Auckland Transport Alignment Project

Demand Management Pricing Report – Evaluation of three representative options

Contents

Preface

This is one of a series of research reports that were prepared as inputs to the Auckland Transport Alignment Project (ATAP). It is one of a number of sources of information that have been considered as part of the project, and which have collectively contributed to the development of the recommended strategic approach. The content of the report may not be fully reflected in the recommended strategic approach, and does not necessarily reflect the views of the individuals involved in ATAP, or the organisations they represent. The material contained in this report should not be construed in any way as policy adopted by any of the ATAP parties.

1. Executive Summary

This report covers the first round Auckland Transport Alignment Project (ATAP) assessment of three representative road pricing options which could potentially be used for the purpose of demand management. The assessment considers the extent to which the options could contribute to the objectives of ATAP. The three options assessed are:

a) A Central Business District (CBD) cordon scheme similar to the option modelled in the Ministry of Transport's Auckland Road Pricing Evaluation Study (2007).
b) A motorway network charge, similar to the option modelled by Auckland Council during recent investigations.[1]
c) A comprehensive network charge applying to all journeys across the network.

The three options were compared to the Auckland Plan Transport Network (APTN) which does not include any time or location based road pricing except a toll on State Highway 1 (SH1) between Orewa and Puhoi.

Based on the initial testing and evaluation, the results indicate that pricing does have the potential to manage demand and improve network performance, compared to the un-priced APTN. This is in line with theoretical expectations, previous research carried out in Auckland and practical experience in other countries.

Of the three schemes, the CBD cordon charge makes the smallest difference from a regional, network wide perspective. However, the scheme performs well at a local level, encouraging a higher mode shift to public transport and reduction in car trips to the CBD.

Using a motorway charge for the purpose of demand management has the potential to cause large scale diversion of motorway traffic onto the local road network, with associated negative effects. In addition, public transport effects are small.

The option modelled, using a flat rate charge, tends to favour long distance motorway trips as the cost per kilometre to the user reduces with distance travelled on the motorway. A variation on this option, based on a per kilometre charge, was also tested. Appendix 3 reports the preliminary results for this variation, which indicates that although a distance based motorway charge is to be preferred over a flat rate charge, this option will still lead to a large displacement of trips onto the arterial network.

The comprehensive network charge has by far the greatest positive impact on the ATAP objectives, particularly for the operation of the network during the peak and for public transport use. The option includes a relatively simplistic charging structure of a fixed rate per kilometre at particular periods of time for trips made in all locations. A next step could include the development and assessment of a more graduated charging structure to mitigate the relatively high net-cost to users arising in non-congested, peripheral parts of the network and where access to employment and other facilities necessitates relatively long journeys.

[1] Subsequent to this assessment an alternative distance based motorway charge was also assessed and the results are summarised in Appendix 3. This assessment tended to confirm the conclusions reached in the assessment of the motorway network charge option.

The key findings from the initial evaluation are shown in the table below:

Table 1: Initial Evaluation Summary

	CBD	Motorway	Network
Positive Effects	• Performs well at a local level. • Encourages a higher mode shift to public transport and reduction in car trips for trips to the CBD. • Lowest cost scheme	• Has moderate to highly positive influence on regional congestion and accessibility indicators • Strongly positive reduction in proportion of congested travel time for heavy freight	• Substantially positive impact on regional accessibility, congestion and modal split, particularly in the peak and for public transport. • Strongly positive reduction in proportion of congested travel time for heavy freight
Negative Effects	• Small impact on indicators at regional level • Some diversion of traffic to local roads	• Creates negative effects on local roads, as trips divert from the motorway network	• Increased numbers of short distance trips by car
Suggested refinements	• Local mitigation to address increased congestion on outside of boundary e.g. Ponsonby Road • Consider additional CBD public transport capacity	• Develop mitigations for choke points on local roads • Investigate public transport alternatives	• Test a more graduated charging structure • Mitigation package designed to provide viable alternatives to vehicle trips

The Net Benefits to Users and Value for Money results for the three options using the agreed assessment approach are presented below:

Table 2: Results for Revised Assessing Approach for User Benefits and Value for Money (For 2036 in 2016$)

ATAP Objective	Objective description	Key indicator	CBD	Motorway	Network
Best possible value for money	Returns to society as a whole	Benefits and costs (EEM) BCR	2.1	1.3	1.6
Best possible outcomes for users of the transport system	Returns to people and businesses that make trips using the transport system	Generalised costs for system users (time, vehicle operating, safety)	$21.0m	$104.4m	$156.0m
Financial costs of using the transport system deliver net benefits to users of the system	Benefits arising from road charges exceed the financial cost of those charges to road users	1. Change in generalised costs *for those paying road charges* (time, vehicle operating, safety, road charges)	-$63.8m	-$167.1m	-$830.0m
		2. Change in generalised costs *for users of the transport system* charges (time, vehicle operating, safety, road charges)	$21.0m	$104.4m	$156.0m

This assessment approach confirms that the different interpretations of users makes a significant difference to the results. In addition, the treatment of the revenue raised is fundamental to the overall result. Excluding revenue obscures a potentially significant benefit.

Based on the initial analysis, it is recommended that:

- ATAP consider the use of road pricing for demand management in subsequent rounds of evaluation because of its potential contributions to the ATAP objectives;

- The next stage focuses on the development and refinement of the particular option(s) selected for the next round;
- The choice of road pricing scheme would depend on the approach to transport identified for round 2, noting that:
    - A CBD cordon charge would be suitable to encouraging public transport mode shift to the CBD;
    - A motorway network charge would be suitable to assisting the State highway network, and therefore most of the heavy freight network, to operate with less congestion, but other interventions would be needed to address impacts on the local network;
    - A comprehensive network charge would be suitable if widespread and significant changes in access, congestion and public transport mode share are sought across the network.

The next steps in the refinement of the options that could be progressed for further investigation should include:

- Review of the modelling approach
    - Investigating practical ways of incorporating the estimation of a distribution of values of time (e.g. by user groups) into modelling.
- Review of the approach to appraisal
    - Taking account of revenue (above reduction in vehicle operating costs) as a benefit.
    - Including other supporting key performance indicators in the evaluation framework for the next round.
    - This investigation should also consider whether pricing for demand management could reduce the level of investment required in the network to achieve a given level of performance, relative to the APTN.

The proposed way forward, based on the results from the first round of modelling, and taking into consideration the need to optimise the application of the available modelling resources, is to continue with testing of a road pricing option that is appropriate for the approaches to transport to be tested in the second round and to undertake the refinements listed above.

A key implication for package development in the second round that is emerging from the assessment of pricing options, is to analyse the scale of any potential opportunity to either re-prioritise current planned investment, or, reduce overall investment whilst balancing against a desired level of service for the network as a whole.

2. Background

Purpose of the report

The purpose of this report is to set out the development, assess and ultimately the recommendations made on the merits of three representative road pricing options for the purpose of managing demand and improving the operation of Auckland's transport system, as part of ATAP.

Objective of this assessment

The aim is to determine the extent to which the three proposed road pricing options developed for the purpose of demand management could contribute to the objectives of ATAP (relative to the APTN without pricing), and to determine whether road pricing is worthy of further consideration post ATAP.

As part of this, the investigation has also aimed to develop a view on whether pricing for demand management could reduce the level of investment required in the network to achieve a given level of performance, relative to the APTN. This was undertaken through a process of identifying a small number of representative schemes and testing these against the agreed ATAP objectives and the deficiency analysis.

This report summarises the assessment of the three pricing options and recommends that a road pricing option is considered for more detailed assessment in Stage 2. It also identifies useful modifications to the preferred option that might improve its performance against the ATAP objectives.

Limitations of the assessment

Investigating pricing as a revenue raising tool is not an objective of ATAP, but pricing will raise revenue. How this revenue might be used is an important question, as this will have some influence over the net benefit of pricing. However, resolving this question is beyond the scope of this investigation.

This evaluation is indicative at this stage and does not consider a complete range of economic and social impacts, which would be required for a more comprehensive road pricing study.

This evaluation has not considered the effects of optimising the transport network to reflect the demand management effects of a road pricing scheme.

The recommendations of this workstream are not intended to identify an actual pricing scheme for implementation. If the parties agree that road pricing is a useful tool for Auckland, then further work could be undertaken to determine an optimal road pricing scheme.

3. Narrative

3.1. Methodology and options for assessment

The evaluation approach adopted is broad based, using quantitative and qualitative information including:

- Data from the Auckland Regional Transport (ART3) model for all modes.
- Information from previous studies (to inform option development).
- Independent research (to inform the development of option costs).
- Relevant theory (to inform the evaluation of benefits and costs).

The specific intention for this round of the evaluation has been to test whether, at a high level, the pricing options could potentially be an effective tool for influencing traffic demand. This is demonstrated through testing for improved network performance (assessed against the ATAP objectives) relative to the APTN without pricing. Some of the assumptions used are intentionally towards the extreme (e.g. price is set at a relatively high level) in order to attempt to provoke a demand response.

The choice of representative pricing options was guided by a number of factors including:

- The desire for schemes to improve the operation of the transport network through managing demand, rather than maximising revenue.
- The desire to incentivise a change of time/mode of travel rather than removing trips.
- The need to keep schemes relatively simple at this early stage of investigation.
- The need for an assessment of schemes which covers a broad range of scenarios including:
    - small to large geographical/network coverage
    - with and without good public transport alternatives

In light of these considerations, the three pricing options chosen for assessment are intended to represent three different but potentially feasible approaches to pricing (see Appendix 1 for details and note: first round schemes are indicative concepts only and are based on relatively high charges so as to be able to assess the full potential effects of potential charging regimes):

- CBD cordon scheme: A small scale scheme to address issues in an area with high public transport provision and walk cycle options.
- A motorway network charge: Similar to the option modelled by Auckland Council during recent investigations by the Independent Advisory Board (IAB), but using a higher charge to reflect a demand management focus.
- A comprehensive network charge – prices all trips based on the distance travelled.

The extent of the effects of any scheme will depend on the price level. The prices were set at similar levels for each scheme, so that their effects could be comparable.

Some other pricing options considered at a high level by the Working Group but not taken forward for assessment:

Table 3: Options considered and not taken forward

Scheme	Reason for not progressing
Single Cordon:	Likely significant negative equity impacts, based on evidence from previous road pricing assessments in Auckland
Double Cordon	Same as for single cordon
Parking charge	Unlikely to make a significant difference to network performance, based on evidence from previous road pricing assessments in Auckland

3.2. Results of Analysis

The analysis of pricing options is reported at two levels:

- A summary of regional impacts based on the ATAP objectives and indicators.
- A more detailed analysis of:
    - Traffic flows
    - Travel time benefits
    - Access to employment
    - Change in costs and benefits to users
    - Average speeds.

Note: This is an early analysis to test initial responses and identify areas where an initial scheme could be modified to improve performance. It is important to interpret information carefully and recognise that while modelling results provide useful information to inform the decision making process, they are only one input and need to be weighed up carefully against other information.

3.2.1. Summary of Regional Impacts Assessment

The table below provides a summary of the performance of each option against the ATAP objectives.

Table 4: Regional Impacts Summary

Objective	Measure	Headline KPI	Metric	CBD	M/way	Network
Improve access to employment and labour	Access to employment and labour within a reasonable travel time	Jobs accessible by car within a 30-minute trip in the AM peak	Number of jobs	✓	✓✓	✓✓✓
		Jobs accessible by public transport within a 45-minute trip in AM	Number of jobs	☐	☐	✓

Objective	Measure	Headline KPI	Metric	CBD	M/way	Network
		peak				
		Proportion of jobs accessible to other jobs by car within a 30 minute trip in the interpeak	%		✓	✓
Overall				☐	☐	✓
Improve congestion results	Impact on general traffic congestion	Per capita annual delay (compared to maximum throughput)	Hours per person	TBC	TBC	TBC
		Proportion of travel time in severe congestion in the AM peak and interpeak	% AM	✓	✓✓	✓✓✓
			% IP		✓✓	✓✓
	Impact on freight and goods (commercial traffic) congestion	Proportion of freight travel time spent in severe congestion (in the AM peak and interpeak)	% AM		✓✓✓	✓✓✓
			% IP		✓✓✓	✓✓✓
	Travel time reliability	Proportion of travel time in severe congestion in the AM peak and interpeak	% AM		✓✓	✓✓✓
			% IP		✓✓	✓✓
			% PM	TBC	TBC	TBC
	Increase vehicle occupancy	Average vehicle occupancy for road vehicles (cars and buses)	Number of people/car and bus AM peak			✓
Overall				☐	☐	✓✓
Increase public transport mode share	Public transport mode share	Proportion of total trips in the AM peak made by public transport	%			✓✓
	Increase public transport where it impacts on congestion	Proportion of vehicular trips over 9km in the AM peak made by public transport	%	☐	✓	✓✓✓
Overall				☐	☐✓	☐✓✓

Objective	Measure	Headline KPI	Metric	CBD	M/way	Network
Increased financial costs deliver net user benefits	Net benefits to users from additional transport expenditure	Increase in financial cost per trip compared to savings in travel time and vehicle operating cost (Excludes benefit of toll revenue)	$ per trip/(TT+ VOC) - Base Value	-76.1	-193.5	-990.3
Overall				□	□	□
Ensure value for money	Value for money	Package benefits and costs (Net benefit = total benefits (inc toll revenue) – cost)	$ Net Benefit	11.0	25.4	59.0
Overall				□✓	□✓✓	□✓✓

✓✓✓	More than 35% in desirable direction
✓✓	15%-35% in desirable direction
✓	>5-15% in desirable direction
Blank	5% or less

The main finding of the regional impacts assessment is that all three charging options tested have the potential to improve the operation of Auckland's transport system, relative to the un-priced APTN through managing demand, but the scale and nature of effects differs significantly between the three schemes.

In general at network wide level compared to a position with APTN without charges:

- CBD charging has the least impact on regional accessibility, network performance and modal share. Several of the results are still positive, including reductions in AM and interpeak travel in congested conditions, improved access to jobs and increased public transport mode share. The small impact is to be expected due to the small geographical coverage of the CBD scheme.
- Motorway charges have a greater positive impact on regional accessibility and congestion indicators compared with CBD charging, although the impact on modal share is similar to the CBD charge. The negative effects on local roads, arising as a consequence of trips diverting from the motorway network to avoid being charged, are significant.

- Whole of network charging has a substantially more positive impact on regional accessibility (measured in terms of travel times) congestion and modal split, particularly in the peak and for public transport (although with the charges road users would face substantially increased total travel costs). One issue identified is that as currently formulated, this option is forecast to result in increased numbers of short distance trips by car, although this effect is more than counterbalanced by reduction in longer distance car travel and some shift to public transport. This results in a substantial reduction in the total numbers of trips made in the AM peak with some travellers diverted to other time periods and others simply discouraged from travelling

For most indicators the ART3 model is able to provide the outputs required to undertake the assessment of the options against the ATAP objectives. Where gaps exist input from the Evaluation Team will be necessary to complete an assessment against these indicators. However, it is not considered to be likely that completing the analysis for the three indicators where data was not available would materially change the conclusions reached. The assessment of pricing options did not consider the other ATAP KPIs but these will be included in the next stage of the evaluation.

3.2.2. Detailed Impacts Assessment

In order to provide a more informative assessment of performance and support the interpretation of the regional impacts assessment, the analysis against a number of indicators has been extended to a more local level.

Impact on Traffic Flows (AM Peak 2036)

Impacts on traffic flows are assessed to determine the parts of the network where flows will decrease or increase as a consequence of pricing.

- As expected, the impact of CBD charging is mainly focussed on CBD and immediate surrounds. Within the CBD traffic flows are reduced but links just outside the boundary, e.g. Ponsonby Road, experience increased flows.
- Motorway charging generally takes traffic away from the motorways (although very small effect on SH20) but moves substantial volumes on to local road network and increases congestion there.
- Network charging generally removes traffic from both motorways and local roads but with some minor increases on particular links as congestion levels and traffic patterns change.

Average Travel Time Benefits ($ per trip, 2036 AM Peak)

Travel time benefits (report in $s) are assessed for all trips, based on trip origins.

- CBD charging generally creates a small reduction in travel times for most trips, but there are some increases in travel times for trips originating from just outside the CBD cordon, as traffic diverts to avoid charges on CBD trips.

- Motorway charging has large impacts, reducing travel times for trips from further away from the CBD, but this option increases travel times for trips from closer in, primarily due to motorway traffic diverting to the local road network.
- Network charging reduces travel times for all origin zones across the network, as trip volumes are reduced on both motorways and local roads.

Change in Employment Access Car Trips (2036 AM Peak)

Accessibility to employment via a car trip is estimated by assessing the number of jobs accessible by car within a 30-minute trip in the AM peak:

- CBD charging generally has modest positive impact on accessibility to jobs, but it does lead to decreases in accessibility for trips originating close to but outside the CBD cordon, as travel times increase. There is a strong positive impact on the North Shore and in West Auckland, and also in Mangere and central Manukau.
- Motorway charging has significant positive impacts on accessibility to jobs for trips originating from the North Shore and West Auckland, but also leads to the creation of areas where access to employment reduces, due to increased local congestion.
- Network charging gives employment access benefits across almost all of the region with particularly large increases across the North Shore, West Auckland and central Manukau, and no significant reductions in access.

Figure 1 below depicts general access to employment based on the percentage of total jobs accessible via a 30 minute car trip or 45 minute trip using public transport.

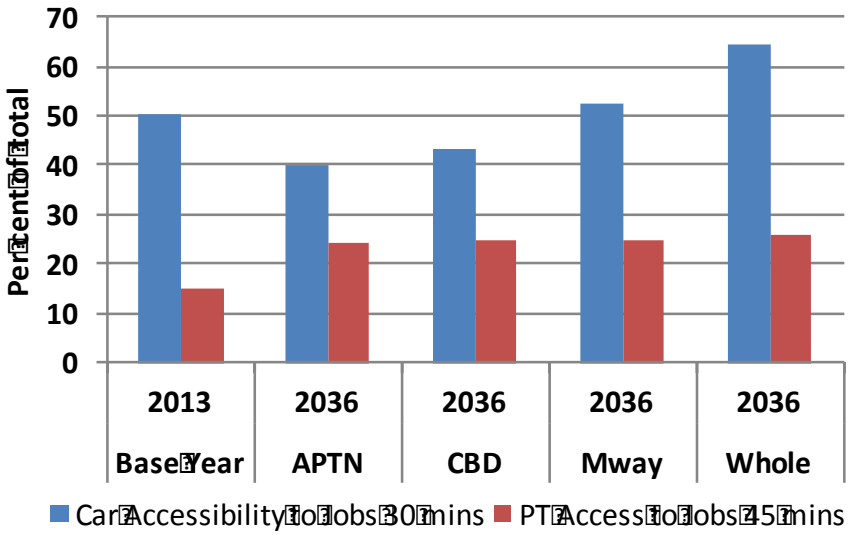


Figure 1: General access to employment

For the un-priced APTN, accessibility by car to employment declines from 2013 to 2036. With charging options accessibility gradually increases and with whole area charging it is significantly higher than 2013. Public transport accessibility increases roughly equally to 2036 for all options, including the un-priced APTN.

Net Benefits to Users – Initial Assessment

ATAP Objective 4 seeks to ensure that "any increases in the financial costs of using the transport system deliver net benefits to users of the system."
This objective was assessed using ART3 outputs to determine the difference in the generalised cost of travel between the pricing options and the APTN for the 2036 AM peak. The generalised cost of travel combines the time and monetary costs (e.g. vehicle operating costs and pricing for demand management) of a trip into a single monetary measure. The result is an indication of the change in the financial cost per trip compared to the change in travel time and vehicle operating cost. The 'net benefits to users' takes no account of the potential benefit associated with any revenue generated.

The approach was adopted for this round of analysis as a practical way of determining the net effect of pricing on remaining road users, arising from the combination of improved network conditions and increased user charges.

The initial results from this assessment indicated that for all three pricing options the benefits to users (road users who continue to drive) are more than offset by the dis-benefits to those who change travel patterns as a consequence of pricing and by the cost of the charge to remaining users. The CBD Cordon has the smallest negative impact on benefits to users ($-76m in 2036) and the Network Charge the greatest (-$990.3m in 2036).

Table 5: Annual Net Benefit to Users for 2003 (2015$m)

	CBD Cordon	Motorway	Network
User Benefit from time and vehicle operating cost savings	35.3	130.7	316.2
Dis-benefit from trips discouraged by charging who have to divert to a less desirable alternative	-14.3	-26.4	-160.3
Net User Impact before charges on continuing users	21.0	104.4	156.0
Charging Revenue (User cost)	97.0	297.9	1146.2
Annual Net Benefits to Users	**-76.1**	**-193.5**	**-990.3**

However, on reflection this result raised a number of questions in relation to Objective 4 including:

- Ensuring net benefits to users could be argued to be an appropriate objective for a toll scheme, but is this actually an appropriate objective for a pricing scheme intended to manage demand?
- Is there a fundamental difference between road pricing to manage demand and road tolling to fund a network improvement?

A pricing scheme to manage demand is an example of using a corrective tax to increase price and reduce consumption in a situation where marginal social cost exceeds marginal private cost due to the presence of negative externalities e.g. congestion (See Appendix 2).

This is fundamentally different to the rationale underpinning a toll (revenue) scheme, where a user is asked to pay a toll in return for a travel time or reliability benefit, whilst those who choose not to pay are provided with a 'free' alternative route. Here it is clearly important for user benefits to exceed user costs, otherwise there would be no revenue.

Therefore, an important finding is not that the net costs to users exceed the benefits for all schemes, but that this result is, in fact, the most likely outcome where road pricing is being contemplated for demand management.

Value for Money – Initial Assessment

This assessment includes revenue within the benefits. The initial results are shown in the following table.

Table 6: Value for Money for 2036 (2015$m)

	CBD Cordon	**Motorway**	**Network**
User Benefit from time and vehicle operating cost savings	35.3	130.7	316.2
Dis-benefit from trips discouraged by charging who have to divert to a less desirable alternative	-14.3	-26.4	-160.3
Net User Impact before charges on continuing users	21.0	104.4	156.0
Charging Revenue	97.0	297.9	1146.2
User Impact Including charge	**-76.1**	**-193.5**	**-990.3**
Overall Benefit	**21.0**	**104.4**	**156.0**
Annual Opex	10	79	97
Surplus After Opex	**11**	**25**	**59**
Ratio of Annual Benefit (2036) to Annual Cost	2.1	1.3	1.6

These highlight:

- The benefits to users from reduced travel times and vehicle operating costs as levels of congestion are reduced.
- The dis-benefits to those users who with the toll either divert to less desirable uncharged alternatives or who cease to travel altogether.
- The combination of these first two elements which gives the net user impacts before the effects of pricing on those prepared to pay is assessed.
- The revenue generated. The way in which this additional revenue to the public sector is treated is not considered here.

Taking these factors into account, the key points that emerge from the analysis are:

- Overall welfare is improved under all three options, with the benefits from time and vehicle operating cost savings combined with revenue more than offsetting the loss of benefit to users who pay or switch to less attractive alternatives.
- The Network scheme generates the most benefit and the CBD scheme generates the lowest benefit.

As with Net Benefits to Users, this indicator is easier to interpret in conjunction with an understanding of the economics of road pricing[2]

Revised assessment of Net Benefits to Users and Value for Money

The initial assessment of Net Benefits to Users and Value for Money generated significant debate at the Working Group around the interpretation and way in which the options should be assessed for these two objectives.

For example, we can either look at "users" narrowly, as the group of road users that pay the charge; or more broadly, as the users of "the system": not only those that directly pay, but presumably also others who derive some benefit or experience the costs from the fact that the charging system is in place (eg congestion due to traffic diversion). As the ATAP objective refers to "users of the system". It would seem reasonable to accept the broader definition, although there will also be some interest in understanding the impacts on those who pay.

Another consideration is the understanding of what is meant by "net benefits". In the case of pricing, the treatment of revenue is an important factor. If the revenue is hypothecated to transport and spent in the general area (or part of the network) from which it is collected, then it seems reasonable to treat this as a benefit. This is consistent with the approach outlined by Goodwin (1997) for assessing the benefits of pricing for demand management.[3] Similarly, if the charging system enabled other transport charges (e.g. Fuel Excise Duty, Road User Charges, property rates) to be reduced or removed, then again, the "benefits" of this need to be taken into account.

As a result of this discussion, the following assessment framework was developed by the Working Group (see Appendix 4 for detail).

The results for the three options using the revised assessment approach are presented below:

[2] See Appendix 2 for a discussion on the ART model and the economics of road pricing.
[3] Goodwin, P B (1997), Ibid.

Table 7: Results for Revised Assessing Approach for User Benefits and Value for Money (For 2036 in 2016$s)

ATAP Objective	Objective description	Key indicator	CBD	Motorway	Network
Best possible value for money	Returns to society (NZ Inc) as a whole	Benefits and costs (EEM) BCR	2.1	1.3	1.6
Financial costs of using the transport system deliver net benefits to users of the system	Benefits arising from road charges exceed the financial cost of those charges to road users	1. Change in generalised costs *for those paying road charges* (time, vehicle operating, safety, road charges)	-$63.8m	-$167.1m	-$830.0m
		2. Change in generalised costs *for users of the transport system* (time, vehicle operating, safety, road charges)	$21.0m	$104.4m	$156.0m

Caveat to the assessment of net benefit to users and value for money

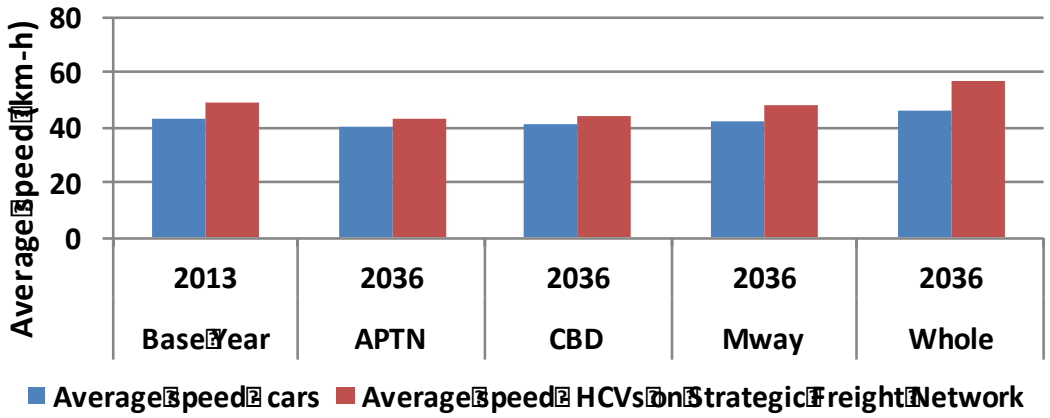
It is also important to be aware that the modelling carried out to date has applied a standard (equity) value of time to all trips. NZTA's Economic Evaluation Manual (EEM) generally requires the use of an "equity value of time" (EEM p4-117) for economic assessments and the ART3 model adopts this approach. However, in relation to the assessment of tolling schemes the EEM guidance states that an "equity value of time will substantially over-estimate the perceived dis-benefits of tolling." The assessment of toll schemes in NZ (e.g. Tauranga Eastern Link) has also confirmed that an equity value of time will underestimate the benefits to remaining users. The same would be true of a pricing scheme for demand management, suggesting that the estimated net benefits to users and value for money is understated in this round of the assessment.

If further analysis of the scenarios is to be undertaken it is recommended that consideration be given to the potential for the estimation of differing distributions of values of time, however, this is technically demanding within the ART3 model.

Average Speeds

With the unpriced APTN, average speeds in the 2036 AM peak are below the 2013 level. The CBD Charge and Motorway Charging options lead to an increase in speed over the unpriced APTN but still result in a slower speed in 2036 than 2013. Motorway Charging has more impact on average speeds than CBD charging. Whole Network charging has a more significant impact and results in speeds in 2036 which are faster than in 2013.

Figure 2: Average speeds AM peak.

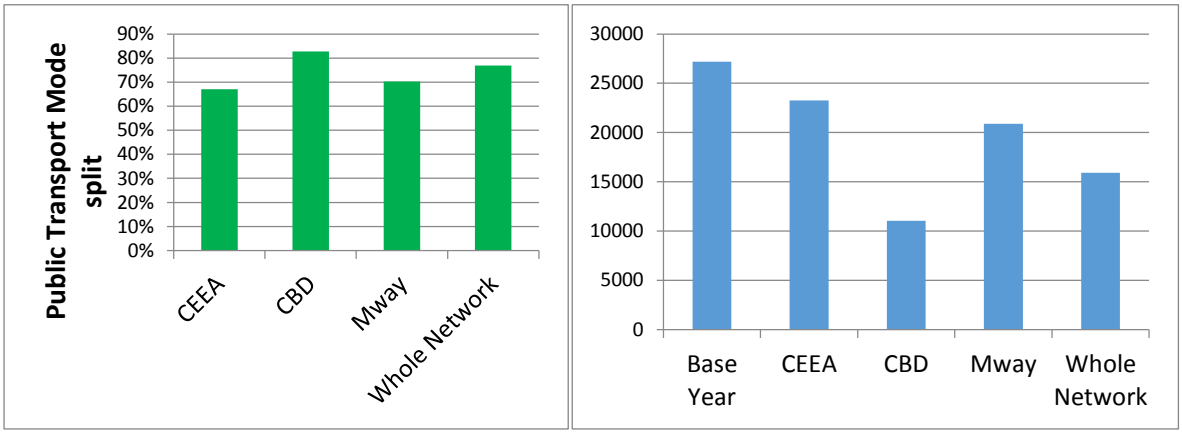


3.3. Summary of Results

3.3.1. CBD Cordon

Of the three schemes, the CBD cordon charge is the lowest scoring option from a regional, network wide perspective. However, the scheme performs particularly well at a local level, encouraging a higher mode shift to public transport and a corresponding reduction in car trips to the CBD.

Figure 3:
Public Transport Mode Split into CBD (2036 AM Peak) **Car Trips into CBD AM Peak**



3.3.2. Motorway Charge

A key observation from the analysis is that trying to achieve traffic demand management objectives using a motorway charge is likely to result in large scale diversion of motorway traffic onto the local road network, with associated negative effects. In addition, public transport effects are small.

The option modelled, using a flat rate charge, tends to favour long distance motorway trips as the cost per km to the user reduces with distance travelled on motorway. A variation on this option, based on a per kilometre charge, was also tested. Appendix 3 reports the preliminary results for this variation, which indicates that although a distance based motorway charge is to be preferred over a flat rate charge, this option will still lead to a large displacement of trips onto the arterial network.

3.3.3. Network Charge

The whole of network charge has by far the greatest positive impact on the objectives, particularly for the operation of the network during the peak and for public transport use. The option modelled includes a relatively simplistic charging structure and a next step could include the development and assessment of a more graduated charging structure, to mitigate the relatively high net-cost to users arising in non-congested, peripheral parts of the network.

4. Conclusions and Recommendations

4.1. Conclusions

4.1.1. Will pricing lead to an improvement in the performance of the transport network?

The first key question is whether road pricing for demand management will lead to an improvement in the performance of the transport network, relative to the APTN without pricing?

Based on the initial testing and evaluation, the results indicate that pricing does have the potential to manage demand and improve network performance, compared to the un-priced APTN. This is in line with theoretical expectations, previous research carried out in Auckland and practical experience in other countries.

4.1.2. Are the merits of road pricing sufficient to include as part of the findings of ATAP?

The second question is whether the merits of road pricing, for the purpose of managing demand, are sufficient to include this as a recommended intervention as part of the findings of ATAP.

At this point in the process, based on the generally positive results observed, but noting the issues raised, it is recommended that ATAP continue with the assessment of pricing for demand management. It is recommended that the next stage focuses on the development and refinement of a road pricing option that is suitable for the approaches to transport that are to be tested in the second round.

The next steps in the refinement of the options that could be progressed for further investigation will include:

- Modelling a more graduated network charge to mitigate user cost in non-congested parts of the network.
- Investigating practical ways of incorporating the estimation of a distribution of values of time (e.g. by user groups) into modelling.
- Taking account of revenue (above reduction in Vehicle Operating Costs) as a benefit.
- Including other supporting KPIs in evaluation framework for next round (e.g. safety), although may not be an important differentiator for pricing.
- This investigation should also consider whether pricing for demand management could reduce the level of investment required in the network to achieve a given level of performance, relative to the APTN.
- Modelling using Auckland Public Transport (APT) will need to use the crowding function to ensure that public transport capacity requirements are clearly identified.

4.1.3. Could pricing reduce the level of investment required in the network?

The investigation is also expected to develop a view on whether pricing for demand management could reduce the level of investment required in the network to achieve a given level of performance, relative to the APTN.

The initial testing indicates that this is likely to be the case, and supports the view that pricing for demand management provides an opportunity to move towards planning and providing the additional transport capacity required to meet a planned level of traffic demand.

4.2. Recommendations

Based on the results to date and taking into consideration the need to optimise the use of the available modelling resources, it is recommended that:

- ATAP consider the use of road pricing for demand management in subsequent rounds of evaluation because of its potential contributions to the ATAP objectives;
- The next stage focuses on the development and refinement of the particular option(s) selected for the next round;
- The choice of road pricing scheme would depend on the approach to transport identified for round 2, noting that:
    - A CBD cordon charge would be suitable to encouraging public transport mode shift to the CBD;
    - A motorway network charge would be suitable to assisting the State highway network and therefore most of the heavy freight network, to operate with less congestion, but other interventions would be needed to address impacts on the local network;
    - A whole of network charge would be suitable if widespread and significant changes in access, congestion and public transport mode share are sought across the network.

4.3. Implications for other workstreams

A key implication for package development in the second round that is emerging from the assessment of pricing options is to analyse the scale of any potential opportunity to either re-prioritise current planned investment, or reduce overall investment whilst balancing against a desired level of service for the network as a whole.

Appendix 1 Pricing Scheme Options

The key characteristics of each scheme are (note: first round schemes are indicative concepts only):

CBD Cordon

Concept / rationale

- Small geographical area,
- Good public transport and active mode alternatives

Scheme characteristics

- Cordon is inside the motorway corridor
- Charge is as close as possible to the point where vehicles enter CBD
- Not intended to capture through-trips on motorways
- Charges (2015 $s)
  - $10 AM Peak Inbound
  - $2.50 interpeak, PM Peak Inbound
- Relatively high charge to stimulate a demand response

Motorway Charge

Concept / rationale

- Represents a feasible larger-scale scheme with wide geographical coverage
- Captures a high volume of trips using a relatively short section of the regional roading network
- Also reflects recent proposal investigated by Auckland Council, but with charges increased to reflect TDM intent rather than revenue raising

Scheme characteristics

- Modelled in the same way as the IAB proposal.
- Single charge for each motorway trip
- Covers all of motorway network
- Charges (2015$s)
  - $5 AM/PM Peak
  - $1.25 interpeak
- Charge significantly higher than IAB scheme ($2) as purpose of this investigation is to test demand response. IAB scheme was focused on revenue raising and adopted lowest charge required to meet the revenue target.

Network Charge

Concept / rationale

- Represents a possible future scheme which allowed for full network coverage
- Captures all vehicle trips across regional network

Scheme characteristics

- Applies to whole region
- Per kilometre charge
- Charges (2015 $s)
    - 44 cents/km AM/PM Peak
    - 12 cents/km interpeak
    - partly offset by 6c/km reduction in VOC (RUC and FED).

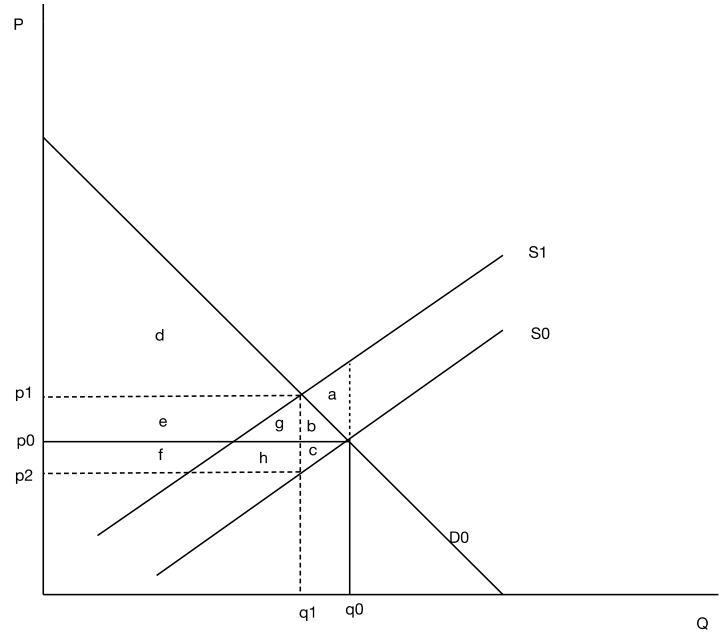
Appendix 2: Economic Aspects of Modelling Road Pricing

ATAP is assessing pricing options to manage demand and improve the operation of the transport network.

Pricing to correct for external costs

Currently, the costs faced by road users do not always fully reflect the resource costs associated with road use. For example, when travelling on a congested network individuals impose a time cost on others but do not take account of this cost when deciding whether to travel or not. In this situation the imposition of a corrective tax (pricing) can lead to an improvement in social welfare.
In economic terms the intersection of the supply (or marginal private cost) curve (S0) and demand curve (D0) shown on Figure 1 will not represent an efficient optimum from society's perspective when external costs are present. The efficiency loss to society is depicted by area a in Figure 4.

Figure 4: Tolling to correct for external costs.



Following the imposition of a toll (value p1-p2) and assuming the toll is efficient (e.g. it corrects for external costs not reflected in time cost to the individual[4]) then the following gains and losses can be observed:

- Reduction in deadweight loss to society = **a**
- Gain to government from toll revenue = **e + f + g + h**
- Gain to remaining road users from time saving = **f + h**
- Loss to remaining road users (toll payment) = **e + f + g + h**
- Loss to suppressed users for trips not made = **b**

The aggregate effects are:

[4] This is assumed to simplify the analysis. The toll level adopted for ATAP analysis is intended to correct for externalities but at this stage of investigation could be above or below the optimal price.

- Government gains **e + f + g + h**
- Remaining road users lose **e + g** ((**e + f + g + h) – (f + h))**
- Suppressed users lose **b**
- Net change in overall welfare is **gain (f + h) – loss (b)**
- The net change in overall welfare is equivalent to area **a** the deadweight loss to society

An important observation from this analysis is that individual road users can potentially be made worse off whilst society is made better off following the imposition of a toll. Therefore, from a welfare perspective it is important to ensure that the economic analysis of pricing options (including ART model outputs) captures the full range of impacts (including the benefit of the revenue raised and external costs avoided).

A further complexity to bear in mind is that agglomeration effects are a positive externality and are positively related to accessibility. Pricing will increase the cost of accessing a given location thereby reducing accessibility. Where agglomeration effects are present (e.g. in Auckland) then the optimal price will need to reflect both the negative and positive externalities of road use.

To address these considerations it will be important to:

a) Include the user charge within the user benefits,
b) Include time savings and vehicle operating cost savings within the user benefits,
c) Include the lost surplus from suppressed trips within the user benefits
d) Ensure external cost reductions to non-users are recognised.
e) Take account of the positive externality of agglomeration.
f) Include the net revenue raised within the public costs and revenues.

The net effect to society can be calculated as follows:

Table 8: Losses and Gains from Pricing

Travel Time Benefits	Gain
Impact of Supressed Trips	Loss
User Charges	Loss
Environmental Benefits	Gain
Safety	Gain
Agglomeration Effects	Loss
Consumer Surplus	**= A**
Public Revenue and Costs	
User Charge	Gain
Operating Cost	Loss
Increased Public Transport Fares	Gain
Additional Public Transport Costs	Loss
Decreased Road User Revenue	Loss
Net Revenue	**= B**
Overall	**=A+B**

A final observation is that in the presence of externalities this analytical framework is enquiring into the optimal price to charge to road users. The fundamental premise of the analysis is that in the presence of external costs a corrective tax has the potential to lead to an improvement in overall welfare.

The Correct Value of Time to Apply to Pricing Scenarios

The EEM generally requires the use of an “equity value of time” (EEM p4-117). This is both a simplifying assumption and it avoids favouring road schemes used by higher income groups. The ATAP modelling is consistent with this approach and has relied on the use of an equity value of time.

However, in relation to the assessment of tolling schemes the EEM guidance states that an “equity value of time will substantially over-estimate the perceived dis-benefits of tolling.” The technical interpretation is that using an equity value of time will result in the area of loss to supressed users (area b in Figure 1) being significantly larger than would be the case in reality.

The use of specific values of time for unique users groups in the assessment of toll schemes in NZ (e.g. Tauranga Eastern Link) has also confirmed that an equity value of time will underestimate the benefits to remaining users, who have an above average value of time.

Therefore, it is suggested that consideration be given to the potential for the estimation of a distribution of values of time, (e.g. for disaggregated user groups) in order to avoid overestimating the dis-benefits to supressed users and underestimating of the benefits to remaining users from pricing.

Appendix 3: Motorway Distance Charge

Subsequent to the initial options assessment, and in response to the observed characteristics of the motorway network charge (MAC) an alternative distance based motorway charge was developed for assessment. Two options were examined, both based on a rate of 40c/km for peak travel and alternatives of either 30 c/km or 10c/km for interpeak travel. To ensure comparability with earlier work the analysis was undertaken for 2036 only.

The results of this assessment, including comparison with the initial MAC option are summarised in the table below:

Table 9: Alternative Distance Based Motorway Charge

MDC Option 1: 40c/km PK/10c/km IP	• Slightly worse network performance in terms of speeds than MAC for both peak and interpeak • Substantial switch of traffic away from motorways but impacts on other roads limited • Peak car accessibility slightly better for both travel time and generalised cost measures • Largely positive travel time benefits in both peak and interpeak in urban areas although some disbenefits to far north
MDC Option 2: 40c/km PK/30c/km IP	• Significantly worse network performance in interpeak than 40/10 and MAC and also APTN • Travel time benefits in interpeak largely negative across much of region • Substantial switch in interpeak from motorways onto other road types which may be slower or more congested

In terms of comparing the overall performance, both options are finely balanced. Option 1 (MDC 40/10) has worse network performance but higher benefits and higher accessibility compared to Option 2 (MDC40/30). Option 2 leads to poor performance in interpeak which suggests that a 30 c/km differential between peak and interpeak is too high. The results for Option 1 tend to suggest that a differential of around 10c/km is more reasonable.

Overall, this assessment tends to indicate that a distance based charge motorway charge is to be preferred over a flat rate charge. However, the assessment has also tended to confirm the main conclusions reached in the assessment of the motorway network charge option, that using pricing for demand management on just the motorway network will lead to a large displacement of trips onto the arterial network.

Appendix 4: Revised Approach to Assessing User Benefits and Value for Money

ATAP Objective	Objective description	Key indicator	Example (Motorway charging)	Example (Motorway widening)	Example (Busway)
Best possible value for money	Returns to society (NZ Inc) as a whole	Benefits and costs (EEM)	The full range of benefit and costs arising from a motorway charging scheme	The full range of benefit and costs arising from a motorway widening	The full range of benefit and costs arising from the busway
Financial costs of using the transport system deliver net benefits to users of the system	Benefits arising from road charges exceed the financial cost of those charges to road users	1. Change in generalised costs *for those paying road charges* (time, vehicle operating, safety, road charges)	The change in benefits and costs to motorway users who pay the charges	Not applicable	Not applicable
		2. Change in generalised costs *for users of the transport system* charges (time, vehicle operating, safety, road charges)	The change in benefits and costs to all transport system users, including those who use the motorway and those who don't	Not applicable	Not applicable