“Quantitative Welfare Analysis of Road Pricing/Toll Pricing- Post evaluation”

12th April 2005（Tuesday）

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Out line of Presentation

- **Objectives**
- **London Congestion Pricing -Welfare Impacts**
  (Source: Transport for London web site: http://www.tfl.gov.uk/tfl/)
- **91 Express Lanes (SR 91) in Orange County, California - Welfare Impacts** *(Source :http://www.91expresslanes.com/)*
- **HOT Express Lanes/Fas Trak (I-15), San Diego, California - Welfare Impacts** *(Source: http://agro.sadag.org/fastrack/index.html)*
- **Urban Road Pricing-Lyon** *(Source: Charles Raux and Stephanie Souche (2004), The Acceptance of Urban Road Pricing-Lyon,. Journal of Transport Economics and Policy, Vol.38, Part 2, May 2004.pp191-216.)*
- **Discussion**

Objectives

Quantification of welfare benefits in the form of Benefit Incidence Table(BIT), which gives the clear understanding of various sectors in the scheme with equity and efficiency.

London Congestion Pricing- Welfare Impacts

Introduction

Congestion Charge £5 / day

Benefits in the form of:

i) Direct

Reduced congestion,

Reduction in accidents,
Improvement in public transport

Travel time savings

ii) Perceived benefits (In Direct)

Savings in Vehicle Operating costs,

Reduction in Environmental pollution

Reliability benefits to car, Taxis, and commercial vehicles etc..,

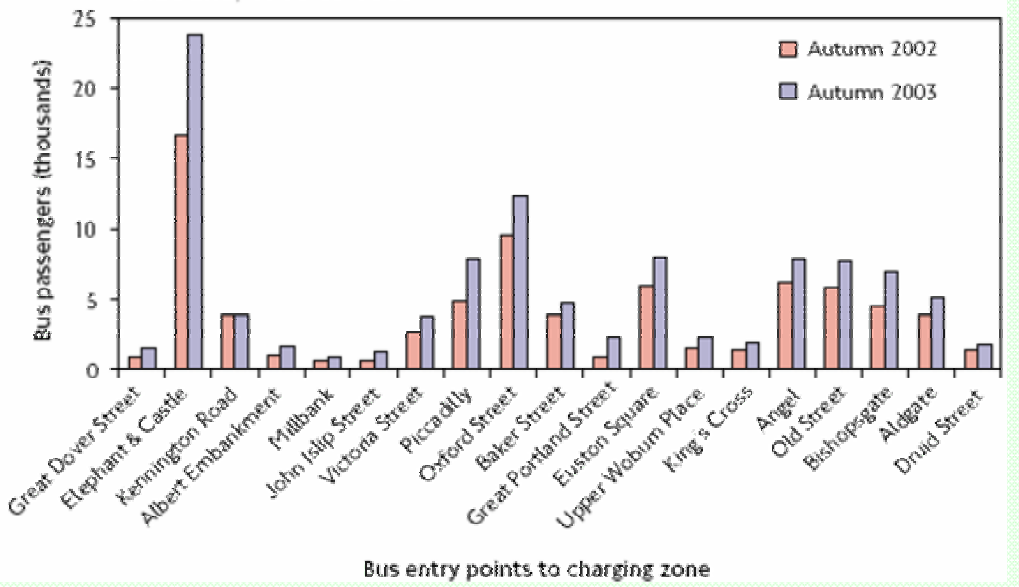
Central London Congestion charging area covering about 22 square kilometers

London Congestion Pricing- Welfare Impacts

- Improvement of Public Transport
- Social and behavioral impacts
- Business and economic impacts
- Accidents, amenity and environment

Improvement of public transport〔1〕

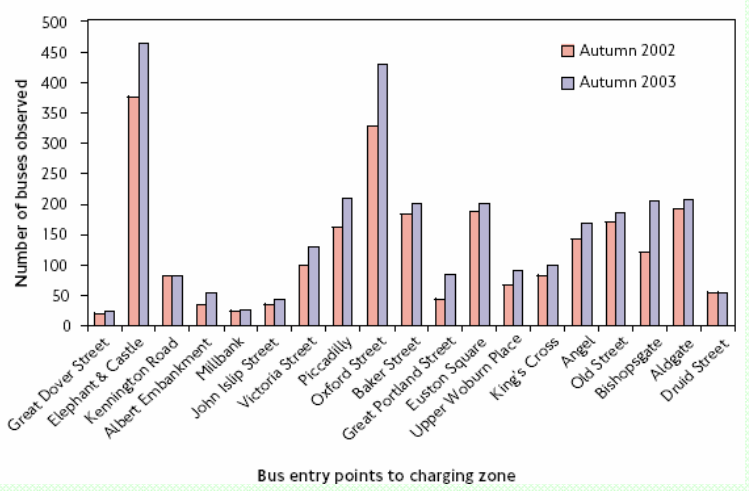
Charging zone boundary, number of bus Passengers by location, inbound ,0700 to 1000



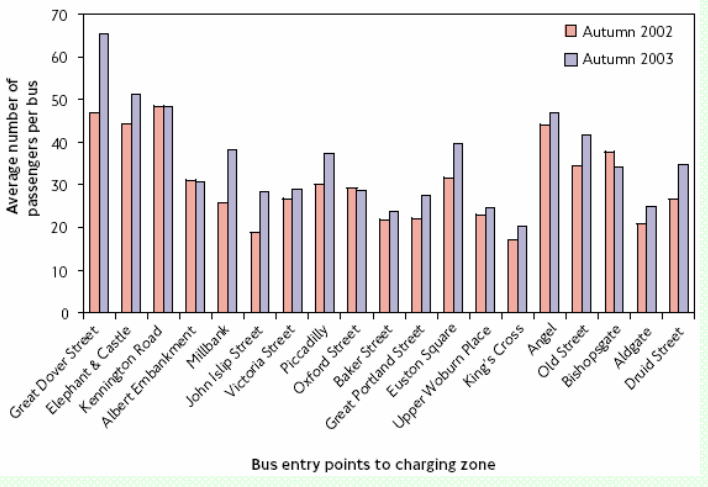
An increase in number of public transport users from individual mode(car)use.

Improvement of public transport〔2〕

Buses observed by location, inbound, 0700 to 1000



Average number of passengers per bus by location,inbound 0700 to 1000

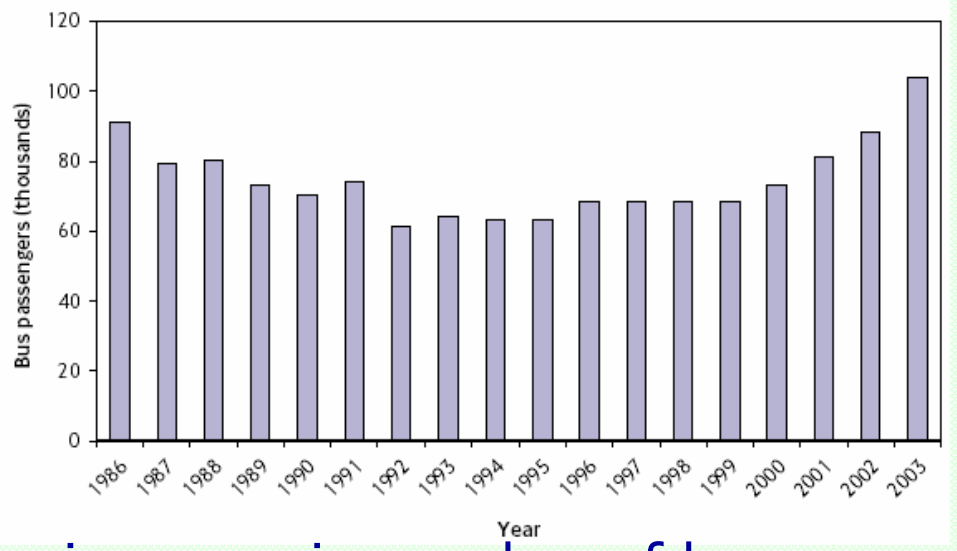


Increase in public transport fleet entering the charging zone

Increase in public transport users in charging area.

Improvement of public transport〔3〕

Bus passengers, inbound, Central Area peak count,0700 to 1000
Autumn counts, 1986 to 2003



An increase in number of bus users

Reasons:

① **50 percent are due to congestion pricing**

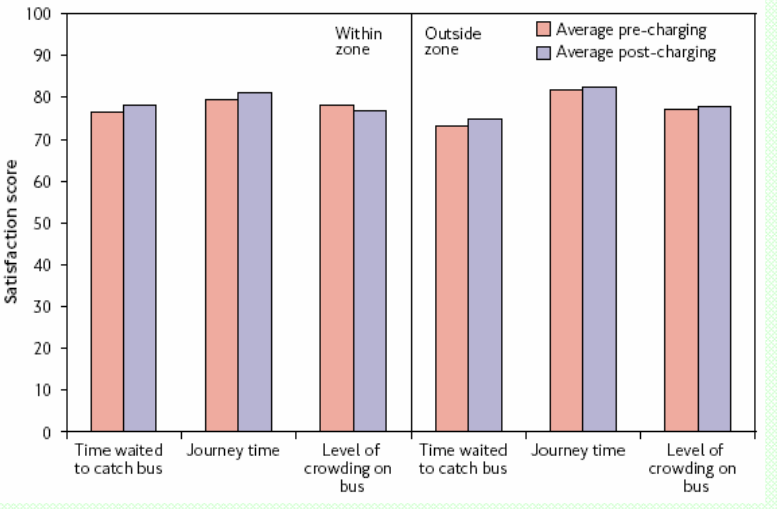
② **Rest are other reasons (convenience, Improvement in route,increased bus frequency etc.)**

Improvement of public transport〔4〕

Overall customer satisfaction with bus services within and outside of the charging zone, 2002 to 2003

	Within charging zone	Outside charging zone
Jan-Mar 2002	77	76
Apr-Jun 2002	78	77
Jul-Sep 2002	76	76
Oct-Dec 2002	77	75
Jan-16 Feb 2003	78	76
17 Feb-Mar 2003	77	76
Apr-Jun 2003	78	77
Jul-Sep 2003	77	77
Oct-Dec 2003	77	76

Customer satisfaction with aspects of bus services within and outside of the charging zone, 2002 to 2003

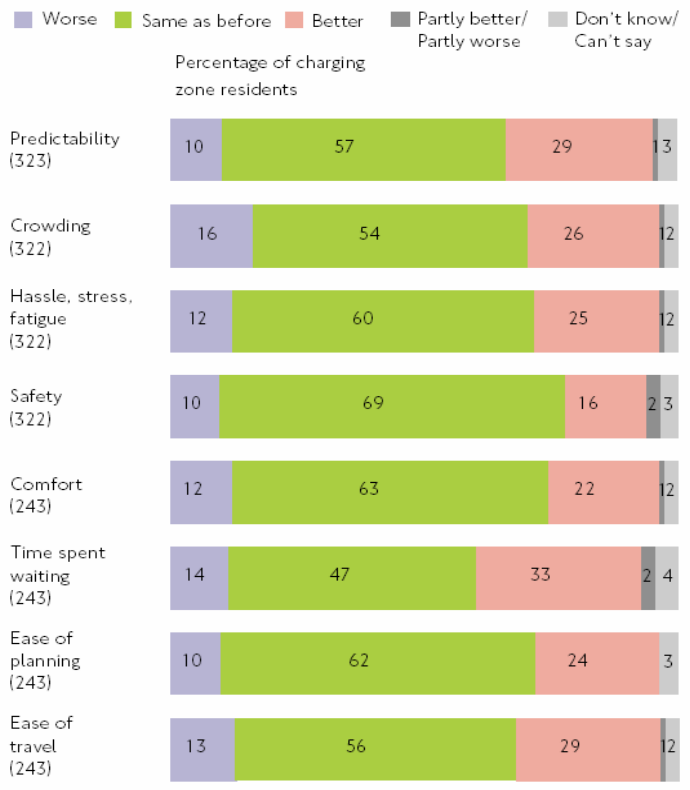


Customers Satisfaction high within the charging zone

Satisfaction is high after imposition of charge compared to before within charging zone

Social and Behavioral Impacts

Perceived changes to journey experience, charging zone residents, Autumn 2002 to 2003



Base: All respondents who have travelled to or within the zone since the scheme has been introduced

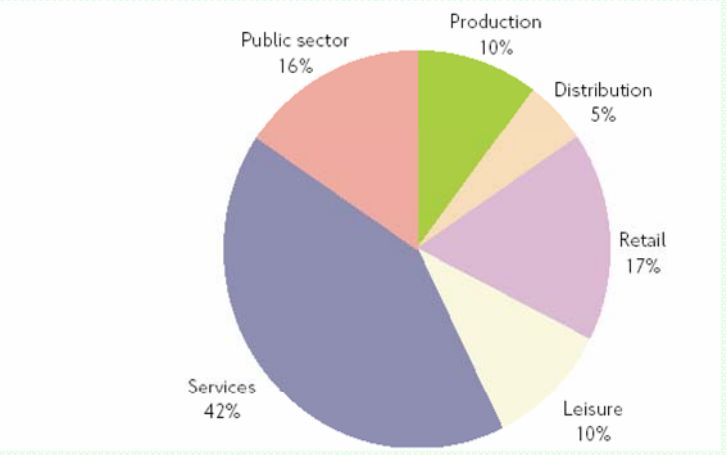
① **Over 40 percent of residents within the charging zone say situation is improved**

② **30 percent say pollution, noise, reliability of public transport, availability of public transport and congestion are now better.**

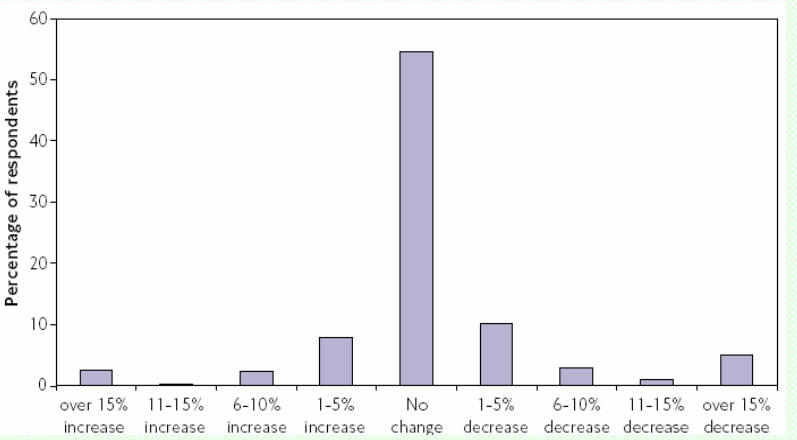
About 80 percent say that the scheme had been effective in achieving its primary objectives shifting the opinion towards favoring the scheme and its effects.

Business and Economic Impacts〔1〕

Central London employment by business sector, 2003



Changes in sales within the charging zone, 2003

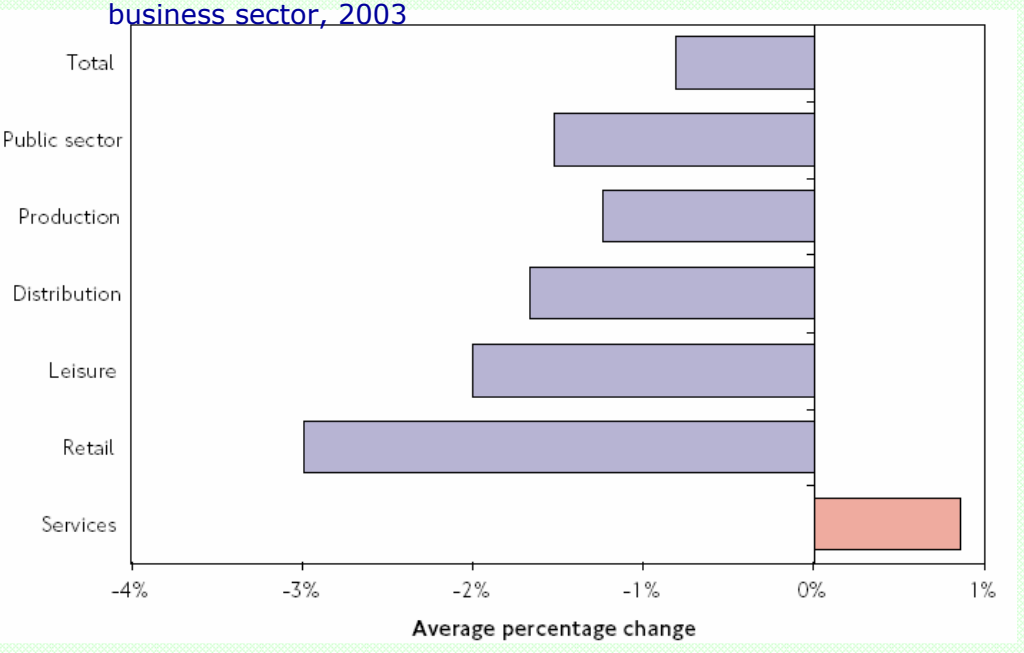


① **Little or no change to overall business performance**

② **Marginally more respondents saw a decrease in performance than the growth, indicative of a relatively weak economic performance overall**

Business and Economic Impacts〔2〕

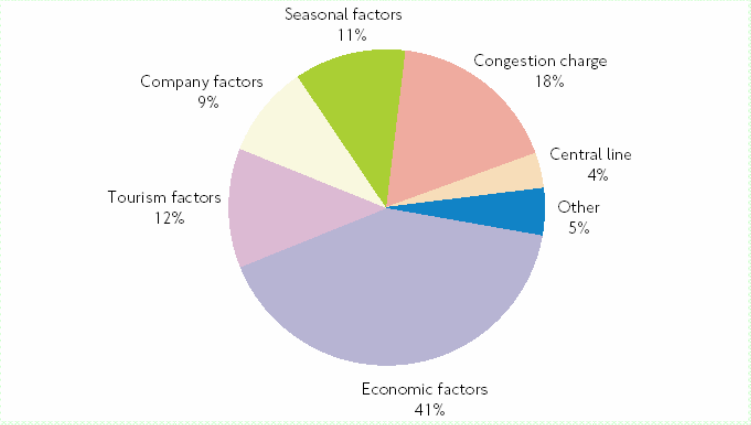
Average business performance during the first half of 2003 by business sector, 2003



① 1% increase only in service sector
② Retail, leisure and distribution sectors are reported a decline around 3 %.

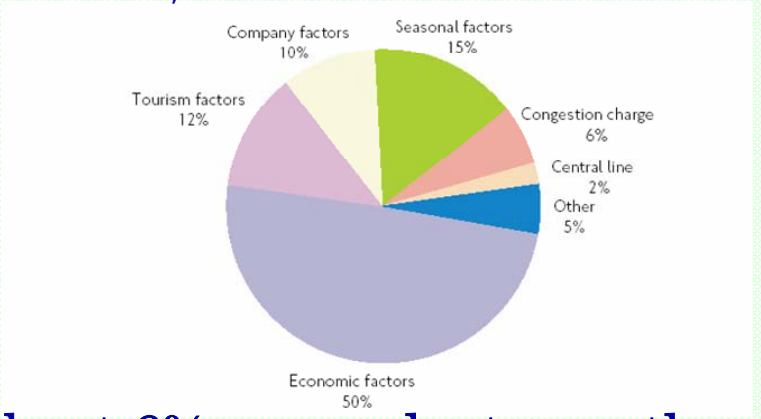
Business and Economic Impacts〔3〕

Central London employment by business sector, 2003



Eighteen percent of retailers regarded congestion charging as an influence on their businesses that have, on average, declined by 3 percent over the period concerned. But service sector registered a growth in contrast.

Perceived influences s on business performance in the service sector, 2003



About 6% respondents say the congestion charging influences the business sector

Cost Benefit Analysis (1)

Cost million pounds/year	130
Administrative and other costs	5
Scheme operation costs	90
Additional bus costs	20
Charge payer compliance costs	15
Total receipts from charging	−200
Producer's surplus＝200−130＝70	

Cost Benefit Analysis

〔2〕

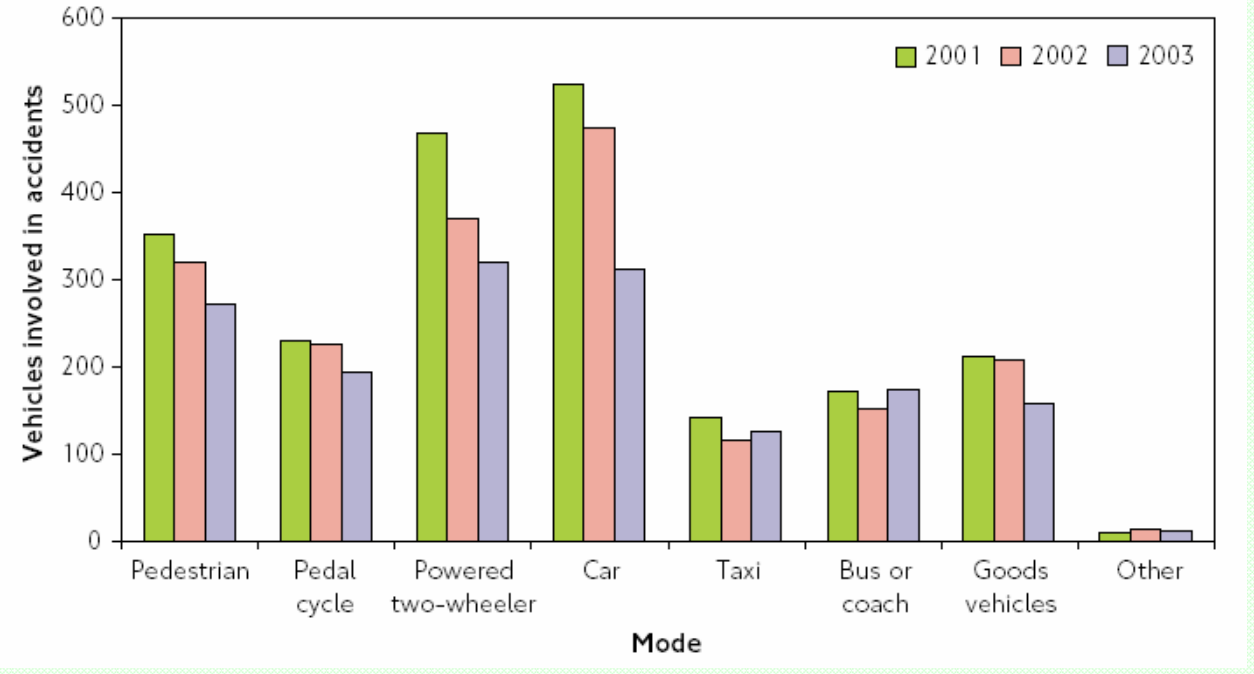
Total Annual Benefits	180
Time savings to car and taxi occupants, business use	75
Time savings to car and taxi occupants, private use	40
Time savings to commercial vehicle occupants	20
Time savings to bus passengers	20
Reliability benefits to car, taxi and commercial vehicle occupants	10
Reliability benefits to bus passengers	10
Vehicle fuel and operating savings	10
Accident savings	15
Disbenefit to car occupants transferring to public transport, etc.	−20
Total toll charges −200）	

User benefits＝180−200＝−20

Total net benefits＝Producer's surplus＋user benefits＝70−20＝50

Accidents

Accidents involvement by vehicle type within the charging zone 0700 to 1900, March to October,2001 to 2003



Accidents continue to decrease within the charging zone and overall in London..

BIT (London Congestion Pricing)

Sector		Users		Households (CBD)	Producers (Firms) (CBD)	Producers (outside CBD)	(Revenue)	Total (Mill. pds)
		Road	Public Transport					
Road User Benefits	**Pricing**	**-200 (150from charge+ 50 from penalty)** (5 pounds/entry) 1.About 70,000car trips are reduced 2. 20 to 30% above diverted around charging zone 3. 15 to 25%, other options such as changing timings of travel	(No change in fares) Out of above reduced car trips 50 to 60 % transferred to PT				**+200**	**0**
	Congestion relief	**++135=+155- 20 (−20=disbenefits to car users)** 1. 30% reduction. 2. Delays reduced from 1.9min/Km to 1.5min/Km. 3. Speeds increased to 17kmph	**++ +30** 1.Improved frequency. 2. Bus speeds increased by 6 % 3. 38% increase in bus patronage					**+165**
Accidents, amenity and environment		+ **+15** 1. Reduction in accidents		+ 1. 12% emission reductions of Nox, PM10 2. No evidence of noise reduction	+ 1. 12% emission reductions of Nox, PM10 2. No evidence of noise reduction			**+15**
Business and Economic	**Service sector**				+ 1% increased	- Decreased		**0**
	Retail, Tourism, Distribution Sectors				- 3% decreased	+ Increased		**0**
Revenue							**-130***	**-130**
TOTAL		**-50**	**+30**	**+**	**+/-**	**+/-**	**+70**	**+50**

*operating cost 110 million +bus costs 20 million

91 Express lanes (SR-91), Orange County,California, USA

- Length of Project：16 kms
- Principle：Addition of new Priced lanes
- Charges: SOV will be charged from $1.05 ~$7, HOV will be charged half of the displayed charges only on Mondays
- Cost ：$207 million
- Traffic share of priced lanes：40%
- Traffic Speeds (priced lanes)：60mph, GPLs： 20mph

91 Express lanes (SR-91), Orange County,California, USA

■ Started with Private consortium: (California Private Transportation Company (CPTC))

Conditions：1. Agreement stipulated that highway department would not do anything that might damage the private company business
2. 2.5 kms Protection zone along the corridor

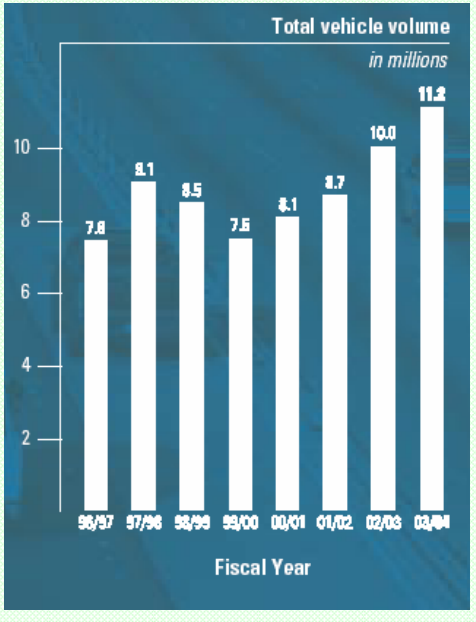
Public Opposition

Orange City County, OCTA in 2003

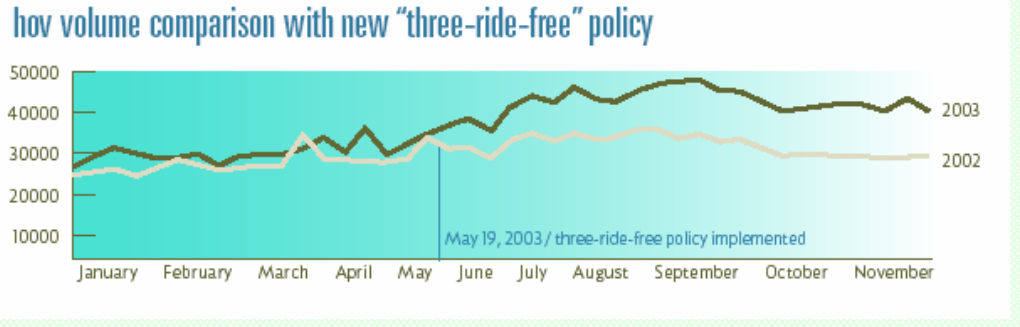
91 Express lanes (SR-91), Orange County,California, USA

- Annual Report 2004

Increase in traffic volume using the priced lanes and increase in AVO



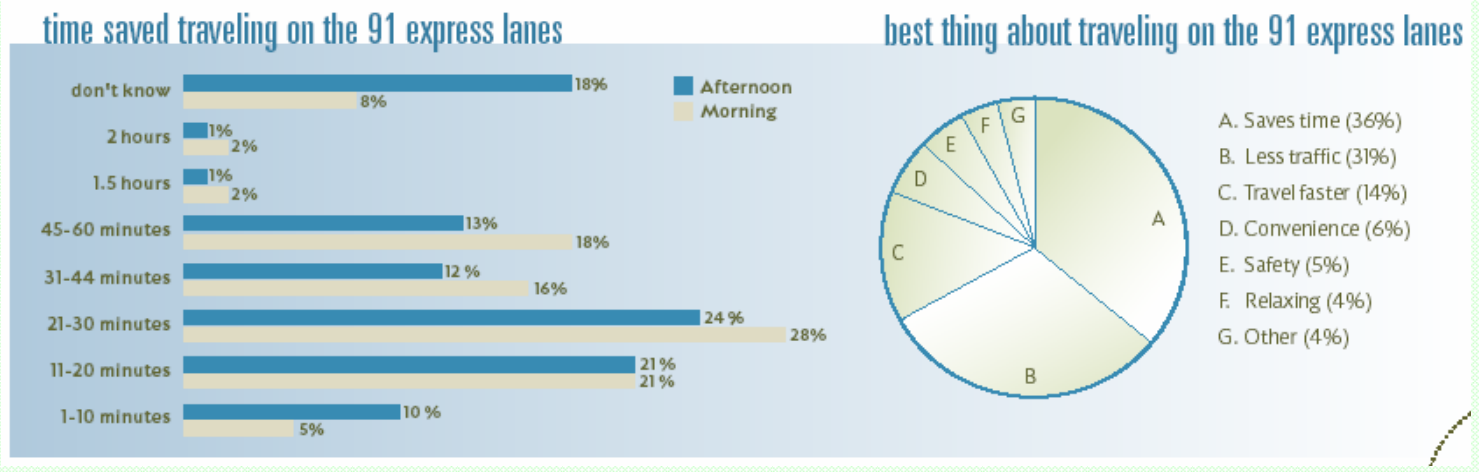
Effect of three occupants free rider facility



- 12% increase in toll road traffic
- 43% increase in HOV
- AVO is increased from 1.36 to 1.49

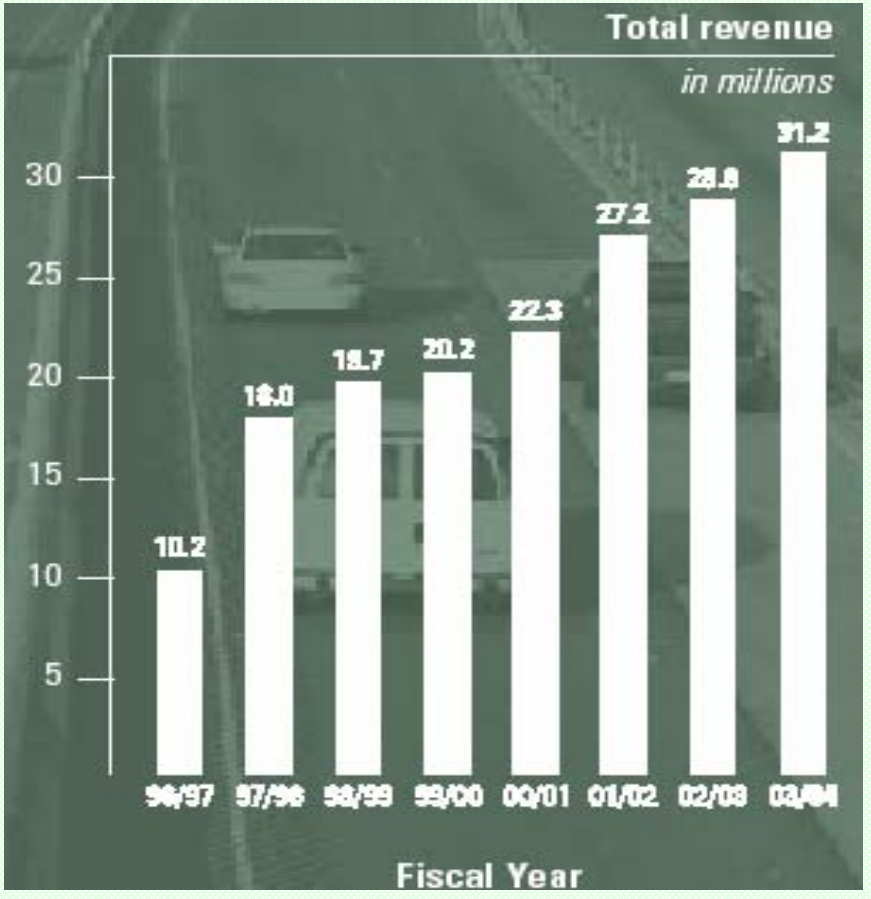
91 Express lanes (SR-91), Orange County,California, USA

- Annual Report 2004



- Travel time savings are around 36 minutes per trip
- 70 percent are viewed as time savings and less traffic to travel on 91 express lanes as a priority

91 Express lanes (SR-91), Orange County,California, USA



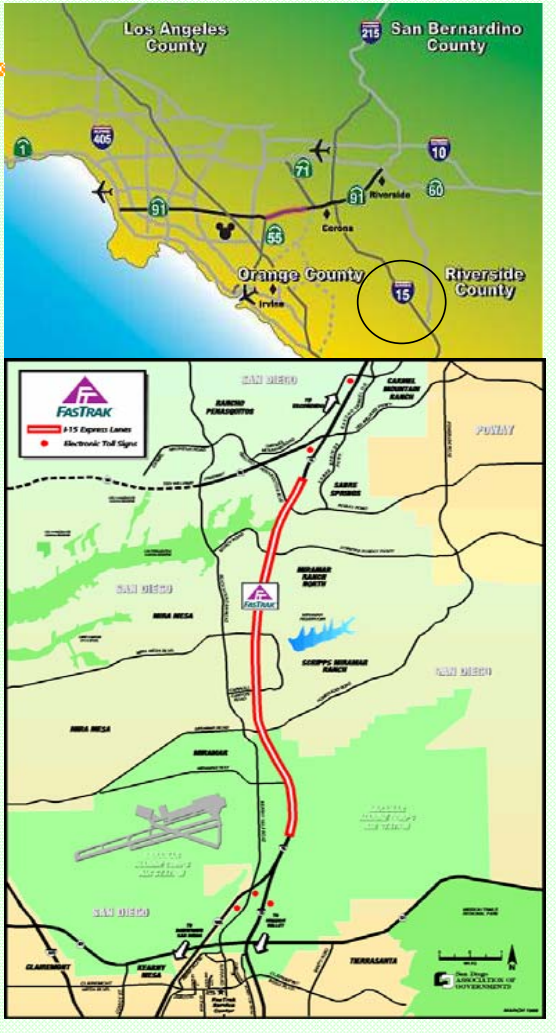
Toll Revenue

BIT for 91 Express lanes (SR-91), Orange County,California, USA

Sector		Road Users			Toll Corporation (OCTA)	Total ($ millions)
		91 Express Lanes		GPL Users		
		HOV	*SOV*			
Road User Benefits	**Toll charges**	- **4.5**	- **22.1**	+ No charge	+ **26.6**	**0**
	Congestion relief	+ **24.6**	++ **67.5**	+		+ **92.1**
Operating cost/Impl.cost					- **7.0** $207 Million	- **7.0**
Total		+ **20.1**	+ **45.4**	+	+ **19.6**	+ **85.1**

HOT Express lanes/Fas Trak (I-15) San Diego,USA

- **Cost**：$10 million（13km）
- **Principle**:HOV to HOT (Value added pricing)
- HOV：Free of charge for high occupant vehicles
- HOT：Free of charge when the occupants are three or more
- Charges：$0.5～$8



HOT Express lanes/Fas Trak (I-15) San Diego,USA

Objectives :

1. Use efficiently the excess capacity under HOT

2. Improve the transit and rideshare services along I-15 corridors

3. Impact of value pricing to relieve the congestion

SIGN BORAD SWOING
VARIABLE TOLL RATES

Welfare benefits in the form of :

1. Reduced travel congestion of General purpose lanes (GPL)

2. Funding transit improvements and indirectly responsible to increase rider share on transit services

BIT for HOT Express lanes/Fas Trak (I-15) San Diego,USA

Sector		Road Users				Toll Corporation (SANDAG)	Total ($ Million)
		HOT Users		*GPL users*	Transit Users		
		HOV	SOV				
Road User Benefits	**Pricing**	+ **0**	- **2.2**	+ No charge	+ No change in fares	+ **2.2**	**0**
	Congestion relief	+ **24.9**	+ **9.3**	+	Fare receipts are diverted to the public, traffic service improvement.		+ **34.2**
Operating cost/Impl.cost						- **1.2***	- **1.2**
Total		+ **24.9**	+ **7.1**	+ Smaller gains	+ Increase in frequency, fleet and reliability of service	+ **1.0**	+ **33.0**

*($10.23 mil construction cost/30yrs+0.8million operating cost/yr)

Urban Road Pricing-Lyon

- Equity and Efficiency

1. **Spatial Equity**
   (Guarantee the right of access to goods and services from any location)
2. **Horizontal Equity**
   (Equality of treatment of different users and, in particular, the user pays principle)
3. **Vertical Equity**
   (Explicitly considers social inequalities (income)and their consequences with regard to transport)

4. **Efficiency**
   Social net benefits

Urban Road Pricing-Lyon

- Total Length: 10km（main tunnel 3.5km）
- **Cost**：900 million Euro
- **Public funding**：52%

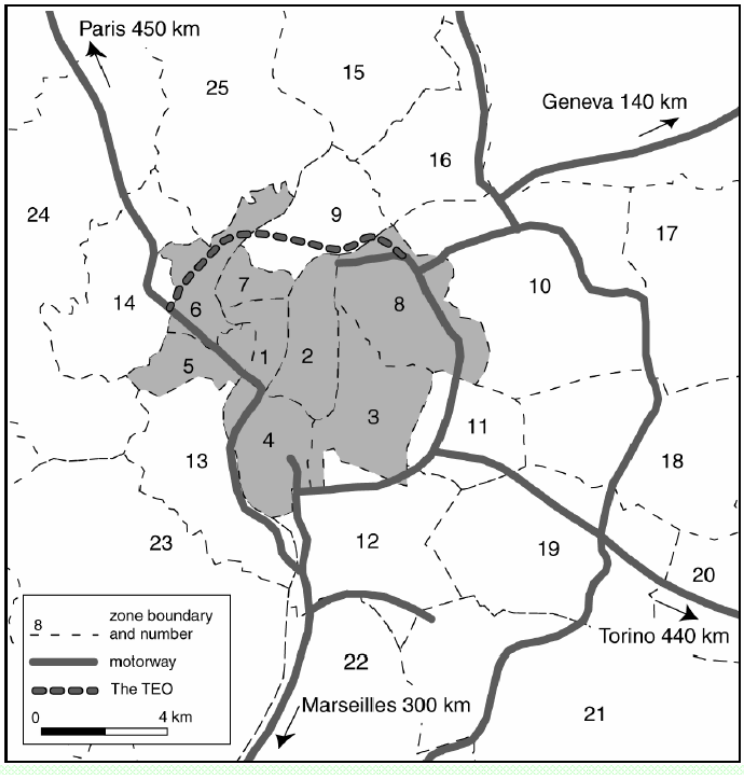
Opened to traffic in August, 1997 by TEO private operator

:Capacity restrictions on usage of parallel roads, high toll rates and congestion away from the CBD is increased during peak travel times leads to public opposition to reject the scheme

First action in September, 1997 the existing proposal is stopped, and started with partial restoration of capacity restrictions on parallel roads

Second action in February 1998 concession contract was terminated

Again Opened in June 2006 under BPNL with reduced toll rates and charging only 3.5km tunnel .

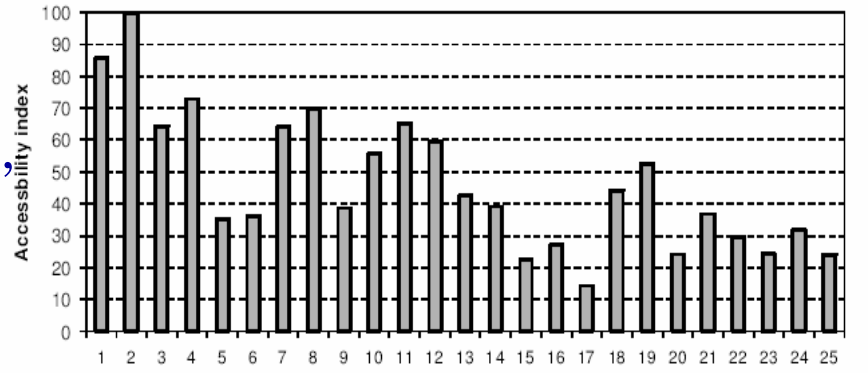


Urban Road Pricing-Lyon

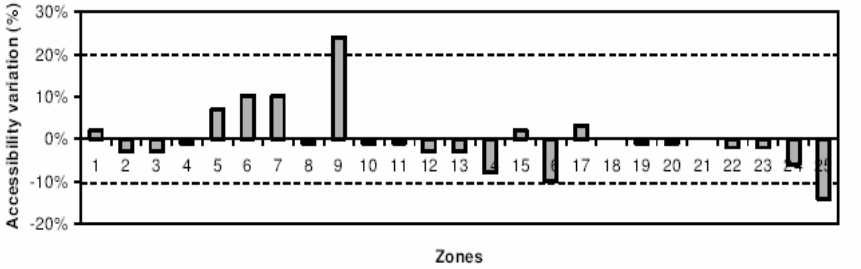
Spatial Equity and Accessibility under TEO

Because of high toll rates, there are some improvements in north zone areas.

Where as residents in south to east zones are worsened.



（Before ）



（After opening under TEO）

Urban Road Pricing-Lyon

- Results under TEO operation

1. **Only 0.3 percent of private car trips are transferred to public transport which accounts only 1 percent of public transport trips.**

2. **Total change in the surplus of the users who remained on public transport is negligible**

3. **There is an over all negative surplus for those who continue to use the car , this is at the order of 114,000 euro per day.**

Urban Road Pricing-Lyon

Vertical Equity under TEO

Changes in Surplus and Measures of Inequality

Decile	*D2*	*D3*	*D4*	*D5*	*D6*	*D7*	*D8*	*D9*
Value-of-time (euros/min.)	0.089	0.100	0.111	0.123	0.135	0.152	0.177	0.222
Mean change in surplus								
Time saving before/after				27 min.				
For a trip (€)	−0.04	0.27	0.57	0.87	1.21	1.66	2.33	3.56
For a typical day*	0%	1%	2%	3%	4%	5%	6%	7%
Time saving before/after				15 min.				
For a trip (€)	−1.11	−0.93	−0.77	−0.60	−0.41	−0.16	0.21	0.89
For a typical day*	−5%	−4%	−3%	−2%	−1%	0%	1%	2%
Time saving before/after				4 min.				
For a trip (€)	−2.08	−2.04	−1.99	−1.95	−1.90	−1.83	−1.73	−1.55
For a typical day*	−10%	−8%	−7%	−7%	−6%	−5%	−4%	−3%
Time saving before/after				0 min.				
For a trip (€)	−2.44	−2.44	−2.44	−2.44	−2.44	−2.44	−2.44	−2.44
For a typical day*	−11%	−10%	−9%	−8%	−8%	−7%	−6%	−5%

* % daily salary.

In D2 deciles category, even though time savings are at the order of 24 minutes still the mean changes in surplus is negative.

BIT for Urban Road Pricing *(Operation under TEO, 1997-98)*

Sector		Road Users														Road Corporation (TEO)	Total (FF million)
		Zones near to toll road								**Zones away from toll road**							
		Car/Motor User		Mode change User		Public Transport		Toll free road		Car/Motor User		Mode change User		Public Transport		Toll free road	
		High income	Low income	High income	Low income	High income	Low income	High income	Low income	High income	Low income	High income	Low income	High income	Low income	High income	Low income
Road User Benefits	Toll charge	- FF 16/trip		No change in fares		No change in fares		No charge		- FF 16/trip		No change in fares		No change in fares		No charge		+ FF 16 X No.of trips	**0**
	Spatial	++	++	+	+	+	+	+	+	-	-	-	-	-	-	-	-		-
	Horizontal	- 68		+ 2		+ 3		- 68		- 68		+ 2		+ 3		- 68			- 262
	Vertical	+	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-		-
Operating cost/Impl. cost																		- FF 6000 million (FF324 million/ Year)	- 324
Total		**-68** Direct and perceived benefits are lesser than the toll paid.		**+2** Gains are very small as compared to over all consumer surplus		+3 Gains are very small as compared to over all consumer surplus		**-68** Loss due to capacity restrictions on parallel roads		**-68** Direct and perceived benefits are lesser than the toll paid		+2 Gains are very small as compared to over all consumer surplus		+3 Gains are very small as compared to over all consumer surplus		**-68** Loss due to capacity restrictions on parallel roads		+ Start up stage authority got good revenues, but due to pubic opposition it is rejected, later	**-586**

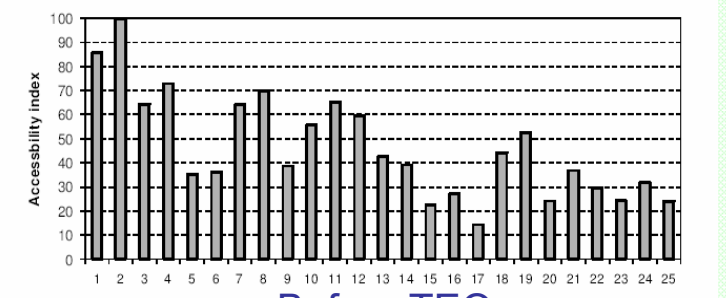
Over all consumer surplus loss who continue to use the Car/Motor is at the order of FF 272million

Urban Road Pricing-Lyon

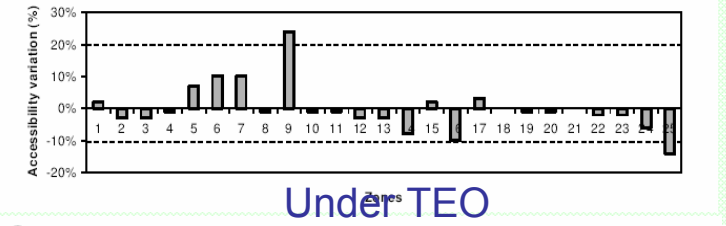
- Under BPNL operation

Charges
：FF10（1.5 Euro）

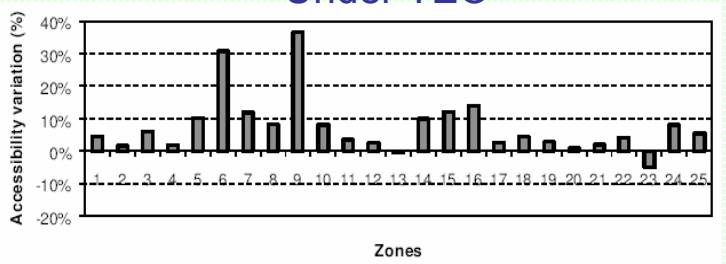
Spatial Equity
：improved in all regions



Before TEO



Under TEO



Under BPNL

Urban Road Pricing-Lyon

- Horizontal Equity under BPNL

1.Improved route choices for those not using toll road
2.Reduced toll rates further helped for those who use toll road save travel time more than they pay the toll.
3. Hence the horizontal Equity achieved but at cost of tax payers money.

- Vertical Equity under BPNL

① Reduced toll rates improved conditions to low income groups

② Now the D2 deciles category no longer losing but gaining

BIT for Urban Road Pricing *(Operation under BPNL form June 2000)*

Sector		Road Users										Road Corporation (BPNL)	Total (FF million)
		North Zone Users					*Other Zone Users*						
		Car/Motor User		Mode change from Car/Motor to PT	Public Trans port	Toll free road	Individual Mode		Mode change from Car/Motor to PT	Public Trans port	Toll free road		
		High income	Low income				High income	Low income					
Road User Benefits	Pricing	- FF 10/trip	- FF 10/trip	No change	No change	No charge	- FF 10/trip	- FF 10/trip	No change	No change	No charge	+ FF 10 X No.of trips	**0**
	Direct and Perceived benefits	+++ 1 Accessibility Increased, 2.Increase in Travel time savings	++ 1.Accessibility Increased, 2. Small Increase in Travel time savings	+ Small gains	+ Moderate gains	+ Increase in accessibility relatively, Congestion observed during peak hours	++ Increase in accessibility relatively lesser	+ Increase in accessibility is relatively lesser	+ Moderate	+ Moderate	+/- Small gains, Congestion observed during peak hours		+
Operating cost/Implementation cost												- FF 6000 million (FF324 million/Yr)	- 324
TOTAL		+ Gains in (accessibility) Spatial equity Horizontal and Vertical equity	+ Gains in accessibility, Horizontal equity and gains Vertical equity are less	+ Due to lesser change in mode, gains are moderate	+ Gains are moderate	+ Moderate	+ Gains are relatively low compared to North zones, but improved under BPNL	+ Gains are relatively low, but improved under BPNL, Vertical Equity is less	+ Improved over previous situation	+ Moderate	+/- Moderate	+ Due to reduce toll rates, the revenue is at lower side	+/- Gains for the North zones are increased relatively; vertical equity for the low-income groups is less. Though there are gains for the car/motor users, from economic efficiency point of view, it is still sub-optimal, because these gains are still at the detriment of tax payers money and are not distributed evenly among zones and all income classes..

Discussion

Name of Road Pricing	*Nature of Pricing*	Total Annul Benefits B	Total Annual project cost C	Total Net benefits to costs ratio (B/C)	Total Toll Revenue R	R/C	Net Users Benefits =B−R	Equity			Economic efficiency	Acceptance level (Percentage)
								Spatial	Horizontal	Vertical		
London Congestion pricing (million £)	Cordon pricing	**180**	**130**	**50 (1.4)**	**200**	**1.5**	**-20**	Initially it may be compromised but in long run it will be achieved	For the private car users it is a loss, for the public car users, it is gains, However, the part of revenue also funded from revenue, to some extent	Lower income groups are always looser because of more travel usage from higher income groups	Less than Sub optimal	90 (among the house holds in the charged zone)
91 Express lanes, Orange county (SR91) (million $)	New priced lanes	**92**	**7**	**85 (13.1)**	**27**	**3.9**	**65**	Not much changes	Social welfare benefits will be created by reducing flows on GPLs, but these are not sufficient against the project revenue, hence it rated as fair from social welfare point of view, good from toll revenue point of view	Lower income groups are always looser because of more travel usage from higher income groups	Sub optimal	90
I-15 San Diego HOT lanes/Fas Trak (million $)	Value added Pricing (HOV lanes to HOT lanes)	**34**	**1.2**	**33 (28.3)**	**2**	**1.8**	**32**	Not much changes	Part of generated revenue is funded for improvements in public transport/transit services, hence this can be rated as good	Lower income groups are always looser because of more travel usage from higher income groups	Sub optimal	92
Urban Road Pricing – Lyon Under TEO (million FF)	Toll road pricing	NA	**324**	**-586 (NA)**	NA	-	**-262**	Zones away from toll road got dis-benefited, leads rejection	There is overall loss to user who continue to use the car/motor vehicle, leads rejection	Lower income groups are always losers,for higher income groups time savings benefits gained are very less leads to rejection	sub optimal	rejected
Urban Road Pricing – Lyon Under BPNL (million FF	Toll road pricing	NA	**324**	NA	NA	-	-	Initially it may be compromised but in long run it will be achieved	Horizontal equity is improved some extent under BPNL,**but at the cost of tax payers money**	Lower income groups equity improved in addition to higher income groups	Less than sub optimal	Acceptance level is increased


Thank You