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Congestion Pricing in Auckland: *analysis of effects on households*

Prepared for

Auckland Transport

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Executive Summary

Scope of Report

This report provides an input to *The Congestion Question* (TCQ) project, a joint project between central government and Auckland Council to investigate whether to introduce congestion pricing in Auckland. This study aims to support the project Steering Group to deliver a social assessment required as part of the evaluation of a short-list of options.

An initial report[1] summarised the analysis of five charging options on households in low, medium and high income categories. The analysis in this current report examines one specific charge option - a refined corridor charge on the main arterial routes in the city. It would:

- be based on distance travelled in the charging area, calculated from the charge points crossed; and
- levy a charge of $0.20/km for trips taken during AM and PM peaks.

This study examines the impacts on:

- households classified:
    - as all households
    - as Maori or other households;
    - by income category;
    - by Local Board Area (LBA); and
- business.

This study does not address the full set of costs and benefits that would be included in a cost benefit analysis. It examines financial costs in comparison with income.

Analysis Methodology

For the analysis, we undertake the following steps:

- The Auckland Forecasting Centre's Macro Strategic Model (MSM) is used to simulate trips taken within Auckland with and without road charges. MSM estimates some impacts of congestion charging (particularly route and mode changes) but does not fully capture trip suppression or trip chaining[2] responses. The MSM outputs are in the form of origin-destination matrices, including trip numbers and trip costs.

- The trips are distributed to households within the trip origin areas using:
    - Trip rates for different household types taken from the Ministry of Transport's Household Travel Survey (HTS); and
    - Statistics NZ census data on household numbers by type and location.

[1] Covec and MRCagney (2018)

[2] Trip-chaining is when people combine trips so they go to more than one destination in a single trip, eg to a shop on the way home from work.

- Price elasticities are applied to modelled household private vehicle trips and costs to estimate the total travel demand response, including impacts on mode choice.

- Difference between the results for the base case and those with a congestion charge are estimated. This includes differences in trip rates and costs, by location and household type. The analysis focuses on changes in travel costs resulting from the congestion charge as a percentage of household income.

Trip rates, ie the number of trips per household in each peak period, differ with the structure of the household. This is defined by the number of people and the number of vehicles. There was no basis to adopt different trip rates by income level or for Maori and non-Maori households. Impacts differ by LBA within Auckland because of different trip characteristics (their length and the extent to which they face the congestion charge) and differences in the mix of household types. Within each LBA and in total, impacts relative to income differ between Maori and other households to the extent that there are differences in mean income.

The business analysis is more straightforward than it is for households. We assume, as a first approximation, that there is no price response beyond that estimated by MSM. MSM simulates some changes to routes based on changes in relative costs, but we assume businesses pay the charge rather than change trips to avoid it. We estimate impacts for business in aggregate based on modelled employer business trips and freight trips.

Results of Analysis

Changes in Trips

Table ES1 shows the estimated changes in numbers of trips for Auckland as a whole as a result of the congestion charge. This includes trips that have shifted to public transport (PT), those that have changed the time of the trip and those which are supressed completely. The impacts on business car trips are significantly less than for households. The 7% increase in business PT trips appears to be quite high, but is from a low base (PT trips increase from 2.6% to 2.8% of all business trips).

Table ES1 Changes in car and PT trips from the base case (household and business)

Income group	Car trips	PT trips
Low	-12.0%	6.8%
Medium	-11.8%	6.7%
High	-11.7%	6.7%
All households	-11.8%	6.7%
Business	-1.2%	7.1%

Average Household Cost Increases

Table ES2 shows average increases in costs of the congestion charge across all household types. Cost increases are:

- greater for high income households than for low income households because they tend to be larger households and take more trips;
- more significant as a percentage of mean household income for low income households; and
- not significantly different as a percentage of income between Maori and other households.

Table ES2 Cost of congestion charge ($/hh pa) and as a percentage of income

	Cost ($/hh pa)	All households	Maori households	Other households
Low	$225	0.83%	0.83%	0.83%
Medium	$330	0.43%	0.43%	0.43%
High	$404	0.25%	0.25%	0.25%
Average	$320	0.36%	0.36%	0.36%

Table ES3 shows, for each LBA, the average cost increases as a percentage of mean annual income, for all households, Maori households and by income category.

Table ES3 Cost increases per household per annum (% of annual income)

	All households	Maori households	Low Income	Medium Income	High Income
Otara-Papatoetoe	0.65%	0.60%	1.00%	0.48%	0.30%
Mangere-Otahuhu	0.56%	0.56%	0.94%	0.44%	0.25%
Henderson-Massey	0.51%	0.50%	0.75%	0.39%	0.22%
Papakura	0.50%	0.50%	0.92%	0.46%	0.27%
Upper Harbour	0.48%	0.42%	0.91%	0.44%	0.26%
Maungakiekie-Tamaki	0.48%	0.51%	0.79%	0.37%	0.20%
Howick	0.39%	0.35%	0.71%	0.36%	0.21%
Whau	0.38%	0.36%	0.54%	0.28%	0.15%
Puketapapa	0.36%	0.34%	0.69%	0.31%	0.17%
Manurewa	0.36%	0.36%	0.74%	0.34%	0.20%
Kaipatiki	0.35%	0.33%	0.55%	0.29%	0.16%
Devonport-Takapuna	0.35%	0.30%	0.55%	0.28%	0.17%
Albert-Eden	0.33%	0.30%	0.51%	0.23%	0.15%
Rodney	0.28%	0.29%	0.54%	0.28%	0.17%
Waitakere Ranges	0.27%	0.26%	0.41%	0.23%	0.13%
Franklin	0.26%	0.27%	0.58%	0.31%	0.19%
Waitemata	0.26%	0.24%	0.44%	0.18%	0.13%
Hibiscus & Bays	0.25%	0.23%	0.35%	0.21%	0.13%
Orakei	0.23%	0.22%	0.40%	0.19%	0.12%
Auckland	0.36%	0.36%	0.63%	0.31%	0.18%

There are significant differences between LBAs. Costs vary from 0.23% (Orakei) to 0.65% (Otara-Papatoetoe) of mean annual household income across all households and from 0.22% to 0.60% of mean income of Maori households. This is calculated as the average costs of the congestion charge (which reflects the types of trips taken from that LBA) divided by the average income in the LBA.

Compared to the average impact on all households, impacts on Maori households are:

- greater in Maungakiekie-Tamaki, Franklin and Rodney;
- the same in Manurewa and Papakura; and
- lower in all other areas.

To a significant extent, these differences reflect the distribution of Maori households across low, medium and high income bands; the areas where the impacts are greater for Maori households are areas where a higher proportion of Maori households are low income than for other households.

When the analysis is undertaken by income category, the differences are more stark. Costs vary from 0.12% of annual income of high income households in Orakei to 1% of income of low income households in Otara-Papatoetoe.

Business Impacts

Overall the modelling suggests business obtains a $20 million benefit from the congestion charge (Table ES4). Reductions in travel time because of reduced congestion of the road network is estimated to have benefits that exceed the costs of paying the congestion charge.

Table ES4 Estimated impacts on business costs ($ million)

Cost element	Base Case	Change	Change in total costs %
Fuel	$144	-$0.7	-0.06%
Parking	$68	-$0.8	-0.07%
Congestion charge	-	$58	5.06%
PT fares	$5	$0.4	0.03%
Value of travel time	$924	-$77	-6.74%
Total cost	$1,141	-$20	-1.77%

Main Findings

Trip Numbers

The introduction of congestion charging is expected to result in a reduction in car trips (12%) and an increase in PT trips (7%). The reduction in car trips will include the shifts to PT, shifts in the time of the trip away from the peak periods which are charged and some overall trip suppression.

Costs and their Distribution

The estimated financial costs of the schemes are higher for high income households, because they use more transport and are more likely to continue to take trips in the charged period and to pay the charge. However, as a percentage of annual income, costs are greater for low income households. This result is consistent with the international literature.

There is no significant difference between impacts on Maori and other households.

1 Introduction

1.1 Background

This report examines the potential differences in impacts of congestion pricing on Auckland households including Maori households. It extends an earlier report which examined the potential distributional impacts of congestion pricing options on households by location within the Auckland region and by household income.[3]

This report:

- Analyses the impacts of the Strategic Corridors congestion charging option;
- Updates the assumptions on scheme coverage and charge rates; and
- Extends the household numbers and income data to include Maori and other household classifications.

A Maori household is defined as one in which one or more adults in the household identifies as Maori.

1.2 The Congestion Pricing Option

For this study we examine the impacts of a Strategic Corridors congestion charging option for the Greater Auckland urban region, broadly consistent with the major road corridors in the urban area (Albany to Westgate, Papakura to Botany).

The option assumes a charge rate of $0.20/km would be levied for trips taken during AM and PM peaks. Distance would be calculated from the charge points crossed.

1.3 Analytical Approach

Figure 1 provides an overview of the approach taken to the analysis.

The steps are as follows for the household analysis:

- The Auckland Forecasting Centre's Macro Strategic Model (MSM) is used to simulate trips taken within Auckland with and without road charges. MSM estimates some impacts of congestion charging (particularly route and mode changes) but does not fully capture trip suppression or trip chaining responses. The MSM outputs are in the form of origin-destination matrices, including trip numbers and trip costs.
- The trips are distributed to households within the trip origin areas using:
    - Trip rates for different household types taken from the Ministry of Transport's Household Travel Survey (HTS); and

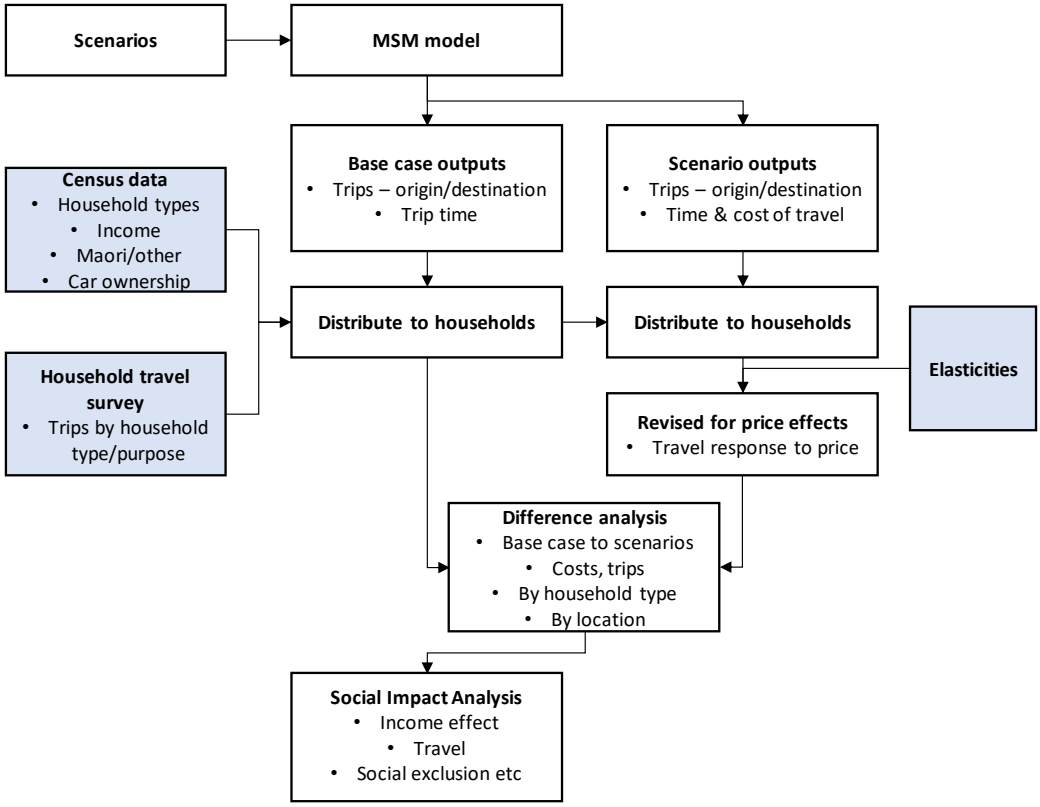
[3] Covec and MRCagney (2018)

- Statistics NZ census data on household numbers by type and location.

- Price elasticities are applied to modelled household private vehicle trips and costs to estimate the total travel demand response, including impacts on mode choice that are measured by MSM.

- A difference analysis is undertaken between the base case and the options, of the trip rates and costs, by location and household type. The analysis focuses on changes in travel (or trip) costs as a percentage of household income.

Figure 1 Overview of approach



Trip rates, ie the number of trips per household in each peak period, differ with the structure of the household. This is defined by the number of people and the number of vehicles. There was no basis to adopt different trip rates by income level or for Maori and non-Maori households. Impacts differ by LBA within Auckland because of different trip characteristics (their length and the extent to which they face the congestion charge) and differences in the mix of household types. Within each LBA and in total, impacts relative to income differ between Maori and other households to the extent that there are differences in mean income.

The methodology and different elements are explained in more detail in the first report. We note the following key assumptions used in this study:

1.3.1 Household Types

The same household types were used as in the initial study, although these are further split into Maori and other households. Table 1 shows the initial numbers of households for the Auckland region as a whole, taken from the 2013 census; the income categories are defined so that there are close to one third of Auckland households in each of the low, medium and high categories.

Table 1 Household numbers by household category (2013 Census)

Household type	Ethnicity	Low Income	Medium Income	High Income	Total
All households with no vehicles	Maori	3,375	540	102	4,017
	Other	18,987	3,390	786	23,163
	Total	22,362	3,930	888	27,180
1 or 2 person households with 1+ vehicles	Maori	5,367	5,379	3,021	13,767
	Other	66,024	55,038	38,019	159,081
	Total	71,391	60,417	41,040	172,848
3 person households with 1+ vehicles	Maori	2,196	3,282	3,180	8,658
	Other	12,726	21,561	24,513	58,800
	Total	14,922	24,843	27,693	67,458
4 or more person households with 1+ vehicles	Maori	2,868	6,006	8,343	17,217
	Other	15,726	34,065	51,915	101,706
	Total	18,594	40,071	60,258	118,923
All households	Maori	14,352	15,411	14,775	44,538
	Other	116,352	115,293	115,968	347,613
	Total	130,704	130,704	130,743	392,151

Note: Income levels are: <$50,400 (low), $50,400 - $107,599 (medium) and ≥$107,600 (high)
"All households" totals include households not classified by household type
Source: Statistics NZ

In the earlier report, Jensen-equivalised incomes[4] were used to categorise the households into low, medium and high income categories. For this revised analysis, unadjusted income is used. Some households (1.5%) could not be classified and were ignored in the analysis.[5]

Data on household numbers and incomes were provided by Statistics NZ for the Auckland region as a whole and for 19 separate Local Board Areas (Box 1). The household numbers were updated using Auckland Transport's projections of household numbers by area in 2028. This year was used for modelling the trips in MSM on the assumption that it represented a year after the road charging has been introduced, including changes in trips as households had then changed their behaviour to take account of new costs of travel.

[4] Jensen equivalised household income is calculated by dividing household income by household size and adjusting for the number of children in the household. It provides a measure of available income.
[5] These were marked "Not elsewhere included" in the dataset provided by StatsNZ and are a combination of residuals, such as 'not stated', 'response outside scope', 'response unidentifiable', 'refused to answer', and 'don't know'.

Box 1 Local Board Areas used for Analysis

Rodney	Waitemata	Howick
Hibiscus & Bays	Whau	Mangere-Otahuhu
Upper Harbour	Albert-Eden	Otara-Papatoetoe
Kaipatiki	Puketapapa	Manurewa
Devonport-Takapuna	Orakei	Papakura
Henderson-Massey	Maungakiekie-Tamaki	Franklin
Waitakere Ranges		

The analysis still uses 2013 income assumptions. Growth in population in individual LBAs between 2013 and 2028 was assumed to be the same across all income categories within those LBAs. However, because some LBAs are assumed to grow more than others, and the income mix differs between LBAs, the simulated population increases led to some rebalancing of the proportion of households in each income category. The final numbers summarised for the Auckland region are shown in Table 2.

Table 2 Projected 2028 household numbers by household category

Household type	Ethnicity	Low Income	Medium Income	High Income	Total
All households with no vehicles	Maori	6,149	975	328	7,453
	Other	33,532	6,091	1,506	41,129
	Total	39,682	7,066	1,834	48,582
1 or 2 person households with 1+ vehicles	Maori	9,606	9,589	5,280	24,475
	Other	114,909	95,357	65,503	275,770
	Total	124,515	104,946	70,783	300,245
3 person households with 1+ vehicles	Maori	3,933	5,828	5,584	15,346
	Other	22,190	37,403	42,083	101,676
	Total	26,123	43,232	47,668	117,022
4 or more person households with 1+ vehicles	Maori	5,207	10,756	14,693	30,656
	Other	27,657	59,428	89,548	176,633
	Total	32,863	70,184	104,242	207,289
All households	Maori	24,895	27,149	25,886	77,930
	Other	198,288	198,279	198,641	595,207
	Total	223,183	225,427	224,527	673,137

Although the number of households in each income band is roughly a third each at the regional level, it differs by LBA (Figure 2) and, alongside the differences in charge incidence, and options to avoid the charge, this will affect the local household impacts of the charge.

Figure 3 presents the same data but for Maori households only. The order is broadly similar, but one difference is that there are some areas in which the percentage of low income Maori households is very small as a percentage of total Maori households, eg 15% in Upper Harbour. These are areas in which the number of Maori households is small also, eg Maori households represent 4% of the total in Upper Harbour compared with 12% in total for Auckland.

Figure 2 Proportion of households in low, medium and high income bands

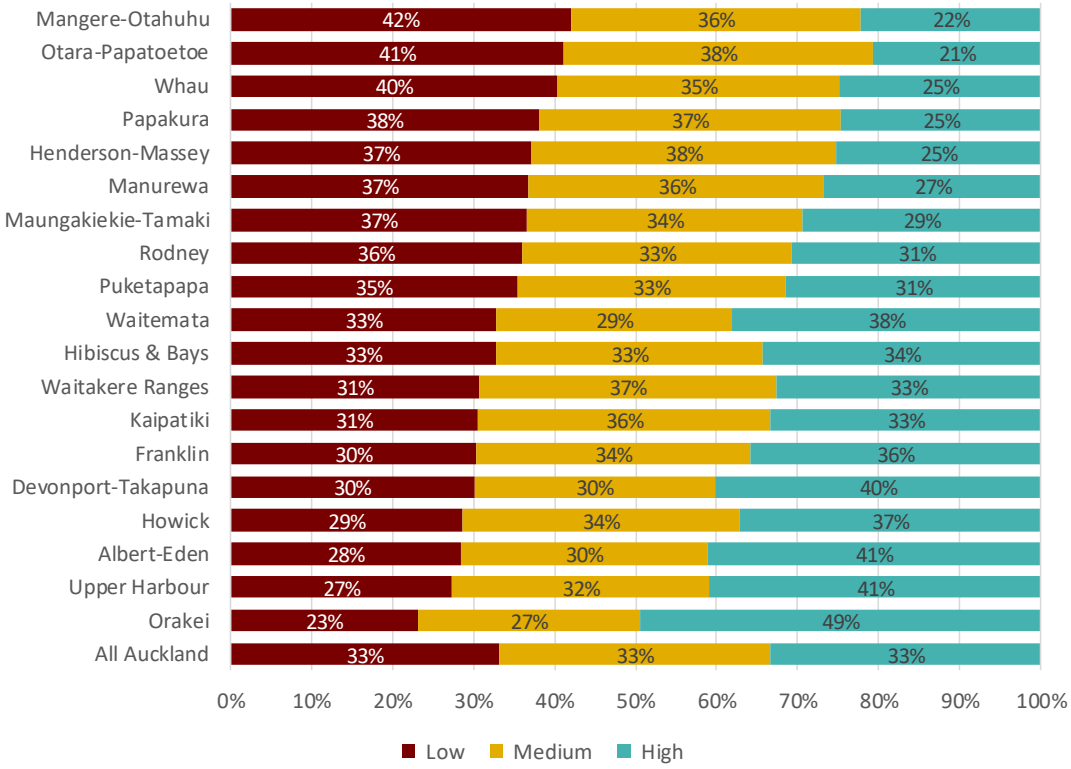
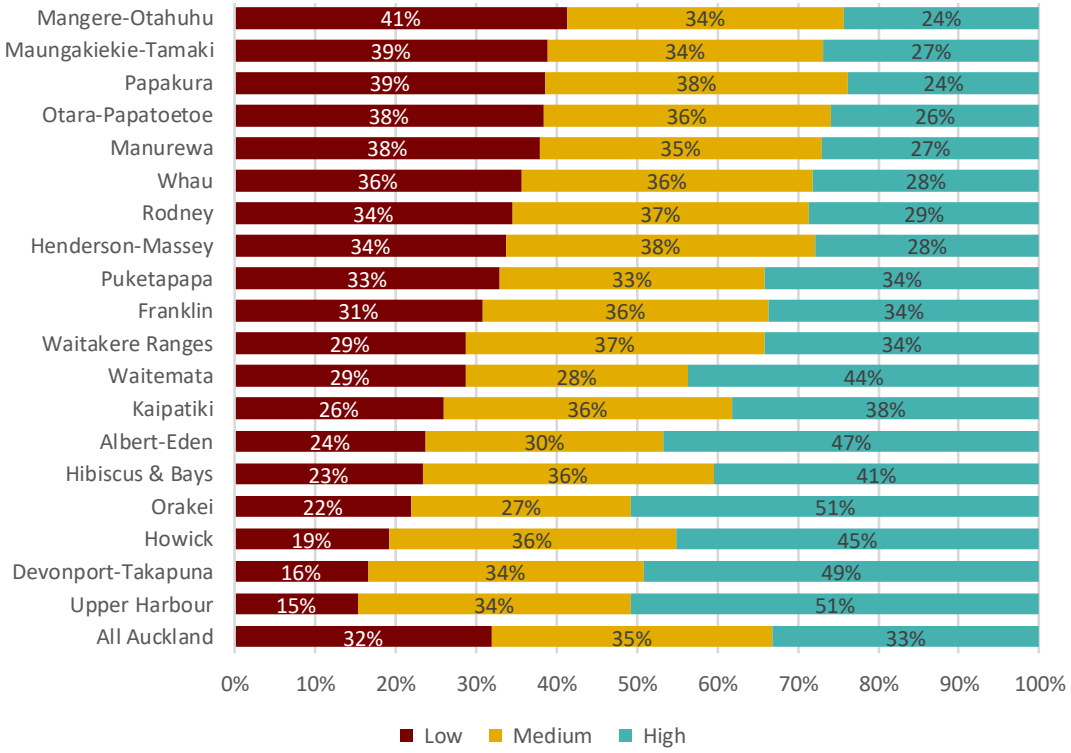


Figure 3 Proportion of Maori households in low, medium and high income bands



Source: Stats NZ Income data

1.3.2 Trip Rates

Total trip rates and trip costs are outputs of MSM. However, MSM does not model travel at the household level so trips were allocated to household types using trip rates from the Ministry of Transport (MoT) Household Travel Survey (HTS). StatsNZ household counts were multiplied by HTS trip rates to estimate the number of trips which originated in each LBA, by household type. The trips from each LBA, based on this HTS-based analysis, were then adjusted so the total trips for each LBA was the same as that estimated by MSM. Different adjustment factors were used for each LBA, but the same adjustment factor was applied to all households in each LBA.

The starting trip rates used for analysis, both for car use and public transport (PT), are the same as used in the first study (Table 3). However, as noted in Section 2, final trip rates differ from these as we adjust trip numbers to equal those estimated by MSM.

Table 3 morning peak trips per household per day by household type, mode, and purpose.

	To work or education		Other	
Household type	**Car**	**PT**	**Car**	**PT**
All with no vehicles	0.12	0.15	0.04	0.10
1 or 2 persons; 1+ vehicles	0.37	0.03	0.31	0.01
3 persons; 1+ vehicles	0.68	0.09	0.68	0.01
4+ persons; 1+ vehicles	1.26	0.16	1.54	0.02

1.3.3 Elasticities

Responses to a congestion charge will vary with the reasons for the trips and the characteristics of the people. MSM estimates some changes to trips following the introduction of a congestion charge:

- trip mode from car use to public transport (PT);
- trip route to avoid or to reduce the charge faced;
- time of departure; and
- destination, in some circumstances.

However, MSM does not include any additional price response, eg total trip suppression. We estimate these effects using elasticities.

Because they provide daily peak elasticities, we have taken values from a Swedish study.[6] The average price elasticity for Stockholm and Gothenburg is -0.6. This is a measure of the change in traffic volume (0.6% reduction in vehicles/hour) in response to a 1% change in cost measured as fuel cost times 1.2[7] (for a one-way trip) plus the congestion charge. A change in vehicles per hour across a cordon is equivalent to a change in the number of trips across a cordon. We also use this elasticity with a per-km charging scenarios, on the assumption that the charging approach is equivalent to multiple cordon charges.

[6] Börjesson (2017)

[7] The average price of travel was based on the driving cost per kilometre assumed by Sweden's tax authorities. The kilometre rates for taxation purposes in Sweden are largely based on fuel costs; the calculation is 1.2 times the estimated fuel cost (Harding 2014).

Some international studies have examined differences in price elasticities by household type and income. These have been identified for fuel price elasticities rather than congestion charges. In the previous study, we used the differences in elasticity from these studies to alter the average elasticity by household type and income. In this updated analysis we use a single elasticity of -0.6 for all incomes and household types.

1.3.4 Estimation of Differences

We estimate results from the change in trips (by purpose) relative to the base case and the costs of the congestion charge for households in each LBA and household type.

Different costs are used for different elements of the analysis.

- In MSM, changes in trip routes and timing result from responses to changes in the full financial costs of the trip, including fuel costs, parking costs and congestion charges.

- The elasticities we have used are applied to changes in the sum of fuel costs and congestion charge only. This is consistent with the methodology used in deriving these elasticities.

- When we report the impacts as a proportion of household income, the results are based on the costs of the congestion charge alone. The reason for doing this is to eliminate the impact of potentially perverse model results.

The perverse results occur when, in some instances, the results suggest a reduction in total household costs from the congestion charge. This would imply that the charge was encouraging some people to make trip changes which they should have made without the congestion charge (assuming they are trying to minimise trip costs). These results occur because of the differences in costs used for different elements of the analysis.

Measuring just the costs of the congestion charge relative to income is a simplification. It takes the total congestion charge payment for a LBA and averages this across all households in the LBA. It does not measure the change (increase or decrease) in costs for trips which avoid the charge (in whole or part). Compared with the actual change in average costs, this will be lower for some areas and higher for others.

1.4 Social Impacts

We compare the costs of the different options against mean household incomes. We use separate values for all 19 LBAs and for Maori and other households. Values for Auckland as a whole are shown in Table 4 below. There is very little difference between mean incomes between Maori and other households.

Table 5 shows mean income by LBA for all households and Maori households. For Auckland as whole, mean incomes of Maori households are slightly lower, but in some LBAs they are higher. Income levels of Maori households partly reflect their larger size on average.

Table 4 Mean income (2013 census) – Total Auckland

Household type	Maori Low	Maori Medium	Maori High	Other Low	Other Medium	Other High
All with no vehicles	$20,300	$67,800	$143,800	$20,600	$69,500	$148,100
1 or 2 persons; 1+ vehicles	$28,300	$74,100	$150,200	$28,200	$74,300	$157,500
3 persons; 1+ vehicles	$30,000	$77,400	$156,700	$29,000	$77,400	$161,400
4+ persons; 1+ vehicles	$30,100	$78,500	$165,400	$29,200	$78,700	$166,800
All households	$26,969	$76,325	$160,149	$27,144	$76,056	$162,447

Table 5 Mean income (2013 census) – by Local Board Area

LBA	All	Maori	LBA	All	Maori
All Auckland	**$88,575**	**$88,402**	Puketapapa	$88,295	$93,945
Orakei	$110,806	$112,675	Waitakere Ranges	$87,119	$90,433
Upper Harbour	$98,984	$114,431	Maungakiekie-Tamaki	$85,508	$80,099
Albert-Eden	$97,359	$104,256	Rodney	$84,832	$80,559
Devonport-Takapuna	$96,894	$112,075	Whau	$78,657	$84,683
Waitemata	$92,808	$100,013	Henderson-Massey	$78,169	$80,080
Howick	$92,732	$104,635	Manurewa	$77,403	$77,528
Franklin	$91,002	$87,440	Papakura	$76,134	$74,834
Kaipatiki	$90,025	$96,850	Mangere-Otahuhu	$74,452	$75,184
Hibiscus & Bays	$89,412	$98,230	Otara-Papatoetoe	$70,403	$76,579

Source: StatisticsNZ data

2 Impacts

2.1 Base Case

Household trips in the base case total 823,257 across the 19 LBAs of which 85% are car trips and 15% public transport; these are one-way trips per morning peak. For analysis we assume that every trip in the morning peak has a corresponding return trip in the evening peak. The household trip rates as an average for the Auckland region are shown in Table 6, including those to work and education and all trips (ie work & education plus other trips). These are different from the trip rates in Table 3 because we have scaled the number of trips so the totals are equal to the trip numbers estimated by MSM for each LBA origin.

Table 6 Trips per household per day (morning peak)

	Car trips			PT trips		
	Low	Medium	High	Low	Medium	High
Trips to work or education						
All with no vehicles	0.09	0.08	0.08	0.27	0.29	0.28
1 or 2 person with 1+ vehicles	0.27	0.27	0.26	0.05	0.05	0.05
3 person with 1+ vehicles	0.50	0.51	0.50	0.16	0.16	0.17
4 or more person with 1+ vehicles	0.95	0.94	0.93	0.27	0.27	0.28
All trips						
All with no vehicles	0.12	0.11	0.11	0.46	0.50	0.50
1 or 2 person with 1+ vehicles	0.49	0.50	0.50	0.06	0.06	0.06
3 person with 1+ vehicles	0.99	0.99	1.00	0.19	0.19	0.20
4 or more person with 1+ vehicles	2.05	2.04	2.06	0.31	0.30	0.31

Table 7 shows average costs for trips per household per year in the base case, prior to introduction of a congestion charge. These include the costs of fuel, parking and PT. The following patterns emerge:

- Costs of trips are higher for larger households as they take more trips.
- There is little difference in costs between households by income within any household category. However, the weighted average costs are higher for high income households because these households tend to be larger and take more trips.

Table 7 Base case trip costs per household per year (morning peak)

	Car trips			PT trips		
	Low	Medium	High	Low	Medium	High
All with no vehicles	$203	$220	$223	$783	$796	$800
1 or 2 person with 1+ vehicles	$803	$820	$855	$111	$112	$112
3 person with 1+ vehicles	$1,551	$1,565	$1,621	$353	$357	$359
4 or more person with 1+ vehicles	$3,046	$3,093	$3,234	$574	$581	$588
Weighted average	$1,114	$1,652	$2,117	$327	$327	$391

2.2 Trips Facing the Congestion Charge

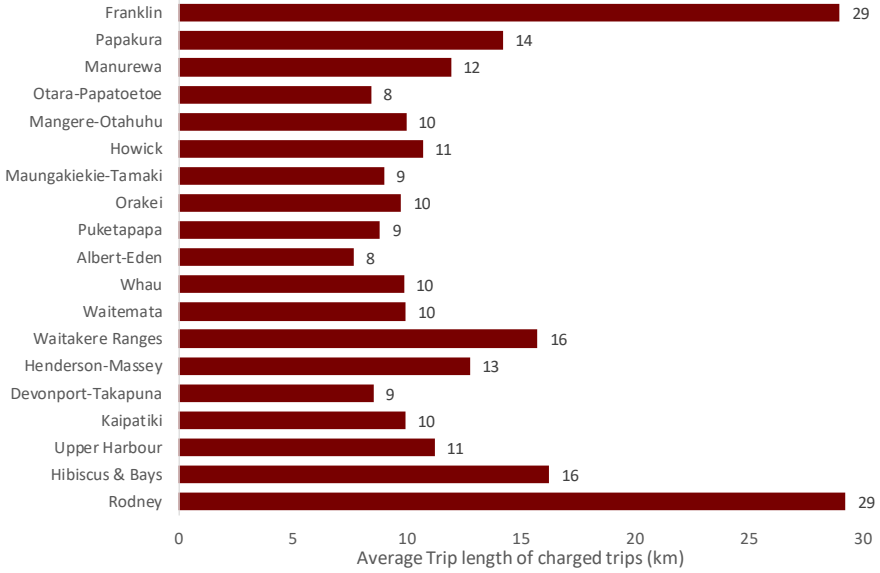
Table 8 shows, for Auckland as a whole and for the individual LBAs, the total car and PT trips and the number and percentage of car trips which would face the congestion charge. These are the base case trips which, if they do not shift (mode, time or route) or are not avoided, will pay the charge. The corridor option charges 67% of car trips on average, ranging between 25% (Franklin) and 88% (Otara-Papatoetoe and Albert-Eden).

Table 8 Daily household trips by LBA and percentage facing the congestion charge

Local Board Area	Total Car trips	Car trips charged	% Facing charge	Total PT trips
Otara-Papatoetoe	34,521	30,431	88%	5,049
Albert-Eden	48,990	43,170	88%	11,995
Devonport-Takapuna	26,099	22,229	85%	5,014
Puketapapa	25,729	21,554	84%	5,762
Upper Harbour	39,933	32,308	81%	5,876
Maungakiekie-Tamaki	46,667	37,477	80%	7,876
Mangere-Otahuhu	27,639	21,887	79%	5,044
Whau	32,405	24,219	75%	6,984
Kaipatiki	36,288	26,493	73%	6,665
Henderson-Massey	48,545	33,116	68%	9,431
Waitemata	33,967	22,770	67%	12,315
Howick	65,656	43,695	67%	8,500
Orakei	44,244	28,633	65%	8,300
Papakura	24,816	15,081	61%	4,442
Manurewa	28,694	16,717	58%	5,034
Waitakere Ranges	20,106	10,129	50%	3,681
Hibiscus & Bays	40,845	18,246	45%	6,492
Rodney	32,859	8,640	26%	3,647
Franklin	37,673	9,411	25%	5,473
Auckland region	695,678	466,205	67%	127,579

Figure 4 shows the average kilometres charged, per charged trip for the different LBA origins. The highest charged trip lengths are for Franklin and Rodney.

Figure 4 Average trip length of charged trips by LBA Origin



2.3 Changes in Trip Numbers

2.3.1 By LBA

Table 9 shows the revised number of car and PT trips after the charge is levied and the percentage change in trip numbers.

Table 9 Daily household trips by LBA and change in trips following the introduction of the charge

Local Board Area	Total Car Trips	Change in car trips	% reduction	Total PT Trips	Change in PT trips	% increase
Otara-Papatoetoe	28,917	5,603	16%	5,411	363	7%
Albert-Eden	41,178	7,812	16%	12,648	654	5%
Devonport-Takapuna	21,767	4,331	17%	5,308	295	6%
Puketapapa	21,921	3,809	15%	6,048	286	5%
Upper Harbour	34,030	5,904	15%	6,380	504	9%
Maungakiekie-Tamaki	39,876	6,791	15%	8,383	507	6%
Mangere-Otahuhu	23,646	3,993	14%	5,471	428	8%
Whau	28,319	4,085	13%	7,299	315	5%
Kaipatiki	31,694	4,595	13%	6,966	301	5%
Henderson-Massey	41,922	6,623	14%	9,994	563	6%
Waitemata	29,522	4,445	13%	12,840	525	4%
Howick	58,095	7,561	12%	9,149	650	8%
Orakei	39,625	4,619	10%	8,943	643	8%
Papakura	21,997	2,818	11%	4,900	457	10%
Manurewa	26,059	2,635	9%	5,502	468	9%
Waitakere Ranges	18,710	1,396	7%	3,872	191	5%
Hibiscus & Bays	38,143	2,702	7%	6,727	236	4%
Rodney	31,608	1,251	4%	4,179	532	15%
Franklin	36,356	1,317	3%	6,134	660	12%
Auckland region	613,387	82,291	12%	136,156	8,577	7%

The number of car trips that are supressed is broadly proportional to the number facing the charge. It varies from 16% in Otara-Papatoetoe and Albert-Eden (where 88% face the charge) to 3% in Franklin (where only 25% face the charge). The number of trips supressed as a percentage of those that are charged varies much less – from 14% in Franklin to 20% in Henderson-Massey and Waitemata.

Changes in PT trips follow a different pattern, with the largest percentage increases in Rodney and Franklin. The PT changes are predicted by MSM rather than via the elasticities applied in this study; they will reflect car route and PT options available and the modelled relative prices.

2.3.2 By Household Type

Table 10 shows the estimated morning peak trip changes in response to the congestion charge across Auckland as a whole, by household type. This includes the responses estimated by MSM and the price elasticity response that we have estimated.

Table 10 Changes in morning peak trip numbers (% of base case) total Auckland

	Car trips			PT trips		
	Low	Medium	High	Low	Medium	High
1 or 2 person with 1+ vehicles	-11.4%	-11.7%	-11.7%	7.0%	6.9%	6.7%
3 person with 1+ vehicles	-12.2%	-11.9%	-11.8%	6.8%	6.7%	6.7%
4 or more person with 1+ vehicles	-12.4%	-11.8%	-11.7%	6.8%	6.8%	6.7%
All households	-12.0%	-11.8%	-11.7%	6.8%	6.7%	6.7%

Because of the low trip rates for households with no vehicles and uncertainty over whether they bear the costs of congestion charging, we have not presented the analysis of impacts of the congestion charge on households with no vehicles.

Low income households are expected to reduce car trips and increase PT trips slightly more than high income households. As noted above, we do not analyse differences in trip rate response between Maori and other households because we assume the same trip rates per household, costs and price elasticities. The differences arise when we examine costs in comparison with income below.

2.4 Costs of Congestion Charge

Table 11 shows the annual average estimated costs of the congestion charge per household for Auckland households. It also shows the costs relative to income.

- The congestion charge costs are the amounts paid by those households which continue to make trips which face the charge after the charge has been introduced.

- Household incomes are mean household incomes by household category.

Table 11 Costs of congestion charge ($ per household and as % of household income)

	$/hh/year			% of mean income		
	Low	Medium	High	Low	Medium	High
1 or 2 person with 1+ vehicles	$153	$155	$154	0.5%	0.2%	0.1%
3 person with 1+ vehicles	$314	$311	$307	1.1%	0.4%	0.2%
4 or more person with 1+ vehicles	$648	$634	$625	2.2%	0.8%	0.4%
All households	$225	$330	$404	0.8%	0.4%	0.2%

On average, there are higher cost increases (in dollar terms) for high income households ($404/hh/year) than for low income households ($225/yr). This reflects the larger household sizes and thus the larger number of trips taken. However, as a percentage of income, the impacts are much greater on low income households (0.8% compared to 0.2%). For the largest household category, impacts on low income households are estimated to be equal to over 2% of mean annual income.

Table 12 shows the average cost increases as a percentage of annual income for households, by LBA.

Table 12 Cost increases per household per annum (% of annual income)

	All households	Maori households	Low Income	Medium Income	High Income
Otara-Papatoetoe	0.65%	0.60%	1.00%	0.48%	0.30%
Mangere-Otahuhu	0.56%	0.56%	0.94%	0.44%	0.25%
Henderson-Massey	0.51%	0.50%	0.75%	0.39%	0.22%
Papakura	0.50%	0.50%	0.92%	0.46%	0.27%
Upper Harbour	0.48%	0.42%	0.91%	0.44%	0.26%
Maungakiekie-Tamaki	0.48%	0.51%	0.79%	0.37%	0.20%
Howick	0.39%	0.35%	0.71%	0.36%	0.21%
Whau	0.38%	0.36%	0.54%	0.28%	0.15%
Puketapapa	0.36%	0.34%	0.69%	0.31%	0.17%
Manurewa	0.36%	0.36%	0.74%	0.34%	0.20%
Kaipatiki	0.35%	0.33%	0.55%	0.29%	0.16%
Devonport-Takapuna	0.35%	0.30%	0.55%	0.28%	0.17%
Albert-Eden	0.33%	0.30%	0.51%	0.23%	0.15%
Rodney	0.28%	0.29%	0.54%	0.28%	0.17%
Waitakere Ranges	0.27%	0.26%	0.41%	0.23%	0.13%
Franklin	0.26%	0.27%	0.58%	0.31%	0.19%
Waitemata	0.26%	0.24%	0.44%	0.18%	0.13%
Hibiscus & Bays	0.25%	0.23%	0.35%	0.21%	0.13%
Orakei	0.23%	0.22%	0.40%	0.19%	0.12%
Auckland	0.36%	0.36%	0.63%	0.31%	0.18%

There are significant differences between LBAs. Costs vary from 0.23% (Orakei) to 0.65% (Otara-Papatoetoe) of mean annual household income across all households and from 0.22% to 0.60% of mean income of Maori households. This is calculated as the average increase in costs (which reflects the types of trips taken from that LBA) divided by the average income in the LBA.

Compared to the average impact on all households, impacts on Maori households are:

- greater in Maungakiekie-Tamaki, Franklin and Rodney;
- the same in Manurewa and Papakura; and
- lower in all other areas.

To a significant extent, these differences reflect the distribution of Maori households across low, medium and high income bands (Figure 3); the areas where the impacts are greater for Maori households are areas where a higher proportion of Maori households are low income than for other households.

In Upper Harbour, for example, where only 15% of Maori are in the low income category (compared to 27% of all households), Table 12 shows that the congestion charge impacts are significantly lower for Maori than for other households (0.42% versus 0.48%). In contrast, in Maungakiekie-Tamaki, 39% of Maori households are low income (just above 37% for all households) and they face a higher average impact (0.51% compared to 0.48%). In Otara-Papatoetoe 38% of Maori are low income, but an even larger proportion (41%) of all households are low income also.

When the analysis is undertaken for households divided into low medium and high income categories, the differences are more stark. Costs vary from 0.12% of annual income of high income households in Orakei to 1% of income of low income households in Otara-Papatoetoe.

2.5 Impacts on Households Paying the Charge

Table 11 (above) shows the annual average estimated costs of the congestion charge per household. Individual households will pay more or less than this average. Some households will make no trips during the peak periods (this might include workers with flexible hours or retired people) and others might make and be charged for multiple trips during peak periods (households with several working adults). To get an idea of the upper bound of charges that a household could potentially face, we adjust the values in Table 11 to take account of two factors:

1. **The trip rates per household**. The lowest trip rate we are considering is 0.5 per household per morning peak; this is for a 1 or 2 person household with one or more vehicles (Table 6 on page 9). Doubling this gives a trip rate of 1.0 for this household type; we similarly double the trip rates for the other household types. This is assumed to represent the maximum expected trip rates per household.

2. **The proportion of trips that face the charge**. For Auckland as a whole this averages 67% (Table 8). If we assume that all trips face the charge, this can be approximated by multiplying the costs by 1.5.

The combination of these factors (multiplication by three) results in the estimated costs per household shown in Table 13. These costs are then divided by mean household incomes to suggest a range of impacts from 1.6% to 6.6% of annual income for average low income households (in the different categories) making the maximum potential number of trips.

Table 13 Maximum costs of congestion charge ($ per household and as % of household income)

	$/hh/year			% of mean income		
	Low	Medium	High	Low	Medium	High
1 or 2 person with 1+ vehicles	$456	$462	$458	1.6%	0.6%	0.3%
3 person with 1+ vehicles	$938	$928	$915	3.2%	1.2%	0.6%
4 or more person with 1+ vehicles	$1,935	$1,891	$1,864	6.6%	2.4%	1.1%
All households	$670	$985	$1,205	2.5%	1.3%	0.7%

The effects would be even larger if the income levels of a specific household were lower than average for low income households.

This table is likely to represent an upper bound of costs for Auckland households, noting that there would also be regional variations across individual LBAs.

2.6 Business Impacts

Table 14 shows the employment-based and freight trips per morning peak.

Table 14 Base case trips per morning peak (Auckland region)

Mode	Number
Car	71,237
PT	2,800
HCV	35,499
Total	109,536

Table 15 shows the estimated change in business trip numbers in response to the charge. The changes shown are those estimated by MSM and include some shifts in mode (car to PT) and some changes in destination or scheduling. We do not assume any price elasticity response. The impacts on business car trips are significantly less than for households, based on the assumption that businesses will largely pay the charges rather than seek to avoid them. The increase in business PT trips is from a low base (from 2.6% to 2.8% of all business trips).

Table 15 Impacts of corridor charge on business trip numbers

	Annual Trips	Change	% change
Car	17,453,138	-210,379	-1.21%
PT	685,954	48,560	7.08%
HCV	8,697,262	0	0.00%
Total	26,836,354	-161,819	-0.60%

Table 16 shows the estimated impacts on business costs from the congestion charge. In addition to the costs of the congestion charge itself ($58 million), there will be offsetting benefits particularly from reduced travel time.[8] This is not from avoided trips, such that there need to be offsetting reductions in business profits also. Rather, these are the estimated time saving benefits from reduced congestion in the road network and resulting from reduced household travel in response to the congestion charge. Overall

[8] The value of travel time uses values taken from MSM

the modelling suggests business obtains a $20 million benefit from the congestion charge.

Table 16 Estimated impacts on business costs ($ million)

Cost element	Base Case	Change	Change in total costs %
Fuel	$144	-$0.7	-0.06%
Parking	$68	-$0.8	-0.07%
Congestion charge	-	$58	5.06%
PT fares	$5	$0.4	0.03%
Value of travel time	$924	-$77	-6.74%
Total cost	$1,141	-$20	-1.77%

There will be some additional costs which have not been included. For example, the mode shifts from car to PT in response to the charge and as predicted by MSM, will have some business costs which have not been counted. However, these are likely to be small compared to the major impacts of the congestion charge itself and the value of travel time.

3 Conclusions

3.1 Results

The quantitative results in Section 2 show the expected effects of congestion charging on:

- household costs relative to income: and
- business costs.

The analysis includes little examination of the congestion benefits. We have not quantified the congestion benefits for households, but we have included impacts on business travel costs.

3.1.1 Household Impacts

The introduction of a congestion charge during morning and evening peaks is expected to lead to a reduction in car trips and an increase in PT trips during these times. The reduction in car trips will include those that shift to PT, shifts in the time of the trip away from the peak periods and some overall reduction in trips.

Consistent with the international literature, the estimated financial costs of the congestion charge are:

- higher for high income households, because they take more trips and are more likely to pay the charge and continue to take trips in the charged period.

- greater for low income households as a percentage of their income.

There is no significant difference between the impacts on Maori and non-Maori households.

3.1.2 Business Impacts

Congestion charging is estimated to have net benefits for business. Reductions in travel time because of reduced congestion of the road network is estimated to have benefits that exceed the costs of paying the congestion charge.

3.2 Mitigation of Effects

The greater impacts on low income households proportional to income suggests the potential need for measures to be taken to mitigate these impacts. Decisions on mitigation should take account of:

- whether other transport projects or policies are having effects that are relatively favourable to low income households, which might suggest less need for mitigation; and

- whether mitigation is best tackled through transport-related policies or in other policy spaces.

Whatever approach is used to mitigation, care should be taken to ensure its implementation does not diminish the effectiveness of the congestion charge, eg by reducing the incentives for travel in peak periods.

4 References

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