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Domestic Transport Costs and Charges

Information session – road passenger and road freight transport

22 August 2022

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Results included in this file may be subject to revision as the project team finalises the estimates for the DTCC Final Report.

Road passenger and road freight transport

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Road passengers and road freight

	Economic costs	User charges & revenue	Accidents	Local emissions	Global emissions	Biodiversity and biosecurity	Noise
Light vehicles	✓	✓	✓	✓	✓	✓	✓
Motor cycles	✓	✓	✓	✓	✓	✓	✓
Trucks	✓	✓	✓	✓	✓	✓	✓
Buses & coaches	✓	✓	✓	✓	✓	✓	✓

Tools and methodologies

	Economic costs	User charges & revenue	Accidents	Local emissions	Global emissions	Biodiversity and biosecurity	Noise
Coverage	Infrastructure Travel time	NLTF, fares, fees and charges Revenue	Social cost (VOSL and other components)	Social cost of mortality and morbidity	Social cost of carbon	Biodiversity and biosecurity	Noise impacts
Quantification	By expenditure type	By charge type	By mode and severity	By fuel type Location specific HAPINZ 3.0 VEPM	By mode, vehicle type and distance	By type of impacts	By location
Valuation	Cost Models Capital charges Depreciation rate MPL and WTP	Actual administrative data Annual reports Providers' data	WTP based VOSL Resource costs Administrative costs	MBCM	Shadow price of carbon (MBCM)	Contingent valuation (with and without treatment) Cost to treat	Dose-response curves (EEA) DALY

Road passengers and road freight

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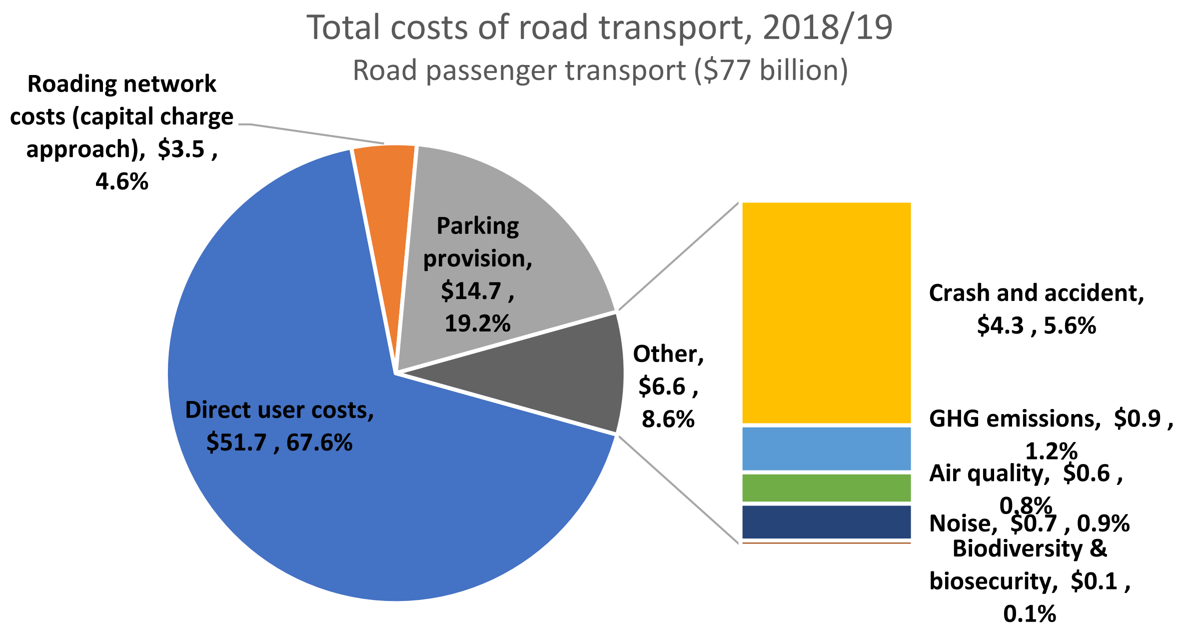
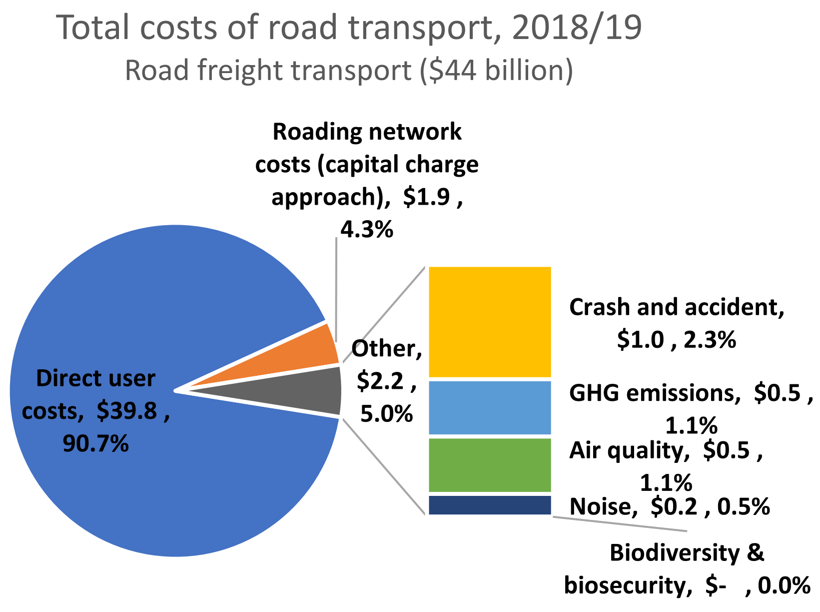
Trucks	✓	✓	✓	✓	✓	✓	✓
Buses & coaches	✓	✓	✓	✓	✓	✓	✓

DRAFT RESULTS

Total costs of road transport – road passenger vs road freight





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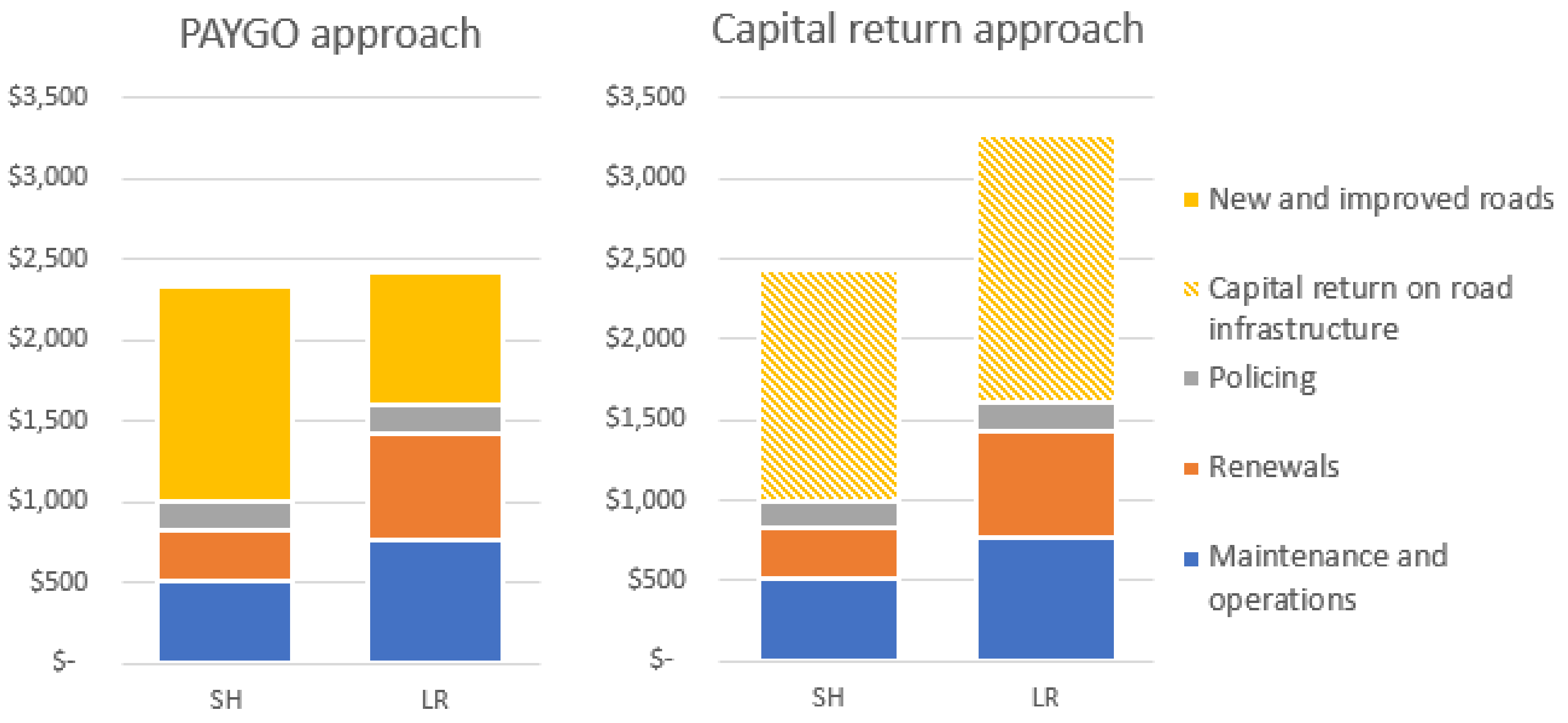
Total cost of roading infrastructure 2018/19

Two approaches

1. Financial approach (PAYGO)
   From administrative data and Cost Allocation Model

2. Economic approach (opportunity cost)
   Replacing expenditure on new and improved roads by a 4% capital return of the ODRC roading asset values

Total infrastructure cost of the roading network, 2018/19 ($ million)



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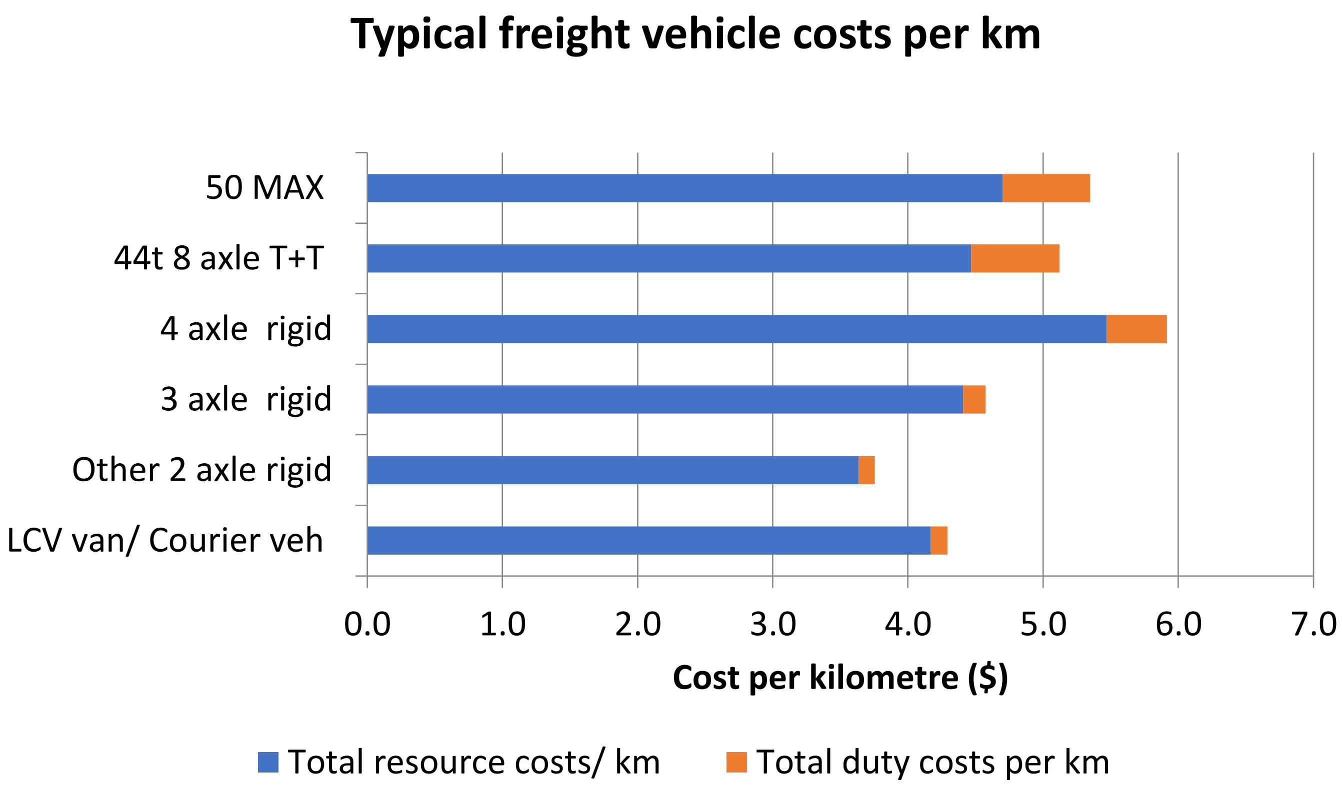
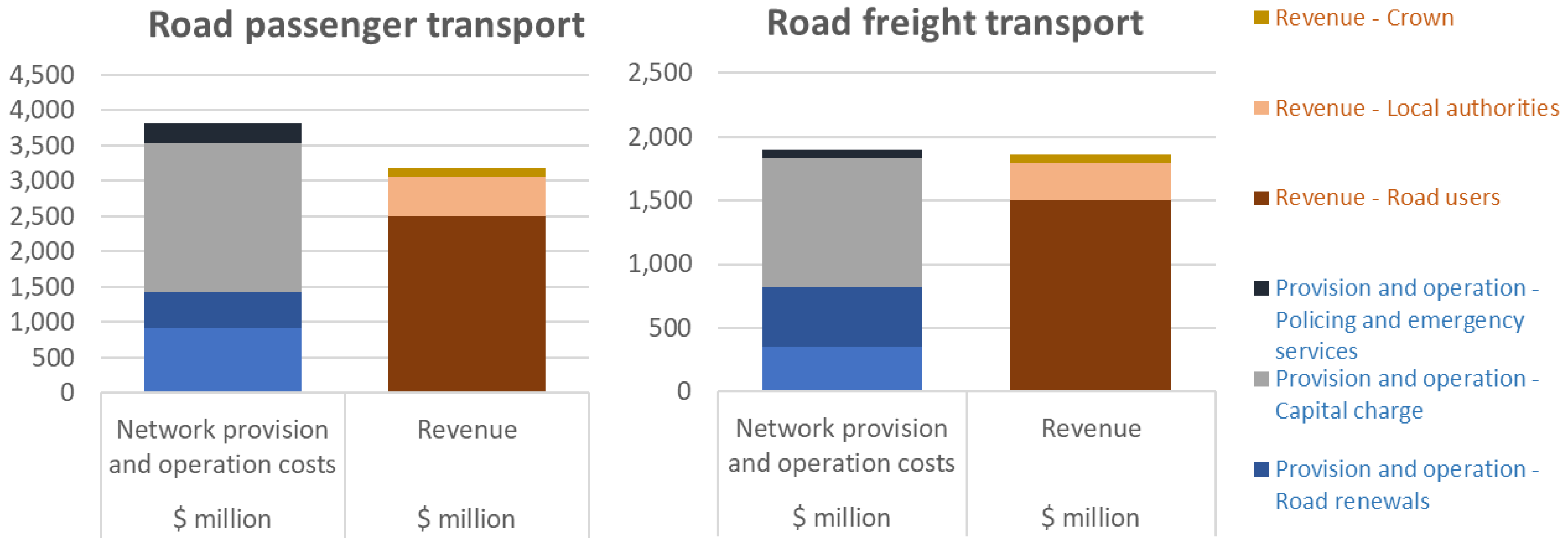
Vehicle operation costs

- Vehicle operating costs
    - NZAA for cars
    - National Road Carriers for freight vehicles
- Take into account the resource costs faced by users and also the fees, charges and duties paid
- Allows typical costs per vehicle kilometre or per passenger kilometre or net tonne kilometre to be estimated by vehicle type

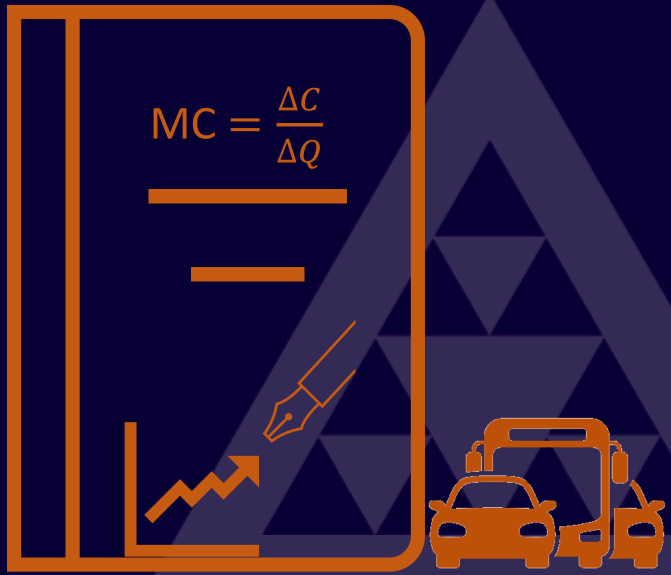


Users contribution to the provision and operation of the roading network (2018/19, $ million)



Marginal costs of road capacity

David Lupton – David Lupton Associates



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Short Run Marginal Costs (SRMC) – road capacity

- SRMC assumes road capacity is fixed – also referred as social marginal cost (SMC)
- When there are too many vehicles attempting to use a road

➔ its carrying capacity actually reduces (Greenshields 1935)

Based on previous work and study of the literature, we investigated a BPR function:

$$t = t_f + t_f * \alpha \left(\frac{Q}{K}\right)^{\beta}$$

t = travel time

t_f = free flow time

Q = demand

K = maximum capacity

α and β are coefficients.

NB: Travel times are influenced by many random factors – the relationship is behavioural. We chose the BPR function because it has a logical basis, it provides a good fit and it is mathematically tractable.

BPR = US Bureau of Public Roads

In almost all cases we were able to fit a BPR function with β=4

$$t = t_f + t_f * \alpha \left(\frac{Q}{K}\right)^{\beta}$$

Mathematically $\alpha = \frac{1}{(\beta - 1)}$

The most consistent fit was

α = 0.33

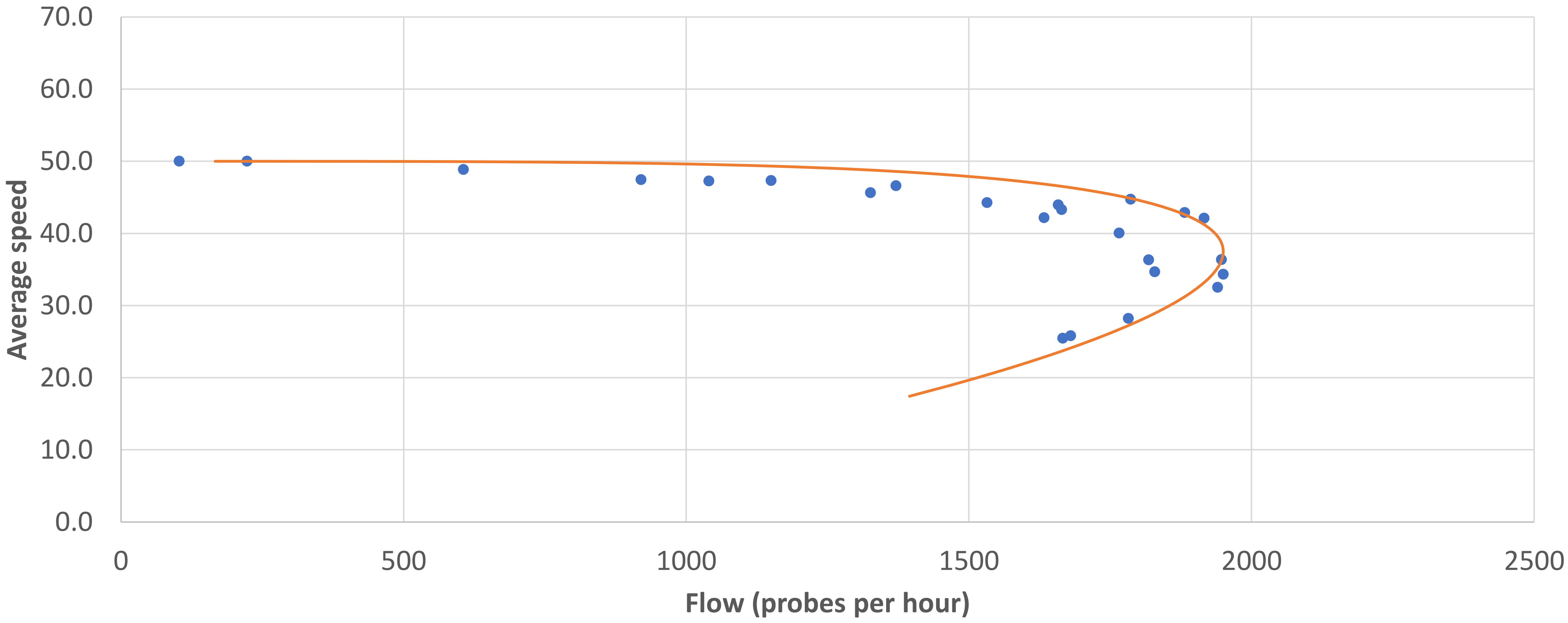
β = 4

The BPR function relates travel time (t) to traffic demand (Q). But we don't know the demand, only the resultant flow.

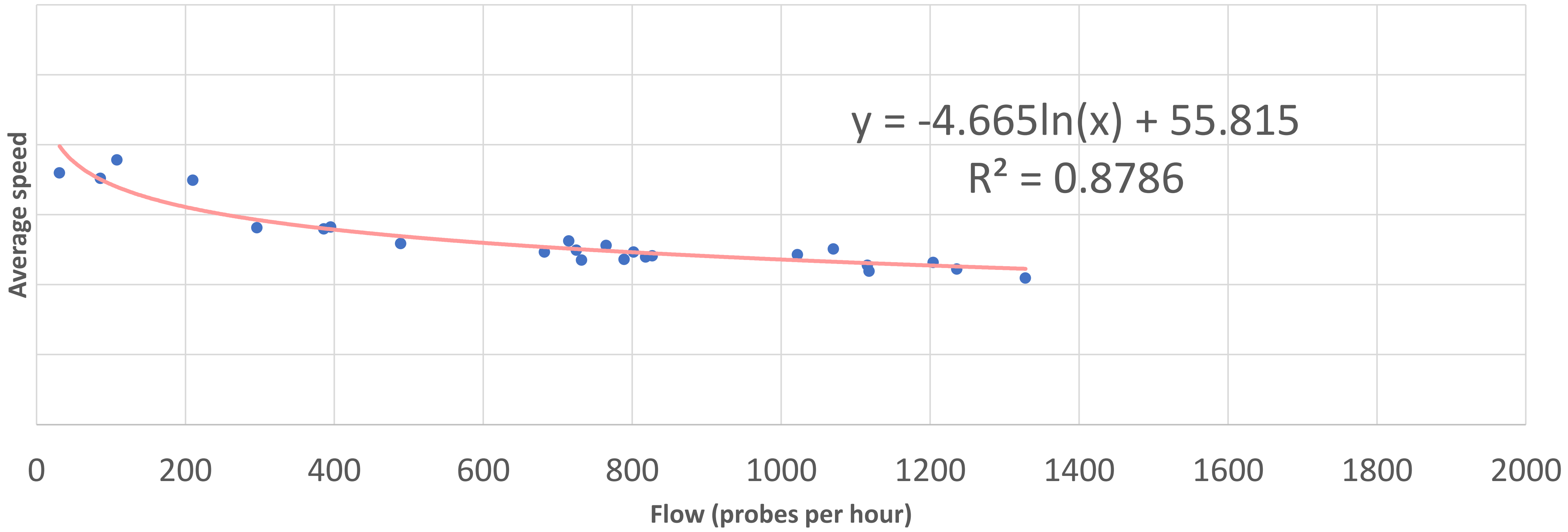
Flow (F) = density (D) * speed (S).

Assuming density is a good proxy for demand then substituting $F = \frac{Q}{t}$, we can create a BPR function in the speed vs flow space as shown on the next slide.

Observed speed vs flow - Petone Esplanade



There were cases where a completely different curve emerged



This case (Fitzherbert Ave Palmerston North)
appears to be due to side friction rather than congestion

Estimating social marginal cost – road capacity

There are a number of other functions, such as Akçelik & Drake, that can replicate the observed behaviour with similar accuracy. The beauty of the BPR function is that estimation of the SMC is mathematically simple and intuitively plausible.

$$SMC = Q\frac{dt}{dQ}$$

$$= \mu\beta[t - t_f]$$

μ =value of time; β,Q, t and t_f as before

Or in other words the SMC is proportional to the excess travel time.

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Long Run Marginal Costs (LRMC) – road capacity

- LRMC is the cost of expanding capacity to cater for additional traffic
- Practical and theoretical problems in determining LRMC are that capacity expansion
  - can only be made in large increments
  - is only needed for the peak flow

- We compiled the costs of recent road widening projects and estimated the LRMC as the cost per additional lane km / 2.5 hour lane capacity
- The figures by main centre were
  - $0.80 per pcu-km for Canterbury
  - $3.10 per pcu-km for Auckland
  - $3.20 per pcu-km for Wellington and Waikato.

Comparing short and long run marginal cost – road capacity

SRMC = LRMC

- The economic condition for network optimality
- This is the **Boiteux - Turvey** rule

SRMC < LRMC

- Typical results from this study

SRMC > LRMC

- Capacity expansion could therefore be justified
- Found in some situations in Auckland

LRMC > AC

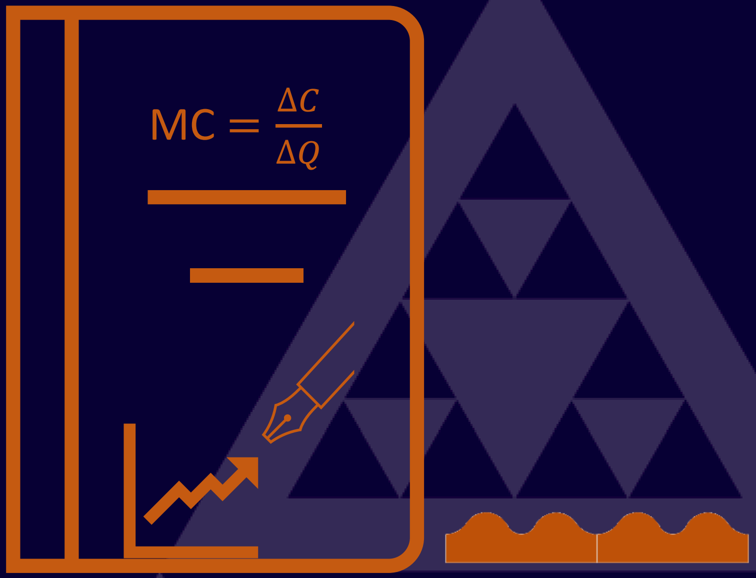
- all cases with congestion
- With 10 l/100 km fuel consumption, AC = 4.5 cents/km

Conclusions: SMC and LRMC – road capacity

- We show a simple way of calculating the SMC, the LRMC is harder
- SMC and LRMC are very situation specific
- We cannot use a standard value, hence we use cost-benefit analysis
  - Since SMC > LRMC is equivalent to B>C
  - Cost-benefit analysis has the same effect as applying the Boiteux - Turvey rule
- The price motorists currently pay in congested conditions is much less than the SMC or the LRMC.
- If motorists paid the SMC, the investment rule would be

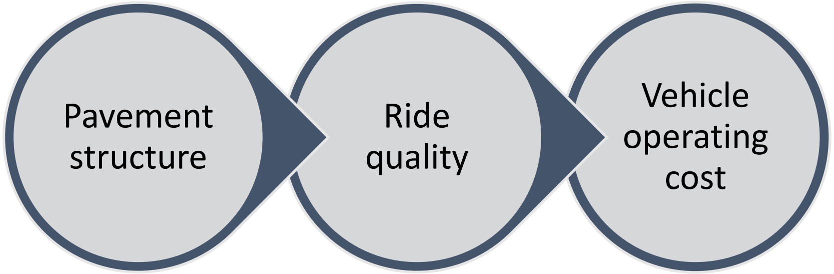
  expand if the toll exceeds the investment cost per pcu-km.

Marginal costs of road wear



Heavy vehicles impose costs on all other vehicles

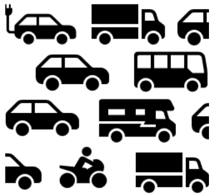
Due to their impact on



These costs depend on

axle load

remaining strength of the pavement



volume and mix of other traffic

and continue until such time as the road is repaired.

Traditional measure of short run marginal costs – road wear

- A commonly cited measure of the SRMC is the cost of bringing forward road rehabilitation or construction

- This measure ignores the cost imposed on other motorists due to the deteriorated state of the road

- We estimated the cost to society rather than just the cost to the road agency

Two measures of short run marginal cost – road wear

Short run marginal costs

the total cost (user + agency) assuming the road is repaired

the conventional definition

Social marginal costs

the cost to other road users if the road is not repaired

knowing the cost with and without intervention to inform if intervention is justified

Method - Short run marginal costs

- For the SMC, we needed a way to estimate the damage (wear) caused by the passage of each heavy vehicle and the resulting increase in vehicle operating cost for all traffic
- For the SRMC, we also needed to determine when the road would be repaired following New Zealand norms and the cost of the repair with or without extra heavy vehicles
- To undertake these tasks, we sought the help of Infrastructure Decision Support (IDS) who run asset management software (dTIMS) on behalf of New Zealand road controlling authorities
- IDS used dTIMS to predict the road user cost and the maintenance cost for eight road types with and without intervention

DRAFT RESULTS

Results – social marginal cost and short run marginal costs

Social marginal Cost (dollars per ESA kilometre)

(per year until repaired)

	Rough	Smooth
Rural_High Volume	1.71	0.49
Rural_Low Volume	1.72	0.23
Urban_High Volume	1.34	1.19
Urban_Low Volume	1.84	0.14

Short run marginal cost (dollars per ESA kilometre)

	Agency cost		User cost externality	
	Rough	Smooth	Rough	Smooth
Rural_High Volume	0.20	0.48	0.93	0.25
Rural_Low Volume	0.96	0.19	1.33	0.19
Urban_High Volume	6.31	2.16	0.49	0.71
Urban_Low Volume	6.54	2.39	1.12	0.14

Many factors at work here:

Both user and agency costs are higher for rough roads

Method - Long run marginal costs

- The long run marginal cost is the additional rehabilitation cost required to cater for an additional ESA-kilometre

- There are significant returns to scale in pavement construction

- One consequence of this is that the LRMC for high volume roads is much lower than for low volume roads

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Results – long run marginal costs

Long run marginal cost (dollars per ESA kilometre)

	Long run marginal cost	
	Rough	Smooth
Rural_HighVolume	0.16	0.13
Rural_lowVolume	0.71	0.56
Urban_HighVolume	0.43	0.26
Urban_LowVolume	3.66	3.32

- The LRMC are consistently lower than either the SMC or the SRMC.

➔ This implies that the cost to society is lowest if additional heavy vehicles are catered for at the reconstruction stage.

- The marginal costs are in all cases higher than the estimated RUC.

Conclusions

- We calculated two short run costs:
  - SMC (without intervention)
  - SRMC (with intervention)

  Intervention is economically justified if SMC > SRMC.

1. We found that:
   - additional vehicle operating costs due to additional heavy vehicles persist until the road is repaired
   - SMC will exceed SRMC if intervention is left for more than about three years
   - the cost to both user and agency are lower if the road is kept in good condition

   ➔ These support current road maintenance policies

2. We found that the SRMC is generally higher than the LRMC

   ➔ This suggests there may be benefits from building stronger roads

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Questions?