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Assessing Toll Road Demand in New Zealand

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Abstract

If the Auckland Harbour Bridge toll had been in place in 2021 the car toll would have been approaching $6 but the toll was removed in 1984. However, there are three toll roads operating in New Zealand in 2021 which is what most of this paper is about. There are two in Tauranga and one north of Auckland. The tolls are low at only half what the Auckland Harbour Bridge would probably have been. The tolls are also low when benchmarked against Australian and some other overseas examples.

After assessing the low level of toll, the paper moves on to using the New Zealand Transport Agency electronic toll registration database to assess vehicle and revenue ramp-up, frequency of toll road use, demand and revenue by class of vehicle and the geographic spread of registered users.

An innovative gravity model is fitted to the registration data and used to forecast demand for a major new 27 kilometre highway out of Wellington under construction at the time of writing. The gravity model is compared with a more conventional approach of using a road traffic assignment model with toll included as a time penalty. The gravity model forecast annual revenue of $9 million which was three-quarters of the road traffic assignment model. Neither of the two forecasts are high however with revenue amounting to only 3% of the $300 million annual revenue of the 'hypothetical' Auckland Harbour Bridge toll. The low revenue forecast reflects the prevailing low toll environment in New Zealand, low values of travel time and a likely lack of competitiveness of the road in question.

1.Introduction

In 1959, the Auckland Harbour Bridge opened with a toll of 2 shillings and sixpence for cars (25 cents in today's decimal dollars). 11,205 vehicles crossed the 1.2 km bridge. With 23-fold CPI inflation, the toll in 2020 would be $5.77 for cars and motorcycles and $11.54 for HGVs and buses. With 170,000 vehicles using the bridge per day, revenue would be around $300 million (including GST) after allowing for some toll aversion. Such an amount would be welcome funds for transport projects needed to cater for Auckland's increasing population.

As with the Tauranga Harbour Bridge (tolled for 13 years between 1988 and 2001) the Auckland Harbour Bridge toll was removed in 1984 after the $15 million construction cost ($347 million in 2020 dollars) was paid off.

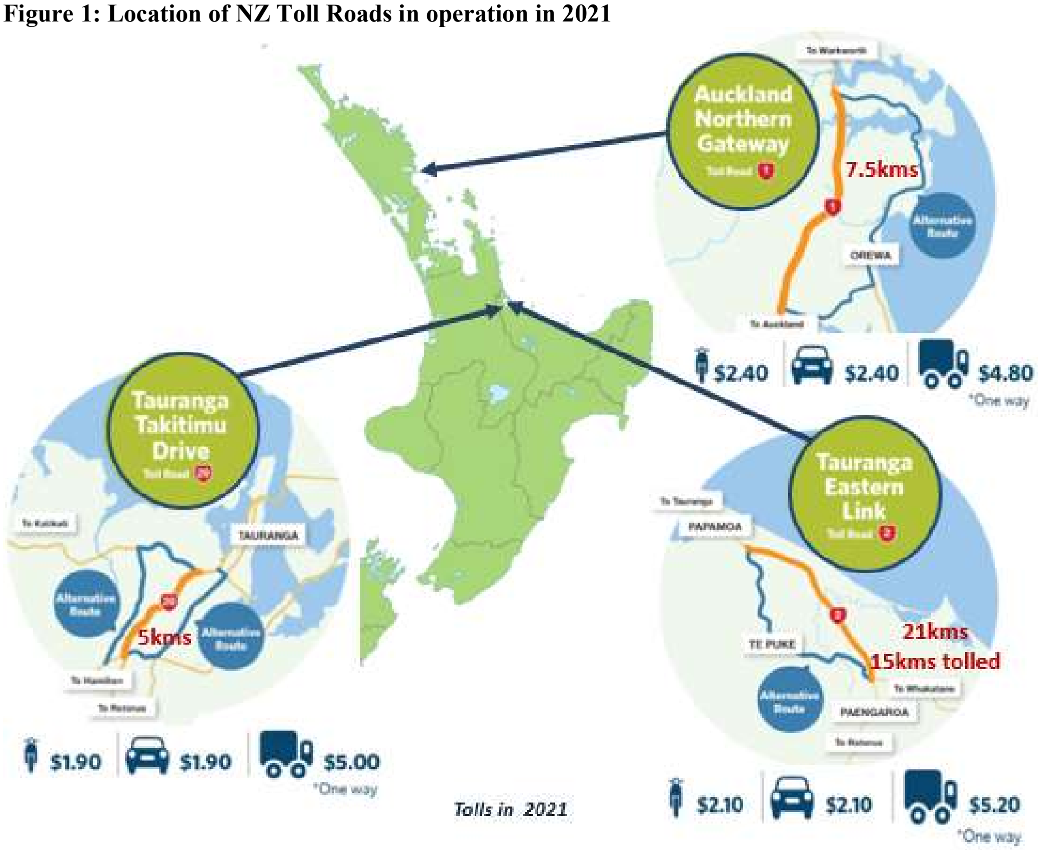
By contrast, the Sydney Harbour Bridge has remained tolled (southbound) despite paying the construction cost off several times. The toll was used to pay off the Harbour Tunnel and then when that was paid off, retained as State revenue (since most taxes and charges are levied federally) and provide a 'demand management tool' ($4 peak $2.50 off-peak in 2020).

Back in NZ, three toll roads were operational in 2021. All three are located in the top half of the north island as shown in Figure 1.   The 7.5km Northern Gateway was opened in 2009 and extended the motorway north of Auckland from Orewa to Puhoi bypassing the seaside towns of Orewa, Hatfields Beach and Waiwera. In so doing, it cut the drive time from 35 to 25 minutes.

Tauranga has two toll roads which started operations in mid-2015. The 5km Takitimu Drive bypasses the city centre on the northern side taking traffic off SH 19 to SH 2 in the direction of the Port of Tauranga and Mt Maunganui.

The Tauranga Eastern Link (costing $455 million) runs 21 kilometres between Papamoa and Paengaroa. Of this 15kms is tolled. The tolled section provides an alternative to driving through Te Puke when travelling between Tauranga and Rotorua or the East Cape.

Figure 1: Location of NZ Toll Roads in operation in 2021

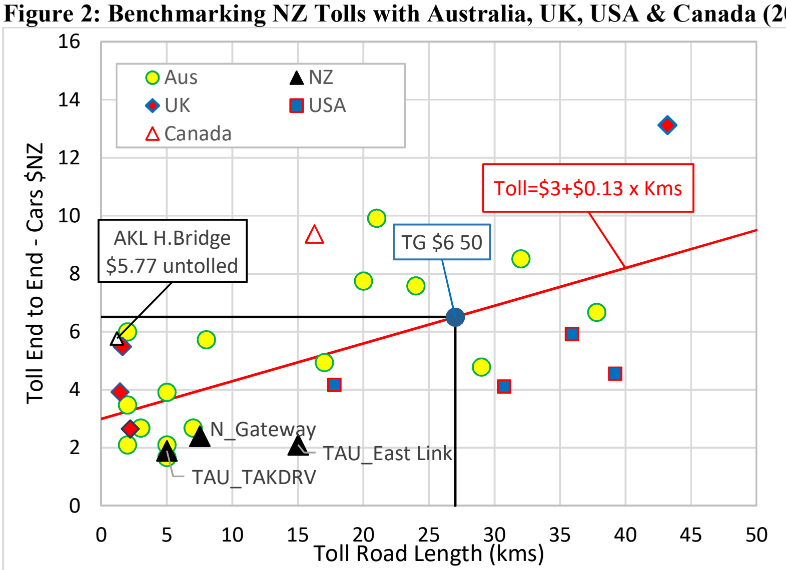


After benchmarking the three NZ toll roads with Australian and overseas examples in section 2, the paper describes the results of using the NZTA electronic registration database to look at demand and revenue ramp-up in section 3. Section 4 delves into the database in more detail to look at the frequency of use, revenue and traffic by vehicle type. Section 5 looks at the geographic origin of registered users. In section 6, an innovative gravity type model is fitted to the geographic spread of toll road users by taking account population and distance. As a worked example, the model is used in section 7 to forecast the demand and revenue for a major new radial road out of Wellington if the road was tolled. The model is compared with a more conventional approach of using an assignment road traffic model that uses time penalties calculated via values of time to assess the toll. The main findings of the paper are summarized in section 8.

2. Benchmarking NZ Tolls

The tolls set on the three toll roads in NZ are low by international standards. In 2021 (unchanged on 2020), the Northern Gateway charged $2.40 for cars and Light Commercial Vehicles (LCVs). The Tauranga Eastern Link charged $2.10 and Takitimu Drive $1.90. Motorcycles paid the same as cars. Heavy commercial vehicles (including buses) paid double the car toll on the Northern Gateway ($4.40) and around 2½ times more on the Tauranga toll roads. All the tolls are one way tolls that apply throughout the day.

Figure 2: Benchmarking NZ Tolls with Australia, UK, USA & Canada (2020 data)



Note: AKL Harbour Bridge not included in regression analysis (red line).

Tolls in Australia (8 in NSW, 6 in Queensland and 2 in Victoria) were twice as high as NZ in 2020. In the UK, tolls on the Dartford Tunnel and Humber Bridge and, up until 2018, the Severn Crossing ranged from $2.60 to $5.50. The only major road toll in the UK is the Midland Expressway which bypasses the M6 for 43 kilometres around Birmingham for which the 'end to end' car toll is $13. Mainland USA has 77 toll roads (excluding managed lanes, bridges, tunnels) with 25 in Florida and 24 in Texas. As examples, three suburban toll roads in Florida, California and Illinois plus an orbital toll in Texas are plotted on the graph. The US tolls are higher than NZ reflecting longer distances although the rate per km is similar. In Canada, the Toronto 407 has a toll of $9.40 for a 16 km trip. Combining the data gives a flag fall toll for cars of $3 plus 13 cents per kilometre in 2020. It should be stressed that Figure 2 does not take account of the benefit the toll road provides over the alternative routes which obviously affects the revenue and demand the toll road will achieve.

If this formula was applied to the nearly completed 27 km Transmission Gully highway out of Wellington, the toll would be $6.50 for cars, LCVs and motorcycles and $13 for HCVs. This toll compares with $2.50 if it was set to be comparable with the three NZ toll roads.

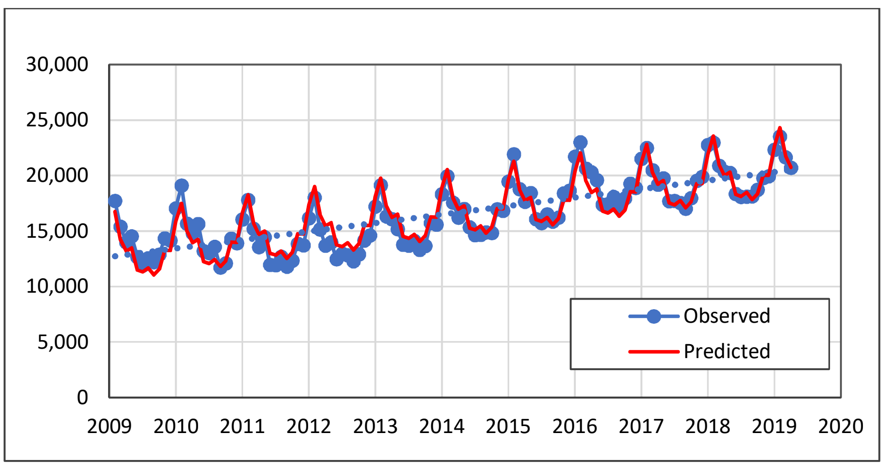
Unlike Australia, all NZ toll roads are Government operated. Tolls are increased with consumer price inflation (CPI). For the Northern Gateway, the car toll increased 40 cents in ten years from $2 to $2.40. By contrast, Transurban, an Australia-owned company has increased tolls considerably more than inflation. For example, the car toll for the M2 in Sydney rose 6.6% a year from $5 in 2013 to $7.83 in 2020. Indeed, O'Sullivan (2019) has argued that Transurban has raised tolls so much (by triple the rate of inflation) that a rethink was in order since some users were struggling to pay.

3. New Toll Road Demand & Revenue Ramp-Up

An area of interest to toll forecasters and financiers is the extent to which demand should be reduced for 'ramp-up' during the first months and/or years of toll road operation. There has been little published research however. A review by Davidson (2011) concluded ramp-up dampened demand by 30% with full demand achieved after two years. However no empirical evidence was provided to substantiate his conclusions.

The three NZ toll roads use electronic toll collection which has allowed the build-up in pre-pay registration and revenue growth to be assessed as well as vehicle numbers. The data showed the ramp-up of revenue to be more pronounced than ramp-up of vehicles which reflected revenue 'losses' in the early months of operation. For the Northern Gateway, time-series regression found no evidence of vehicle ramp-up as can be seen in Figure 3.

Figure 3: Growth in Northern Gateway Car & LCV Use per Month

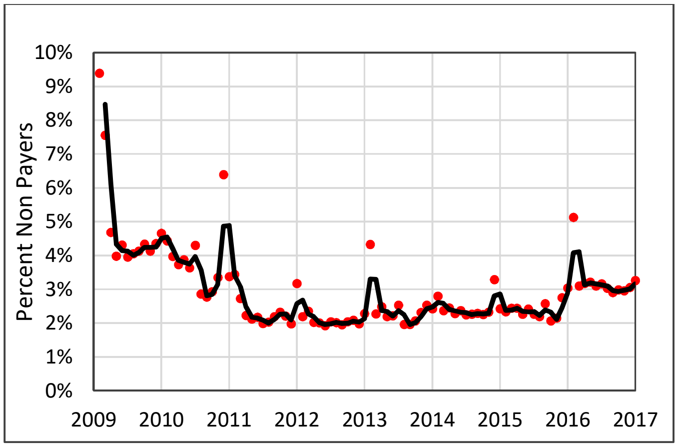


Traffic grew linearly (i.e. not compounded) at 9,000 vehicles a year (4.6% p.a.). Linear growth (the red line labelled 'predicted') rather than compound is noteworthy and supports the recommended forecasting approach of traffic engineers of Tranzit NZ in the 1990s.

For Tauranga, car, LCV and HCV traffic was 8.5% lower than the predicted estimate for the first 3 months for Takitimu Drive and 6% down for the Eastern Link. There was no evidence of ramp-up for the number of motorcycles however.

There was greater revenue ramp-up due to non-payment as the electronic system bedded in. For the Northern Gateway, non-payment started around 8% then dropped to 4% within 4 months and to 2% after 2 years as shown in Figure 4. The profile was similar for HCVs. Motorcycles weren't tolled for the first 18 months and when a toll was introduced, 22% of motorcyclists didn't pay initially with the percentage declining to 10% after six months.

Figure 4: Percent Non Payers – Northern Gateway – Cars & LCVs



Revenue ramp-up was less for the two Tauranga toll roads. In fact, there was zero revenue ramp-up for cars and LCVs. For HCVs, non-payment was 2% greater during the first four months of operation than in subsequent months. Non-payment for motorcycles was noticeably higher with 50% of Takitimu Drive motorcyclists not paying at the outset. The share then declined to 33% after 4 years.

For the Eastern Link, non-payment by motorcyclists has remained relatively constant at around 1 in 5. Clearly non-payment is an issue that reflects motorcyclist antipathy to paying tolls and also a difficulty for the tolling authority to read motorcycle number plates.

Tauranga motorists mounted a protest in 2015: "*In a car, you can take four or five people. But for 90 per cent of bikes its one person, or two. It's a lot less weight, so that's what a lot of people are kicking up a fuss about… they have gone and made cycle tracks for cyclists. There is a lot of council dollars tied into that and nobody on a push bike has to pay for the usage of those tracks, which have to constantly be maintained and upheld.*" Ryan Carmichael (2015)

Figure 5: Motorcyclists Protest over Tauranga Tolls in 2015

Photo by Cameron Avery

Motorcyclist protests about tolling have not been limited to NZ. In the UK, protests have been made over the Tyne Tunnel (2010) and Cleddau Bridge (2012). Protests over the

Humber Bridge toll between 2004 and 2010 helped lead to the toll being removed for motorcyclists from 2012 onwards.

4. Frequency, Type of Vehicle Use and Toll Revenue

The front and rear registration plates of vehicles using NZ toll roads are read using optical character recognition cameras. A registered owner lookup permits non-registered vehicles to be issued a Toll Pay Notice (which includes an administration fee of $4.90).

Processed and anonymized data from the registration database has been used to develop a profile of toll road use. This is somewhat unique for Australasia. Toll road data in Australia is held privately by toll road companies. Some cross-referencing with State registration databases occurs for infringement notices but only under conditions of confidentiality.

In terms of trip frequency, the NZTA database shows that for 2018, 70% of vehicles used the Northern Gateway less than six times during the year. The high percentage reflects the use of the Northern Gateway as a 'holiday' route. By contrast, the figure was 58% for the two Tauranga toll roads. The frequency percentages are shown in the left hand side of Figure 6.

When the number of trips made be each vehicle was taken into account, the trip share of infrequent users (< 6 times per year) dropped down to 18% for the Northern Gateway and 8% for the two Tauranga toll roads. These percentages are shown on the right hand graph. For Tauranga, nearly half the vehicles made over 100 trips each reflecting high regular use by commercial vehicles and cars (commuting, business, shopping etc). For the Northern Gateway, the distribution was more evenly spread with as many trips made in total by infrequent users (0-5) as by regular users (21-50 times per year).

Over the decade 2009 to 2019, 3.7 million different vehicles were recorded as using a toll road. This figure compares with 4.1 million vehicles registered in NZ in 2017.

Figure 6: Frequency of Use of NZ Toll Roads (Calendar year 2018)

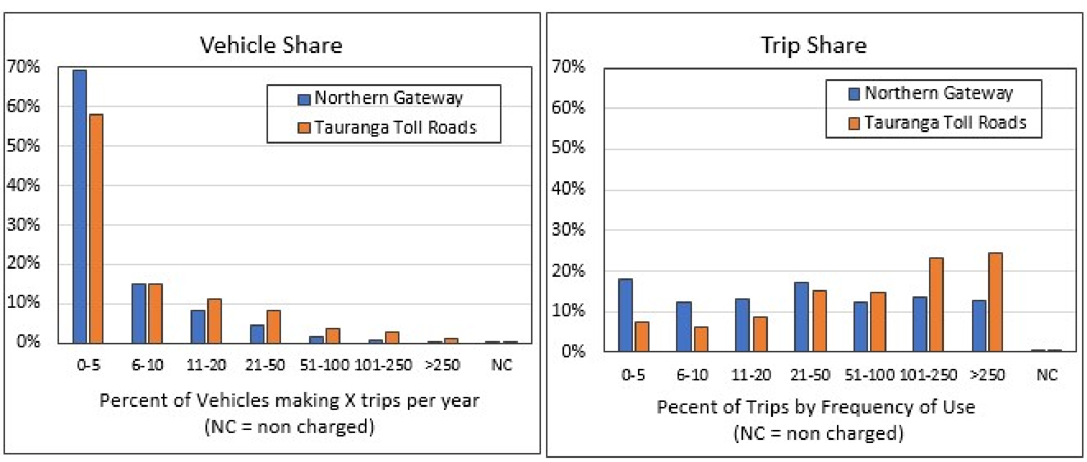
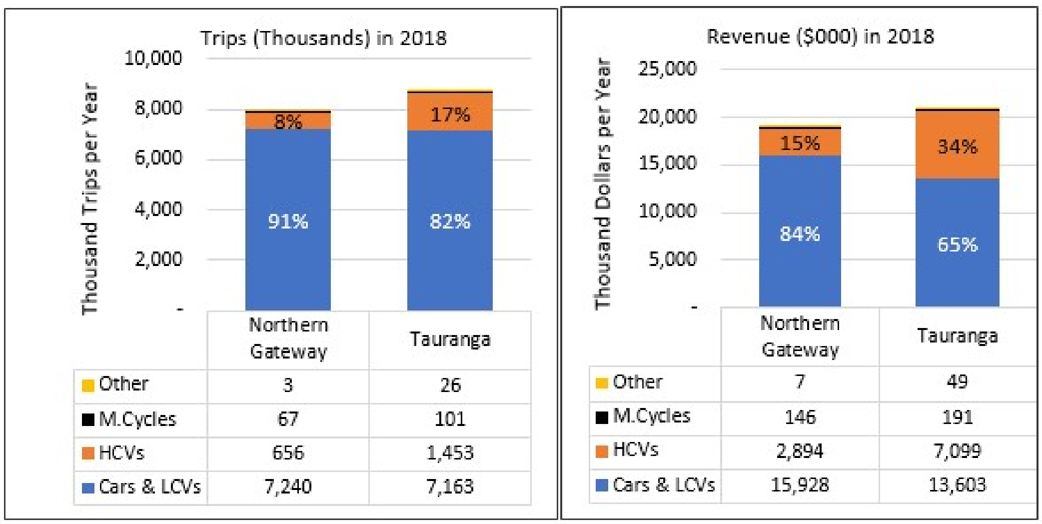


Figure 7 shows the composition of vehicles and revenue for 2018. A total of 16.7 million vehicle trips were made on the three toll roads with 8 million using the Northern Gateway and 8.7 million using the two Tauranga toll roads (Takitimu Drive and Tauranga Eastern Link had similar use). 91% of the Northern Gateway vehicles were cars and LCVs and 8%

HCVs whereas for Tauranga, the car/LCV share was lower at 82% and the HCV share higher at 17%. Motorcycles accounted for around 1%.

Toll revenue for 2018 was around $40 million with $19 million on the Northern Gateway and $21 million on the Tauranga toll roads (calculated assuming full compliance and excluding the administration fee). Given HCV tolls are twice the car toll, the revenue share for HCVs increases to 15% for the Northern Gateway and 34% for Tauranga. Motorcycle revenue (calculated assuming all motorcyclists pay) was around a third of a million dollars (<1% of total revenue). With 1in 5 not-paying the Tauranga toll, the revenue loss is around $40,000.

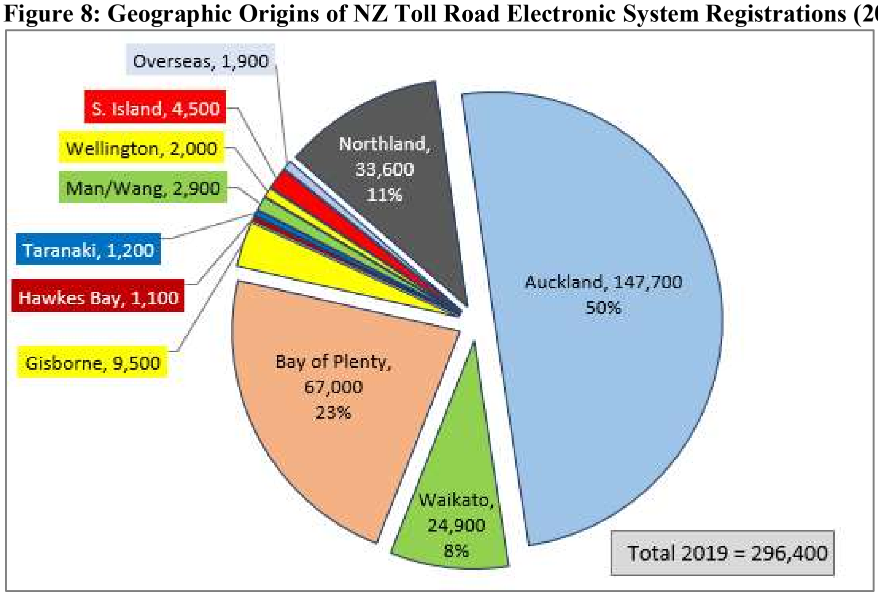
Figure 7: Toll Road Trips and Gross Revenue (including GST and assuming full compliance) 2018



5. Geographic Spread of Toll Road Users

Registering for a toll road card, requires an address to be entered. By analyzing the anonymized records, the origin of registered vehicles was determined, Figure 8.

Figure 8: Geographic Origins of NZ Toll Road Electronic System Registrations (2019)



In September 2019, there were 296,400 ‘live’ accounts. One half (148,000) were in the Auckland region, 23% in the Bay of Plenty (67,000) which includes Tauranga, 11% in Northland (33,600) and 8% in the Waikato (24,900). These regions where either where the toll road was located or close to them. The remaining registrations were spread across the rest of NZ with 5% in the rest of the North Island and 2% in the South Island or were overseas with 1% (mainly Europe 1,000 and Australia 550).

6. A Gravity Model of Toll Road Use

The profile of toll road users based on electronic registration data has rarely been published. In Australia for example, data is provided by customers of toll road companies and is held privately. Some cross-referencing with State registration databases occurs for infringement notices but only under strict confidentiality conditions.

The geographic spread of registrations (Figure 8) was reassessed before and after 2015. Before 2015, only the Northern Gateway was operating but after 2015 the two Tauranga toll roads were also operational. The two periods of cross-sectional data were used to estimate a gravity model of regional toll road use.

Before presenting the results, we take the opportunity to thank Newton (1687) for the original development of the gravity model. After recovering from the apple landing on his head Isaac developed a theory that has stood the test of time (minor perturbations attributable to Einstein accepted). The application of Newton’s down to earth theory has, amongst other things, helped Neil Armstrong walk on the moon. Back on earth, the gravity model has been used in tourism and travel demand forecasting. However to our knowledge, there has been no application of a gravity model to forecast the national demand for toll roads. So we consider this application quite innovative.

The number of registrations made by residents of each of the fourteen regions of New Zealand was divided by their respective populations. Impedance was road kilometres from the main centre of each region to the Northern Gateway or the Tauranga toll roads.

The distance and demand variables were transformed to improve the fit of the model. The square root of road distance and the natural logarithm of registrations/capita were computed. These transformations helped match the steep distance decay in registrations per capita observed in the data. Figure 9 overlays the predicted model over the observations.

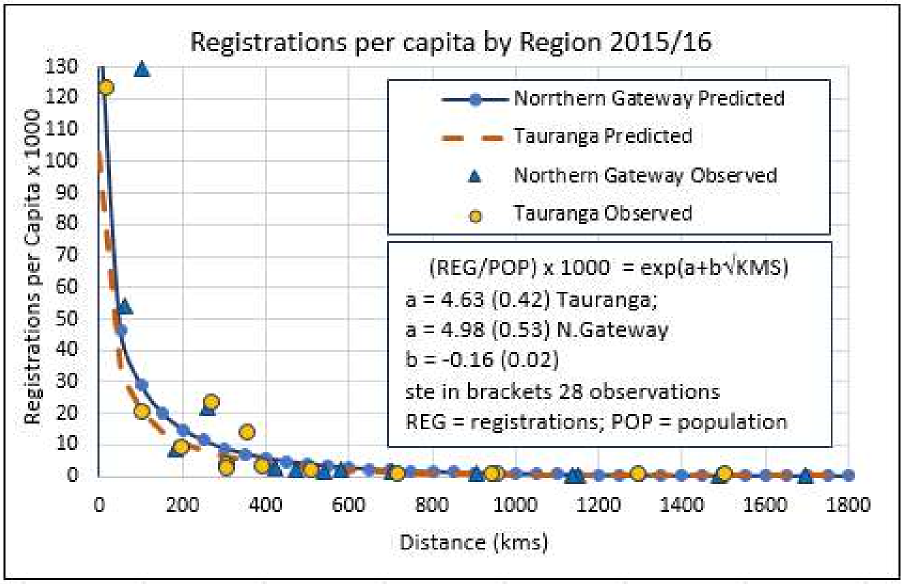
The Northern Gateway was distinguished from the two Tauranga toll roads which doubled the number of observations to 28. The same distance parameter of -0.16 was found appropriate for both groups and the small standard error of 0.02 indicated a high measure of statistical accuracy with a Student’s t test value of -9.8.

The Northern Gateway had a slightly larger constant (4.98) than the two Tauranga toll roads (4.63) which reflected higher registrations per capita, other things being equal.

7. Modelling Transmission Gully as a Toll Road

As a worked example, the gravity model was used to predict toll registrations and likely vehicle use and revenue for a new radial highway out of Wellington called Transmission Gully (TG). The forecast was then compared with a more conventional traffic assignment model that introduced toll as a time penalty.

Figure 9: Gravity Model of NZ Toll Roads



TG is a 27 kilometre highway that began construction in September 2014 and is likely to open in late 2021 or early 2022. Its cost has been variously reported as $1.25 billion to $3.5 billion, Milne (2021). It has also been a controversial road proposal for over a century since it was first suggested in 1919, (Evening Post, 1919).

The existing highway (SH1) runs through the coastal settlements of, Plimmerton, Pukerua Bay and Paekakariki. All three have been become traffic bottlenecks during commuter peaks and bank holidays. Figure 10 shows the TG route.

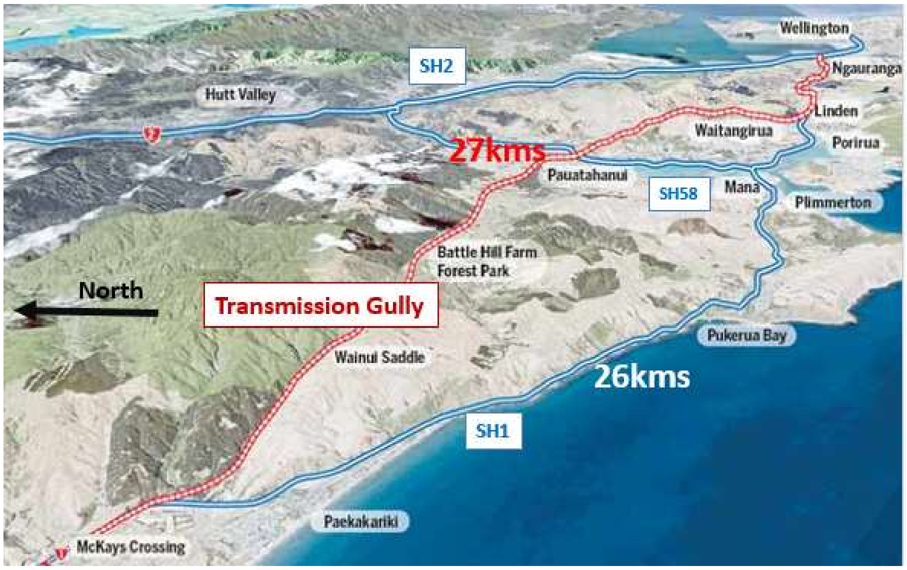
TG rises steeply over 4 kms along a geomorphological fault line from MacKays Crossing to the summit of Wainui Saddle at 262 metres. It then descends back down to Pautahanui at sea level where it intersects with SH58 (a short state highway that joins the Kapiti coast to the Hutt Valley, the other major population and transport corridor in the Wellington region). The road then rises again to 170 metres before joining SH1 at Linden. The total distance is 27 kilometres, one kilometer longer than the existing coastal route.

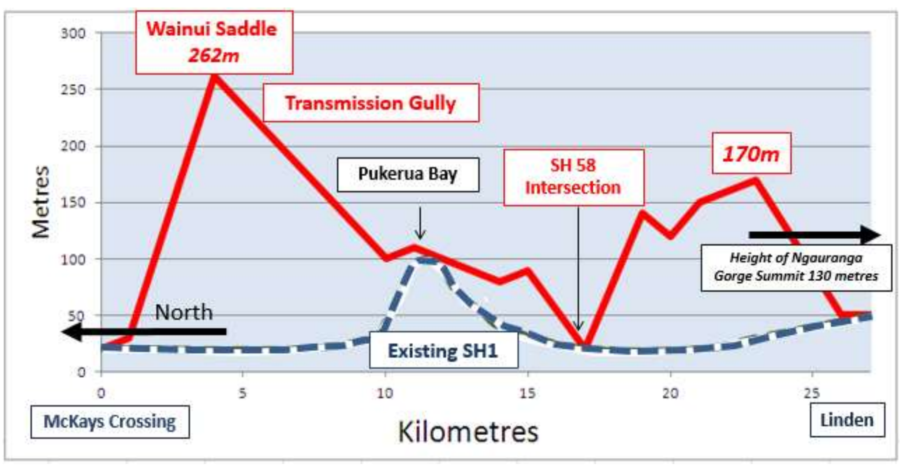
The longer route and the two steep sections are likely to dissuade some heavy vehicles from using TG particularly in the off-peak due to the extra fuel, braking and slower travel time. Therefore, the appropriate road to toll to encourage traffic to divert away from the coastal settlements would be the shorter, flatter, existing coastal road. However, despite strong economic logic, legislation currently prevents the tolling of existing roads and the only section of the Wellington Roads of National Significance (RoNS) considered to date for tolling has been TG.

Tolling TG has been considered for at least thirty years. A 1992 study by Steer Davies and Gleave surveyed private, business and heavy commercial vehicle (HCVs) users, Douglas (1992). Revenue maximizing tolls for cars and other Light Commercial Vehicles (LCVs) were estimated at $2.50 for the off peak, $3 in AM peak and $4.50 for the PM peak. HCV tolls were double those for car. Over the 30 years, consumer price inflation has increased by 77%, so had the road been built and tolls levied and CPI indexed, the off-peak LCV toll in

2021 would have been $4.40 and the HCV toll $8.80. The PM car toll would have been $8 and the HCV $16. These tolls are markedly higher than the Northern Gateway and the Tauranga toll roads but would not be dissimilar to Australian and overseas tolls plotted in Figure 2 where a LCV toll of $6.50 is predicted for the 27 kilometre TG route. Brought forward to 2021, toll revenue would probably be around $30 million.

Figure 10: Transmission Gully



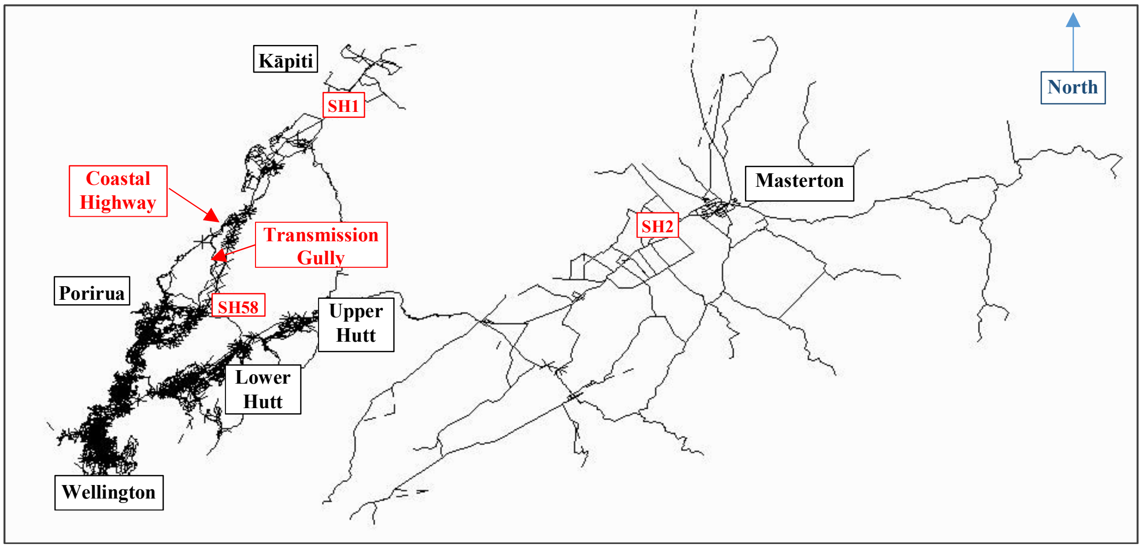


Applying the gravity model to TG produced a forecast increase in national toll registrations of 62,500. This represents an increase of just over 20% on 2019 registrations. Two thirds of the new registrations were forecast to be in the Wellington region with one third spread across the rest of NZ. An additional 400 overseas registrations were forecast.

To forecast revenue, tolls were set according to the three existing NZ toll roads but taking account the longer distance of TG. Tolls of $2.50 for cars, LCVs and motorcycles and $5 for HCVs were assumed. The existing 'national' ratio of toll road use to registrations and tolls was also assumed to continue. Given these two assumptions, TG annual vehicle traffic was forecast at 3.3 million trips and revenue at $9 million for 2021.

A conventional road traffic assignment model was developed to test the gravity model forecast. The North Wellington model which uses the software package SATURN, hence the acronym NWSM. It covers the two northern Wellington radial corridors as can be seen from Figure 11. Within these corridors, NWSM uses detailed modelling of intersections together with link speed flow relationships to assign demand and to describe operational network conditions.

Figure 11: NWSM SATURN Road Network



NWSM was used to forecast the likely traffic diversion of TG as a free road or as a tolled road. Also assessed was toll revenue. The forecasts were undertaken for 2021 assuming full demand take up (zero demand and revenue ramp-up).

Tolling was modelled by adding cost penalties to the TG road links. The penalties were calculated from values of time (VOT) taken from the New Zealand Monetised Benefit and Cost Manual, NZTA (2021). These values derive from a twenty year old 'Willingness to Pay' survey, Beca (2001).

A VOT of \$17.60 per hour was adopted for cars and Light Commercial Vehicles LCV) including motorcycles and \$60.22 per hour for Heavy Commercial Vehicles (HCV) were based on a split of private versus company business travel and the likely proportion of time spent in congested conditions.

The impact of the cost penalties meant that a \$3 toll levied on LCVs converted to a travel time 'penalty' of just over 10 minutes (60 x [3/17.60]) whereas a \$6 toll for a HCV converted to just over 5 minutes of travel time.

The penalties were added to the link times forecast by NWSM. The tolls were applied in two sections to the northern and southern sections of TG either side of SH58 (which links Porirua with Hutt City).

As illustrated in Figure 10, TG has some steep sections compared to the coastal route as well as being 1km longer. HCVs therefore are likely to opt for the coastal route other things being equal. To reflect the length and severity of grade, specific LCV and HCV speed-flow curves were included in NWSM. On the uphill TG section south of Mackays Crossing, LCVs were coded as operating between 40 and 102 kilometers per hour depending on link flow. For HCVs, the operating speed range was between 30 and 50 kilometres per hour.

The effect of tolling TG was modelled for two scenarios governing the speed and performance of the existing coastal road (SH1). Under scenario 1, SH1 remained unaltered with road speeds and capacity kept at 2019. Under scenario 2, SH1 was assumed to revert to 'local road' status with lower speeds and capacities. A time cost of 3 minutes to the section north of SH58 was added and a 3 minute cost was applied on the southern section.

The eight scenarios listed below were modelled for the AM Peak:

1. No TG.
2. TG No Toll.
3. TG $2 LCV, $4 HCV tolls no coast road treatment.
4. TG $2 LCV, $4 HCV tolls with coast road treatment.
5. TG $3 LCV, $6 HCV tolls no coast road treatment.
6. TG $3 LCV, $6 HCV tolls with coast road treatment.
7. TG $4 LCV, $8 HCV tolls no coast road treatment.
8. TG $4 LCV, $8 HCV tolls with coast road treatment.

The traffic and revenue forecasts are tabulated in the Appendix. A clear toll level for the AM Peak was established which lessened the need to undertake runs for the inter-peak and PM peak. For these time periods, three toll options were undertaken:

9. Do Minimum (no TG).
10. TG no tolls.
11. TG $3 LCV, $6 HCV tolls with coast road treatment.

With the coast road slowed, a $3 LCV toll ($6 HCV) for the full length of TG diverted 6% to 9% of traffic from the northern section of TG in the AM peak, inter-peak and PM peak. The sensitivity to toll was high however as moving to a $4 LCV ($8 HCV) toll increased diversion to over 50% in the AM peak period.

Diversion was noticeably higher on the southern section than the northern section of TG. On the southern section, diversion reached 40%. This suggested the toll ($1.50 for cars) probably needed to be lower (although the coast road remained well within capacity). Alternatively, stronger traffic management measures would be needed on the coastal road. It is however possible that rapid housing development along the SH1 coast road would increase the attractiveness of TG and so reduce the diversion from tolling.

In terms of revenue, a $3 LCV toll ($6 HCV) was forecast to generate $12m in the first year (assuming zero toll leakage from non-payment). By way of comparison, the toll revenue would be half the concession payment to the construction company ($25 million per year). It would also make TG comparable to Takitumu Drive or the Tauranga Eastern Link and two-thirds the revenue of the Northern Gateway toll road.

In terms of the level of toll, a $3 car toll would be similar to the three existing toll roads in NZ. However, it would be lower than a $6.50 toll produced by the international benchmarking regression analysis as shown in Figure 1.

The revenue of $12 million is a quarter higher than the $9 million forecast by the toll registration gravity model.

The estimated diversion rates are similar to actual diversion rates for the Auckland Northern Gateway Toll Road where post-opening monitoring estimated diversion at 20% but lower than the forecasts which put likely diversion at 30%, NZTA (2010).

8. Conclusions

NZ has three toll roads with tolls ranging from $1.90 to $2.40 for cars. These tolls are low; they are less than half the $6 toll that would likely be in place on the Auckland Harbour Bridge had it not being removed in 1984. They are also half those set in Australia. The low level of toll compromises new toll road opportunities.

A component of traffic forecasting is 'ramp-up'. There has been little published evidence on the subject however. This paper has utilized NZTA data to assess vehicle and revenue ramp-up in the early months and years of the operation of the three toll roads. There was little evidence of vehicle ramp-up but there was some evidence of early month revenue ramp due to non-payment. Both findings are considered insightful for new toll road forecasting.

The NZTA data highlighted an aversion amongst New Zealand motorcyclists to paying the toll with 1 in 5 of Tauranga Eastern Link motorcyclists not paying. The toll aversion is not limited to New Zealand. The UK has seen motorcyclist protests which contributed to the removal of tolls on the Humber Bridge. For NZ, with motorcyclists contributing 1% of total potential revenue, non-payment represents a shortfall of 0.2%.

The profile of toll road users has rarely been published probably due to the data being in private company hands. NZTA's registration and usage database has enabled the frequency of use and the geographic distribution of toll road users to be established. An innovative gravity model using regional population and distance was fitted and used to predict the increase in registrations, vehicle demand and revenue for Transmission Gully, a new under construction road out of Wellington if it was tolled.

The gravity model was compared with conventional demand modelling in which toll was represented by time penalties based on assumed values of time. The two approaches were tested for Transmission Gully. Revenue was forecast to be three-quarters that of the conventional model for similar tolls of $3 for LCVs and $6 for HCVs.

Forecast revenue was low when compared with the forecasts undertaken thirty years ago. After taking account of inflation, the tolls are only half as high and forecast revenue was only a third that forecast in 1992. Compared to the Auckland Harbour Bridge, a revenue of $12 million amounts to just 3% of the $300 million revenue that could have been collected had the bridge toll been still in place in 2021. Low values of time given in the NZTA CBA manual, engineering improvements to the coastal road and New Zealand's low toll environment all contributed to the low revenue forecast for Transmission Gully.

To end on a positive note, the electronic toll system introduced in 2009 has been in operation for over a decade and has garnered registrations nationwide. Improved over the decade, the electronic system is readily extendable to other roads to help fund transport infrastructure and manage traffic demand on New Zealand's increasingly busy roads.

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Appendix: Forecasts of Transmission Gully as a Toll Road using NWSM

SCENARIO	SH1 COAST ROAD (NORTH)			TG (NORTH)			Diversion	SH1 COAST ROAD (SOUTH)			TG (SOUTH)			Diversion
2021 AM peak	**LV (PCU)**	**HV (PCU)**	**Volume (PCU)**	**LV (PCU)**	**HV (PCU)**	**Volume (PCU)**	**TG to SH1 (North) %**	**LV (PCU)**	**HV (PCU)**	**Volume (PCU)**	**LV (PCU)**	**HV (PCU)**	**Volume (PCU)**	**TG to SH1 (South) %**
Do Minimum (no TG).	1,371	315	1,690	n/a	n/a	n/a	n/a	4,137	567	4,734	n/a	n/a	n/a	n/a
TG no tolls.	313	84	401	1,677	402	2,081	0%	1,662	199	1,866	2,239	463	2,715	0%
TG $2 LV, $4 HV tolls **no** coast road treatment.	994	311	1,407	987	176	1,152	-45%	5,326	592	5,954	790	69	859	-85%
TG $2 LV, $4 HV tolls **with** coast road treatment.	387	79	468	1,593	408	2,001	-4%	2,499	283	2,812	1,521	312	1,833	-33%
TG $3 LV, $6 HV tolls **no** coast road treatment.	1,191	314	1,508	785	172	957	-54%	3,731	558	1,320	751	62	813	-87%
TG $3 LV, $6 HV tolls **with** coast road treatment.	428	86	515	1,549	401	1,949	-6%	2,629	295	2,953	1,149	298	1,337	-36%
TG $4 LV, $8 HV tolls **no** coast road treatment.	1,257	320	1,581	712	164	877	-58%	3,972	560	4,561	40	56	96	-88%
TG $4 LV, $8 HV tolls **with** coast road treatment.	1,137	87	1,228	832	397	1,009	-52%	3,358	299	3,687	145	291	436	-37%
2021 Inter-peak	**LV (PCU)**	**HV (PCU)**	**Volume (PCU)**	**LV (PCU)**	**HV (PCU)**	**Volume (PCU)**	**Diversion %**	**LV (PCU)**	**HV (PCU)**	**Volume (PCU)**	**LV (PCU)**	**HV (PCU)**	**Volume (PCU)**	**Diversion %**
Do Minimum (no TG).	891	271	1,162	n/a	n/a	n/a	n/a	2,661	528	3,227	n/a	n/a	n/a	n/a
TG no tolls.	229	78	307	943	305	1,247	0%	1,873	318	2,210	1,024	209	1,233	0%
TG $3 LV, $6 HV tolls **with** coast road treatment. .	306	79	484	864	303	1,167	-6%	1,713	286	2,017	539	194	733	-41%
2021 PM peak	**LV (PCU)**	**HV (PCU)**	**Volume (PCU)**	**LV (PCU)**	**HV (PCU)**	**Volume (PCU)**	**Diversion %**	**LV (PCU)**	**HV (PCU)**	**Volume (PCU)**	**LV (PCU)**	**HV (PCU)**	**0**	**Diversion %**
Do Minimum (no TG).	1,957	359	2,324	n/a	n/a	n/a	n/a	4,026	419	4,453	n/a	n/a	n/a	n/a
TG no tolls.	389	69	491	1,949	418	2,358	0%	3,299	286	3,677	2,461	288	2,748	0%
TG $3 LV, $6 HV tolls **with** coast road treatment.	607	70	680	1,741	415	2,155	-9%	3,285	257	3,574	1,304	276	1,580	-43%