

The response of travel behaviours and transportation patterns to fuel-price increases and legislative constraints

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1 Introduction

Around October 1973 there was a worldwide "oil shock" as members of the *Organisation of Petroleum Exporting Countries* manipulated the oil supply/price-setting mechanisms so as to quadruple world oil prices. From early in 1979 disruptions to some exporting of oil caused by the Iranian Revolution raised concern as to the general security of oil supply and the situation of a second "oil shock" was created. In response to these "oil shocks" the New Zealand Government imposed significant legislative conditions to restrain the local use of transportation fuel.

New Zealand's private transportation patterns, during the period from 1970 through to the end of 1980, operated within the standard context of ongoing transportation influences but were also subject to Government's response to the "oil shocks". This Paper specifically examines the 1970s for evidence of the extent that established travel behaviours were affected by the dramatic immediate changes surrounding the "oil shocks". This evidence would be of high current relevance given the need to reduce emissions of greenhouse gases.

1.1 Study notes

A lot of "knowledge" about the effects of the 1970s "oil shocks" is anecdotal and frequently gives biased and undue emphasis to particular impositions such as "carless days", at the expense of recollecting the situation in its full context. There appear to have been few studies of the effectiveness of the fuel-conservation measures implemented and any assessment of effects would probably have been difficult without the benefit of an extended perspective in which to place the period, such as is available now.

This investigation puts aside anecdotal recollections of responses to the "oil shocks" during the 1970s and focuses on using historical quantitative information on motor vehicle ownership, petroleum fuel usage, and patronage of public transport to objectively describe transportation patterns. The majority of the data and information was sourced from *Statistics New Zealand* publications, Government reports, and Parliamentary debates from the period, supported by opinion articles from the *New Zealand Listener* and *New Zealand Motor World*. Throughout this Paper, interpretative conclusions have been made however, due to the complex interactions between the many factors that affect transportation patterns and travel behaviours, other valid interpretations are possible.

In New Zealand during the 1970s, the vast majority of privately owned motor vehicles were cars or motorised two-wheelers, such as motor cycles and power cycles, and, correspondingly, the vast majority of cars and motorised two-wheelers were privately owned. Thus, in this Study, the number of cars and motorised two wheelers is taken to approximate the size of the private motor vehicle fleet.

Additionally, New Zealand motor vehicles are required to be licensed annually so the number of licensed motor vehicles approximately represents the size of the motor vehicle fleet. A motor vehicle is generally only registered within New Zealand once in its lifetime, when it is initially added to the motor vehicle fleet therefore the number of registrations is taken as a proxy measure of vehicle purchases.

2 Fuel demand and supply during the 1970s

2.1 Fuel pricing

Preceding the 1970s decade and continuing on through to the mid-1980s, the New Zealand market was highly regulated by the government. This included Government setting the cost of fuel. The pricing of premium petroleum over the 1970s decade is plotted in Figure 1. (The profile for pricing of other fuel types is similar.)

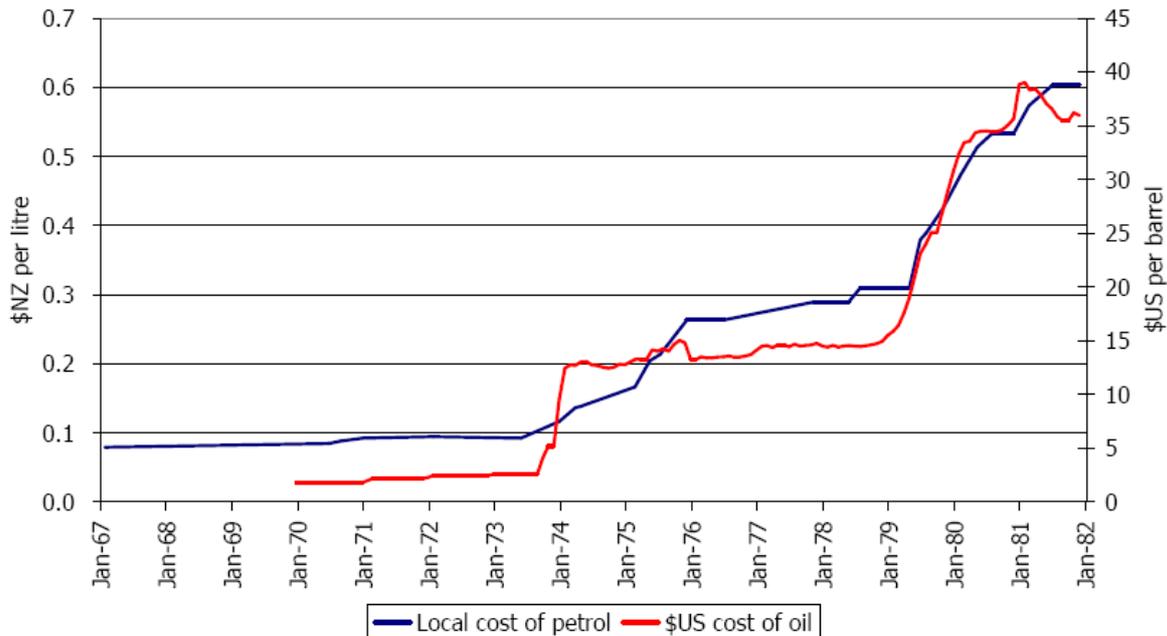


Figure 1 Pricing of a litre of premium petroleum (excluding local authority tax) within New Zealand and world pricing of a barrel of oil

Figure 1 shows a plateau in the fuel pricing from the beginning of the plot through to mid-1973. It is important to appreciate that this plateau actually stretches from the mid-1950s to mid-1973, with the price of fuel in New Zealand only ranging slightly from about 7 cents per litre in 1955 to about 9 cents per litre in June 1973.

In response to the 1973 "oil shock" the local price of petrol then increased rapidly, approximately tripling, from the long-term plateau at about 9 cents per litre to approximately 26 to 31 cents per litre in 1976.

The petrol price plateau, around 31 cents per litre in New Zealand, continued until about the time of the second "oil shock", when from May 1979 to July 1981 the price of petrol in New Zealand approximately doubled.

2.2 Governmental response to the "oil shocks"

During the 1970s, uncertainty of oil supply and high cost for oil threatened both the ability of the New Zealand economy to function and the country's balance of trade. Fuel conservation measures were therefore considered by the New Zealand Government under the auspices of "Economic Stabilisation". One of Government's primary concerns was to maintain a base level of fuel reserves so as to insure against any temporary cessations in supply. This would be aided by minimising the country's level of fuel use.

The New Zealand Government investigated and introduced a wide range of measures to strongly influence the use of fuel for transportation during the 1970s decade. Some of the measures targeted fuel conservation through efficient driving practices, such as lowering of the speed limit. Other fuel-conservation measures included widespread education and promotion of the fuel efficiencies that could be gained from proper tuning of motor vehicle engines or from optimal selection of engine "gear" while driving.

The Government also applied various regulations throughout the 1970s to influence motor vehicle engine-size purchasing decisions:

- Prior to the 1970s a tax was imposed on sales of private cars at a rate of 40% of the wholesale tax. In August 1974, this sales tax was differentiated so that larger-engined cars were taxed at a rate up to 60 % for vehicles while the sales tax on cars with small engines was only 30 %.
- Around 1975, annual motor vehicle registration payments were also adjusted to impose greater cost on larger-engined motor vehicles.
- Prior to 1976, Government allowed purchase of motor vehicles to be supported through hire-purchase agreements that required only 50 % to 67 % of the purchase price, and allowed 12 to 24 months for repayment. From 1976 to 1978, Government disallowed hire-purchase support entirely.

Some of the other measures introduced by Government targeted fuel conservation through influencing travel behaviours or travel opportunities. For example:

- Limiting the availability of fuel sales during weekends required motorists to consider and forecast their weekend travel carefully. This restriction also effectively sets a finite level to weekend travel distances.
- Government encouraged employers to offer employees "glide-time" working hours or the option of "working from home". These would reduce the traffic congestion during peak commuting times and thereby minimise some of the extra fuel demand that driving in those conditions can create.
- Around the second "oil shock", the "carless day" scheme required one day per week to be nominated for each motor vehicle and that vehicle would not be driven on that day each week. The "carless day" also encouraged motorists to consider their trip-making patterns, even if only to identify the day which having as "carless" would inflict the least disruption or inconvenience. Some motorists overcame their lack of motor vehicle on their "carless day" by car-pooling, using another (household) motor vehicle, or through use of an alternative mode of transport, such as walking, cycling, or public transport, where available.

It is notable that although some measures would indirectly influence the rate of public transport use, Government appeared to do little to actively improve or promote the public transportation services available. The thrust by Government was toward conservation of fuel and replacement of international fuel sources with local fuel sources, and not toward public transport expansion.

The intention and degree of change imposed by individual Government responses to the "oil shocks" ranged but as a package the impositions were unequivocal and comprehensive. The actions Government required would broadly and suddenly affect a large proportion of the travel activities undertaken by the general public.

3 General impacts of severe Governmental impositions

3.1 The private motor vehicle fleet

Figure 2 shows the number of private motor vehicles licensed and registered each year during the Study Period.

Overall, Figure 2 shows that, despite vehicle running costs (including fuel prices and registration costs) increasing at unprecedented rates, still the private motor vehicle fleet's established trend of growth continued throughout the 1970s decade.

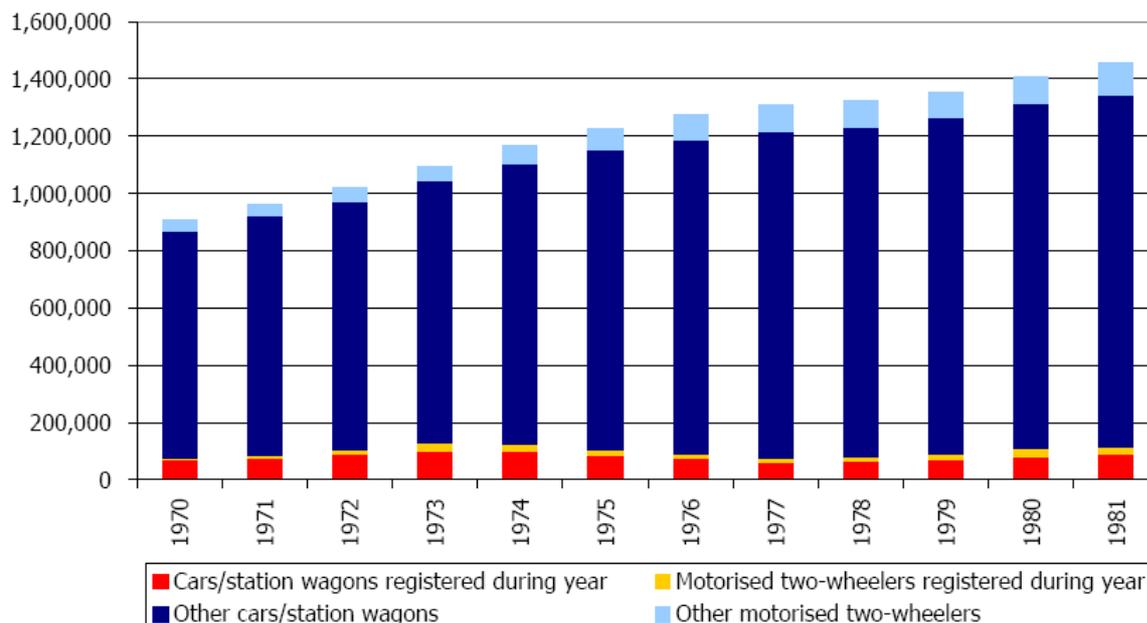


Figure 2 Total number of private motor vehicles licensed each year including the number of "new" private motor vehicles registered that year

While growth of the private motor vehicle fleet as a whole appears generally unaffected by the Governmental impositions of the time, Figure 2 illustrates fluctuation within the number of private motor vehicles added to the fleet each year over the Study Period:

- From 1970 to 1973 and then from 1978 onwards the number of private motor vehicle registrations each year increased upon the preceding year.
- 1973/1974 is the approximate timing of the first "oil shock" and from this time until 1978 the rate of private motor vehicle registrations decreased from one year to the next.
- Government removed its allowing of financial support for vehicle purchase from 1976 to 1978 and this is considered as having particular influence on the relatively small number of registrations around this time.

Figure 2 shows that motorised two-wheelers increased their presence in the private motor vehicle fleet over the 1970s decade:

- In 1970 motorised two-wheelers accounted for approximately 5 % of the fleet.
- In 1980, motorised two-wheelers accounted for approximately 9 % of the fleet.

The smaller engine-size typical of motorised two-wheelers, compared with cars, would deliver greater fuel economy and also attract lower costs under the Government's acting graduated vehicle sales tax and vehicle registration schemes. Government did not actively and overtly promote motorised two-wheelers due to concern over the high incidence of traffic crashes involving these types of vehicles and recognition that motorised two-wheelers

cannot necessarily fully replace some of the practicality offered by cars, particularly in relation to carrying-capacity.

3.2 Travel information from Census data

A national census is conducted in New Zealand on a five-year cycle. The censuses completed in 1971, 1976, and 1981 are considered in this Study.

"Travel to work" trips are generally undertaken within time and modal choice constraints and with such frequency that this travel behaviour is typically habitual. "Travel to work" data from the censuses is presented in Table 1.

Table 1 Census information on "travel to work"

Year of Census	Mode for "travel to work" (percentage of trips)					
	Private vehicle driver	Private vehicle passenger	Public transport: Train or bus	Motorcycle or powercycle	Bicycle or walk	Other- mode or did not go to work
1971	44.2 %	9.6 %	14.1 %	2.1 %	16.1 %	13.8 %
1976	48.3 %	9.9 %	11.2 %	3.8 %	14.2 %	12.7 %
1981	46.9 %	10.6 %	8.9 %	4.4 %	14.5 %	14.8 %

Note: One travel journey may consist of more than one mode of travel and each change of travel mode is recorded as one trip.

Note: "Other mode or did not go to work" includes those who worked at home and those who did not specify their mode for "travel to work"

The change in transportation patterns shown by the yellow-shaded parts of Table 1 is that over the three censuses, the proportion of "travel to work" trips made using public transport buses and trains decreased by about five percent, from 14.1 % to 8.9 %. From the data it is not possible to identify how decline in one travel mode was redistributed as growth amongst the other modes or vice versa but Table 1 does suggest that the trips that were transferred from public transport were mainly transferred to motorised private transport, and primarily as drivers of those motor vehicles. This is interesting in that even during a period of unprecedented increases in private motor vehicle operating costs still public transport modes could not retain their patronage rates.

The blue-shaded parts of Table 1 provide evidence that travel by motorised two-wheelers was increasing over the 1970s decade. Also, comparing the two categories of self-driven motorised transport modes (vehicle driver versus motorcycle or powercycle) indicates the increasing attractiveness of motorised two-wheelers relative to cars over the 1970s as was also noted in Section 3.1.

3.3 Households and private motor vehicle ownership

There are known links between households and private motor vehicle ownership, with each household typically having access to at least one vehicle. Table 2 presents census information that describes this relationship during the 1970s decade and shows a dramatic decrease in the proportion of households with no available household-vehicle from 1971 to

1981. Considering the set of households with "available" household-vehicles, over the decade there was a tendency for those households to increase the number of household-vehicles available. This change was occurring even while Government was promoting and regulating for reduced use of private motor vehicles.

Table 2 Census information on household-vehicles

Year of Census	Percentage of households having			
	0 vehicles	1 vehicles	2 vehicles	3 or more vehicles
1971	21 %	55 %	20 %	4 %
1981	12 %	50 %	28 %	10 %

The number of household-vehicles available per household was not reported in the 1976 Census

The increasing rate of household-vehicle ownership is even more notable given that, as shown in Table 3, there was a concurrent decrease in the average household size. Thus over the 1970s decade, despite Governmental encouragements for the contrary still the incumbent trend towards greater private motor vehicle accessibility continued as evidenced by an increase in the rate of "household-vehicles per household-member".

Table 3 Census information on household-size

Year of Census	Number of households	Population	Mean number of household members
1971	801,686	2,862,631	3.57
1976	923,257	3,129,383	3.39
1981	1,002,282	3,143,307	3.14

3.4 Use of public transport for suburban travel

Public transport patronage is another measurable component of transportation patterns. Figure 3 illustrates the numbers of suburban passenger journeys taken by rail (train) and by road (bus) annually within the Wellington area during the 1970s decade.

The datasets displayed on Figure 3 will be fairly comprehensive but will not account for all passenger bus journeys in Wellington as other minor service providers operated in the region throughout the 1970 to 1981 period. Totalling the number of passenger journeys on an *annual* basis smoothes the influences of seasonal variations and diminishes any possible effect caused by an unknown and variable lag between the time of a ticket sale (upon which some of the data are based) and the time that the associated journey is made.

Overall Figure 3 shows a marked decline in the number of Wellington suburban public transport trips taken annually during the 1970s decade. The rate of decline was generally steady but some plateaus in the decline approximately coincide with the timing of the two "oil shocks".

Other evidence suggests that trip rates and travel demands were not declining during the 1970s and so Figure 3 illustrates that public transport modes were losing their proportional share of travel made during the period, with the retention of passenger journeys by road (bus) slightly greater than the retention by rail (train).

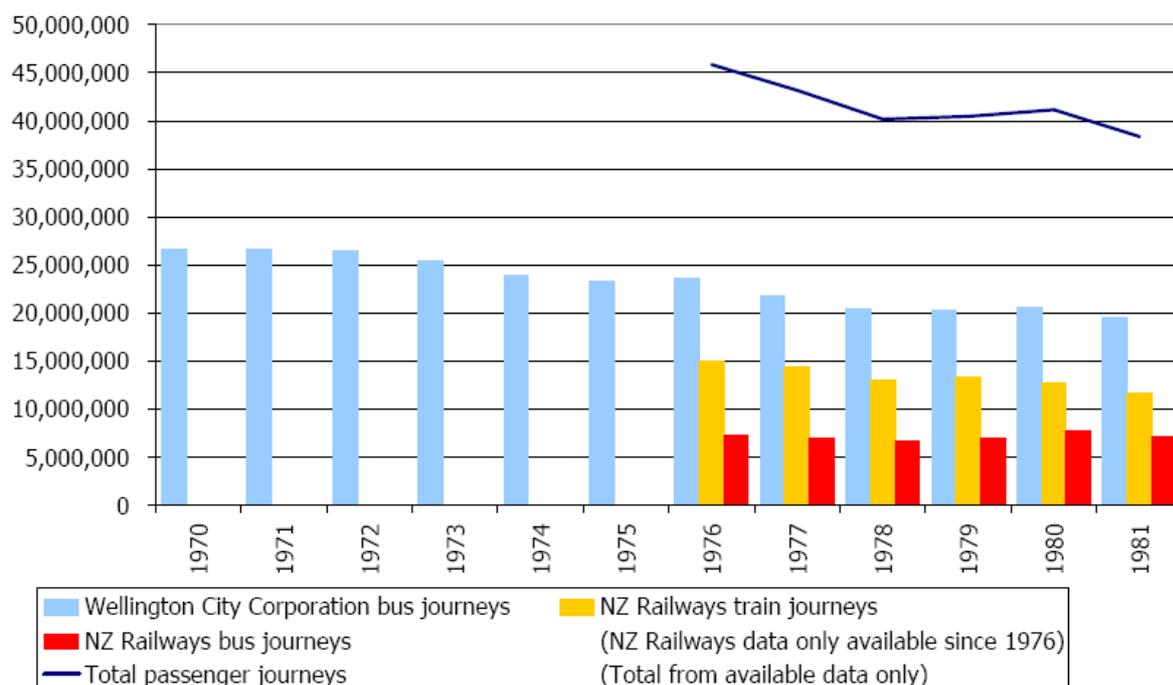


Figure 3 Wellington annual passenger journeys (suburban trips)

Within their role as regulators of public transport services during the 1970s, central and local government agencies held responsibility for development of these services. In Wellington, and also generally nationwide, little was done to extend or enhance public transport services through the 1970s, and this could have exacerbated a decline in the perceptions of public transport relative to the perpetually increasing attractiveness of personal motor vehicles, made so evident through marketing and the accessibility of motor vehicle ownership. This is important to note given that switching of travel from private motorised transport modes to public transport modes would have assisted the major objective of fuel conservation.

4 Characteristics of the private motor vehicle fleet

Section 3 broadly indicates that the dramatic regulatory and pricing changes made by the New Zealand Government in response to the "oil shocks" had little effect on established transportation trends such as movement towards private motor vehicle purchase and increased usage of private motor vehicles. This Section expands the analysis of Section 3 and gives the trends consideration within greater context.

4.1 Composition of additions to the private motor vehicle fleet

Figure 4 illustrates the number of private motor vehicles registered each year through the 1970s decade, with bandings to indicate the engine-sizes of the cars. The four banded categories cover car engines of:

- 1300cc and under taken to represent small-engined vehicles,
- 1301 to 2000/2200cc taken to represent medium-engined vehicles,
- 2000/2200 to 4000/5000cc taken to represent large-engined vehicles, and
- Over 4000/5000cc taken to represent very-large-engined vehicles.

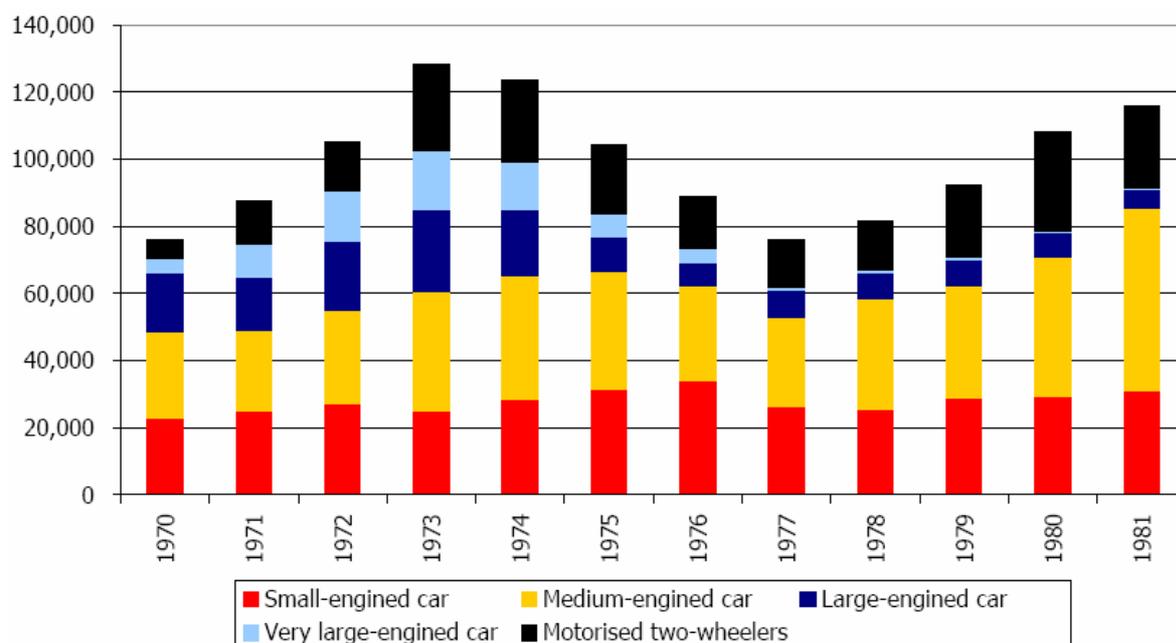


Figure 4 Private motor vehicles registered into the fleet yearly, as absolute numbers

In Section 3.1 the fluctuations in the number of annual registrations were primarily ascribed to changes in the extent Government allowed offering of financial support for private motor vehicle purchase. This section focuses on the matter, illustrated by the bandings in Figure 4, that the variations were not distributed uniformly between the different engine-sizes available:

- From the start of the graph to 1973, the rate of registration of very-large-engined and large-engined cars steadily increased from 31 % to 41 % of all yearly cars registrations.
- From 1973, approximately the time of the first "oil shock", to 1976, this trend was reversed so that registration of very-large-engined and large-engined cars changed from 41 % to 15 % of all cars registered within each year.
- From 1976 until the end of the graphed period, year-upon-year, the proportion of cars registered each year of very-large and large engine-sizes continued to decline, but at a less marked rate than demonstrated from 1973 to 1976.
- The proportional representation of small-engined cars rose year-upon-year from 1973 to 1976 but then the trend was one of steady decline towards the end of the decade.

Overall it appears that cars with medium-sized engines were being introduced to the private motor vehicle fleet in preference over very-large-engined and large-engined vehicles and also in preference over small-engined vehicles. With respect to engine-size, car additions to the private motor vehicle fleet were more homogeneous at the end of the decade than at the beginning.

The black banding on Figure 4 indicates that motorised two-wheelers represented 7 % to 15 % of private motor vehicle registrations at the beginning of the 1970s decade and this share increased to be approximately 18 % in the middle of the decade then greater than 20 % of registrations from 1979 onwards.

Figure 4 shows that within the environment of very high fuel prices and graduated taxation and pricing measures combined with heightened awareness of fuel issues, the behaviours around purchasing of new private motor vehicles altered substantially and quickly.

4.2 The private motor vehicle fleet and population

Section 3 considers the New Zealand private motor vehicle fleet in absolute terms and highlights sustained growth of the fleet. This section recognises that some of this growth could be related to simultaneous changes in characteristics of the New Zealand population:

- To maintain static private motor vehicle accessibility rates, the number in the fleet would increase or decrease as the size of the population increases or decreases.
- An individual's interactions with transportation generally alter with age as age (and life-stage) generally alters one's transportation needs and capabilities.

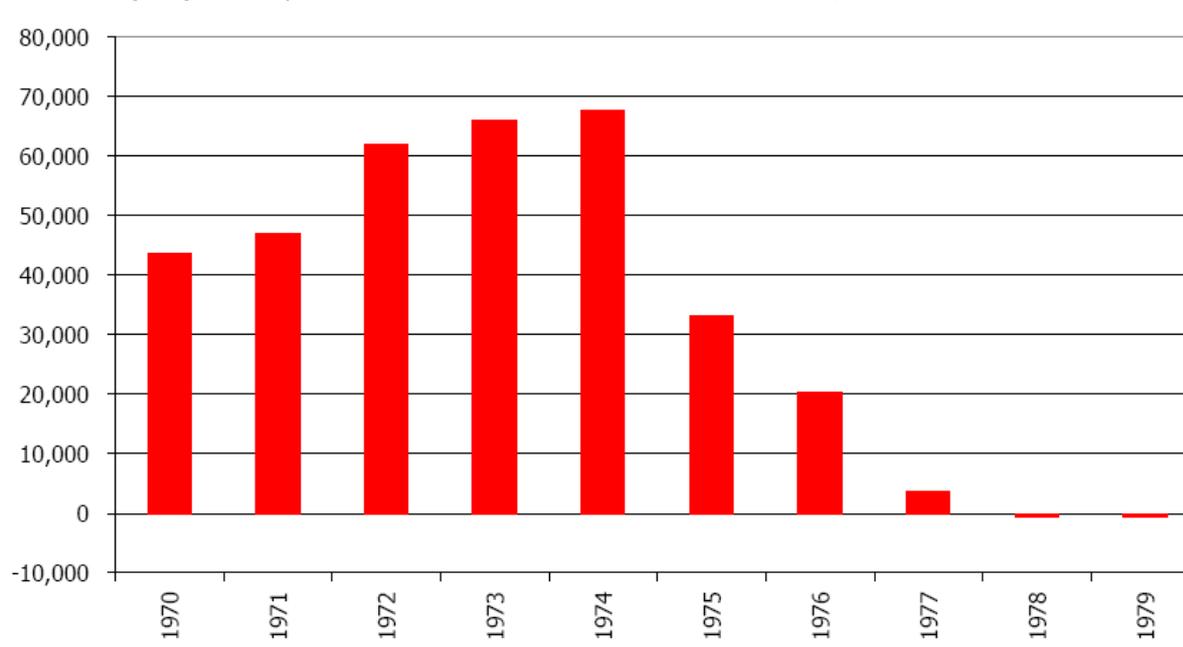


Figure 5 New Zealand population change, yearly as absolute numbers

Figure 5 shows how the size of New Zealand's population increased each year over the period from 1970 to 1977. The annual rate of increase built from 1970 to peak in 1974 then the rate of increase declined from 1974 to 1977. The total population decreased during 1978 and then decreased again over the 1979 year.

Change in the New Zealand population is strongly characterised by cyclical flows of immigration and emigration. Migration patterns have significance to the private motor vehicle fleet in that they usually affect the *adult* population and so affect the number of people likely to own and/or drive vehicles. Thus:

- To meet the vehicle-access needs of immigrants the private motor vehicle fleet may be added to.
- A vehicle-purchaser may purchase a vehicle from an emigrating vehicle-owner instead of purchasing a *new* vehicle and so the private motor vehicle fleet is not added to.
- An emigrating vehicle-owner may sell their vehicle at a rate that allows the vehicle-purchaser to affordably increase the number of vehicles owned, by an individual or by a household, and so more private motor vehicles are retained in the fleet.

The impact of the immigration/emigration cycle that was discussed around Figure 5 can be seen in Figure 6 which shows the total population of New Zealand, each year from 1970 to 1980, subdivided by age grouping. Over the Study Period:

- As the total population changes the number of people in the group aged less than 20 years old (shown in red) is principally static.
- The growth of the total population in the first half of the decade is reflected by growth in the *adult* population, particularly the group of people aged between 20 and 65 years (shown in yellow).

- Towards the end of the decade when emigration is strong both the size of the "20 to 65 years" group and the total population are basically static from year to year.

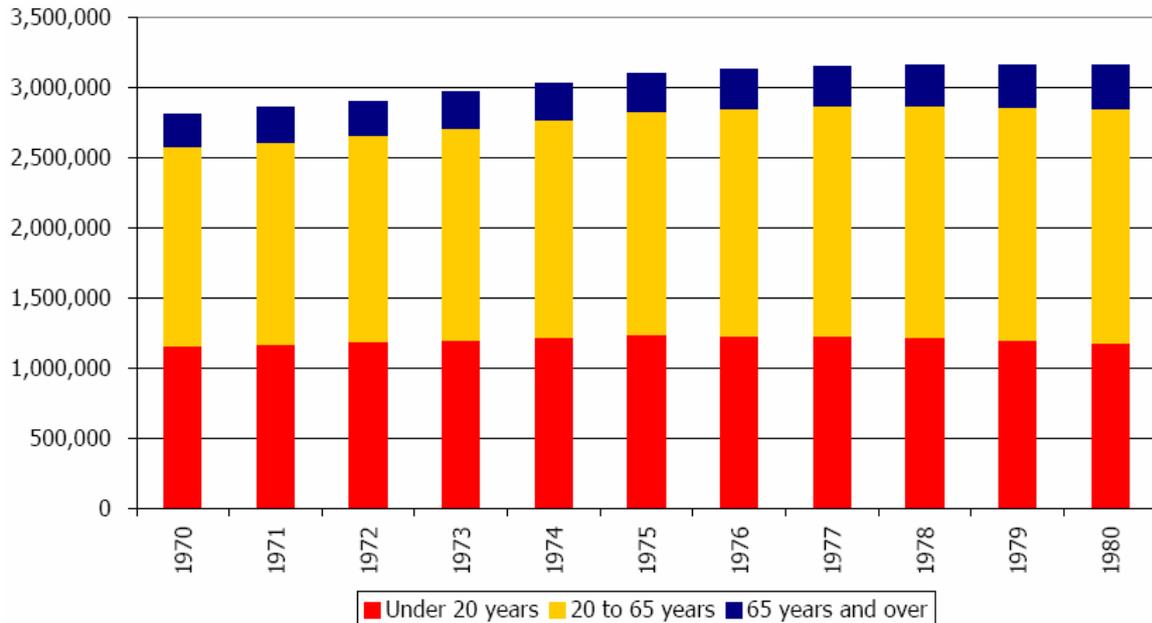


Figure 6 Age structure of the New Zealand population, yearly as absolute numbers, and absolute numbers of New Zealand households from Census data

The set of people aged between 20 and 65 is considered to strongly reflect the actual number of the population who would be viable for vehicle ownership and driver licensing. From 1970 to 1980 the number of people in this group increased by 290,000. Thus it is surmised that the number of the population likely to own and be able to drive vehicles increased over the Study period by an approximately equivalent amount.

With this information on the New Zealand population, it is possible to reappraise the private motor vehicle fleet by comparing the fleet with the number of people aged between 20 and 65 years.

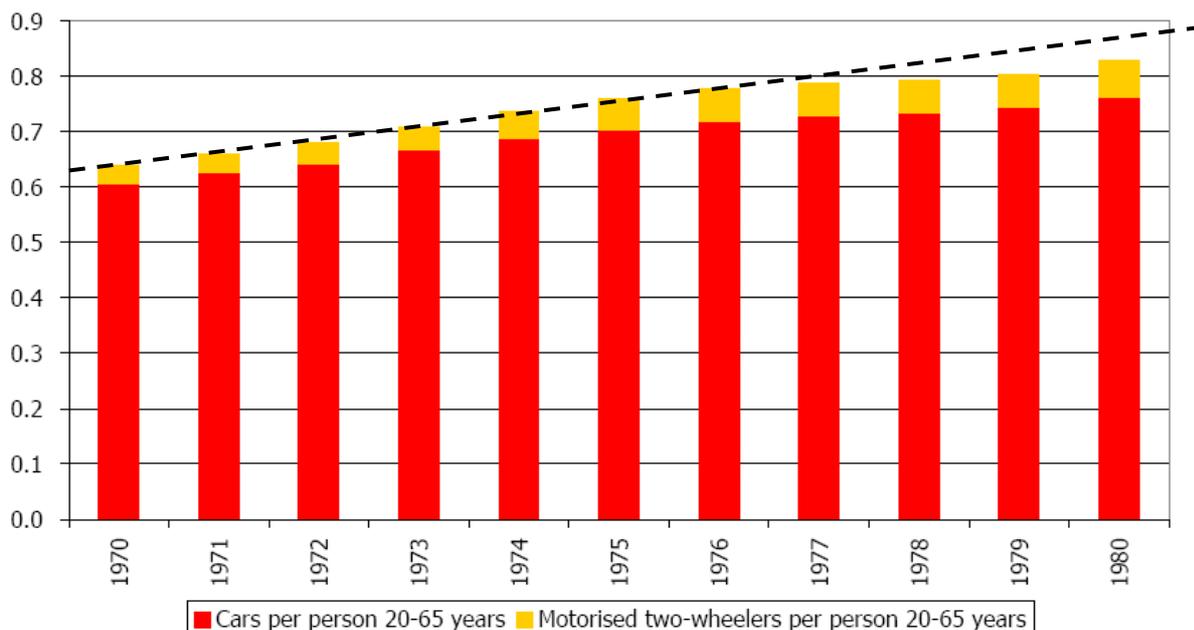


Figure 7 Cars and motorised two-wheelers per person aged 20 to 65 years

Overall, looking at the full bars in Figure 7, and as shown by the sketched trendline, the rate of private motor vehicles per person aged between 20 and 65 years increased over the decade. The rate of increase of this growth slowed from 1976 onwards, diverging from the trendline sketched based on the beginning of the decade.

Inspection of the red and yellow portions of the bars in Figure 7 indicates that the proportional split of motorised two-wheelers to cars increased over the period.

4.3 Workforce

The employment status of a person holds great influence over their transportation patterns. Engagement in employment, naturally, generates the necessity to "travel to work". It also generally affects an individual's availability to make other trips during the day and during those periods when public transport modes are more readily available and when walking and cycling modes are more practical.

Comparing the 1970 New Zealand workforce with that of 1980:

- 70,000 additional males were engaged in employment with growth occurring almost entirely within full-time employment.
- 135,000 additional females were engaged in employment with growth split almost evenly between full-time employment and part-time employment.

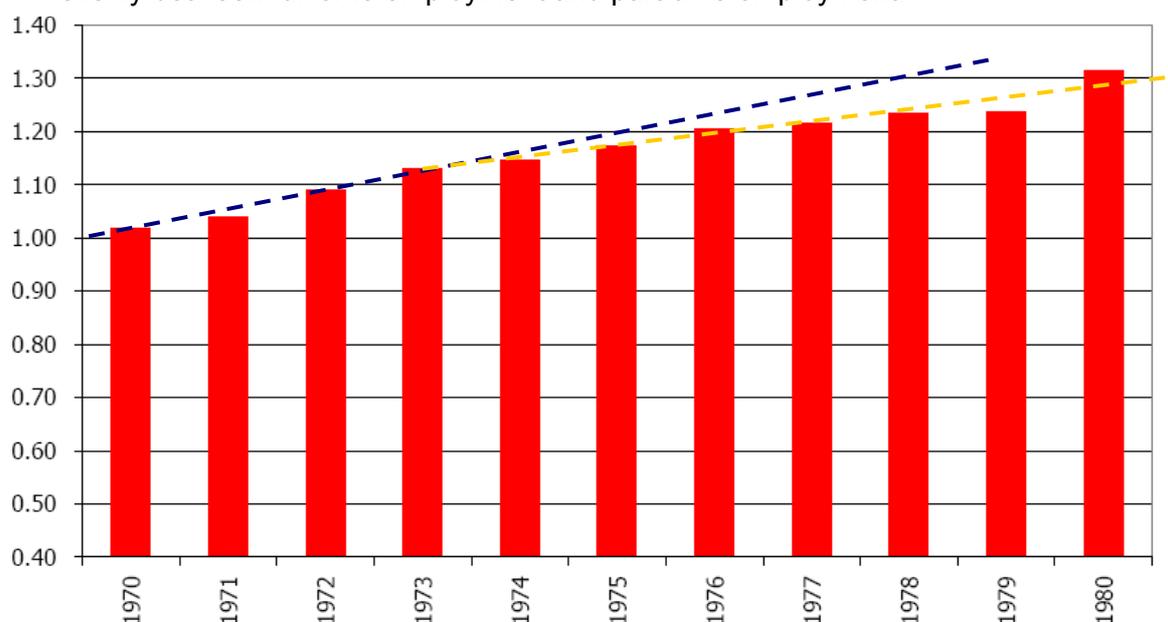


Figure 8 Cars and motorised two-wheelers per person engaged in employment –
Note truncated vertical scale

Figure 8 plots the private motor vehicle fleet relative to the number of people engaged in employment and shows that the rate increased substantially over the 1970s decade.

- The initial trend of growth established from 1970 to 1973 (and shown by the blue line) changes to a slightly slower rate of growth from 1973 onwards. The timing of the change in trend coincides with the timing of the first "oil shock" but actual links cannot be established.
- The 1979 rate/bar falls below the 1973 - 1978 trend (shown by the yellow line), but then the 1980 rate/bar approximately rejoins the trend.

5 Transportation use and travel patterns

5.1 Fuel deliveries as a proxy measure of private motor vehicle fuel use

National statistics of "vehicle kilometres travelled" are not available as a series to describe use of private motor vehicles during the 1970s however statistics of the quantities of petrol delivered to New Zealand by oil companies through the 1970s are available. Light petrol-fuelled vehicles, such as cars and station wagons and other private motor vehicles, were the primary users of petrol during the 1970s and so, in this Study, the deliveries of petrol by oil companies are taken as a proxy measure of the quantities of fuel used by private motor vehicles for transport.

Figure 9 plots the rate of oil company deliveries per private motor vehicle over the 1970s decade to inspect for effects of the increased petrol prices and Government fuel conservation initiatives, such as restrictions on fuel sales and lowering of the speed limit.

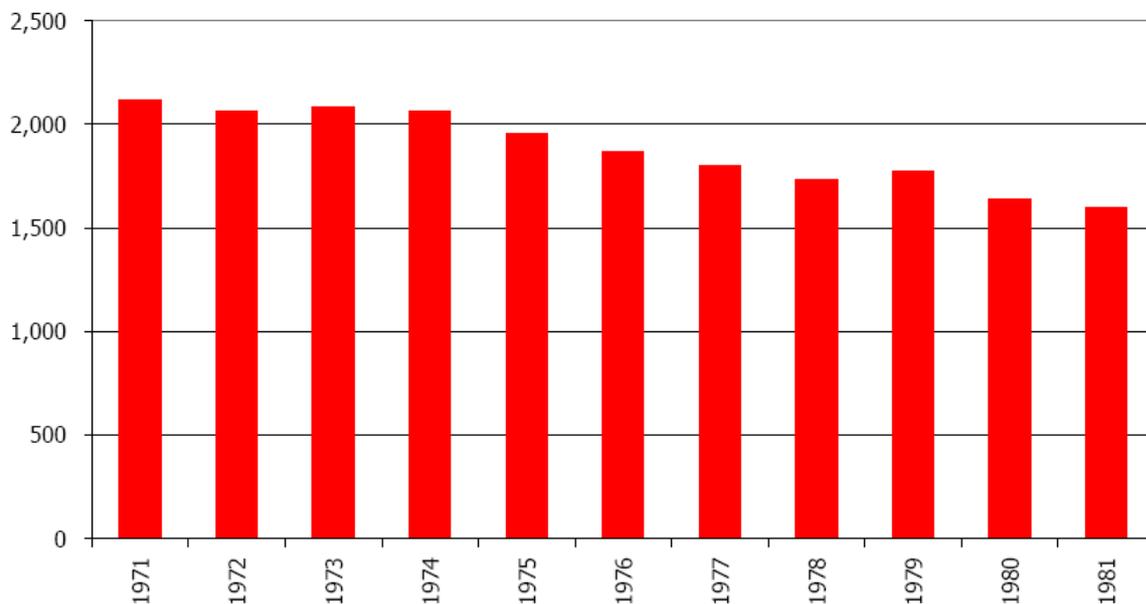


Figure 9 Annual oil company deliveries compared with the private motor vehicle - displayed as litres of petrol delivered per licensed private motor vehicle

Taking oil company deliveries as a proxy measure of fuel use by the private motor vehicle fleet Figure 9 shows that the fuel usage per private motor vehicle was stable between 1971 and 1974; but there was a decrease in the yearly rate from 1974 through to 1980, which was both definite and dramatic in the order of 20 % (when the 1981 figure is compared with the 1971 to 1974 baseline).

Some of this decline can be ascribed to improvements in the efficiency of the private motor vehicle fleet through vehicle technology developments and the sway towards private motor vehicles with smaller engines. However, considering the turnover rate of the New Zealand private motor vehicle fleet these explanations have some limits to their application.

Government initiatives plus public advertising and education, over 1974 to 1980, encouraged more efficient driving methods, such as effective gear selection and lower open road speeds. These could also have factored in the decline. (There was also interest in use of alternatives fuels but implementation of this was only limited within the 1970s and was more of a factor in the 1980s.)

A subjective evaluation poses that the aforesaid factors cannot explain the entire 20 % decline. Rather some of the declining rate of fuel use per private motor vehicle, seen in Figure 9, can be attributed to the average distance travelled by each vehicle decreasing. This would indicate a reduction in private motor vehicle use.

6 Concluding discussion

Prior to the 1970s, private motor vehicles had established themselves in New Zealand as the prevalent and desirable means of travel:

- Petrol pricing was stable for approximately twenty years prior to the 1970s, supporting the perception of the affordability of private motor vehicle usage.
- Ownership of at least one private motor vehicle per household was already the norm.
- No significant measures to affect declining public transport patronage rates were evident and this could also be considered as effectively supporting uptake of personal motor vehicles.

The first "oil shock" occurred around 1973 and the second around late-1979. With particular respect to transport, Government's primary responses were increased petrol prices, public education, and legislative restraints. Thus petrol conservation was encouraged principally through rationalising use of private motor vehicles rather than through promoting use of buses, trains, or other alternative modes of transport.

However, Government's package of impositions produced little change in the public's established general transportation patterns:

- The private motor vehicle fleet continued to grow over the 1970s decade.
- The modes of travel used for the "journey to work" and records of public transport patronage show a continuation of decline in use of trains and buses during the 1970s.

Throughout this time, despite fuel pricing and Governmental legislation aimed at restricting use of petrol for transport, still the perceptions of the benefits of private motorised transport were apparently increasing with a corresponding uptake of those modes. In comparison, the perception of the level of service offered by modes of public transport would have remained static or even decreased as few modifications were made to the services over the period.

Government provided little guidance towards patronage of public transport and only minor support or prominence to development of public transport services and, in turn, the public maintained its established relationship with public transport and declining use of public transport continued.

The 1970s demonstrate that the public could not be "pushed" towards public transport modes by making private transport modes less attractive. A different tactic of upgrade and promotion of public transport modes may be more effective in "pulling" the public towards use of those services.

More encouragingly, where Government provided particular leadership public's reaction was greater. For example, Government's graduation of private motor vehicle taxations according to engine-size significantly affected vehicles being purchased:

- Large-engined and very-large-engined cars represented a substantial and increasing proportion of the private motor vehicle fleet additions until 1973 then their representation steadily declined over the remainder of the 1970s decade.
- Motorised two-wheelers increased their proportional share of the private motor vehicle fleet.

Similarly, as increases in petrol prices during the 1970s were strong, relentless, and prominent so usage of petrol (for transportation) appears to have responded in kind. When

related to the private motor vehicle fleet, quantities of petrol deliveries were almost uniform through the early 1970s and then from 1974 through to the end of the decade the annual rate declined each year. Vehicle-efficiency improvements during that period are considered to justify only part of this decline and it is posed that some of the decline must be attributable to a reduction in distances being driven by private motor vehicles.

The Government measures that were most effective in eliciting the desired public response were those that altered market conditions. The public generally accepted those Government's impositions that were clear in their purpose and where the requirements were perceived to be distributed "fairly" across the population.

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