Market-based Instruments for Reducing Vehicle Emissions in Sri Lanka

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1. Urban Air Pollution by Vehicular Traffic

Emissions of carbon monoxide (CO), hydrocarbons (HCs) and oxides of nitrogen (NOx) from mobile sources have an adverse impact on human health and the environment by contributing to the formation of photochemical smog, acid rain and elevated CO levels. Reactions of NOx and HCs with hydroxyl radicals in the presence of ultraviolet light lead to the formation of ozone (a principal component of photochemical smog) in the lower atmosphere. The majority of urban NOx emissions in the United States are from mobile sources and data from the eastern United States indicate that nearly 30 - 40% of acid rain is due to nitric acid. Carbon monoxide, like ozone and NOx, is also a respiratory irritant and has been regulated as a criteria pollutant by the United States Environmental Protection Agency (USEPA). Hydrocarbons and smoke particulates include toxic materials that are very harmful to the public health and increase mortality.

Measurement of these constituents in automobile exhaust is therefore important in urban air quality control, human health impact assessment and environment pollution assessment. Rapidly increasing vehicle population and fuel consumption, particularly diesel, high proportion of old vehicle usage in transportation and poor vehicle maintenance, absence of clean fuel and high rate of urbanization are some of the factors contributed to high air pollution levels in Sri Lanka, which are significantly higher than the recommended health standards.

Automobile exhaust is a major source of air pollution in Sri Lanka. The existing evidence has shown that the urban environment of Colombo is heavily contaminated with vehicular emissions. Various studies undertaken by regulatory agencies and researchers clearly indicate that inefficient combustion of petroleum in motor vehicles is the primary cause of growing air pollution in Colombo, which is the largest metropolitan area with nearly 50% of the vehicle population is on the move and where 30% of the nation's human population dwells. The observed lead (Pb), total suspended particulates (TSP), sulphur dioxide (SO_2), and ozone (O_3) levels are significantly higher than the levels recommended by the World Health Organization (WHO) and the Central Environmental Authority (CEA) of Sri Lanka.

2. Demand Management on Urban Traffic Congestion

Urban traffic congestion, particularly in the rapidly growing major metropolitan areas of developing countries, is imposing increasing economic and environmental costs. Traditional methods of curtailing congestion have largely failed, particularly on the supply side: reduction of congestion following expansion and improvements of roads are typically short-lived,[1] and are constrained by increasingly tight fiscal, physical and environmental constraints. However, demand side options, particularly pricing,[2] offer a more promising long-term solution – as evidenced by the successful pricing scheme in Singapore,[3] one of the few large Asian cities free of major road congestion.[4]

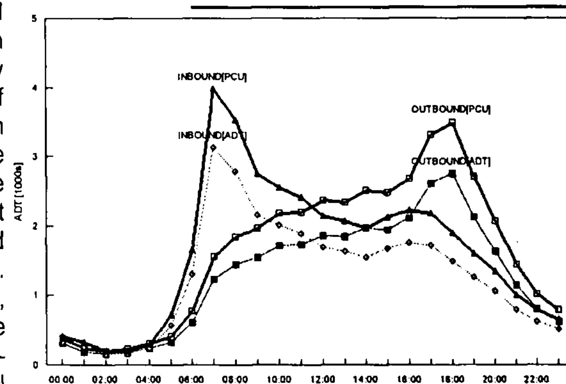


Figure 1 - Hourly average daily traffic by hour for the A3 (Peliyagoda-Puttalam Road)[8]

Source: Ministry of Transport and Railways, Journey Time Survey, 2006

Is there traffic congestion in Colombo? Whatever the anecdotal evidence, there is a rigorous definition: congestion can be said to occur at the point at which an additional vehicle entering a road segment causes the normal speed of other vehicles to decrease, thereby imposing a cost not only on that additional vehicle, but on *all* vehicles using that road segment (Jayaweera, 1999). Based on a definition of congestion as occurring whenever average speeds of 30 km/hr cannot be maintained, the Colombo Urban Transport Study[5] estimates the costs of congestion at Rs 29 (At 2007 prices) billion/year.[6] This is clearly significant and which, with the absence of policy reforms, will inexorably rise. Already average speeds in the Greater Colombo Metropolitan Region (GCMR) have dropped to about 14 km /hour (2006), and ranged from 10-15 Km/ hour in the centre to around 24 km/hour at the periphery of the GCMR[7].

The bulk of the traffic to the city of Colombo enters on seven main radial roads, which all connect with the central business district (CBD). These roads all exhibit a very strong peak-hour traffic: Figure 1 shows typical inbound and outbound patterns for the Peliyagoda- Puttalam Road - A3, and Table 1 gives comparison of the inbound traffic counts for four of the main radial roads (morning peak). The active vehicle population in Sri Lanka amounts to 1,840,685 at the end of year 2007, out of which 45% is two stroke motor cycles and 14% is three wheelers. This means that only 41% of vehicles on streets is four the rest are all four wheel vehicles amount. The growth of the active vehicle fleet is mostly a function of per capita income and import duty and other taxes which are direct functions of price of the vehicle.

Table 1

Car journey time survey results (as average speeds, km/hour): Inward direction, morning peak

	1997	1999	2001	2003	2006
Colombo-Galle	28	18	15	13	12
Colombo - Ratnapura	32	16	14	12	12
Colombo – Kandy	23	22	16	14	15
Colombo - Puttalam	18	16	11	10	08
Kollupitiya-Jayawardanapura	23	17	12	09	08
Colombo-Horana	27	17	14	12	10
Wellampitiya – Kaduwela	28	18	15	13	35

Source: Transport Studies Planning Centre, Ministry of Transport and Railways

3 Demand Management on Ownership of Vehicles

Demand for vehicles depend on the price and the purchasing capacity of the population. It was found that growth of vehicle ownership is correlated with the GDP growth of the country and varies with the category of the vehicles (e.g. Motor Car, Motor Cycles, and Three Wheelers etc). Evaluation of the Sri Lankan consumers' behaviour on vehicle ownership is essential for the management of demand for vehicles.

3.1 Vehicle taxation structure for all types of vehicles

Sri Lanka collects its road user charges and other taxes from vehicles through indirect taxes which include; import duty, exercise duty, value added tax, fuel tax, annual revenue fees and registration and other special taxes introduced by the government from time to time. There was no rational justification for these taxes as they are not related to clear policy on traffic demand or any other road user cost or welfare transfers One of the examples for special tax introduced was diesel tax in 1994 for diesel - driven vehicles.

3.1.1 Value Added Tax (VAT)

This tax is collected by the government at the import of all categories of vehicles except land vehicles older than ten years and those operated on kerosene. In 2008, the rate of VAT is 15% of the value of vehicles including import duty, exercise duty and all other taxes. This is a "once and for all payment" before the vehicle is imported to the country. This cost is labelled in other countries as "ownership cost".

3.1.2 Import duty

Import duty charged by the Customs is also a "once and for all" type tax collected by the government as revenue at the time of importing a vehicle. The rate is currently 120% except for those imported with special approval from the Ministry of Transport and special categories like ambulances and prison vans, etc., in which case the rate is only a nominal rate of 28% of the CIF (Cost, Insurance and Freight) value. Commercially-used tank wagons, refrigerated trucks, tippers and dump trucks, etc., are levied a nominal rate of 06%. These taxes are also "once and for all" type of taxes to be paid only at the point of entry of the vehicle into the country.

3.1.3 Charges of Department of Motor Traffic

The Department of Motor Traffic charges vehicle taxes annually for their administrative purposes. The issue of annual revenue license and revenue collection are functions of Provincial Councils under the 13th Amendment to the Constitution of Sri Lanka. The charges for registration and all other penalties and annual revenue license fees charged by the Provincial Council in the year 2008 are shown in Table 2.

Table 2
Annual revenue fees for vehicles - 2008

Category of vehicle	Annual Fee (Rs)
Car (Petrol)	700.00
Car (Diesel)	4,200.00
Utility (Diesel)	2,700.00
Utility (Petrol)	1,800.00
Small Trucks (Diesel/Petrol)	1,675.00
Medium Truck (Diesel/Petrol)	2,800.00
Large 2-Axel Truck (Diesel/Petrol)	4,200.00
Truck 3-Axel (Diesel/Petrol)	5,600.00
Articulated Truck	8,400.00
Medium Bus (Diesel/Petrol)	2,200.00
Large bus	3,600.00
Motor Cycles	275.00
Land Vehicles	200.00
Trailer	1,675.00
Three Wheelers (Petrol)	600.00
Three Wheelers (diesel)	600.00

Source: Department of Motor Traffic and Department of Inland Revenue, 2008

4. Market - Based Instruments (MBI)

Most of the taxes and charges on land transport sector other than those in Airports and Sea Ports do not rationally link with the cost of infrastructure or services provided by the government of Sri Lanka. This is traditionally taken as taxing the vehicle owners for collecting revenue on the ground of social inequalities. The environmental factors such as air and noise pollution have not been taken into consideration in taxation, and MBIs can make a big impact on the demand including operated vehicle km. The following section analyses MBI in the transport sector of Sri Lanka.

5. Analysis of Impacts of the MBI implemented in Sri Lanka

5.1 Tax equalisation on gasoline and diesel fuel

The historical tax differences on diesel and gasoline (both on fuel and on vehicle import duties) have had a serious distorting impact on the fleet mix and on the economics of the refinery. High taxes levied on gasoline have resulted in a relatively low gasoline demand, with the result for several decades, naphtha had to be exported (at a loss), while diesel has had to be imported.[9] As shown in Figure 2, the ratio of gasoline to diesel price has varied over the past 30 years from 3.5 to 1.5. This may be compared to rough equivalence of Singapore prices.

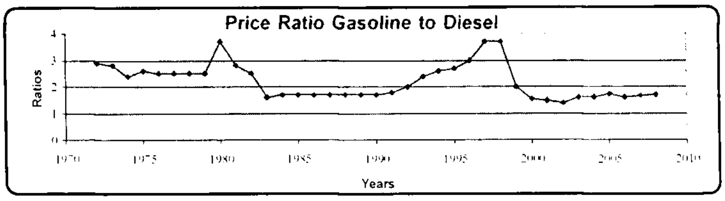


Figure 2: Historical ratio of gasoline to diesel price
Source: Ceylon Petroleum Corporation and Lanka Oil Company

Table 3 shows the official price structure on auto-diesel and gasoline as of 10.03.2008, as given by CPC. The CIF prices correspond to a world oil price of US $ 86/bbl. However, in the case of diesel, these are purely notional figures.[10] Indeed, the selling price shown in Table 3 does not equate the sum of taxes, overheads\margins. and nominal tax. The actual rate of tax on diesel – given the CIF prices noted in Table 3, is 2.50 Rs/litre, compared to 39.00 Rs/litre on petrol.[11]

Table 3

Price structure for auto diesel and gasoline (as of 10.03.2008)

	Normal Petrol	Normal Diesel
Landed cost	74.50	74.00
Manufacturing and administration overheads, Distribution margin & Financial charge	3.50	3.50
Excise duty	39.00	2.50
Selling Price	117.00	80.00

Source: Kumarage review of household income and public transport,2008

As in many other countries, the ostensible rationale for the high level of tax on gasoline is that gasoline is mainly a fuel used by those with relatively high income, while diesel is mainly a fuel used by those with relatively low income. That may have been the case before liberalisation, when car ownership was indeed limited to a very small segment of the population, and diesel vehicles were limited to buses, trucks and tractors. But with the dramatic changes in vehicle mix, such a rationale, as elsewhere, can no longer be sustained as is readily evident from a breakdown of gasoline consumption by vehicle type (Table 4). Gasoline cars account for only 36.5% of total gasoline sales (and hence of gasoline taxes), while motorcycles and 3-wheelers account for 56%, self-evidently the personal transportation mode used by lower income workers.

Table 4
Breakdown of gasoline use by vehicle class, 2007

	1000 tonnes	[%]
Autos	72	36.5
Vans	10	5.0
land vehicles	1	00
Motorcycles	59	30
3-wheelers	55	28
Total	197	100

Source: Author's Calculation

Data on vehicle ownership by income distribution is instructive. Table 5 shows the distribution of vehicle ownership by income class. Motorcycles are the dominant vehicles for 98% of households who are earning average income les than Sri Lankan Rupees 50,000/=; only in the top 2% (earning more than Rs 50,000/ month) are owned cars.

heaviest axle loads, and contribute most to road damage as shown in Table 6. A two-axle medium truck (the most common type in Sri Lanka) imposes road maintenance costs of 7 Rs/vehicle-km, as opposed to 1.35 Rs/vehicle km for passenger cars. It is evident that while the gasoline tax on passenger cars is 134.8% of the road maintenance costs, whereas the diesel fuel tax paid by trucks is between 6% and 26% of the road maintenance cost. But trucks are exempted from the special diesel tax even at the time of imports, pay essentially no tax on diesel, and pay disproportionately lower rates of import duty and annual license fees. It should be noted that 40% lorry fleet includes double cabs with slight modification to get HS code similar.

The first option raises a significant revenue to the Government, but the corresponding increase in diesel fuel would be politically unacceptable. The second option would imply a significant revenue loss to the government, which may therefore, be discarded.[16] However, the third option can easily be structured so that it is revenue-neutral to the Government, and therefore merits detailed consideration.

Theory

Consider the demand for gasoline and diesel shown in Figure 3. At present, tax is levied at τ_p and τ_d on gasoline and diesel respectively, with retail prices of P_{op} and P_{od} at quantities Q_{op} and Q_{od} respectively. If the tax rate is equalized, i.e.

$$\tau_p = \tau_d = \tau^*$$

then diesel consumption will *decrease* by ΔQ_d, and gasoline consumption will *increase* by ΔQ_p

Under revenue neutrality, the tax revenue before the tax change must equal the revenue with the common tax rate τ^*, and therefore

Table 5
Vehicle ownership by income class (2006)

Household(HH) Income[12]	0-5000	5001-10,000	10,001-20,000	20,001-30,000	30,001-40,000	40,001-50,000	>50,000
Veh/100 HH Motor Cycles	5	4	2	14	11	24	21
Cars	0	1	1	1	3	13	36
Income distribution	39.3%	36.2%	7.2%	8.6%	6.2%	1.8%	0.7%
As % Vehicle ownership	12.3%	17.7%	20.6%	24.6%	17.7%	5.1%	2.0%

Source: Dept. of Motor Traffic and Dept of Inland Revenue, 2006

In sum, there is no evidence to show that the present tax structure on transportation fuels is progressive. In fact the present tax structure disproportionately favours the better off – most importantly, the owners of so-called dual-purpose vehicles, whose consumption of diesel (232,000 tonnes in 2000) exceeds the total consumption of petrol.

In addition to the distributional rationale for equalisation of diesel and gasoline taxes, there is also an environmental rationale. In the case of petrol, the main local air emission of concern in Sri Lanka is lead, and particulates from 2-stroke engines – emissions that would increase in any tax-induced shift to gasoline vehicles. But these issues are more easily solved[13] than the main local air emission problems from diesel engines, namely the high emissions of particulates from heavy vehicles.

Finally, there is a further rationale of better matching road user charges to public costs for road maintenance by specific vehicles. As noted by Jayaweera,[14] two-axle trucks have the

Table 6
Road maintenance costs imposed by different vehicle types and fuel tax revenue

	Road maintenance cost Rs/vehicle km	km /litres	litres /km	Fuel tax/km	Ratio of fuel tax to road maintenance cost
	[1]	[2]	[3]	[4]	[5]=[4]/[1]
passenger cars(gasoline)	2.10	10	0.10	2.83	134.8%
passenger cars(diesel)	2.10	10	0.10	0.29	14%
vans/4WD/DualPurpose	4.01	8	0.13	0.36	09%
Buses	4.30	3	0.33	0.96	22%
Small trucks	3.72	5	0.20	0.58	16%
medium trucks(2-axle)	9.02	4	0.25	0.72	08%
medium truck(3-axle)	14.52	4	0.25	0.72	05%
articulated truck	11.99	3.5	0.29	0.83	07%

Source: Author's Estimates

In short, there is a need for rationalization of fuel taxation, options for which we examine in this section are:[15]

- raise the tax on diesel to the same rate as levied on petrol
- decrease the tax on gasoline to the same rate as levied on diesel
- lower the tax rate on gasoline and increase the tax on diesel

$$[B+D] + [X+Y] = [D+E] + [W+X]$$

old tax on gasoline + *old tax on diesel* = *new tax gasoline* + *new tax on diesel*

$$Q_{op}\tau_p + Q_{od}\tau_d = \tau^* Q_p + \tau^* Q_d^*$$

Hence τ^* *follows:*

$$\tau^* = [Q_{op}\tau_p + Q_{od}\tau_d] / [Q_p^* + Q_d^*]$$

where the new quantities Q_p^* and Q_d^* after for equalisation are levels of petrol and diesel consumption respectively.

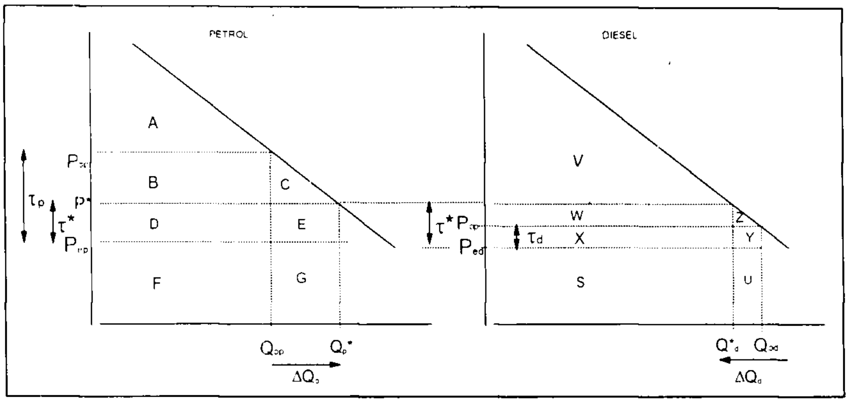
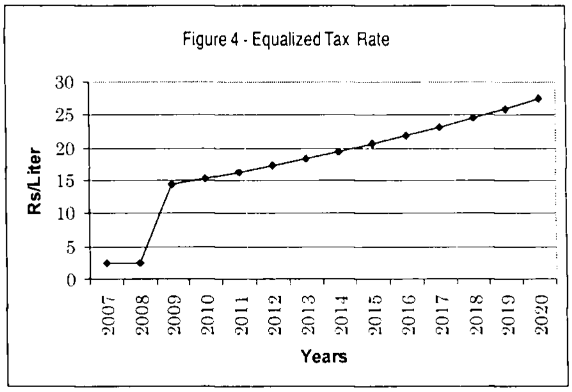


Figure 3: Fuel Tax equalization

However, while the impact on government revenue is (by definition) revenue neutral, the net impact on consumers will be given by the change in consumer surplus (for each user group, which will vary according to the balance of its use of petrol and diesel), and even in aggregate may be non-zero. This is shown in Table 7, which enumerates the net economic benefit before and after fuel tax equalisation. The net (aggregate) impact on consumers is calculated as B+C-W-Z, whose magnitude will be determined by the relative price elasticity is involved.



Source: Author's Calculation

Table 7: Net economic benefits of fuel tax equalisation

	before equalization	after equalization	net change
Gasoline;			
consumer benefit	*A+B+D+F*	*A+B+C+D+E+F+G*	*G+C+E*
-resource cost	*-F*	*-F-G*	*-G*
net economic benefit	*A+B+D*	*A+B+C+D+E*	*C+E*
Distributed among:			
Consumers	*A*	*A+B+C*	*B+C*
government[tax]	*B+D*	*D+E*	*E-B*
Cont.			
Diesel:			
consumer benefit	*V+W+X+S+Z+Y+U*	*V+W+X+S*	*-Z-Y-U*
-resource cost	*-S-U*	*-S*	*U*
net economic benefit	*V+W+X+Z+Y*	*V+W+X*	*-Z-Y*
Distributed among:			
Consumers	*V+W+Z*	*V*	*-W-Z*
government[tax]	*X+Y*	*W+X*	*W-Y*
Total			
Consumers	*A+V+W+Z*	*A+B+C+V*	*B+C-W-Z*
government[tax]	*B+D+X+Y*	*D+E+W+Z*	*[by definition]*

Results

Figure 4 shows the results of tax equalization on diesel and gasoline under revenue neutrality to the Government, expressed as Net Present Value (at a discounted rate of 12% over 15 years), assuming a world oil price of US $ 124/bbl and current retail prices. The resultant rate of (equal) tax is about Rs 14/= per litre and it increases slightly from year to year to maintain the net revenue, because the differences in elasticity values for the two fuels cause shifts in the mix.

Imposition of a diesel tax of Rs 7-8/litre would doubtless be vociferously opposed by the freight industry — which will overlook the fact that, at present, diesel vehicles do not pay an equitable share of road damages, and argue instead that consumer prices would increase – particularly of food. However, as suggested in Box 1, this argument would be hard to sustain.

Box 1

Impacts of diesel fuel taxes on food costs

The question of the impact of diesel fuel prices on marketing costs of vegetables was examined in a 1994 study,[17] using beans as an example.[18] Though that study analysed the benefit of a diesel price decrease (of March 1994), it was found that a Rs 1 /litre decrease in diesel price would result in a decrease in delivered cost of vegetables by Rs 0.0144 - 0.024 /kg, compared to a retail price of Rs 25/kg. This was based on the fuel consumption of a round trip Colombo-Nuwara Eliya (a distance of 360 km up and down, consuming 72 litres) for a saving of Rs 72 per round trip (decrease in price by Rs one). For 5,000 kg of vegetables (say 100 bags @ 50 kg), this calculates to cents 1.4 /kg (with greater savings at lesser loads). Transportation costs were assessed at 7% of the total marketing cost of beans. Considering this it is updated for June, 2008 (diesel price at Rs.110/= per litre increase 7% to 11%)

Since 1994 diesel prices have increased from Rs 11.40 to Rs 110.00 per litre and retail bean prices from Rs 25 to Rs 160 (in 2008) per kg. In contrast to 1994, today's price of beans computes at Rs 110 per kg, and the retail diesel price is Rs 80.00 per litre, from which is evident that the real price of beans has increased much more than the real price of diesel.

The physical impacts of fuel tax equalisation on environment are shown in Table 8. There will be a net decrease in fuel use, a consequence of the differences in the assumed price and cross-price elasticities. While gasoline cars and vans are immediate substitutes for their diesel counterparts, it would be much more difficult for lorry-owners to shift to gasoline vehicles (since these are largely unavailable in the Indian market which is the principle source), therefore lorry-operators can indeed be expected to utilize their vehicles more efficiently if the price of diesel increases (and hence the net savings in total fuel).[19]

The distributional impacts of this fuel tax equalization are shown in Table 9. The net economic benefits of tax equalization are large. First, there is a substantial reduction in road maintenance cost consequent to the reduction in vehicle-km from the heavier diesel vehicles, so the impact on government is positive despite fuel tax revenues remain unchanged. Second, we see significant environmental benefits, bringing the net economic benefit of Rs 15.8 billion (in NPV terms).[20]

Table 8: physical environmental impacts of tax equalisation

		Valuation	2010				Lifetime savings	
		$/ton	Baseline	+policy	delta	%[Baseline]	Discounted	undisc.
Petrol	[1000tonnes]		275	304	29	11%		
Diesel	[1000tonnes]		928	838	-91	-10%		
Emissions								
PM-10	[tonnes]	17790	990	944	-46	-5%	318	
SOx	[tonnes]	2924	9282	8377	-905	-10%	6156	
NOx	[tonnes]	700	49278	46858	-2420	-5%	16682	
Carbon reduction	[1000tonnes]	20	1045	981	-63	-6%	-697	-2073

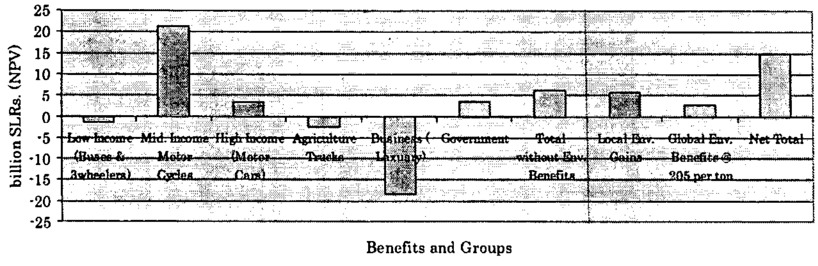
Assumptions: world oil price: US $ 124/bbl; price elasticities from Jayaweera(1999).
Source: Author's Calculation

Table 9
Impact of tax equalisation (Rs Million, NPV)

	road users					govt.	total	environment		total
	low-Income	middle-income	high-Income	Agric	freight			local	global	
tax changes										
diesel tax	-14890	-13221	-2140		-18571	48822	0			0
petrol tax	13410	17878	14965	266	2302	-48822	0			0
d[consumer impacts]										
area[C](petrol)	264	353	291	5	45		958			958
area[B](petrol)	15445	20593	17233	307	2652		56229			56229
area[Z](diesel)	-928		-818	-133	-1153		-3033			-3033
area[W](diesel)	-15199		-13496	-2184	-18957		-49836			-49836
d[road maintenance]										
Diesel						8576	8576			8576
Gasoline						-3968	-3968			-3968
Environment										
PM-10							0	770		770
SOx							0	2459		2459
NOx							0	1591		1591
carbon reduction							0		2073	2073
net impact	-418	20946	3210	-2006	-17414	4608	8927	4820	2073	15820
baseline fuelbill	91176	43845	94484	9038	73120					
net impact as %	-0%	48%	3%	-22%	-24%					

Positive numbers=benefits; negative numbers=costs
Source: Author's Calculation using equation

Figure 5 - Tax Equalization: Winners and Losers



Source: Author's Calculation

Figure 5 illustrate the Net Present Value of gains by different groups of the society. The tax equalization real losers are high income business community who can afford to bare the impacts. The tax equalization gives the higher local environmental benefits than the global environmental benefits as shown in Figure 5.

In this presentation we make the following assumptions:

- low income = bus and 3-wheeler passengers
- medium income = motorcycle owners
- high-income = owners of cars and dual purpose vehicles
- business=owners and operators of lorries

It is evident that equalization of tax rates affects little either low income or high- income road users: their net impact, expressed as a percentage of their baseline fuel-bill and is less than 4%. In the case of low-income users, bus passengers would suffer due to the impact of higher diesel fuel prices, of 3-wheeler users, would experience a fuel cost saving of about the same amount.

6. Conclusion

This analysis shows that the principal beneficiaries are motorcycle owners, while the principal losers are lorry owners and land vehicle owners. In fact, it is clear that the present tax structure is such that the cross-subsidies are not from high income to low income road users, as may be supposed, *but from motorcycle owners (i.e. medium income) to agriculture and lorry operators.* It seems very unlikely that this is the intended effect of the present fuel tax structure. It is also evident that the deadweight losses attributable to the difference in diesel and gasoline price elasticities are in all cases offset by substantial environmental benefits. With regard to the other two options for equalising taxes, if one increases the diesel tax to the same level as that of gasoline, then this would clearly bring larger environmental benefits and greater revenues to the Government, but private costs may be increased unacceptably. The alternative of reducing the gasoline tax to that of diesel (i.e. essentially to zero) is even more infeasible, given the loss of government revenue involved (however popular such a measure might be to road users).

Footnotes

[1] *As noted by Jayaweera, Don S. (1999) "every large congested city harbors a reservoir of potential peak period drivers (latent demand)*
- *who are deterred from adding to congestion only by congestion itself. Once a new highway eases congestion, these drivers, who may now be travelling in other modes, or at other times of the day*
- *will move into the empty spaces, thus driving congestion levels back up*

[2] *Peak hour speeds in Singapore are typically 25km/h during the evening peak, and 30 km/h in the morning peak, compared to speeds of 10km/h in New York, 12km/h in London, and less than 10 km/h in Bangkok (Chin, 2000).*

[3] *The international experience with congestion pricing, including that of Hong Kong and Singapore, as well as several European cities, is reviewed in Jayaweera, (1999).*

[4] *Ibanez Gomez, "Road Pricing in Singapore", Harvard University, 1999*

[5] *W. S. Atkins and University of Moratuwa (1999)*

[6] *This represents about 1.5% of the 1996 GDP of Rs768 billion*

Contd. on page 37

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[7] *Ministry of Transport and Railways, Journey Time Survey, 2006*

[9] *However, hopefully with the completion of the naphtha-fired combustion turbine at Kelanitissa, in future surplus naphtha will be absorbed by the power sector. For a discussion of the economics of naphtha use in power generation, see Meier and Munasinghe (2003a), Section 4.1*

[10] *The rates of tax and on customs duty shown in this table are notional because while they may well be used for CPC's book-keeping purposes, with the selling prices as given the amounts of this nominal tax must necessarily be covered by cross-subsidy from some other source. Indeed, another one of the benefits of tax equalisation is the increase in transparency in the books of the refinery and of the CPC.*

[11] *for petrol: 157.50Rs/liter selling price*
- *2.70 margins*
- *58.97 cif = 98.33; and for diesel 110.00 selling price*
- *2.50 margins*
- *96.11 CIF price = 2.89 Rs/litre*

[12] *Income in current Rupees (2007)*

[13] *e.g. by introducing unleaded gasoline or limiting 2S-motorcycles*

[14] *Don S. Jayaweera, Transport Pricing and Charges in Sri Lanka, op.cit., p.15.*

[15] *This is, to be sure, a limited proposal for reform. Others have called for fundamental changes in the tax structure, not just for auto-fuels, but for all petroleum products and crude oil. The World Bank Petroleum Sector Study (Energy and project Finance Division, Country Department I, South Asia Region, Sept 2, 1996) recommended that the Government introduce a simplified taxation system, replacing the profusion of customs duties, taxes and levies with a single sales tax of the final retail price (p.21).*

This study also proposed (p.20) that The tax differential between gasoline and diesel be corrected by re-establishing a more appropriate ratio between the two prices so as to reflect the true cost to the economy and suggested a 10% increase in the price of diesel. However, this study did not provide any detailed economic analysis of such a proposal, except to note that such a 10% increase " .. would result in a correspondent increase in wholesale prices for basic food commodities in the range of only 0.1% to 0.15%."

This estimate was apparently based on a Central Bank estimate that the fuel cost per kg of rice transported was 0.11/kg, and a 1994 Rice price of Rs12/kg., and hence ,' .. thus fuel transportation cost for rice is equivalent to only 0.9% of the wholesale price". See Box 6.1, below, for further discussion.

[16] *However, we do provide below the calculations for the first two options to show the magnitudes of revenue gain/loss involved.*

[17] *A.D.V.de S.Indraratna, Economic and environmental implications of petrol/diesel pricing, University of Colombo, November 1994.*

[18] *In 1994 the retail price of beans was 25Rs/kg. Average Pettah Market retail prices for the month of April 2001 were as follows: beans Rs57/kg; Cabbage Rs38/kg; Tomatoes Rs39/kg, red onions Rs82/kg, big onions Rs 34/kg, N'EliyaPotatoes Rs64 kg, Dhal Rs54/kg. It may be seen that beans is a representative product for the analysis.*

[19] *The presumption here is that indeed surplus naphtha would have been used by the power sector for power generation, so the economic cost of the additional gasoline imports is taken at the Singapore price plus freight (rather than at Singapore minus freight which would be the relevant cost if naphtha is exported)*

[20] *Note that, unlike in the case of measures discussed in the previous (and later sections), fuel savings (or changes in fuel consumption) do not appear in this table (even though there would undoubtedly be lower diesel consumption and somewhat more gasoline consumption). However, since there is an equivalent loss of benefit (area under the demand curve), the two cancel out. However in the case, say, of the expressway project, fuel savings are counted as an economic gain, because these are achieved without diminution of consumer benefits.*