

INTEGRATING ECONOMIC INSTRUMENTS (EIs) WITH EMISSION REGULATIONS: THE ROAD NOT TAKEN

Shreekant Gupta

Delhi School of Economics, University of Delhi

&

LKY School of Public Policy, NUS

sgupta@econdse.org

CSE Workshop on

Diesel Price Deregulation and its Implications

for Dieselisation of the Automobile Sector

November 28, 2014

(intersecting) story lines...

- Economic growth – the “re-emergence” of Asia
- Growth of cities (urbanisation)... mega-cities & urban sprawl
- Motorisation... fatal attraction
- Air pollution and health
- Policies flawed (and ineffective)
- And so...the road (not) taken... ☹

Summary

- India's economy is growing at the same time as its population is urbanising...
- Important aspect is growing motorisation -- attendant social, economic and environmental consequences..
- In this, India and other dynamic Asian economies following (unfortunate) Western precedent on urban form, cars and policies (regulatory, supply side)
- Several pernicious aspects of motorisation -- focus on air pollution in Indian cities and the role of vehicular emissions. Serious environmental and human health issue
- *Are policies on right track? No! (supply side, regulatory, not cost-effective) need to harness economic instruments*

India's economy, population and cities

- World's 3rd largest (PPP), 10th largest (nominal) economy (\$4.7 trillion and \$1.8 trillion, respectively)
- By 2030, will grow by 4 times to 3rd largest in nominal terms as well
- By 2030 world's most populous country (in 2028: China = India = 1.45 billion)
- Cities ("engines of growth" -- Prime Minister Dr. Singh – 50-60% of GDP)
- Urbanising relatively slowly (compared to other countries and its per capita income levels) -- China 45%, India 31%, Pak 50% (in 1950 -- more Indians in cities than in China)
- But still, by 2030 – 41% Indians in cities...
- And by 2050 world's second largest urban system (China tapers off to 1 billion in cities & India–0.9 billion, over 60%)

India's urban form... cause for concern?

- Two aspects of India's city growth shaping its urban form and its urban future:
- Urban Indians tend to live in bigger cities—about 50% live in cities of half million more and 42% live in cities of over a million. Number of 'million-plus' cities in India grew ten-fold (5 in 1951 to 53 in 2011)
- Three Indian cities among 10 largest urban agglomerations in the world. Delhi NCR -- 23 million --joined an 'exclusive' league of 'meta-cities' -- ranked 2nd behind Tokyo ahead of Shanghai, Mumbai 7th (20 million) and Kolkata 10th (14.4 million)
- Urban sprawl--average density of 53 'million-plus' cities declined by 25% from the 1990s to 2010s (from 40,000/sq km to 30,000/sq km)

Growth in vehicles...

- Growth in motorisation choking Indian cities esp. bigger ones. Delhi largest number of motor vehicles (7.2 million), followed by Bangalore (3.8 million), Chennai (3.5 million), Hyderabad (3 million) and Pune (2 million). These 5 cities alone accounted for over 49% of total vehicles in 'million-plus' cities
- Over last three decades number of motor vehicles more than doubled, every ten years or less
- Registered motor vehicles grew from over 52 million in 2000 to 142 million in 2011, compound annual growth rate of about 10%
- Over a longer time horizon, between 1971 and 2011 the number of vehicles grew 75 times from about 1.9 million to 142 million
- Over same period vehicles per 1000 (of a growing) population increased from mere 3.4 to more than 117, that is, about 34 times! (China 119)

... but worst is yet to come!

- Studies find relationship between vehicle ownership and per capita income to be non-linear (approximately S-shaped, that is, with two inflection points)
- Thus, vehicle ownership grows slowly at low levels of per-capita income, then about twice as fast as income at middle income levels (from \$3,000 to \$10,000 per capita) and finally about as fast as income at higher income levels before reaching its maximum level (the “saturation” point) at the highest income levels (\$5000 per capita – rule of thumb...)
- For India, saturation level estimated at 683 vehicles per 1000 people versus 807 for China and 853 for the United States

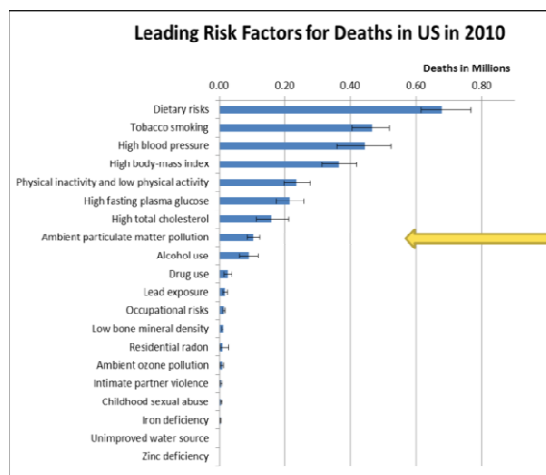
...and then there are (inelastic) oil imports

- Growing dependence on imports (India imports 75% of its oil)
- Important consequences for economy & energy security
- India's oil import bill \$169 billion in 2012-13 (up by 9%)
- And this on heels of a 47% increase from \$106 billion to \$155.6 billion in the previous year (2011-12)
- Massive and unsustainable trade deficit—\$185 billion (more than 10% of GDP) in 2011-12, an increase of almost 56% over the previous year!
- Problem exacerbated by domestic subsidies (pervasive global phenomenon--in 2011, subsidies for fossil fuels worldwide were **\$523 billion**, \$111 billion higher than in 2010)
- Oil most subsidised form of energy followed by under-pricing of electricity
- India among top 4 countries subsidising fossil fuels for a total \$40 billion in 2011 (oil subsidies alone more than \$30 billion)
- By comparison, financial support to renewable energy amounted to \$88 billion in 2011 (op. cit.)

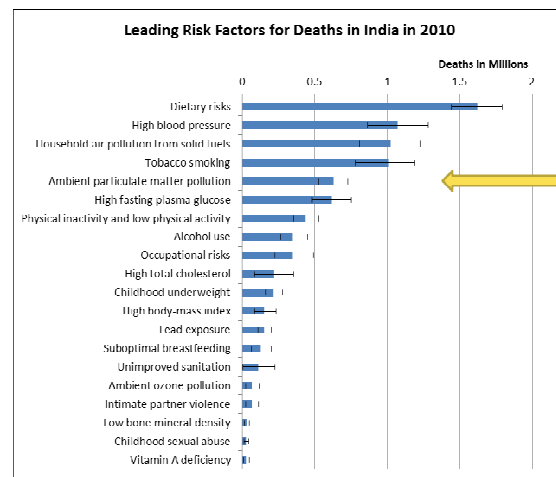
Air pollution in Indian cities is killing people

- *Global Burden of Disease 2010* (consistent and comparative description of the burden of diseases and injuries and the risk factors that cause them): ambient particulate matter (PM) pollution = outdoor air pollution--ranked as sixth leading cause of mortality and morbidity in South Asia (PM10, PM2.5)
- For India alone and only looking at mortality (not morbidity), ambient PM pollution fifth largest killer after high blood pressure, indoor air pollution, tobacco smoking and poor nutrition

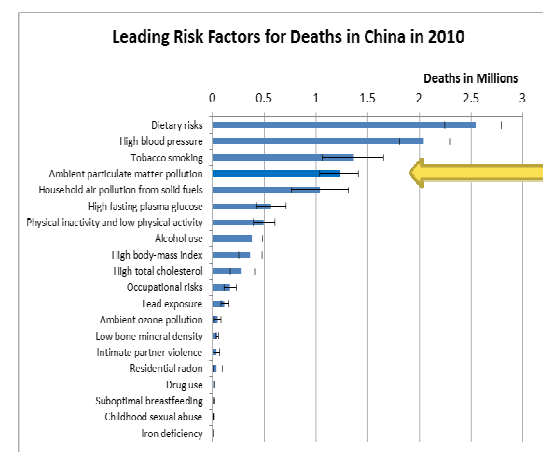
Top 20 Mortality Risk Factors in the US, India, and China in 2010



Ambient PM_{2.5} caused an estimated 103,000 deaths

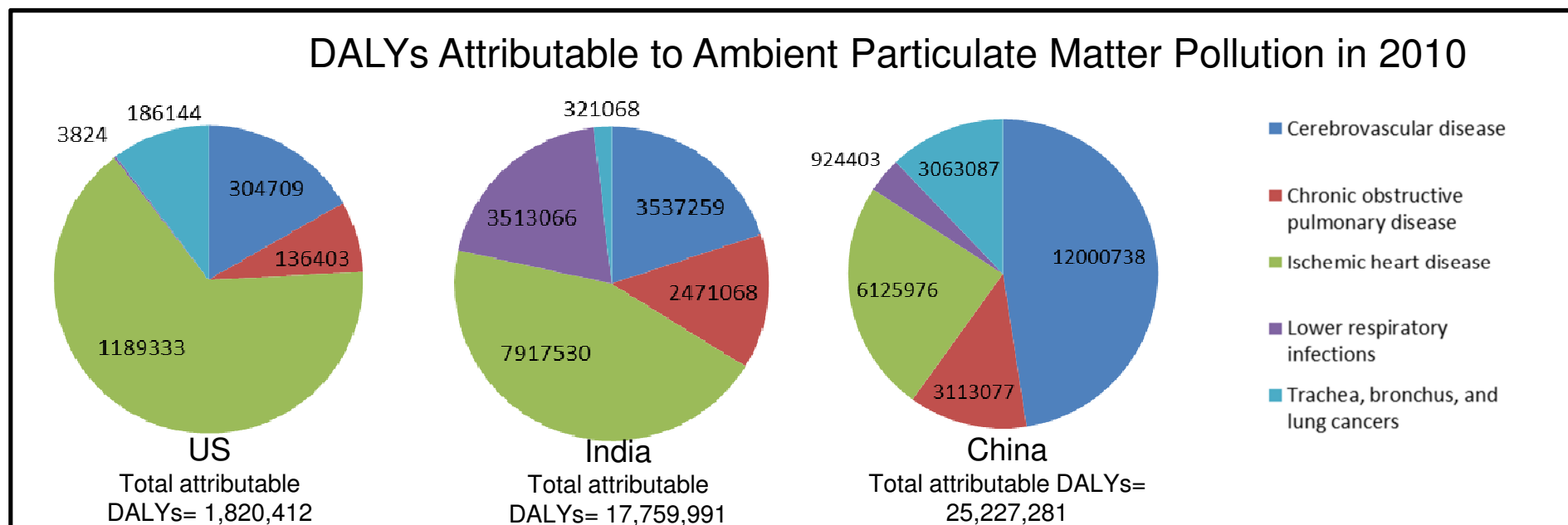


Ambient PM_{2.5} caused an estimated 627,000 deaths



Ambient PM_{2.5} caused an estimated 1,234,000 deaths; 14.9% of all deaths in 2010

DALYs Attributable to Ambient PM_{2.5} by Cause in the US, India, and China in 2010



Air pollution (PM10) in Indian cities is getting worse

- No. of “critically polluted” cities increased from 49 to 89 (2005-10)
- In 2005, about 75% of cities exceeded the standard--78% in 2010
- Levels of PM10 among highest in Delhi National Capital Region (NCR)--annual ambient concentrations averaged 260 $\mu\text{g}/\text{m}^3$ --more than 4 times national annual standard (60 $\mu\text{g}/\text{m}^3$) & 13 times WHO stds (20 $\mu\text{g}/\text{m}^3$)
- Due to seasonal and other factors levels twice as high in winter months
- In 33 out of 35 metropolitan cities PM10 conc. exceeded standard.
- Close to half of Indian cities experience severe particulate pollution.
- Half of urban population of the country exposed to particulate pollution that exceeds the standard
- As much as a third of the urban population is exposed to critical levels of particulate pollution
- Groups vulnerable to air pollution elderly, children and the poor

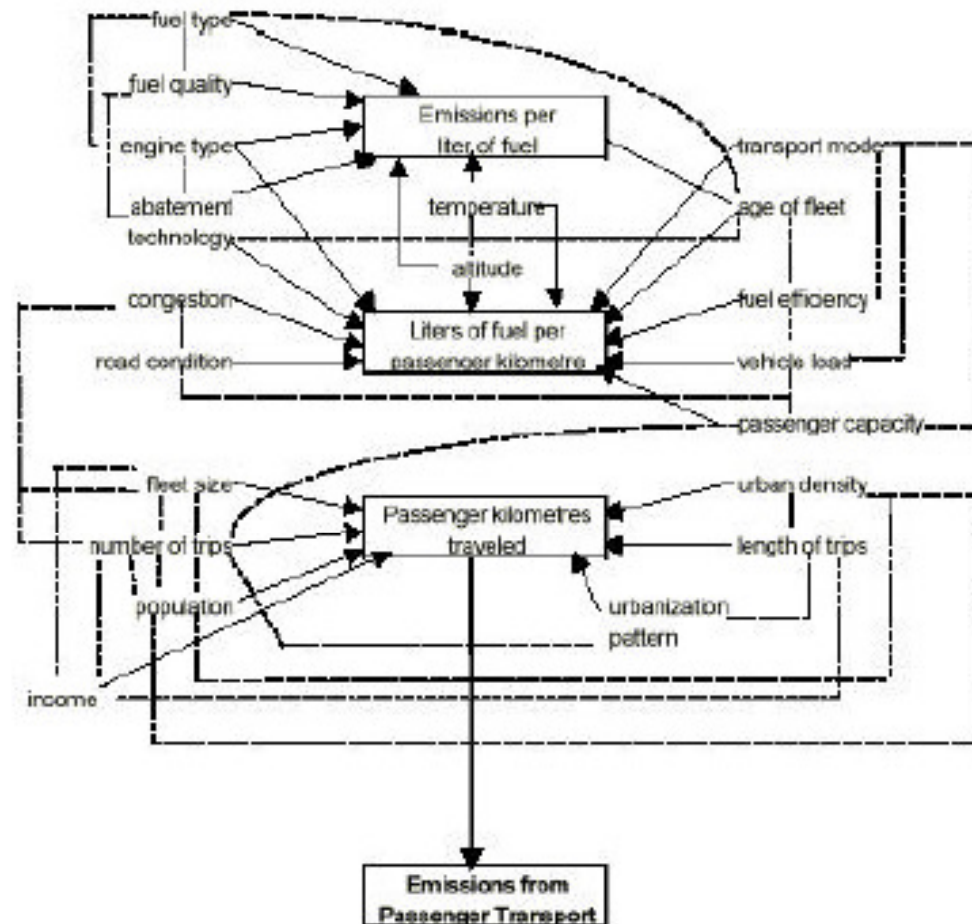
Taxonomy of policy instruments to reduce pollution

Policies	Direct instruments	Indirect instruments
<i>Market-based instruments (MBIs)</i>	Effluent/emission charges; tradeable permits; deposit refund systems	Input/output taxes and subsidies; differential tax rates
<i>Command and control measures (CAC)</i>	Emission regulations (Source-specific, nontransferable quotas)	Regulation of equipment, processes, inputs, and outputs
<i>Government production or expenditure</i>	Regulatory agency expenditures for purification, cleanup, waste disposal, and enforcement	Development of "clean" technologies

Taxonomy of policy instruments to control vehicle emissions

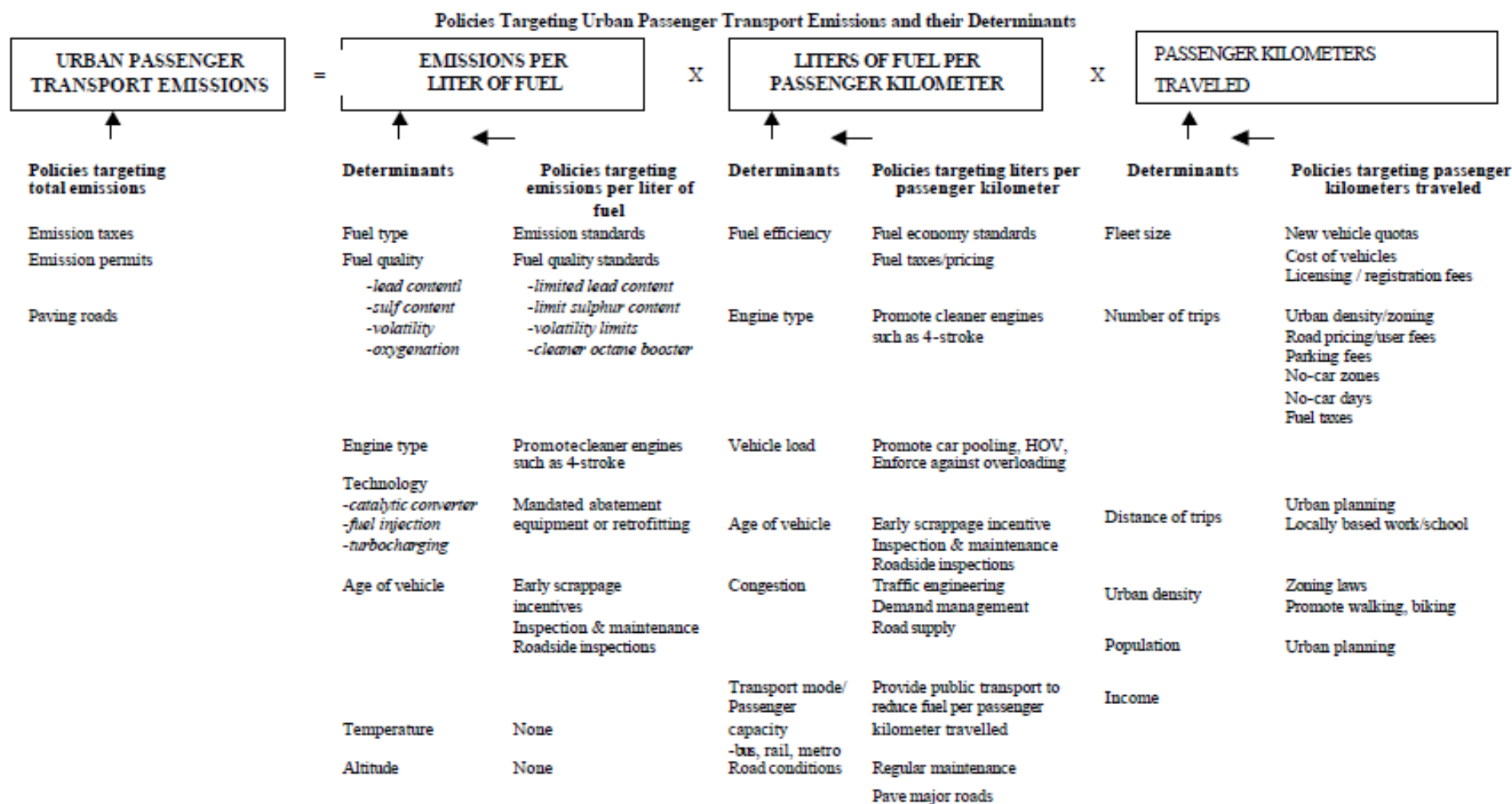
	Market based instruments		Command & control regulations	
	Direct	Indirect	Direct	Indirect
<i>Vehicle</i>	<ul style="list-style-type: none"> • Emissions fees • Tradable permits 	<ul style="list-style-type: none"> • Differential vehicle taxation • Tax breaks for new vehicles • COE (Singapore) 	<ul style="list-style-type: none"> • Emission standards 	<ul style="list-style-type: none"> • Inspection & maintenance • Mandatory use of cleaner vehicles • Scrapping of old vehicles
<i>Fuel</i>	<ul style="list-style-type: none"> • Lead banking 	<ul style="list-style-type: none"> • Differential fuel taxation • High fuel taxes 	<ul style="list-style-type: none"> • Fuel composition • Phase out dirty fuels 	<ul style="list-style-type: none"> • Fuel economy standards • Speed limits
<i>Traffic</i>		<ul style="list-style-type: none"> • Congestion charges (including ERP) • Parking charges • Subsidies for less polluting modes 	<ul style="list-style-type: none"> • Physical restraint of traffic • Designated routes 	<ul style="list-style-type: none"> • Restraints on vehicle use • Bus lanes

Urban Passenger Transport Emissions: Major Determinants and Linkages



Total emissions = emissions per liter x liters per passenger km x passenger kms traveled.

Note: Solid lines represent direct determinants of the components of transport emissions.
Dotted lines show linkages between determinants.



Policies to Mitigate Transport Emissions: Implementation Issues and Examples

Characteristic	Policy Instructions	Implementation Issues	Examples
Transport emissions	directly reduce vehicle emissions through standards.	Emissions standards may be technology-forcing or technology-following.	Emission standards: highly successful in US
Fuel quality	Mandated fuel standards ; emissions tax; emissions permits	Mandated fuel standards have been highly successful in US, Japan Europe. Reformulation cost can be significant, but much lower than health benefit. Oxygenation reduces HC and CO emissions, but may raise Nox	Zero-lead stds: Thailand, Mexico, Brazil, Colombia, Japan. Volatility limits: US, Sweden, Finland. Oxygenation stds: US, Brazil, S.Africa, S.Korea, Thailand, Sweden, Finland. Emission fees: none
Engine type	promote a halt to building and importing dirty 2-stroke engines; convert new 2-strokes; convert bus/truck/taxi engines to run on alternative fuels	Adequate lead-time is required for manufacturers to comply at low -cost. Cost to consumers is about 6% for motorcycles (to add catalytic converters to 2-strokes in Taiwan) Some conversions may have low or negative costs (due to fuel cost saving, etc.). Others may require strong incentive /support programs.	Elimination of 2-stroke motorcycles by setting emissions standards: US Taiwan: adopted US standards, but more recent technology allows some advanced 2-strokes to meet standards. Retrofitting trucks to run on LPG: Bangkok Converting taxis to run on LPG: Tehran Converting buses to run on CNG: Santiago, Delhi
Technology	mandate catalytic converters in new cars ; Mandate PCV valves to control crankcase emission; retrofitting program	Consumer tampering with catalytic converter may be problematic. I/M programme can mitigate this.	Catalytic converters: US Crankcase emissions: US Retrofitting catalytic converters: Germany, Sweden, Hungary
Size of fleet	<u>ownership restrictions:</u> new vehicle quotas; high ownership fees	Requires strong policies to succeed amid economic growth. More feasible if consumer demand is relatively low, cities are dense, public transport is efficient, and complementary policies (like high parking fees, road/area pricing, high fuel taxes) exist.	Quota: Singapore High ownership fees: Singapore Vietnam
Age of fleet	<u>scrappage incentives:</u> higher registration fees for old vehicles; I/M program for high polluters; roadside inspections	Scrappage programs have worked, e.g., subsidized trade-in programs; I/M programs are costly to set-up and administer. Inspecting subset of vehicles may be more feasible.	Scrappage incentives: Singapore, Mexico City (taxis) I/M: US, European Union, Japan, Roadside inspection: Hong Kong, Mexico, Thailand

Characteristic	Policy Instructions	Implementation Issues	Examples
Congestion	<p><u>Direct:</u> new vehicle quotas; high taxes on ownership; no-car zones; no-car days; area pricing; road pricing; insurance adjustments</p> <p><u>Efficiency Enhancement:</u> computerized traffic lights; dedicated road lanes; staggered work hours; car pooling incentives; light rail or bus system</p> <p><u>Road Supply:</u> state built roadways; joint public-private roads; private new toll roads.</p>	<p>Direct policies succeed in some cities. Require political will and strength (because of consumer opposition) No-car days in Mexico had perverse effect of raising emissions. No-car zones have been well received by consumers and business owners in some areas. Area and road pricing requires initial investment, but fees generate revenue. Insurance: verification of usage rates is difficult.</p> <p>Traffic engineering can work, but sometimes there is an immediate one-time benefit followed by gradual deterioration. Initial cost may be high (but usually outweighed by benefits) Commuters spacing has mixed record. Mass transit done well is effective, but may be costly (esp. subway system). Buses are relatively cheaper.</p> <p>Increasing road supply has low prospects for success in long run (since it may encourage more driving), but can help in short run.</p>	<p>Quota: Singapore High ownership fees: Singapore, Vietnam No-car zones: Curitiba, Brazil Tokyo, Hong Kong No-car days: Athens, Mexico City, Santiago Area pricing: Singapore, Amsterdam, unsuccessful in Kuala Lumpur. Road pricing: widespread Insurance adjustment: US</p> <p>Synchronized traffic lights: widespread (London is advanced). Dedicated bus lanes: Bangkok, Jakarta, Manila, Sao Paulo, Tehran, Tokyo; HOV lanes for cars are widespread Staggered work hours: Singapore, Surabaya Car pooling incentives: US, Singapore Light rail/metro: Cairo, Calcutta, Hong Kong, Mexico City, Pisau, Rio de Janerio, Santiago, Sao Paulo, Seoul, Seoul, Singapore</p> <p>New public road construction: widespread New private toll road constructions</p>

International Experience: Policy Implications

- Focusing on reductions in emissions per kilometer (a la US) has only a limited impact on aggregate vehicular emissions since it does not affect VKT (vehicles kms. traveled)
- $\text{Emissions/km} = (\text{emissions/litre}) \times (\text{litres/km})$
- $\text{VKT} = \text{vehicles} \times \text{km/vehicle}$
- United States--even as cars became cleaner, vehicle miles traveled by an average driver doubled between 1970 and 1988 → while technical fixes have been used in many countries such as US, they are not in themselves enough to curb vehicular emissions. Behavioral modifications are crucial.
- Remove perverse incentives for vehicle ownership and use

Cost effectiveness of various control measures (US\$/ton)

Minibus CNG retrofit	(248)
Gasoline truck CNG retrofit	(225)
Centralised I&M high-use vehicles	207
Decentralized (garage-based) I&M high-use vehicles	287
Centralized I&M passenger cars	858
Reduce sulfur content in diesel (from 1% to 0.1%)	961
Decentralized (garage-based) I&M passenger cars	1,025
Road paving (1000 kms.)	1,335
Reduce sulfur content in diesel (from 0.4% to 0.1%)	1,371