocarbon vapors that evaporate during vehicle refueling, tighten tailpipe emission standard, and require improvements in inspection and maintenance program," it concluded that these measures are not sufficient (EPA 1993a). The only way to ensure healthy air is to switch to cleaner fuel or reduce car use markedly. The EPA concluded that "cars are getting cleaner but people are driving more, hence offsetting progress in ozone pollution control." Although the average per-vehicle emissions has been reduced sharply, the increase in vehicle miles travelled offset the positive environmental impact.

In Singapore, regulatory policies used to complement the tax instruments include (a) fuel policies, (b) vehicle emission standards, (c) vehicle inspection and maintenance program, and (d) scrapping of old cars.

3.1.1 Fuel policies As discussed earlier, although the fuel tax in Singapore may have limited effects on the lead level through restricting car use, controlling fuel quality may have a more immediate impact. Since the 1980s, actions to reduce lead levels in petrol were implemented progressively. In June 1987 lead in petrol

was regulated at 0.4–0.15 g/l, which led to lower average lead levels. The fuel tax differential between leaded and unleaded petrol was introduced in January 1991. At the end of 1996 unleaded petrol accounted for 70% of the total petrol sales (Pollution Control Department 1997). Figure 8 shows that since 1992 the lead level has stabilised in the range of 0.1–0.2 $\mu g/Nm^3$ and has since remained low, well below the USEPA standard of 1.5 $\mu g/Nm^3$.

There is also a tax differential between diesel and petrol (panel 1, Table 5). Diesel is taxed at a lower rate because it is regarded as an intermediate input in commercial activities and public transport. However, diesel-driven cars (including taxis) are subjected to a road tax six times that of petrol-driven cars. Compared to diesel, emissions from petrol cars have higher nitrogen oxide and much higher volatile organic compounds and carbon monoxide, but lower sulphur dioxide and much lower particulate.

The quality of diesel is also regulated. As of July 1, 1996, the permissible level of sulphur in automotive diesel was reduced from 0.5% by weight to 0.3% by weight. This helped reduce smoke emission from diesel vehicles, as sulphur in diesel impedes combustion and increases smoke emission.

3.1.2 Vehicle emission standards and regulations The Pollution Control Department works closely with the LTA and the traffic police to monitor the level of vehicle emissions. More stringent standards have been adopted to govern emissions from motorcycles, scooters, and vehicles using petrol and diesel. The standards are revised from time to time, in line with the latest available technology, to minimise air pollution.

As of October 1, 1992, all motorcycles and scooters have had to comply with specified limits of carbon monoxide and hydrocarbon emissions over a test cycle. In July 1992 a stricter emission ruling for imported new cars was adopted. Before these cars can be registered, they must comply with the United Nations Economic Commission for Europe (UN/ECE) R83 or the Japanese internal standard JIS78 emission standards. To comply with the new standard, only cars fitted with catalytic converters are imported. From July 1994, the UN/ECE R83 was replaced by the more stringent consolidated emission directives (CED) adopted in the EC countries (Pollution Control Department 1997, p. 8).

In addition to setting stringent emission standards, there is also strong law enforcement to ensure compliance. The mobile police officers and smoke test teams patrol the roads daily. Through spot checks, vehicles emitting black smoke in excess of 50 Hartridge Smoke Units (HSU) are booked and fined.

3.1.3 Vehicle inspection and maintenance programs An inspection and maintenance (I/M) program is an effective way to ensure that the emission control system on a vehicle is working properly. All cars sold already meet the stringent pollution standards, but the low pollution profile can be retained if the emission control and engine are working properly. According to the EPA (1993b), in the United States, the average car on the road emits three to four times more pollution than the standards allowed for new cars. All vehicles on the road in Singapore are subject to statutory periodic inspection. The schedule of inspection

depends on the age and type of vehicles, with the frequency of inspection being shorter for older and diesel-driven vehicles.

The I/M program is constantly upgraded. Since June 1993, all vehicles must comply with the environmental standard of carbon monoxide emission in the exhaust system. The carbon monoxide level must not be more than 6% by volume for vehicles registered before October 1, 1986 and not more than 4.5% for those registered on or after October 1, 1986.

3.1.4 Scrapping of old cars High registration fees on new cars discourage car owners from replacing their cars or encourage them to buy old cars. This implies an ageing fleet of cars, which in turn has an environmental impact because older cars are not fitted with a catalytic converter and may not meet the environmental standards. Older cars tend to emit more pollutants and are noisier and less safe than newer vehicles. To encourage earlier retirement of older cars, a negative tax or subsidy for early retirement of older cars under the preferential additional registration fee (PARF) was introduced in December 1975. Car owners, in return for scrapping or exporting an old car, which must not be more than 10 years old, enjoy a bonus. The bonus can be used to offset the additional registration fee of any new car they buy. The PARF bounty is a percentage of the OMV and varies with the age of the scrapped vehicle. Scrappage bounty is also a mechanism to control the car population because with every new car registered an old car is deregistered (scrapped). The PARF benefit of deregistering a vehicle less than 10 years old is given in panel 4 of Table 2.

One consequence of scrappage bounty is the creation of a market for scrap cars, the prices of which varied by engine capacity category and according to the demand and supply conditions for scrap cars. For example, in 1990 price inflation for scrapped cars was created because of the low supply of these cars (registered in 1980) because of measures undertaken during the late 1970s to curb car ownership; but in 1998 the drop in the number of new cars registered because of the Asian economic turmoil coupled with an excess supply of cars (registered during the economic boom years of 1988 and 1989) due to be scrapped depressed the price of scrapped cars. To address this problem, the scrappage bounty could now be used to offset the COE premium and registration fee, on top of the ARF. The bounty can also be split up and used for registering more than one vehicle.

If new cars become more unaffordable, existing cars may be kept for a longer period. A shift in the age distribution of cars has been observed recently. In 1991 only 4% of the car population were 15 years or older, whereas in 1996 older cars account for 11% of the car population (Department of Statistics 1996). This has implications on road safety, fuel consumption, and vehicle emission levels. The financial incentives under the PARF may need to be revised to encourage people to retire older cars. With a restructuring toward more use tax, the up-front cost of car ownership can be reduced by having a lower ARF while keeping the quota premium system as a check on the growth rate of the car population.

4 Integrating environmental and tax policy

In addition to the direct impact on the environment, motor vehicle taxes have other wider economy-wide implications. The design of motor vehicle taxes cannot be considered in isolation but must be coordinated with the overall tax policy. Although motor vehicle-related taxes, contributing more than one-fifth of Singapore's total operating revenue, seem buoyant, there are some tax issues that must be addressed. First is the financial viability of relying on revenue from motor vehicle taxes. These taxes, in general, tend to be pro-cyclical. For example, the economic slowdown in 1998 resulted in collections from motor vehicle taxes falling short of the initial official estimate. Total collection was $1.74 billion, below the estimated $2.2 billion, and licenses and permits provided $2 billion, $200 million below estimates (*Straits Times* July 17, 1998). The shortfall is due to weaker demand for new cars, overestimation of COE premiums, and rebates on the road tax as part of the vehicle tax rationalisation to lower the up-front cost of car ownership.

This brings us to the second issue, regarding how the revenue is recycled. Given its pro-cyclical nature, earmarking of motor vehicle revenue for highway maintenance programs is neither efficient nor effective. Motor vehicle tax revenue in Singapore goes into the general revenue. If the revenues generated are offset by lower conventional taxes, which create excess burden by distorting the labour supply, savings, and investment decisions, motor vehicle taxes are welfare-improving as they not only internalise motoring externality but also have a capacity output effect. The overall tax burden ratio is relatively low for Singapore, at 16.2%, compared to the averages of 17.4% and 20.6% for the Asian and OECD countries, respectively.[10] Compared to some developed countries (Australia, Canada, United States, United Kingdom) whose income tax, on average, forms about 10%–15% of the GDP, Singapore's income tax burden (at 6.73%) is relatively low, though slightly higher than that in the Philippines and Thailand.

Given the magnitude, motor vehicle taxes have implications for the overall revenue structure. Because collections from COE and ARF are currently classified as nontax revenue, it is not surprising that Singapore has the highest percentage of nontax revenue relative to the GDP, at 9.7%, compared to the average 3.6% for the Asian countries and 2.1% for the selected OECD countries.

The next tax issue relates to the efficiency of motoring taxes, particularly to the "appropriate" level and mix of taxes. The theoretical underpinning of the congestion tax is straightforward. To internalise externality, the level of tax must be set exactly equal to the congestion externality (i.e., the difference between the marginal and average trip costs). In practice, it is difficult to implement optimal congestion pricing, as the implementing authority must have exact information on the marginal social costs. McCarthy and Tay (1993) produced estimates that the ALS fees may be too high and warned that it may be a traffic restraint policy,

[10] See Chia (1998) for details.

so the road system may actually be underutilised during the operational hours, leading to inefficiency. This result is not surprising, as ALS, being a flat-rate toll, is set to the value of externality imposed on a commuter under average congestion levels. If the congestion pattern is such that it builds up to some peak and then subsides, commuters travelling at the beginning or the tail of the peak are overcharged, and commuters who are travelling at the peak itself are subsidised. This problem has been somewhat rectified by replacing the manual ALS with the ERP. The variable tolls and shoulder pricing under ERP improve efficiency; but efficiency is not fully restored, as the ERP tolls do not fluctuate directly with real-time traffic flow.

Given that the implementing authority may not have complete information, the tax rates and even the tax base must be revised when new information or data are available. For example, both the rate and base for the RPS were adjusted to reflect the congestion externality more accurately. When first implemented, the RPS was S$1 in June 1995 and was revised to S$2 in May 1997 to produce a stronger incentive. In addition to the east-west East Coast Parkway, the RPS has also been extended to the other two major expressways: the east-west Pan Island Expressway and the north-south Central Expressway. However, the different fee structure on different expressways in a manual system can lead to confusion for commuters and more cost uncertainty for some businesses, such as those involved in delivery or taxi services.

This is also true for the ERP on the Central Expressway (CTE), which was implemented in August 1998. Traffic volume on the CTE increased by 23%, largely because there are 64% more commercial vehicles and 90% more taxis, as they pay lower tolls than other vehicles. To relieve congestion, their tolls were doubled from November 1998.

The next issue relates to the optimum tax mix to internalise congestion externality, particularly with respect to optimum composition of ownership and use tax. During fiscal year 1985 (FY85), revenue from ownership tax was 57%, which was just slightly higher than revenue from the use tax; but by FY95 more than three-quarters (83%) of the motor vehicle-related revenue came from ownership taxes. The challenge is to achieve an optimal tax mix that internalises externality while minimising other economic distortions.

The efficiency of motor vehicle taxes must be reexamined. A tax is efficient in a fiscal sense if it does not distort economic decisions. Efficiency in environmental terms, according to the OECD (1996, p. 12), refers to a policy that "induces agents to change their behaviour with the least economic costs, in order to meet environmental goals." If the reduction in peak hour congestion is due to staggering the work-start time and not due to changes in alternative modes of travel, there are other welfare implications. Changing the work-start time has two opposing effects on marginal productivity. The first effect operates because of agglomeration economics of scale, which suggest that marginal productivity of workers may be greatest when workers are all present at the same time, as productivity depends on direct face-to-face interaction and communication. On the other hand, if time spent on commuting yields negative utility and fatigue,

marginal productivity is lower for workers travelling during peak hour congestion. Wilson (1988a) showed that the effect of urban scale economies dominates the marginal productivity effects, especially for professional workers for Singapore. If that is so, we must examine the effect of motor vehicle taxes on work-start time. Wilson (1988b) estimated the welfare effects of congestion pricing in Singapore and concluded that, although congestion toll leads to reduce travel times, commuters are shown to incur rescheduling costs as a result of the toll. However, the result must be interpreted with care, as the study was based on the 1975 survey data. Since then, as part of the four-pronged approach to land-transport policy in Singapore, the public transport system has improved significantly. The Mass Rapid Transit (MRT) system started operating in 1987. These alternative modes of transport may lead to lower rescheduling cost than what Wilson had estimated.

The next consideration relates to the equity aspect of a tax. Motor vehicle taxes are designed to internalise congestion externality and to place the burden directly on those responsible for it. This adheres to the "polluter pays principle" and may be interpreted as a "principle of fairness." If we regard environmental quality as luxury goods, environmental internalisation is pro-rich. The incidence of motor vehicle taxes in Singapore seem to be progressive but with the tax burden borne mainly by the higher income group because they are the main car owners and car users. The 1995 household survey shows that working persons travelling by car to work had the highest median income (S$3750 per month). The median incomes of working persons using other types of transport were much lower: S$2866 per month for those taking taxis, S$1950 for those taking the MRT only, and $1795 for those taking the MRT/public bus combination. Those who did not require any form of transport to work had the lowest median work income ($595 per month) (Department of Statistics 1997).

Finally, there is a need to modify or eliminate policies in the current tax provisions that encourage polluting activities. For example, the use of company cars for commuting to the place of work and free (or reduced costs of) parking space provided by employers are not considered taxable benefits. As part of the revamp in the vehicle tax structure, operating expenses and capital costs of company cars are no longer tax-deductible in Singapore.

5 Conclusions

The design of motor vehicle taxes has focused primarily, if not exclusively, on raising revenue. There is a need to coordinate fiscal and environmental policies for systematically taxing fuels according to their environmental characteristics. Although the design of the motor vehicle tax structure in Singapore is based on land-transport policy for sustainable development, it has achieved environmental goals to some extent. This is reflected in the restructuring toward more use taxes and giving tax concessions to vehicles providing public transport. In a conscious effort to encourage green-friendly cars, under a new transport innovation development scheme, fuel-cell cars powered by hydrogen and hybrid cars that run on

a mix of petrol and electrical power are exempted from ownership taxes and the certificate of entitlements (*Straits Times* May 31, 2001).

Motoring taxes have allowed Singapore to enjoy "double dividends." Motoring taxes and charges accounted for almost one-fifth of the total operating revenue and one-quarter of the total tax revenue. The success of congestion pricing for the city centre and the major expressways has minimised peak hour congestion and pollutant concentration. The overall average levels of carbon monoxide, lead, sulphur dioxide, and nitrogen dioxide are all within the air quality standards established by the WHO and the USEPA.

Moreover, fiscal restraints on car ownership and car use through motor vehicle taxes is but one of the four-pronged approaches to optimise land transport use in Singapore. There seems to be political will and public acceptance to support the "expensive-to-own-and-use-a-car" policy because it is accompanied by three other policy approaches: (1) developing systematic satellite towns as part of land-use planning to minimise the need to travel; (2) investment in an extensive and comprehensive network of roads and expressways augmented by traffic management measures; and (3) a viable, efficient public transport system.

The latter is particularly important. Public transport continues to be Singapore's land transport strategy because it is the most efficient transport solution for a highly urbanised and densely builtup city-state (LTA, 1997). The government's support is reflected in its commitment to a new financing framework. Prior to this commitment, the government paid only the initial capital cost for railways; operators had to rely on fare collections to cover the current operating costs plus the second set of operating assets. Such policy is prudent in that it allows only self-sustaining systems to be built and exerts pressure on operators to raise fares to stay viable.[11] Under the new financing commitment, part of the second set of operating assets will be financed from fare revenue (which covers the historical cost of the first operating assets) and the rest will be co-financed by the government. This keeps public transport affordable and at the same time maintains intergenerational equity. The adoption of the new financing framework has allowed construction of a new northeast MRT line, expansion of the MRT network, and construction of more LRT lines.

Having viable, efficient public transport is necessary for the public's acceptance of motoring taxes. Recently, the United Kingdom announced a plan to start a Singapore-style ERP in London in January 2003. The fee is set at £5 for cars entering central London between 7 am and 7 pm. For road pricing to succeed, the UK Transport Department recognised the need to improve the public transport system, and the expected £200m revenue from road pricing has been earmarked for this purpose.

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[11] Fares for public transport are regulated by the Public Transport Council, a statutory board established under the Public Transport Council Act. The Council is a watchdog safeguarding the interests of the commuters while ensuring the financial viability of public transport operators.

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