

Data 201 Group D report

Cars and Us

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Introduction

Petrol prices have received a lot of news coverage in recent weeks. This is largely due to prices being at “record” levels (this is true in nominal dollars) along with an increase of 4 cents per litre to the fuel excise tax and an Auckland specific fuel tax of 11.5 cents per litre. We wanted to see how prices now compare in real terms to historical fuel prices and look at the major components of fuel prices changes.

This made us think about cars in general - they are the cornerstone of our transport system, and most transport planning is done with private cars in mind, but we didn't know much about how fleet size, fuel use and carbon emissions were changing in New Zealand over time. With the recent release of an IPCC report that urged 50% carbon reductions over the next 12 years, the contribution of our vehicle fleet to emissions was a topic we thought worth exploring.

Along with the price of fuel on individual consumers and the emissions from cars, vehicle accidents are a salient feature of our car-based transport system. Again, we wanted to see how these rates track compared to historical levels when adjusted for population size.

We didn't start this investigation with a specific question in mind. Rather we were just generally interested in aspects of car use in New Zealand and general exploration around these topics led to several large datasets which we could join to investigate changes over time.

Method

As we wanted to see how vehicle statistics change over time, we needed to join together various raw datasets by date.

Some of the datasets had a large number of pages so the *readxl* package was used to select only the raw information we wanted from these spreadsheets.

Population data, vehicle fleet numbers, and carbon emissions were recorded on a yearly basis in the government datasets so we joined these datasets using year as the primary key.

Inflation metrics are recorded on a quarterly basis by StatsNZ, while fuel prices are reported weekly by MBIE. To join these datasets we used *lubridate*, an R package, to determine the quarter for each week in the fuel price dataset. We grouped the fuel price data by quarter and took an average of the weekly prices over each quarter. This dataset was then joined to the inflation figures using quarter as the primary key. Barrel prices for oil are reported in US dollars (USD). To convert this to NZ dollars (NZD) we used datasets from the Reserve Bank which record historical exchange rates of NZD. This was joined to the fuel inflation dataset and the crude prices converted into cents per litre in NZD to match the units of tax and pump price.

The data about the vehicle fleet is only from 2000 to 2017 but population data is from 1920 to 2017. Joining this data in the same table set the data frame from 2000 to 2017. Similarly for fuel prices, statistics go back to 2004 while CPI data dates from 2006 so this dataset starts at Q2 2006.

Although recent media attention to fuel price increases prompted our investigation into car ownership in NZ, our price data does not capture this increase. Fuel prices are reported on a weekly basis while CPI is quarterly and since the tax increase was on October 1st (beginning of Quarter 4 which we do not yet have CPI data for) it is not included in the joined dataset. This is not particularly troublesome, however, as the national excise increase was only 4 cents per litre (less than 1 percent of the pump price), and we are especially interested in long term trends, so the recent small change is not significant to our dataset. Note that although there has also been a 12 cents per litre Auckland specific fuel tax fuel, fuel is still cheaper in Auckland than in the South Island or the regions.

In terms of workflow, Github was used to maintain our code, so anyone could see the latest set of files for the project at a given time. As each of us worked on the code, explored new raw datasets, and produced our own datasets, we uploaded our work to the shared Github repository.

Results and Discussion

In general, we found that the car fleet is growing in New Zealand. This alone may not be interesting since the population is growing, so we adjusted the fleet statistics by population using demographic data from StatsNZ. Figure 1 shows the trends in vehicle ownership - we own more cars now on a per capita basis than we have at any time before.

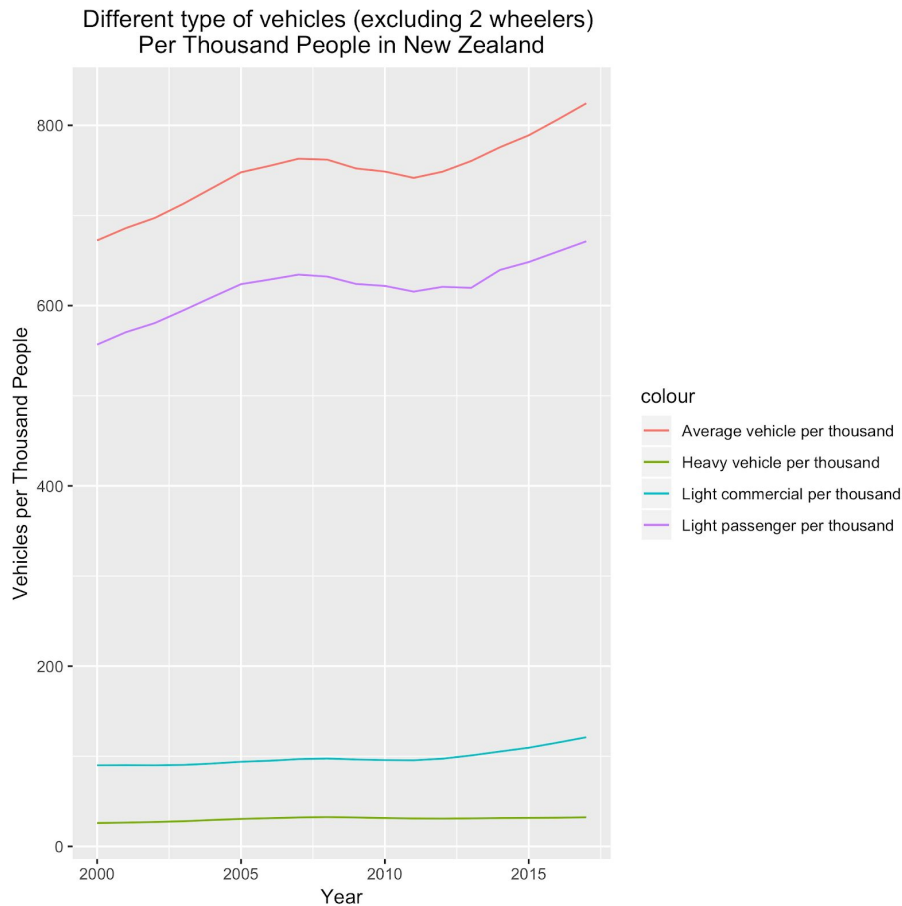


Figure 1

From 2000, light passenger vehicles (cars) grew at a steady rate. The Great Recession saw a small decrease in the national fleet which reversed around 2011. Interestingly light commercial vehicle (pick-up trucks and vans) hardly increased on a per capita basis until taking off around 2012. Heavy vehicle numbers are stable when adjusted for population.

It is interesting to find some possible reasons for why light passenger vehicles were becoming more and more popular in recent years. The first idea is that fuel consumption and price may have influence on the trend of ownership of vehicles.

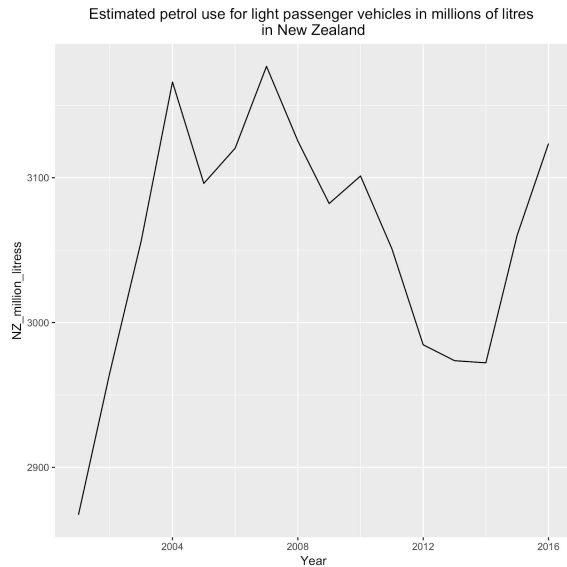


Figure 2

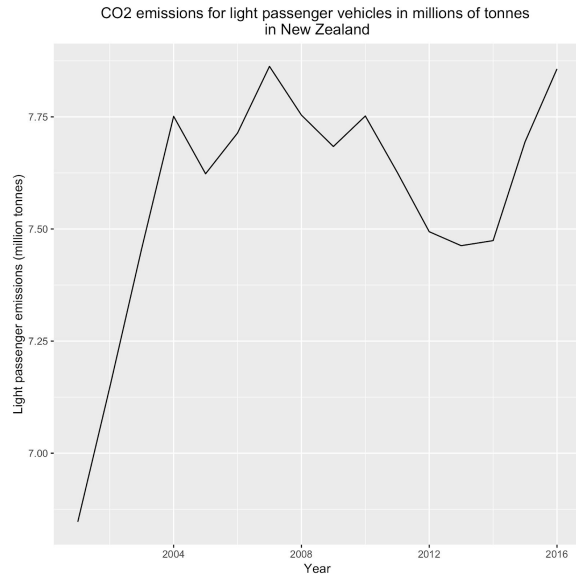


Figure 3

Given the increasing size of the car fleet in New Zealand, the petrol usage in Figure 2 tells an interesting story. Note that the y-axis has units of million litres. Petrol consumption dropped during the recession by about 7%, but has recovered somewhat, although as of 2016 it was not past its peak in 2007. This contrasts with the expansion of the vehicle fleet over this time - although we have more cars on a per capita basis, we are not burning more fuel, even in absolute terms. In other words, it seems that light vehicles are becoming more efficient by using less petrol.

In terms of our countries contributions to climate change, CO2 emissions from fuel burned are important to measure. As Figure 3 shows, these figures track the amount of fuel burned. Emissions from cars in New Zealand are not decreasing in absolute terms. To be noticed, this pattern is similar with Figure 2. It means that the amount of gas emitted is directly related to the amount of fuel used.

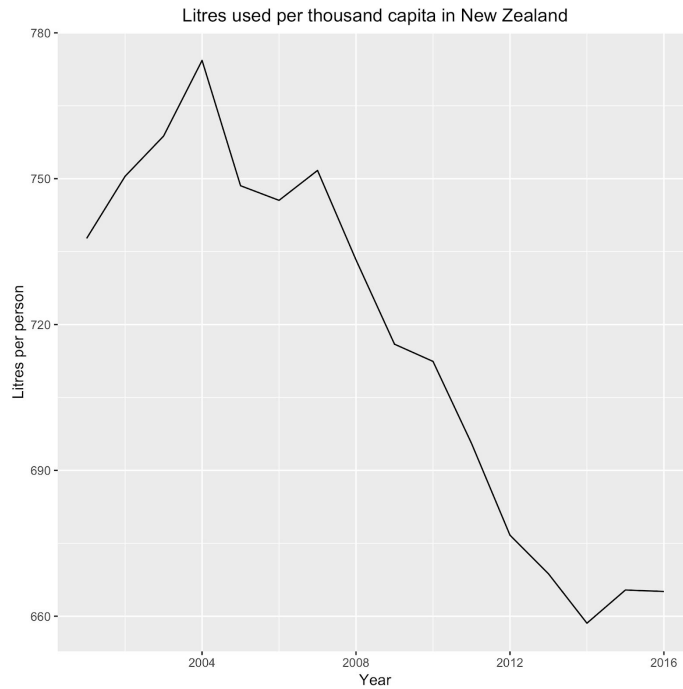


Figure 4

When we adjust petrol consumption to a per capita basis, (Figure 4) we can see that consumption is actually dropping - despite owning more cars we are burning less petrol.

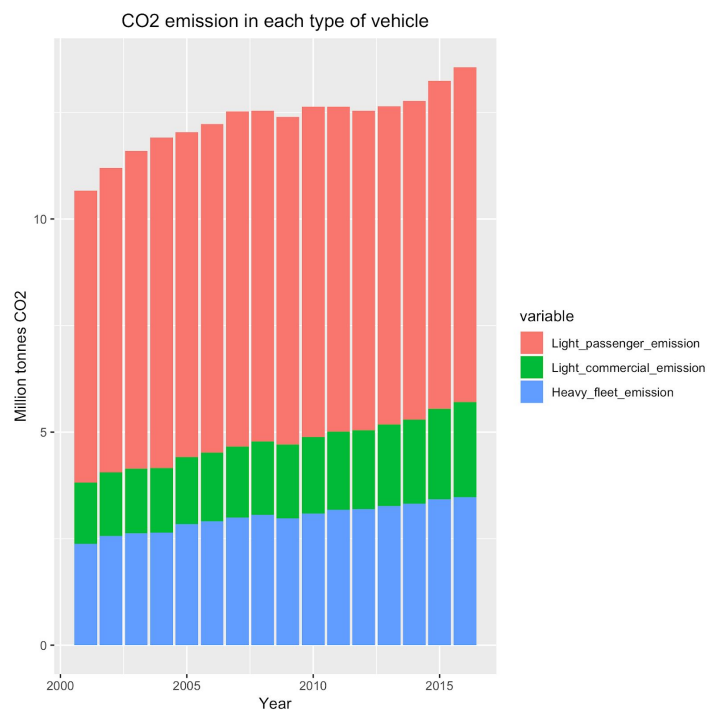


Figure 5

The emission of CO2 in each type of vehicle was increasing by year as shown in Figure 5. This means fuel consumption of each type of vehicle was increasing by year.

However, personal vehicles took the more than 60% of total CO2 emissions which means personal vehicle used more fuel than other types of vehicles.

CO2 emissions were steeply increasing from 2000 to 2008 and turned to a steady increase from 2008 to 2012. Then it was quickly increasing again after 2013.

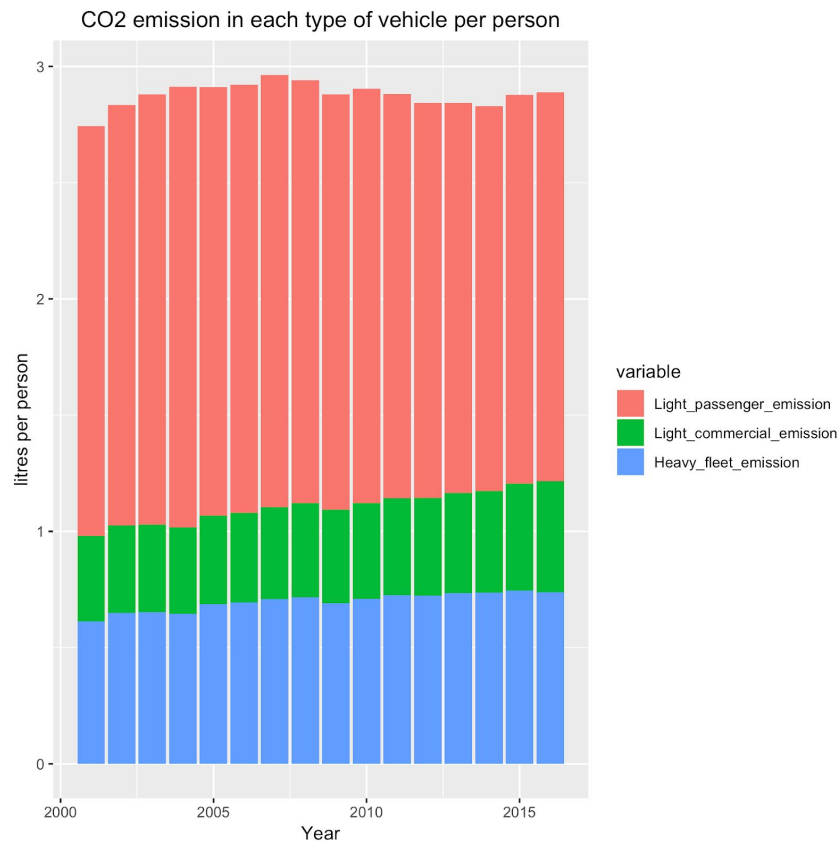


Figure 6

Overall, there was not much change in CO2 emission for each person during these 15 years.

However, when looking at the CO2 emissions by different type of vehicle, it showed both heavy vehicle and light commercial vehicle were increasing the emission of CO2, whereas light passenger vehicle was fluctuating between 1.656 and 1.896 liters. But, light passenger still took more than 50% of total CO2 emissions in vehicles.

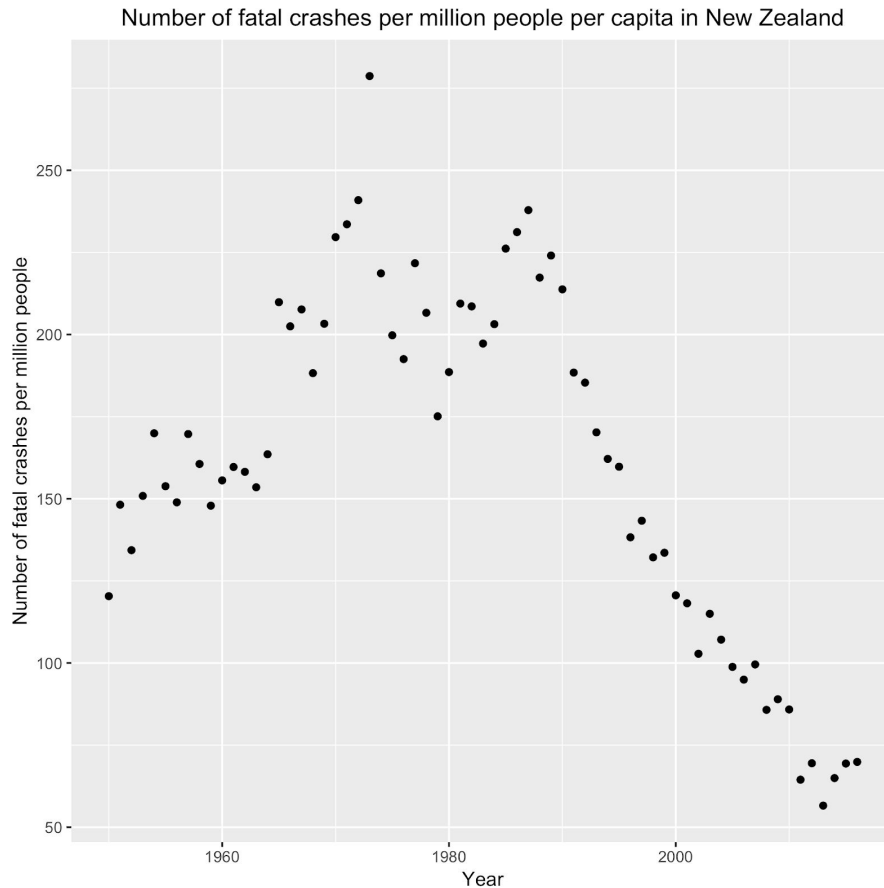


Figure 7

Figure 7 shows fatal accident rates over time, adjusted for population

The plot shows number of fatal crashes per million people was increasing from 1950 to 1972 and reached a peak at 1972 with around 230 fatal crashes per million people whereas it was decreasing a little bit from 1973 to 1980. But it was rising again from 1981 to 1987 and reached a similar rate on 1987 with that of 1972.

However, the number of fatal crashes per million people was dramatically declining since 1987 and reached at historical bottom on 2012 with around 55 fatal crashes per million people. The large drop is probably due to increases in car safety from better manufacturing. Other factors, like government campaigns to reduce speeding and drink driving may also play a role in the measured improvement in road safety.

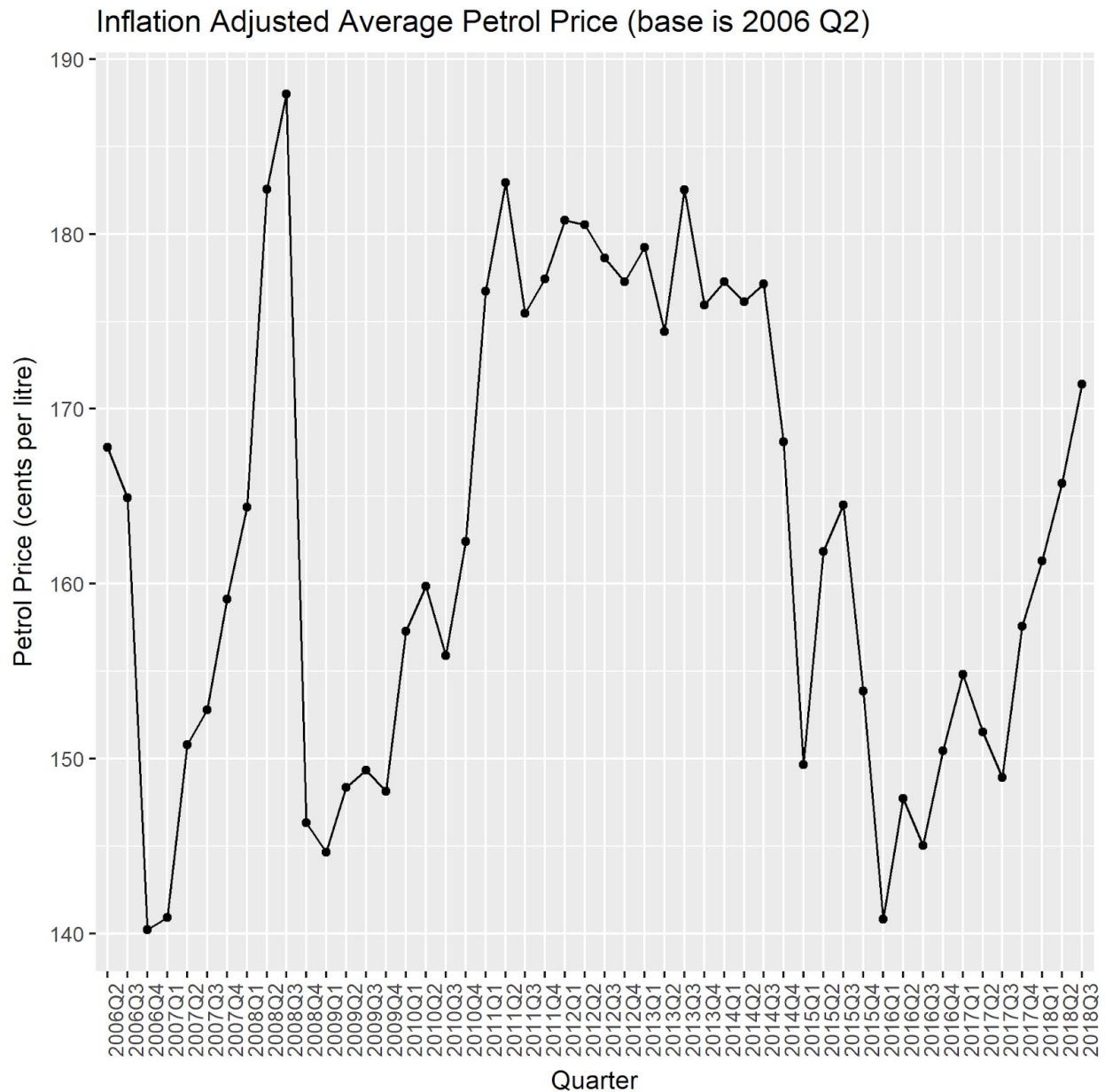


Figure 8

Recent media reports that the price of fuel is historically high, however, when adjusted for inflation, (and averaged nationally and over each quarter), prices are not close to the historic highs reached before the recession. As shown in Figure 8, prices were also higher (although stable) from 2011 to 2014. The increase in fuel prices has been steep recently however, from 2016 to present prices have gone up about 25% in real terms.

We were interested in uncovering why petrol prices have shot up so much recently. Is the media coverage fair? Pump prices include a substantial amount of excise tax, about 40% of the retail cost.

New Zealand imports all of the oil that ends up in our vehicles. Although some fossil fuels are produced in Taranaki these are exported. Hence international crude oil costs are a component of prices. These are reported in USD by MBIE so, using exchange rate from MBIE, we converted the figures to cents per litre in order to compare this cost to fuel taxes and total retail price (in real terms).

Figure 9 shows this comparison.

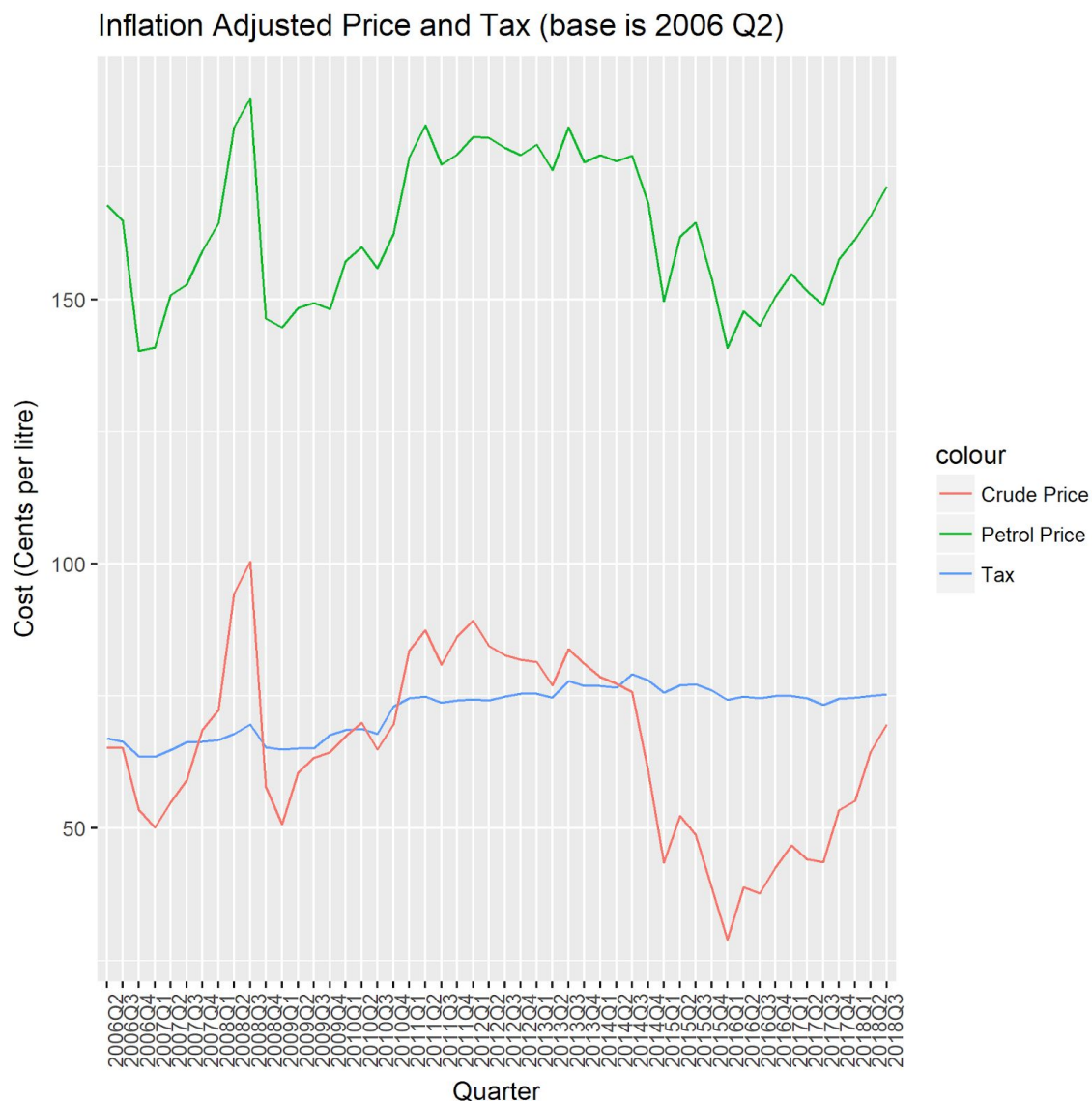


Figure 9

We found this result extremely surprising. The media hysteria over a small increase in fuel excise tax is totally unjustified. Excise tax has been basically flat, in real terms, since 2004. The volatility in pump price **almost exactly matches** the changes in crude price, once the exchange rate is taken into account. So blaming the government for increasing fuel prices due to changes to tax is ignorant - steep price increases are due to international oil prices and the exchange rate, not domestic taxes. The exchange rate from USD to NZD is extremely volatile (New Zealand has one of the most traded currencies in the world). Over the timespan of our dataset, the USD/NZD exchange rate has fluctuated between about 0.6-0.8. Government policy affecting the exchange rate is probably more significant to petrol price changes than taxes - but that probably doesn't make for as good a headline.

Conclusion

Cars are a central part of our lives; our transport system is largely based around private vehicles. The way cars are treated in the media both frames and reflects how we view our relationship with this technology. Our investigation has shown that the mainstream public commentary around cars is simplistic, misleading and misguided.

The vehicle fleet is expanding in New Zealand - far ahead of population growth. Fuel consumption is declining on a per capita basis - this would be a rich vein for future investigation. Why are we each burning less fuel? Is it due to increased uptake of public transport or cycling? Are people simply driving less? If so, why are we buying more and more cars?

Vehicle safety is in the news regularly, especially over holiday weekends. We don't want to be glib about tragedy but the media coverage of accident statistics does not reflect the fact that accident rates have been flat on a per capita basis over the last few years following decades of decline.

Emissions from passenger vehicles are not declining in absolute terms which is concerning in light of last week's release, by the IPCC, of a report urging severe cuts to carbon emissions to keep global warming to moderate levels. Despite the existential crisis facing us, the Labour government announced fuel prices are too high and are empowering the Commerce Commission to investigate with a view to increasing reducing prices for consumers. All of this despite fuel prices not even being at historical peaks in real terms! Meanwhile the media coverage treats taxes as the cause of sharp price changes, ignoring international oil and currency markets.

Transport in New Zealand is an enormous area, with scope to carry on this project in many different directions. Investigation into data around public transport with a view to encouraging people out of private vehicles would be one useful example. The datasets we have produced in this project have combined several government data sources to bring some evidence to a topic often clouded by anecdote and emotion.

References

Links for each dataset used.

Vehicle fleet data (Ministry of Transport):

<https://www.transport.govt.nz/assets/Uploads/Research/Documents/Fleet-reports/NZ-Vehicle-Fleet-Graphs-2017-WEB.xlsx>

Population data:

http://archive.stats.govt.nz/browse_for_stats/population/estimates_and_projections/historical-population-tables.aspx

Crash statistics data (Ministry of Transport):

<https://www.transport.govt.nz/assets/Uploads/Research/Documents/Motor-Vehicle-Crashes-2016/section1-historical-web.xlsx>

Fuel price data:

<https://www.mbie.govt.nz/info-services/sectors-industries/energy/liquid-fuel-market/weekly-fuel-price-monitoring/>

CPI data:

http://archive.stats.govt.nz/datavisualisation/cpi.html?_ga=2.108028610.1183992515.1539904462-1644041295.1539118866&_gac=1.186320731.1539911134.CjwKCAjw3qDeBRBkEiwAsqeO7n2o7s_Dpa7j7WDmEiaxuAseaduyfqth0fog98beoe6nkjPXGXAoShoCbdwQAvD_BwE

Exchange Rate Data (Reserve Bank of NZ)

<https://www.rbnz.govt.nz/statistics/b1>