Final Report

Socio-economic impacts of emissions standards on used imported vehicles

Prepared for

The Ministry of Transport

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Executive Summary

This report examines the social, economic and environmental impacts of proposed emissions standards on used imported vehicles. If implemented, these standards would effectively limit the age of used imports and would have a number of effects. These include:

- reductions in the total number of imports
- increases in average import prices
- increases in the value of vehicles already in the fleet, and
- longer lives for existing vehicles to offset reductions in import numbers.

Previous Study on Socio-Economic Impacts of Emissions Policies

This report represents the second phase of a wider study on vehicle emissions. The first phase, which was completed in 2005, examined the social and economic impacts of a then-proposed in-service vehicle emissions screening programme: a requirement for the emissions of vehicles to be tested as part of the Warrant of Fitness (WoF) or Certificate of Fitness (CoF) test.[1]

The earlier study examined the effects of the vehicle testing regime in terms of costs and the possible social exclusion impact of losing a vehicle. The analysis suggested that the communities at greatest risk are young and old people, particularly those of Maori and Pacific descent. Solo parents were also identified as high risk, especially solo Maori or Pacific Island mothers. They have lower-than-average household incomes and relatively high daily living costs.

There are also risks for large families, related to the lower levels of disposable income and the number of people affected by a loss of vehicle. Disabled people are also vulnerable because of lower incomes and difficulties in accessing other transport means.

The impacts of having to pay a significant bill for low income households include reductions in spending on other items or descending further into a spiral of debt. Studies on poverty in New Zealand have identified a range of implications for low income households including increased probability of eating poorly, not going to the doctor or dentist, reducing participation in recreational activities, reduced educational opportunities for children and living in unsuitable accommodation.

Loss of a car can exclude households from many activities, including health visits, work, shopping, visiting friends and recreation. These difficulties relate particularly to situations where facilities are some distance away.

In June 2005, subsequent to the release of the phase 1 report, the Minister of Transport announced the introduction of emissions control policies to be put in place by the end of 2006, comprising a visual smoke test as part of the WoF/CoF test that would target the

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[1] Covec (2005) Vehicle Fleet Emission Screening Programme Social and Economic Impact Assessment Phase I. Final Report to the Ministry of Transport

worst emitters, and prohibition of removal of (or tampering with) a vehicle's emissions control technology.

Earlier this year, the Ministry of Transport asked us to examine the effects of an alternative emissions policy – this time focused on restricting the entry of used imported vehicles at the border. This report presents the results of our analysis on the social, economic and environmental impacts of that policy.

Proposed Standards underlying the Revised Policy

The emissions standards underlying the revised emissions policy are Japanese manufacturing standards introduced in the late 1990s and early 2000s. Specifically, for petrol vehicles, they are the standards introduced between 2000 and 2002, while for diesel vehicles there are either the standards introduced:

- between 1997 and 1999 (the 97/99 standard), or
- between 2002 and 2004 (the 02/04 standard).

Petrol standards limit emissions of CO, HC, and NO, while diesel standards limit emissions of CO, HC, NO and PM. All standards are expressed as grams per kilometre.

Likely Degree of Impact

The likely success of the policy depends, amongst other things, on the restrictiveness of the underlying standards. Thus, if few prospective imports fail, the policy will be relatively ineffective, and vice versa.

To gauge the restrictiveness of the proposed emissions standards, we compared the 'effective age limits' imposed by them with the age distribution of historic imports. This helped identify the number of imports that *would have* failed if similar standards were in place at the time.

Now, unless emissions standards are updated periodically, these effective age limits will shift over time. For example, for petrol cars, the effective age limit will be 8-years in the second year of the policy, and 9-years in the third year if no updates are made.[2]

Because only used imported vehicles will potentially fail (and not new imports), the overall restrictiveness of the standards has been expressed as the percentage of used imports that would potentially fail (not the percentage of total imports). These figures are summarised in the table below.

[2] At the time of writing, the likelihood and/or frequency of any updates was uncertain. For the purposes of modelling, however, we have assumed annual updating of standards. The consequences of this assumption are discussed on page 45.

Table 1: Proportion of Used Imports Affected in Year 1

Vehicle Type	Standard	% Affected
Petrol Cars	00/02	45%
Petrol Commercial	00/02	71%
Diesel Cars	97/99	28%
Diesel Cars	02/04	95%
Diesel Commercial	97/99	18%
Diesel Commercial	02/04	86%

While the percentages for commercial vehicles are relatively high (particularly for diesel under the 02/04 standard), commercial vehicles comprise only 5% of annual imports. Coupled with other reasons set out in section 4.2, this small share has led us to focus only on passenger vehicles in this report.

Characteristics of At-Risk Parties

Although the policy will have far-reaching effects, consumers prevented from buying their preferred import as a result will be most 'at-risk'. This naturally led us to consider what the geographic, demographic and socio-economic characteristics of 'at-risk' consumers might be. This was done by analysing the motor vehicle register.

The motor vehicle register lists every passenger (and goods) vehicle registered in New Zealand at any given point in time. A snapshot of this (as at 1/1/2005) was obtained during stage one of this project and "geo-coded", so that the precise geographic location of each vehicle (and its owner) was known. These geographic identifiers were then used to link the register to census information, so that socioeconomic and demographic information could be added to the analysis.

Using this data, we identified the characteristics of people that bought used Japanese imports in 2004 that *would have* been banned if similar restrictions were in place at the time. These were taken to represent 'at-risk' consumers.

It is important to recognise that the degree of risk is not uniform across 'at-risk' consumers. Rather, it depends on each consumer's ability to overcome import restrictions by upgrading to a vehicle that meets the standards. This, in turn, depends on the age gap between their preferred import and the oldest import permitted by the standards.

Extending this logic, we segmented at-risk consumers into three groups:

- Group A: people that bought cars one or two years older than the maximum
- Group B: people that bought cars three or four years older than the maximum
- Group C: people that bought cars five years (or more) older than the maximum

Thus, group A consumers are lower risk than group B, who are lower risk than group C. These groupings were used throughout our analysis.

Overall, 'at-risk' consumers were found to be:

- predominantly middle-aged males (30-49 years)
- from all across New Zealand, and especially Auckland and the South Island
- with below-average incomes, and
- larger-than-average household sizes.

In addition, we found that average incomes fall as the focus moves from group A to group B to group C. At the same time, average household sizes increase. This suggests that consumers in groups B and C will have limited capacity to upgrade their intended import to one that meets the standard and therefore truly are most 'at risk.'

Consumer Response Scenarios

The social, economic and environmental effects of the policy depend critically on the response of consumers. For example, if most 'at-risk' consumers end up purchasing a newer import than they would have otherwise, the overall effects will be positive. However, if most end up holding on to their existing vehicle, the overall effects will be negative.

This report considers the social, economic and environmental effects of five consumer response scenarios, in which the probability of upgrading varies across 'at-risk' groups. Two of these scenarios are fairly extreme and have been included only to establish limits on potential outcomes. The remaining three scenarios fall somewhere in the middle and are more representative of likely consumer reactions.

Effects on Vehicle Markets, Prices & Ages

This report considers the potential impacts of the two extreme scenarios on vehicle markets and vehicle prices. It also models the potential effects of these scenarios on average fleet age using the vehicle fleet emissions model (VFEM). Our overall findings were:

Scenario 1: All at-risk consumers upgrade to newer import

- No change in the overall level of imports
- Relatively static import prices
- No significant changes to import industry concentration
- Little effect on the domestic vehicle market
- Static scrappage rates
- No change to the overall size of the fleet
- Average fleet age decreases

Scenario 2: All at-risk consumers exit import market and retain existing vehicle

- Dramatic falls in the overall level of imports
- Higher import prices (and higher import costs)
- Greater import industry concentration
- More activity in the domestic vehicle market (and higher prices)
- Reduced scrappage rates
- Overall size of the fleet will fall (depending on scrappage rates).
- Average fleet age increases

Fuel and Emissions Impacts
This report also considers the potential impacts of the policy on fuel and emissions to 2030. This is done by comparing fuel use and emissions with and without the policy under the five response scenarios, and interpreting any differences as policy impacts.

Under response scenario 1, where all at-risk consumers upgrade to a newer import, potential fuel and emissions savings peak at around 0.5% of annual totals. Under response scenario 2, where all at-risk consumers exit the market and retain their existing vehicle, fuel and emissions *increases* peak at around 2.5% of annual totals. The fuel and emissions effects of the remaining scenarios lie between these extremes, but are skewed more toward scenario 2 than scenario 1.

These results suggest that the potential benefits of the policy pale in comparison to potential downside risks. This is due to the dynamic nature of vehicle market transactions. That is to say, if an affected consumer reacts to restrictions by purchasing a slightly newer import than intended, the incremental fuel and emissions benefits are limited to only that consumer. However, if an affected consumer exits the market and retains their existing vehicle, that decision can halt a series of downstream sales and purchase transactions, and thus have much greater overall effects.[3]

Social Impacts
This report has also considered the social impacts of the revised emissions policy. Overall, these are expected to be minor compared to the previous policy because it:

- does not result in any sudden loss of vehicle, which can lead to social exclusion, and
- does not cause any unexpected (and unavoidable) spikes in the cost of living.

At most, the policy may cause slight increases in the prices of vehicles. However, any such price effects are likely to go unnoticed in context of recent market trends, where the prices of imported vehicles have recently begun to fall.

Policy Options
A number of studies in New Zealand have demonstrated the impacts of local air pollutants from transport. The impacts are serious and have been the motivation for a policy response. Policy options to tackle these effects include those that:

- remove the worst polluters from the fleet;
- ensure optimum performance of the existing fleet;
- change the fleet over time to less emitting vehicles by changing the characteristics of imports;

[3] Another way to look at this is as follows: the size of the fleet in any one year equals last years fleet plus imports less scrappage. If, for any reason, the rate of imports falls, so too must the rate of scrappage otherwise the fleet will be smaller than it would have been otherwise. Now, because vehicles about to be scrapped are typically older, they are typically also high emitters. Thus, any policy that prolongs the life of vehicles about to be scrapped will have adverse effects. This is precisely the finding of this report.

- change travel behaviour to reduce aggregate activity or change its location and thus exposure of people.

This study has analysed the expected effects of an emissions standard that would change the structure of the fleet over time by changing the age composition of imports. The analysis suggests that the policy will have limited positive environmental effects, and that adverse environmental effects are conceivable. It has also been show to have limited positive (and possibly negative) social and economic impacts.

There are no simple solutions that will be effective environmentally and have low costs or low social impacts. Measures that will have a significant impact on the emissions of local pollutants from the fleet, such as more accurate vehicle testing methods, will have adverse social impacts on lower income households. In contrast, measures that seek to avoid these impacts, including the approach analysed here, are likely to have limited positive emissions effects.

Alternative policy avenues include those that focus on direct health effects, for example through tackling the location of emissions in urban centres, and those that focus on measures that target vehicle dependency via changes in urban form that reduce the need to travel, plus improvements in public transport availability, accessibility and utilisation.

The government is left with difficult choices. The broad options appear to be to:

- introduce more stringent testing methods and accept the socio-economic consequences or introduce mitigating polices;

- introduce import standards as examined in this study, although it is not clear that this is a worthwhile policy intervention;

- work with local government more closely to design policies that more directly target problem locations.

1. Introduction

1.1. Background

This report examines the environmental, social and economic impacts of possible regulations to reduce the emissions of vehicles.

The Ministry of Transport (MoT) is considering the introduction of standards that would apply to imported vehicles. Specifically they would be based on Japanese manufacturing standards. Applying these minimum standards will effectively result in restrictions on the maximum age of imported vehicles. This is expected to have a number of effects, including a higher average price of imports, reduced numbers of imported vehicles, increased value of vehicles already in the fleet and the extension of life of existing vehicles to meet demand.

The brief for the study was to identify the extent and severity of impacts across New Zealand society, focusing where appropriate on the already socially- and economically-disadvantaged individuals, groups and/or communities in New Zealand.

This report continues from an initial 2005 phase of this study[4] that examined the social and economic impacts of a then proposed in-service vehicle emissions screening programme.[5] The proposal was to introduce a requirement for the emissions of vehicles to be tested as part of the Warrant of Fitness (WoF) or Certificate of Fitness (CoF) test. At the time, the MoT had favoured a relatively simple test methodology—an 'idle test'[6] for petrol vehicles and a 'snap acceleration test'[7] for diesel vehicles.

After the initial government proposals were published, scientific and technical research undertaken in New Zealand conditions, combined with analyses of overseas research, suggested that simple testing would produce an unacceptable level of false-positive and false-negative results. Further, research also suggested that simple testing would be unlikely to achieve significant and measurable improvements in air quality and health. Subsequently, in June 2005, the Minister of Transport announced the introduction of emissions control policies to be put in place by the end of 2006, comprising a visual smoke test as part of the WoF/CoF test that would target the worst emitters, and prohibition of removal of or tampering with a vehicle's emissions control technology.

Although not strictly relevant to this phase of the study, a summary of our findings from the first phase is provided below as a matter of completeness.

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[4] Covec (2005) Vehicle Fleet Emission Screening Programme Social and Economic Impact Assessment Phase I. Final Report to the Ministry of Transport

[5] Ministry of Transport (2004) New Zealand Vehicle Emissions Screening Programme. Discussion Document.

[6] The idle test tests emissions of engines at idle and for the high-idle test at 2,500 revs per minute

[7] The snap acceleration test requires the rapid acceleration of the engine and uses the engine's resistance to simulate the conditions where smoke is produced.

1.2. Previous Study of Socio-Economic Impacts of Emissions Policies

1.2.1. Approach to Social Impact Analysis

The first report included two main components in its social impact analysis:

- an analysis of income-related effects; and
- social exclusion impacts.

The primary initial effects of the emission screening rule included costs of the test, of vehicle repair, of preventive measures (eg vehicle servicing), of a replacement vehicle where it is not worth repairing (given the value of the vehicle), and/or the costs of doing without a vehicle, where the repair costs and the costs of a replacement vehicle are unaffordable.

As a result of the direct costs of the scheme (repair bill, maintenance cost or purchase price of a replacement vehicle), households and businesses will have reduced disposable incomes. There are two kinds of potential impact:

- Those on health and well-being, eg as a result of reduced expenditure on food, accommodation and so on; and
- Reduced expenditure on activities that involve social participation—these are discussed further below.

Households and individuals may be excluded from participating in some normal activities as a result of either:

- reduced disposable income following payment of repair bills or increased vehicle purchase price (if such an effect results); or
- reduced access to a vehicle where the repair bill required to meet the emission rule is too high and financing a replacement vehicle is unaffordable.

The Ministry of Social Development notes that "people in New Zealand want to be included in the fabric of their society, not excluded from it."[8] Social exclusion occurs when people are unable to fully participate in society in a way that they would like to and might reasonably expect to be able to.[9] This might include access to jobs, services, facilities or to friends and family,[10] and might occur because of reduced income or reduced access to a vehicle.

1.2.2. Risks of Failure

For petrol cars, emissions are higher from older cars and those with higher mileage; this relationship to age does not hold for diesel vehicles. Assuming that the vehicle emissions screening programme operated such that the highest emitters are those most likely to fail, this will also be the oldest vehicles. A regional analysis suggests that

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[8] Ministry of Social Development (2001) *The Social Report*. Wellington, Ministry of Social Development

[9] Burchardt, T. (2000) 'Social exclusion: concepts and evidence' in Gordon, D., Townsend, P. (eds) *Breadline Britain*. Bristol, The Policy Press.

[10] Hine, J., Mitchell, F. (2003) *Transport Disadvantage and Social Exclusion*. Aldershot, Ashgate

vehicles in some regions, and particularly those in the South Island, will have a higher propensity to fail an emissions test because of the greater ownership of older vehicles. Furthermore, low income households have a higher propensity to own older cars because older cars are cheaper to purchase. This implies that low income households will bear a disproportionately high share of the burden of emissions testing.

The requirement for emissions tests would have had impacts on small garages providing WoFs/CoFs. On the one hand they are likely to have higher average costs of emission testing, which will make them less competitive than centralised testing stations in providing emission tests. On the other hand, undertaking emission tests is expected to increase the volume of work; this might allow them to cross-subsidise emissions testing and provide emission tests at more competitive prices.

1.2.3. Consequences of Failure

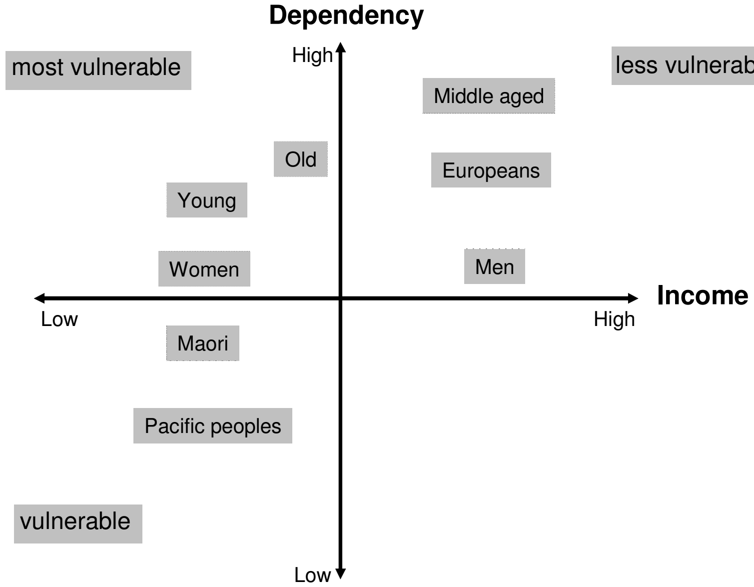
Failing a test can result in a requirement for repair costs, expected to vary widely from close to nothing to over $1,000. As a result of the required repair costs, some vehicle owners will choose not to repair their vehicle and face either the cost of a replacement or of living without a vehicle. In addition, there will be increased incentives to operate a vehicle without a warrant.

The impacts of a test failure will vary with the vulnerability of the household; key elements of vulnerability are income and vehicle dependency. Those most at risk are low income households—most likely to own a vehicle at risk of failure and least able to pay for the repairs—and those who rely on vehicles for their ongoing participation in work and other activities.

The analysis suggests that the communities at greatest risk are young and old people, particularly of Maori and Pacific descent (see Figure 1). Solo parents are likely to be at particular risk, particularly solo Maori or Pacific Island mothers. They have particularly low average household incomes and relatively high daily living costs. There are also risks for large families, related to the lower levels of disposable income and the number of people affected by a loss of vehicle. Overall, we expect the effects of the policy to be felt most severely in areas where such households are prevalent. Disabled people are also vulnerable because of lower incomes and difficulties in accessing other transport means.

The impacts of having to pay a significant bill for low income households include reductions in spending on other items or descending further into a spiral of debt. Studies on poverty in New Zealand have identified a range of implications for low income households including increased probability of eating poorly, not going to the doctor or dentist, reducing participation in recreational activities, reduced educational opportunities for children and living in unsuitable accommodation.

Figure 1: Ranking of Communities at Risk



Loss of a car can exclude households from many activities, including health visits, work, shopping, visiting friends and recreation. The difficulties relate particularly to centralised as opposed to distributed facilities. These include hospitals, educational facilities and supermarkets. Some of these issues are compounding problems for low income households:

- avoiding visiting doctors and dentists because of their costs is compounded by travel difficulties;
- reductions in transport options reduce employment opportunities;
- reduced access to supermarkets will often limit access to lower-priced and/or better quality food.

1.2.4. Policy Options

Policy options that might have been used to address some of the adverse effects of emissions screening programmes include those that reduced the costs of the screening programme itself. Subsequent policy decisions have resulted in a low cost approach. The other policy options remain relevant to the new analysis; they are measures to address vulnerabilities, eg through programmes that address household income or vehicle dependency.

There is a wide range of measures that, in combination, address issues related to the disconnection of people from their communities and the centrality of transport issues within this. The programmes of interest are those that address the vulnerability of communities, and household and individuals within them, to crises such as losing a vehicle and even to debt. They are examples of government programmes aiming to (re)build a sense of community and neighbourhood.

Smart Growth is the description for a range of initiatives in the US aimed at encouraging more compact cities, more use of public transport and a greater sense of community. These are integrated programmes with multiple objectives, but the underlying philosophy is one in which, via the increased interaction of people and the building of a better sense of community, people are more resilient to crises, they make choices which take more account of the external effects and there are benefits for the environment and the economy.

The UK Social Exclusion Unit has identified a number of measures related to social exclusion because of lack of access to transport. These include measures that[11]:

- improve physical accessibility and availability of public transport;
- make travel more affordable, eg concessionary fares, travel vouchers, public transport subsidies;
- provide better information on travel options;
- reduce the need to travel through land use planning, encouraging delivery of goods and services; and
- improve safety of streets and public transport.

These measures are all consistent with the objectives of the New Zealand Transport Strategy and other integrated government programmes such as the Sustainable Development Programme of Action[12]. They are long term measures that may reduce private vehicle dependency and the impacts of emissions screening programmes. However, we assume that they are part of the policy environment in which the emissions screening programme is introduced.

1.3. Scope and Structure of this Report

The remainder of this report is structured as follows:

- Section 2 provides technical definitions of the emissions standards underlying the proposed policy.
- Section 3 compares the age distribution of historic imports with the proposed standards to gauge the potential severity of the policy.
- Section 4 identifies the demographic, socioeconomic and geographic characteristics of consumers likely to be directly affected by the proposed standards.
- Section 5 characterises five consumer response scenarios, against which the economic and environmental effects of the policy are later estimated.

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[11] Social Exclusion Unit (2003) Making the Connections: Final Report on Transport and Social Exclusion. Office of the Deputy Prime Minister

[12] Sustainable Development for New Zealand. Programme of Action. January 2003. Department of Prime Minister and Cabinet.

- Section 6 discusses likely effects on vehicle markets and prices, as well as the implications for average fleet age.
- Section 7 presents the estimated economic and environmental impacts associated with each consumer response scenario.
- Section 8 describes the potential social impacts of the policy
- Section 9 provides a detailed analysis of the proposed policy and suggests other options that might better meet Government's objectives.

2. The Proposed Policy

This section briefly describes the emissions standards underlying the proposed alternative emissions policy.

2.1. Standards for Petrol Vehicles

The proposed standards for petrol vehicles are based on Japanese standards introduced between 2000 and 2002. The specific details are outlined below.

Table 2: Proposed Emissions Standards for Petrol Vehicles

Vehicle Type	Test Mode[13]	Year Enforced	Emissions Limits (g/km)		
			CO	HC	NO_x
Passenger Cars	10.15M	2000	0.67	0.08	0.08
Mini Buses	10.15M	2002	3.30	0.13	0.13
Light Commercials (GVM≤1.7t)	10.15M	2000	0.67	0.08	0.13
Medium Commercials (1.7t<GVM≤3.5t)	10.15M	2001	2.10	0.08	0.13

Table 2 shows that standards for petrol-driven vehicles differ by both vehicle type and weight. In particular, there is one standard for passenger cars, one for minibuses and two for commercial vehicles (that are differentiated by weight). However, since mini buses and light commercial vehicles jointly accounted for less than 1% of petrol imports over the last 6 years, we restrict attention in the remainder of this analysis to only cars and medium-duty commercials.

2.2. Standards for Diesel Vehicles

Two possible sets of standards are being considered for imported diesel vehicles. The first set was introduced between 1997 and 1999 (hereafter 'the 97/99 standard'), while the second was introduced between 2002 and 2004 (hereafter 'the 02/04 standard'). Table 3 presents the 97/99 standards.

Table 3: 1997/99 Diesel Standards

Vehicle Type	Test Mode	Year Enforced	Emissions Limits (g/km)			
			CO	HC	NO_x	PM
Passenger Cars						
- GVM<1250kg	10.15M	1997	2.10	0.40	0.40	0.08
- GVM>1250kg	10.15M	1998	2.10	0.40	0.40	0.08
Trucks & Buses						
- GVM<1700kg	10.15M	1997	2.10	0.40	0.40	0.08
- GVM>1700kg	10.15M	1997	2.10	0.40	0.70	0.09

As with petrol standards, diesel standards also differ by vehicle type and weight. Once again, however, since imports are dominated by only two of the four categories (namely

[13] 10.15M means the 10-15 mode test, which is commonly used in Japan. See http://www.dieselnet.com/standards/cycles/jp_10-15mode.html for further details.

cars with GVM >1250kg and commercials with GVM>1700kg), our analysis is restricted to only these types.

The 02/04 standards for diesel vehicles are presented in the table below.

Table 4: 2002/04 Diesel Standards

Vehicle Type	Test Mode	Year Enforced	Emissions Limits (g/km)			
			CO	HC	NO_x	PM
Passenger Cars[14]						
- GVM<1250kg	10.15M	2003	0.63	0.12	0.28	0.052
- GVM>1250kg	10.15M	2003	0.63	0.12	0.30	0.056
Trucks & Buses						
- GVM<1700kg	10.15M	2002	0.63	0.12	0.28	0.052
- GVM>1700kg	10.15M	2003	0.63	0.12	0.49	0.060

The categories used for the 02/04 standards match those of the earlier 97/99 standard, but with lower thresholds for each of type of emission.

[14] The standards for passenger cars were actually introduced in October 2002, but are treated as the beginning of 2003 for analytical purposes.

3. Likely Degree of Impact

This section compares the age distributions of historic imports with the 'effective age limits' imposed by the proposed policy to gauge its potential severity.

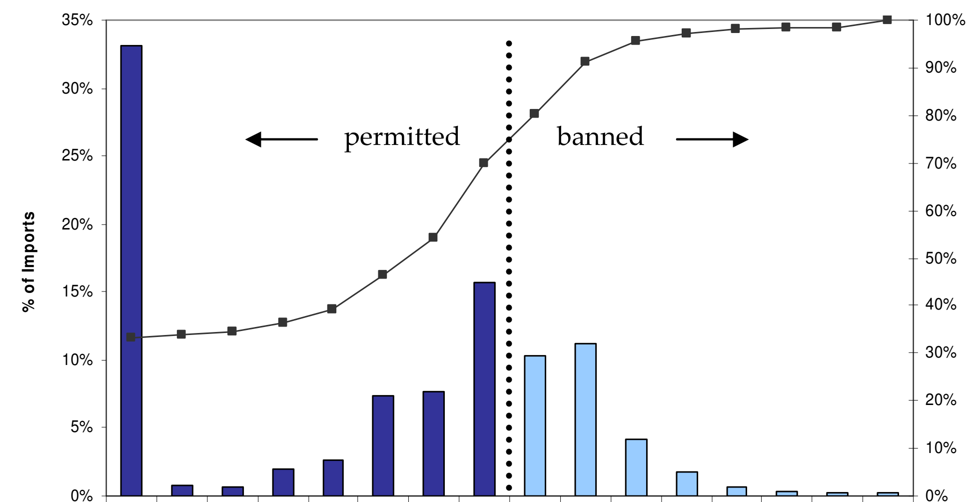
In this section, and throughout the remainder of this report, we assume the policy commences in 2007.

3.1. Petrol Cars

Figure 2 presents the age distribution of petrol cars imported between 2000 and 2005. The individual bars show the proportion of annual imports that fell into each age category, while the s-shaped curve shows the cumulative age distribution.[15]

According to Figure 2, around one-third of imported petrol cars were new and two-thirds were used.[16]

Figure 2: Age Distribution of Petrol Car Imports (2000-2005)



	new	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
annual	33%	1%	1%	2%	3%	7%	8%	16%	10%	11%	4%	2%	1%	0%	0%	0%
cumulative	33%	34%	35%	36%	39%	46%	54%	70%	80%	91%	96%	97%	98%	98%	99%	100%

Age of Car when Imported

Superimposed on this chart is a vertical dotted line. This divides the age distribution into two areas: vehicles that would be permitted under the proposed new rules, and vehicles that would not. The placement of this line (between ages seven and eight) for the first year of policy should be self-explanatory: in 2007, the oldest cars that can be

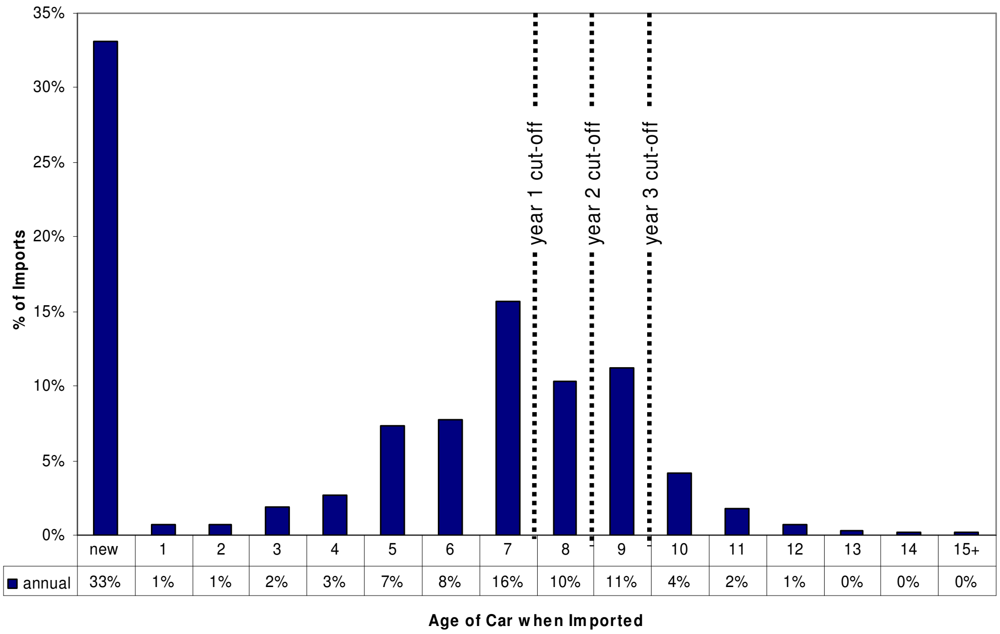
[15] This shows the percentage of imports that were a certain age *or younger* (at the time of import). Thus for petrol cars imported between 2000 and 2005, 70% of were 7 years or younger (and hence 30% were 8 years or older).

[16] There are noticeable jumps in the age distribution at three, five and seven years of age. These most likely reflect the timing of shaken renewals in Japan, which fall exactly at these times.

imported are those manufactured in 2000 *i.e.* those that are 7 years old. Anything older than this (*i.e.* 8 years of older) will be banned.[17]

It should also be clear that, because the proposed rules specify a minimum year of manufacture, rather than a maximum age, this threshold will change over time. Hence, in the second year of the policy, an 8-year age limit will be imposed, while in the following year a 9-year age limit will prevail. These rightward shifts are illustrated in the figure below.

Figure 3: Shifts in the Age Threshold over time



At the time of writing, the likelihood and/or frequency of any updates was uncertain. For the purposes of modelling, however, we have assumed annual updating of standards. The implications of this assumption are discussed on page 45.

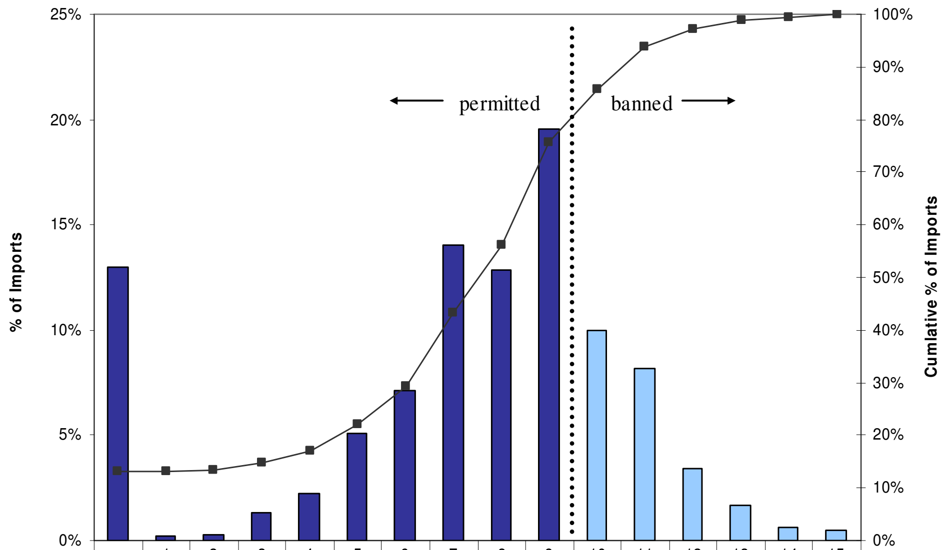
3.2. Diesel Cars[18]

Figure 2 presents the age distribution of diesel cars imported between 2000 and 2005. Once again, the individual bars show the proportion of annual imports that fell into each age category, while the s-shaped curve shows the cumulative age distribution.

[17] Please note that the proposed standards are not strictly age restrictions. On the whole, however, they can be interpreted as such, and this equivalence has been used throughout the analysis.

[18] This section corresponds only to diesel cars with a gross vehicle mass of 1250kg or greater.

Figure 4: Age Distribution of Diesel Car Imports (2000-2005)



	new	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
annual	13%	0%	0%	1%	2%	5%	7%	14%	13%	20%	10%	8%	3%	2%	1%	0%
cumulative	13%	13%	14%	15%	17%	22%	29%	43%	56%	76%	86%	94%	97%	99%	100%	100%

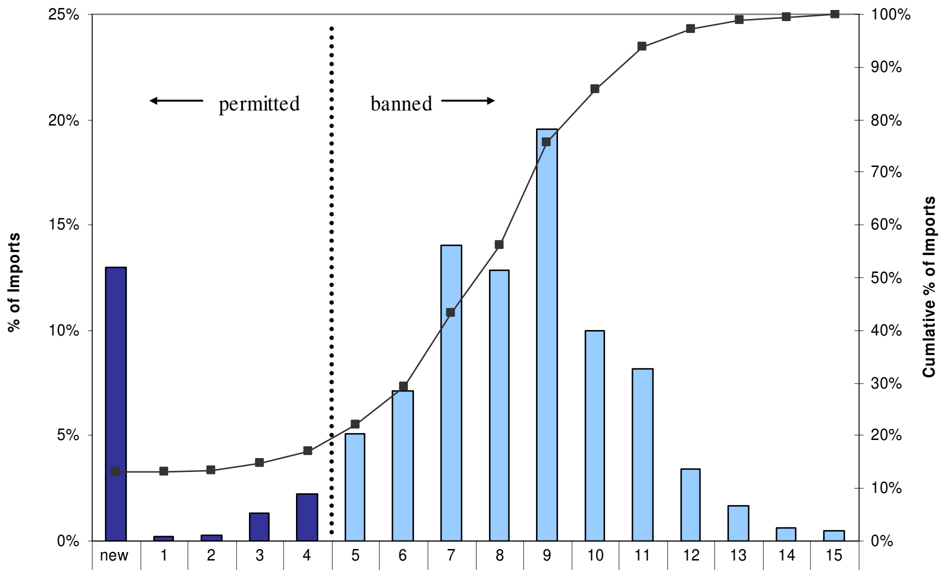
Age of Car when Imported

According to Figure 4, around 13% of all imported diesel cars were new, with the remaining 87% used. As with petrol cars, there are noticeable jumps in the age distribution at ages three, five and seven. There is an even larger spike again at 9 years. These most likely also reflect the effects of shaken requirements.

The exact placement of the dotted line separating permitted and banned future imports depends on the specific standard that is eventually adopted. Figure 4 is based on the 97/98 standard, which affects 24% of imports in year one, 14% in year two and 6% in year three.

Under the much-stricter 02/04 standard, which is depicted in Figure 5, the minimum manufacture date is 2003 for diesel cars. If adopted, this would affect 83% of diesel car imports in year one, 78% in year two and 71% in year three. Clearly, then, the choice of diesel standard has a significant bearing on the overall impacts of the policy.

Figure 5: Application of the 02/04 Standard



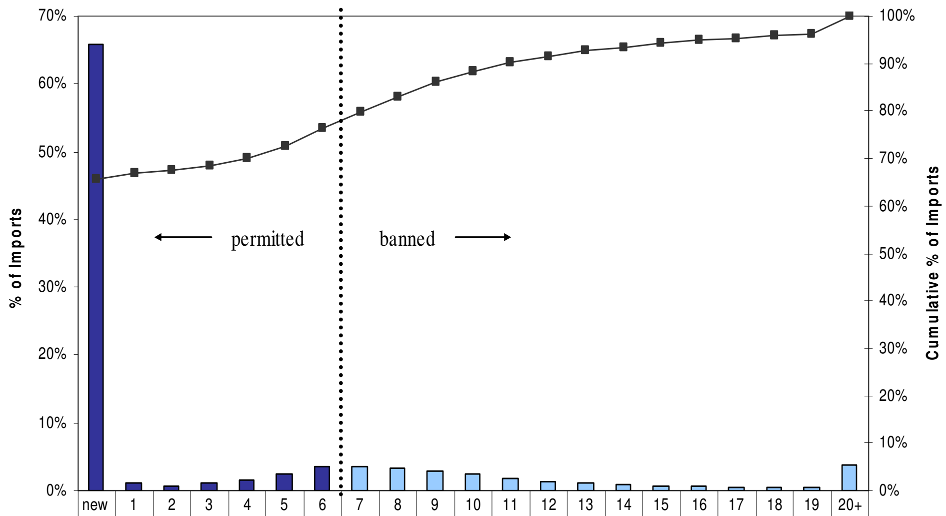
Age of Car when Imported	new	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
annual	13%	0%	0%	1%	2%	5%	7%	14%	13%	20%	10%	8%	3%	2%	1%	0%
cumulative	13%	13%	14%	15%	17%	22%	29%	43%	56%	76%	86%	94%	97%	99%	100%	100%

Age of Car when Imported

3.3. Petrol Commercial Vehicles[19]

Figure 2 shows the age distribution of petrol commercial vehicles imported between 2000 and 2005.

Figure 6: Age Distribution of Petrol Commercial Imports (2000-2005)



Age of Car when Imported	new	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20+
annual	66%	1%	1%	1%	2%	2%	4%	4%	3%	3%	2%	2%	1%	1%	1%	1%	1%	0%	0%	0%	4%
cumulative	66%	67%	67%	68%	70%	73%	76%	80%	83%	86%	88%	90%	92%	93%	93%	94%	95%	95%	96%	96%	100%

Age of Car when Imported

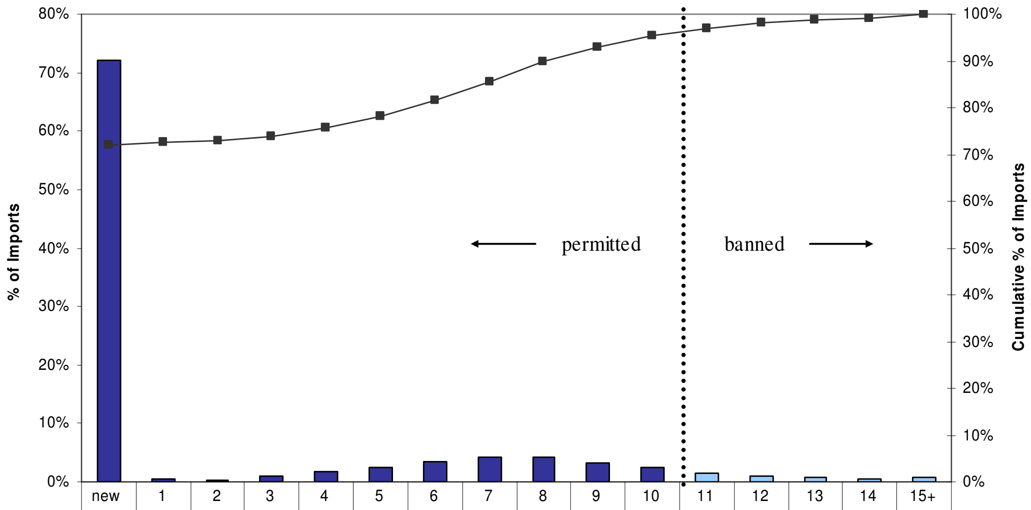
[19] This covers only petrol commercial vehicles with gross vehicle mass between 1.7 and 3.5 tonnes.

According to Figure 6, roughly two-thirds of all medium-duty commercials imported between 2000 and 2005 were new, and only a third were used. Under the proposed standard for this vehicle class, 24% of imports will be affected in year one, 20% in year two and 17% in year three.

3.4. Diesel Commercial Vehicles[20]

Finally, Figure 7 shows the age distribution of diesel commercial vehicles imported between 2000 and 2005.

Figure 7: Age Distribution of Medium-Duty Diesel Commercial Imports (2000-2005)



	new	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
annual	72%	1%	0%	1%	2%	2%	3%	4%	4%	3%	2%	2%	1%	1%	0%	1%
cumulative	72%	73%	73%	74%	76%	78%	82%	86%	90%	93%	95%	97%	98%	99%	99%	100%

Age of Car when Imported

According to this graph, nearly three-quarters (72%) of imported commercial vehicles were new, with only 28% used. If the 97/99 standard is adopted, only 5% of such imports will be affected in year one, 3% in year two and 2% in year three.

Under the 02/04 standard, 24% of imports will be affected in year one, 22% in year two and 18% in year three.

3.5. Summary of Potential Impacts

The table below summarises the proportion of each import type affected by the policy over the first three years (assuming no updates to the underlying standards).

[20] This covers vehicles with a gross vehicle mass between 1.7 and 3.5 tonnes.

Table 5: Proportion of Each Import Type Affected in Years 1 to 3

Vehicle Type	Standard	Proportion of Imports Affected		
		Year 1	Year 2	Year 3
Petrol Cars	00/02	30%	20%	9%
Petrol Commercial	00/02	24%	20%	17%
Diesel Cars	97/99	24%	14%	6%
Diesel Cars	02/04	83%	78%	71%
Diesel Commercial	97/99	5%	3%	2%
Diesel Commercial	02/04	24%	22%	18%

For each vehicle type and standard, the proportion of vehicles affected by the policy falls each year. Moreover, for diesel vehicles, there are significant differences between the impacts of the two possible standards. *e.g.* in year one, only 24% of diesel cars are affected by the 97/99, while 83% are affected by the 02/04 standard.

3.6. Proportion of Used Imports Affected

Before proceeding with the rest of the analysis, it is important to recognise that Table 5 represents the proportions of new *and* used imports affected by the policy. However, since new imported vehicles will always pass the standard, impacts will be borne solely by used imports. The figures above therefore distort the likely impact of the policy on the used import market.

A more accurate indicator of potential impact is the proportion of used imports affected by the proposed standards, which are tabulated below.

Table 6: Proportion of Used Imports Affected in Years 1 to 3

Vehicle Type	Standard	Proportion of Imports Affected		
		Year 1	Year 2	Year 3
Petrol Cars	00/02	45%	30%	13%
Petrol Commercial	00/02	71%	59%	50%
Diesel Cars	97/99	28%	16%	7%
Diesel Cars	02/04	95%	90%	82%
Diesel Commercial	97/99	18%	11%	7%
Diesel Commercial	02/04	86%	79%	64%

Whereas Table 5 suggested that roughly 30% of petrol car imports would be affected in year one, Table 6 translates this to show that 45% of used imports will be affected. These translations are most pronounced for diesel commercials, where the figures in Table 6 are almost four times those in the preceding table.

It should be clear, in light of these revised numbers, that the policy will have dramatic effects on the market for used imported vehicles.

Finally, as a matter of context, Figure 8 translates the percentages in Table 6 to show the total number of imports that would have been affected in 2004 if similar restrictions had been in place at the time.

Figure 8: Number of Imports Affected in 2004 (using 97/99 diesel standard)

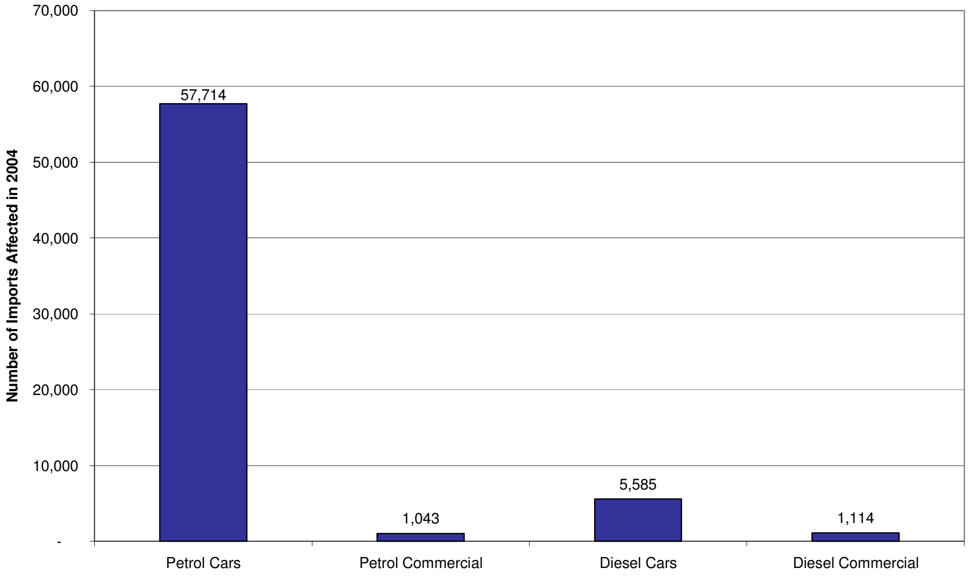


Figure 8 clearly shows that petrol cars account for the majority (88%) of imports affected by the proposed standards, followed by diesel cars (9%) then diesel and petrol commercial vehicles (2% and 1% respectively).

4. Identification of ‘At-Risk’ Groups

This section presents a detailed analysis of ‘at-risk’ groups based on the New Zealand motor vehicle register.

4.1. Objectives

Although the policy will have far-reaching effects, consumers prevented from buying a used import as a result will be most ‘at-risk’. In this section, we seek to identify the demographic and socio-economic characteristics of these people, as well as where they live.

This is done by analysing the characteristics of people that bought used Japanese imports in 2004 that *would* have been banned if similar restrictions were in place at the time.

4.2. Scope

Although the policy will affect passenger vehicles and goods vehicles, this analysis is confined to passenger vehicles only. The reasons are that:

- Passenger vehicles comprise the overwhelming majority of used imports.[21]
- There is no reliable information on the identity, scale and nature of businesses that purchase used imported commercial vehicles (unlike for passenger vehicles)
- Commercial organisations may have scope to pass on costs imposed by the policy, whereas private individuals do not.

4.3. Data

The motor vehicle register lists every passenger (and goods) vehicle registered in New Zealand at any given point in time. A snapshot of this (as at 1/1/2005) was obtained during stage of this project. It was then “geo-coded”, so that the precise geographic location of each vehicle (and its owner) was known. These geographic identifiers were then used to link the register to census information, so that socioeconomic and demographic elements could be added to the analysis. This final data set – comprising both census and the geo-coded register – forms the basis of the analysis presented in this section.

4.4. Approach

The motor vehicle register lists numerous details about each vehicle, four of which were critical to identifying affected parties. They were:

- *First NZ Registration Date* – the date at which the vehicle was first registered in New Zealand.

[21] 95% of used imports first registered in 2004 were passenger vehicles.

- *Import Status* – whether the vehicle was "new", "used" or "re-registered" at last registration.

- *Previous Country* – the previous country in which the vehicle was registered.

- *Year of Manufacture* – used to determine age at the time of import.

Using these fields, the data was restricted to "used Japanese vehicles first registered in NZ in the last 12 months that would have been banned if similar restrictions were in place at the time."

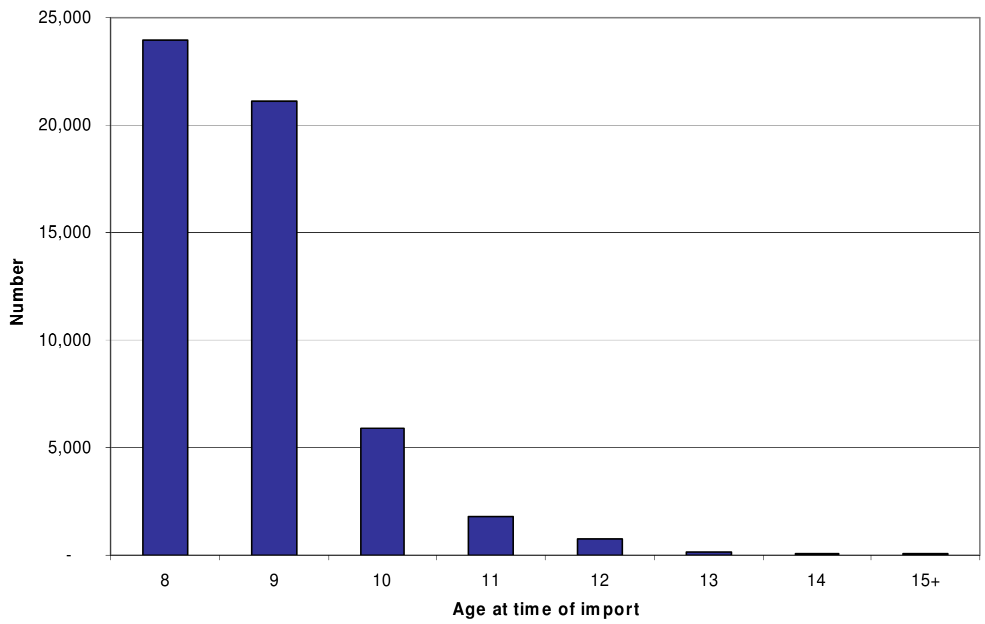
Because the proposed standards differ between petrol and diesel vehicles, the data was then divided into (i) petrol vehicles and (ii) diesel vehicles.

The characteristics of people that bought each type, as well as their geographic location, were directly read from the register and associated census information.[22] The results are presented below.

4.5. Results – Petrol Cars

According to the register, 122,503 used Japanese petrol cars were first registered in New Zealand in 2004. Of these, nearly 54,000 were aged 8 years or older at the time of import.[23] The age distribution of this group is presented below.

Figure 9: Age Distribution of Banned Petrol Cars



[22] We acknowledge that vehicles may have changed owners between being imported and the date at which the register snapshot was taken (1/1/2005). However, by restricting attention to only those vehicles imported over the previous 12 months, such occurrences should be relatively infrequent.

[23] A further 7,300 fell into this category but were missing information in one or more required fields.

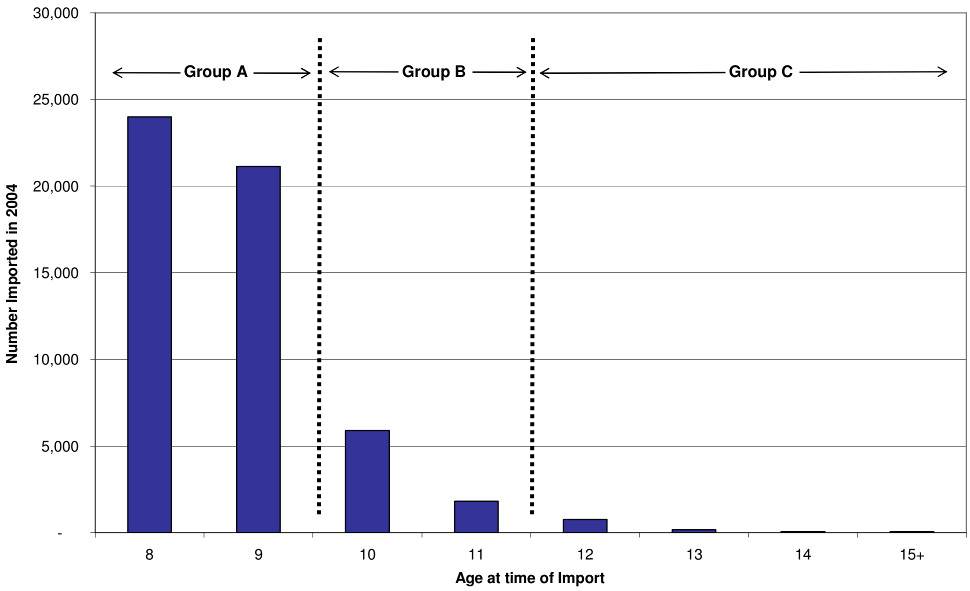
Figure 9 shows that the vast majority of petrol cars banned under the proposed rules would be 8 or 9 years old at the time of import. This is positive from a policy perspective, as it means many at-risk parties could feasibly upgrade to a 7-year old car and stay within their budget (albeit at the expense of certain features etc).[24] Those buying vehicles 10 years or older will have considerably more trouble finding a 7-year old car within their budget.

Extending this logic further, we segment at-risk parties into three sub-groups:[25]

- Group A: those buying 8-9 year old cars. (84%)
- Group B: those buying 10-11 year old cars (14%)
- Group C: those buying cars aged 12 years or older. (2%)

The classification of these groups, which underlie the remainder of this analysis, is illustrated below.

Figure 10: Classification of At-Risk Groups



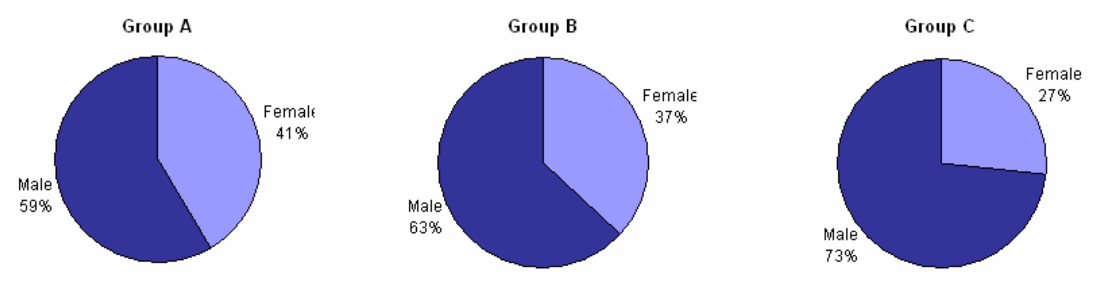
4.5.1. Gender of At-Risk Parties

Figure 11 presents gender splits for the three sub-groups.

[24] See Appendix 2 for the sorts of tradeoffs that consumers might face in this situation.

[25] It should be clear that Group C individuals are at higher risk than Group B, who themselves are at higher risk than Group A. Moreover, it is important to note that 'at-risk' does not imply vulnerability. The latter is a function of both risk *and* the ability to mitigate risk. In most cases, the ability to mitigate is a function of discretionary household income. These issues are discussed in detail later in this report.

Figure 11: Gender of At-Risk Groups



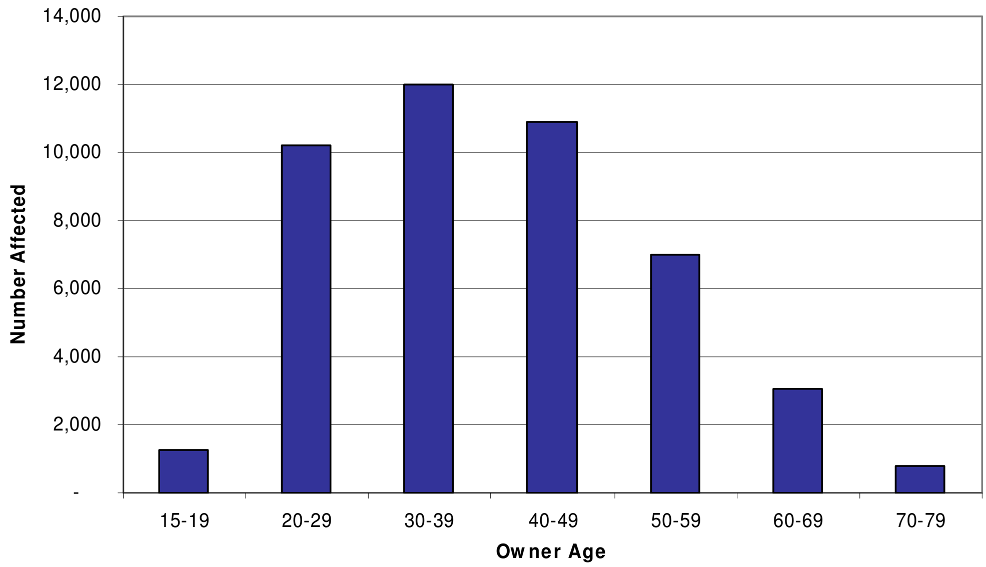
Men dominate all three sub-groups, particularly Group C (the highest risk group). To a large extent, this simply reflects the fact that men have much higher rates of vehicle ownership than women.[26]

4.5.2. Age

Figures 9 to 11 present the age distributions of Groups A, B and C.

As illustrated below, people aged 30-39 comprise the largest share of all three sub-sets, followed by 40-49 then 20-29. People at the age extremes (15-19 and 70-79) account for very small shares within each group.

Figure 12: Age Distribution of Group **A**



[26] According to the vehicle register as at 1/1/2005, nearly two-thirds of all cars are owned by men.

Figure 13: Age Distribution of Group **B**

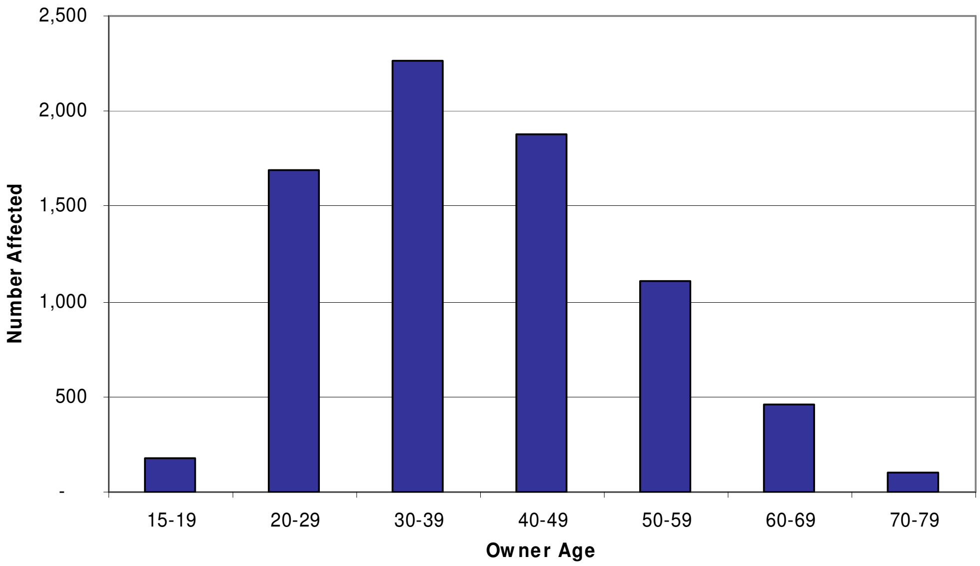
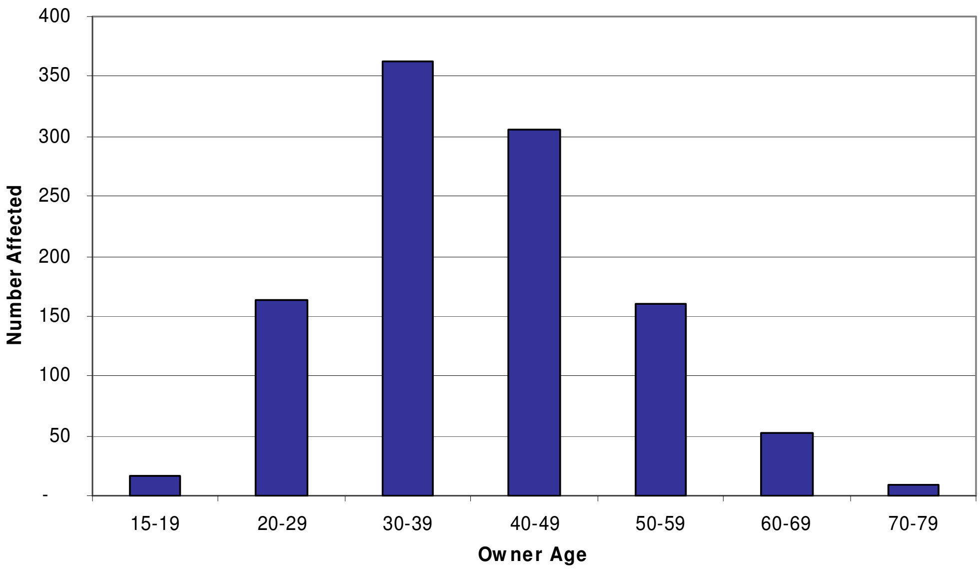


Figure 14: Age Distribution of Group **C**



4.5.3. Geography

Table 7 presents the geographic spread of at-risk consumers. Aucklanders clearly dominate, accounting for 42% of at-risk consumers. Next is Canterbury (on 14%), followed by Wellington and Waikato (9% each). But to what extent do these distributions simply reflect differences in regional population? Table 8 addresses this question by translating figures into per capita terms (incidence per 100,000 population).

Table 7: Geographic Spread

Region	Group A	Group B	Group C	Total	(%)
Auckland	19,204	3,044	399	22,647	42%
Bay of Plenty	2,253	382	61	2,696	5%
Canterbury	6,407	1,203	151	7,761	14%
Gisborne	332	73	16	421	1%
Hawke's Bay	1,518	258	48	1,824	3%
Manawatu-Wanganui	1,633	320	56	2,009	4%
Marlborough	302	72	13	387	1%
Nelson	537	125	18	680	1%
Northland	251	50	5	306	1%
Otago	2,038	355	46	2,439	5%
Southland	763	198	30	991	2%
Taranaki	746	129	17	892	2%
Tasman	350	69	4	423	1%
Waikato	4,196	616	100	4,912	9%
Wellington	4,272	724	92	5,088	9%
West Coast	313	73	14	400	1%
Total	45,115	7,691	1,070	53,876	100%

Table 8 shows that Auckland's dominance is not merely a function of its larger population - it has the highest rate per capita in total (and within Group A). Nelson has the highest per capita incidence of Group B consumers, while West Coast leads for Group C. Northland is significantly under-represented across all three groups.

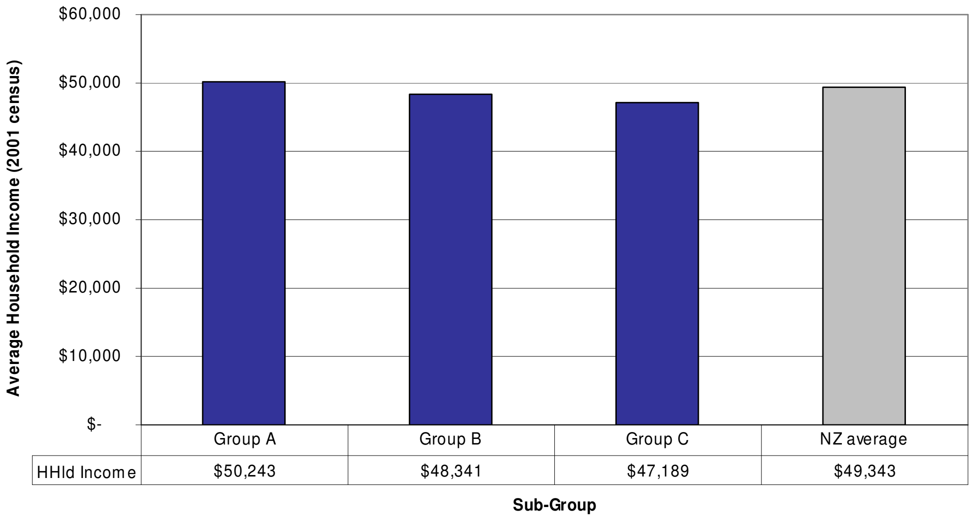
Table 8: Incidence per 100,000 population

Region	Group A	Group B	Group C	Total
Auckland	1,657	263	34	1,954
Bay of Plenty	941	160	25	1,126
Canterbury	1,331	250	31	1,612
Gisborne	755	166	36	957
Hawke's Bay	1,062	180	34	1,276
Manawatu-Wanganui	742	145	25	913
Marlborough	763	182	33	978
Nelson	1,292	301	43	1,636
Northland	179	36	4	218
Otago	1,123	196	25	1,344
Southland	838	218	33	1,089
Taranaki	725	125	17	867
Tasman	846	167	10	1,023
Waikato	1,173	172	28	1,373
Wellington	1,008	171	22	1,201
West Coast	1,033	241	46	1,320

4.5.4. Average Household Income

Figure 15 presents the average household incomes of at-risk parties (as well as the New Zealand average). It shows that the income of Group A households sits above the New Zealand average, while the household income of Groups B and C fall below it.

Figure 15: Average Household Incomes



The following graph reveals the income distributions underlying these averages.

Figure 16: Distributions of Average Household Incomes

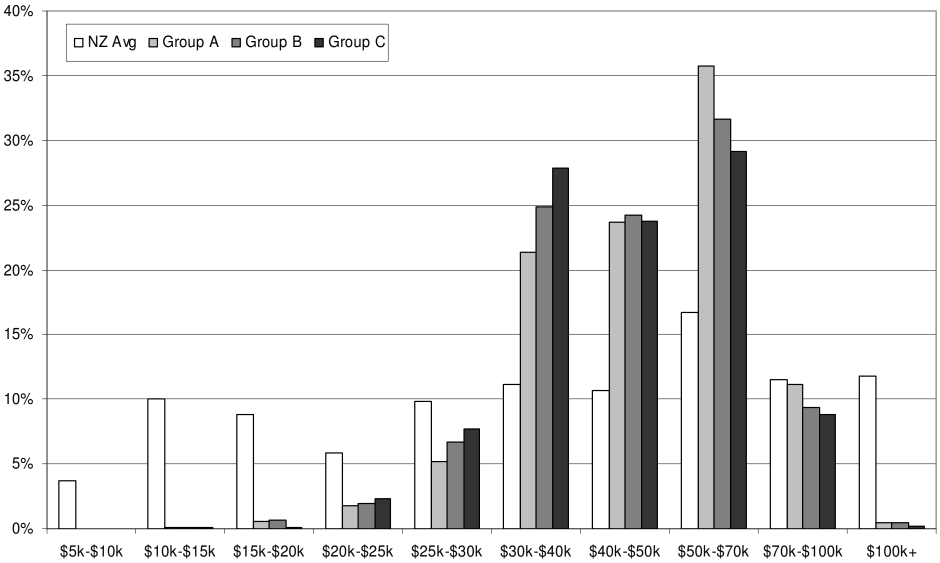


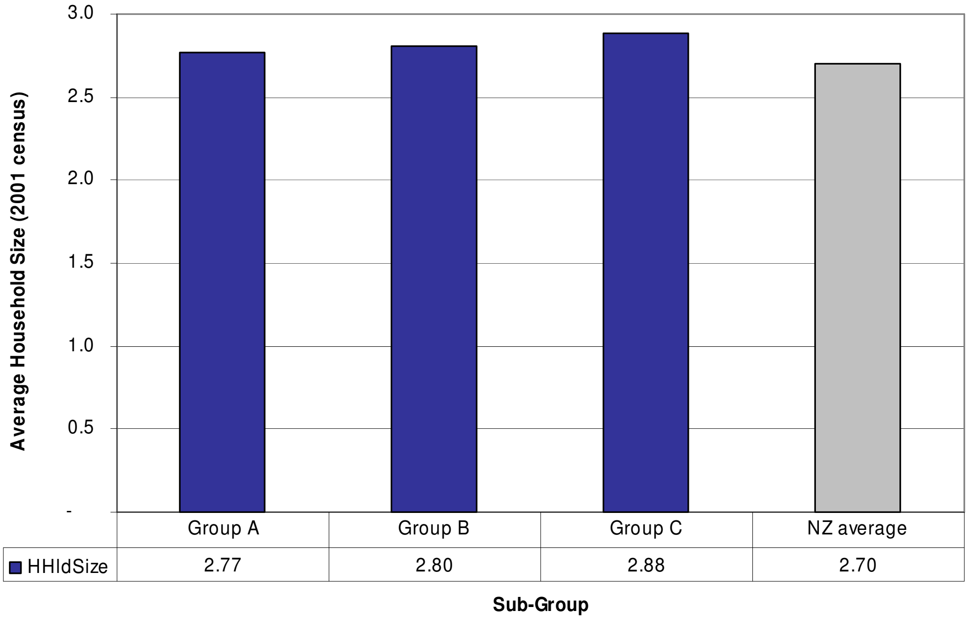
Figure 16 shows that the vast majority of at-risk household fall near the middle of the income distribution, with very few at either extreme. Thus, while at-risk consumers generally have lower-than-average incomes, they are more representative of mid-lower socioeconomic groups, not very low socio-economic.

We note in passing that income comparisons such as these can be misleading. The actual spending power of households depends not only on income, but also on household size. Accordingly, the next section examines the average household sizes of at-risk groups.

4.5.5. Average Household Size

Average household sizes are compared with the New Zealand average below.

Figure 17: Average Household Size

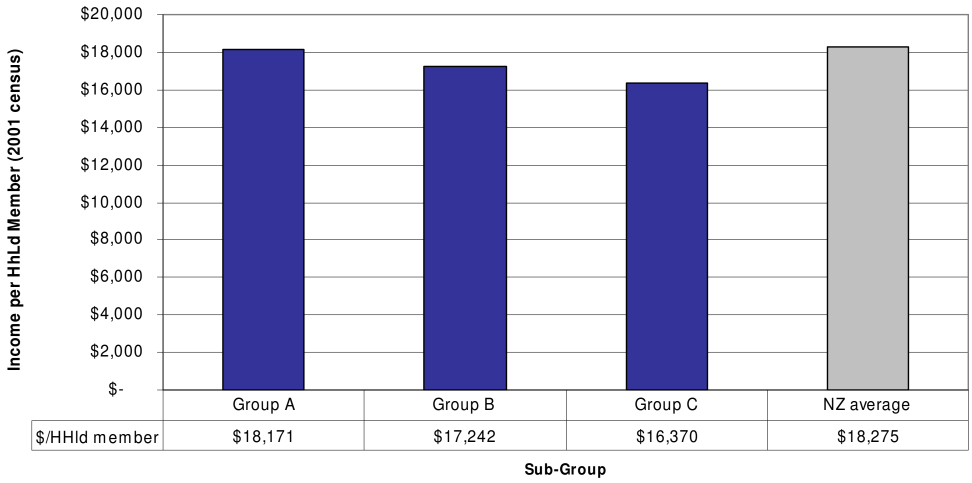


According to Figure 17, the average household size of all groups exceeds the New Zealand average. Coupled with the findings in Figure 15 (*i.e.* that average household incomes fall short of the NZ average), this implies considerably lower spending power amongst at-risk parties.

The following figure combines average household income with average household size to further explore this notion.

Once household size is controlled for, the spending capacity of all at-risk groups falls below the NZ average. For households belonging to Group C, income per household member is more than 10% below the average. This suggests a limited ability to mitigate potential policy impacts.

Figure 18: Income per Household Member



4.5.6. Family Composition

According to Table 9, at-risk parties are more likely to be solo parents than the NZ average and less likely to be couples without children. This further reinforces the earlier observation that at-risk households may have lower spending power to offset any effects on vehicles prices.

Table 9: Family Compositions

Degree	Group A	Group B	Group C	NZ Avg
No Kids	37%	36%	36%	39%
Couple w/children	42%	42%	42%	42%
Solo Parents	20%	22%	23%	19%
Total	100%	100%	100%	100%

4.5.7. Summary

Based on the profiling information outlined above, we conclude that the people/households most likely to be directly affected by the policy are:

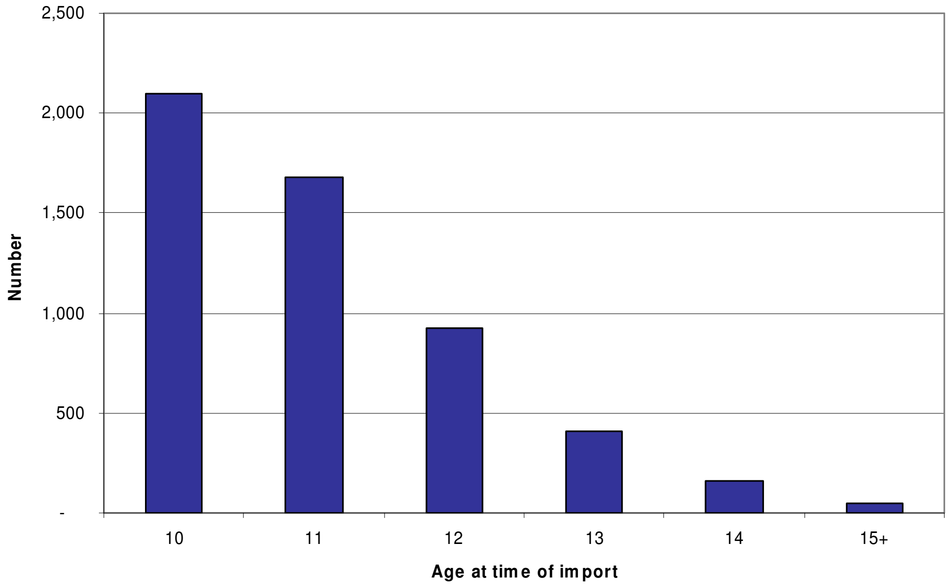
- Middle-aged males
- from all across New Zealand,
- with below-average incomes, and
- larger-than-average household sizes

4.6. Results – Diesel Cars

According to the register, 19,825 used Japanese diesel cars were first registered in New Zealand in 2004. Of these, over 5,300 were aged 10 years or older at the time of import.[27] The age distribution of this group is presented below.

[27] A further 800 fell into this category but were missing information in one or more required fields.

Figure 19: Age Distribution of Banned Diesel Cars



According to Figure 19, over 70% of diesel cars banned under the proposed rules would be 10 or 11 years old at the time of import. Once again, this is a positive finding, as it implies many at-risk parties could feasibly overcome restrictions by upgrading to a 9-year old car (which would be permitted under the proposed standards).

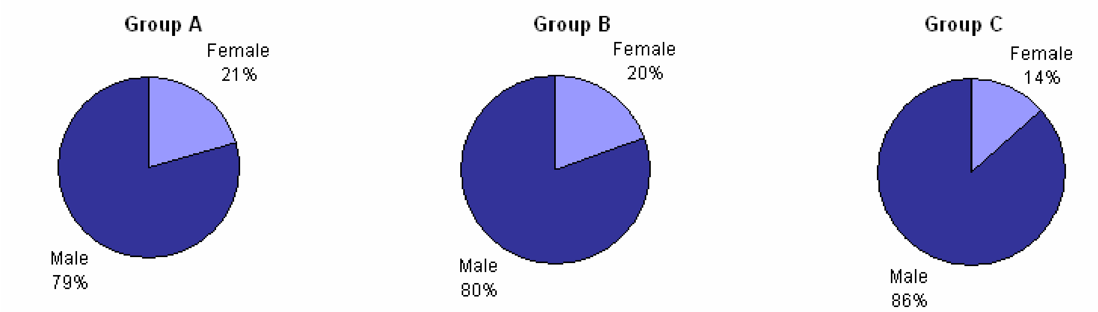
As with the analysis of banned petrol cars, we once again segment at-risk parties into three sub-groups:

- Group A: those buying 10-11 year old cars. (71%)
- Group B: those buying 12-13 year old cars (25%)
- Group C: those buying cars aged 14 years or older. (4%)

4.6.1. Gender of At-Risk Parties

Figure 20 presents gender splits for the three sub-groups.

Figure 20: Gender of At-Risk Groups



Male dominance of ownership is even stronger for banned diesel cars than for banned petrol cars.

4.6.2. Age

Figures 18 to 20 present the age distributions of Groups A, B and C.

Except for Group A, where 40-49 year olds are marginally higher, people aged 30-39 tend to own the largest proportion of banned diesel cars than any other age group. As with petrol vehicles, people at the age extremes (15-19 and 70-19) account for very small shares within each group. Indeed, there are no 15-19 year olds in Group C.

Figure 21: Age Distribution of Group **A**

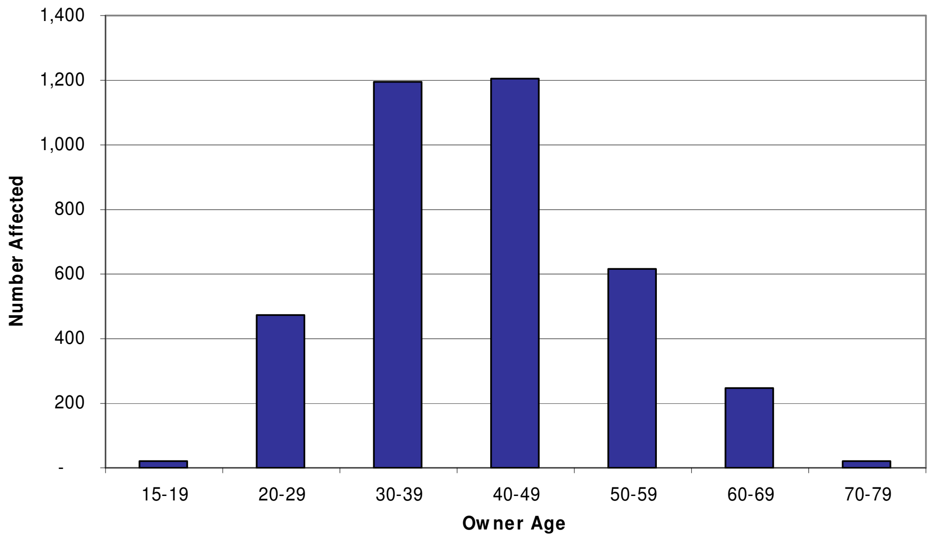


Figure 22: Age Distribution of Group **B**

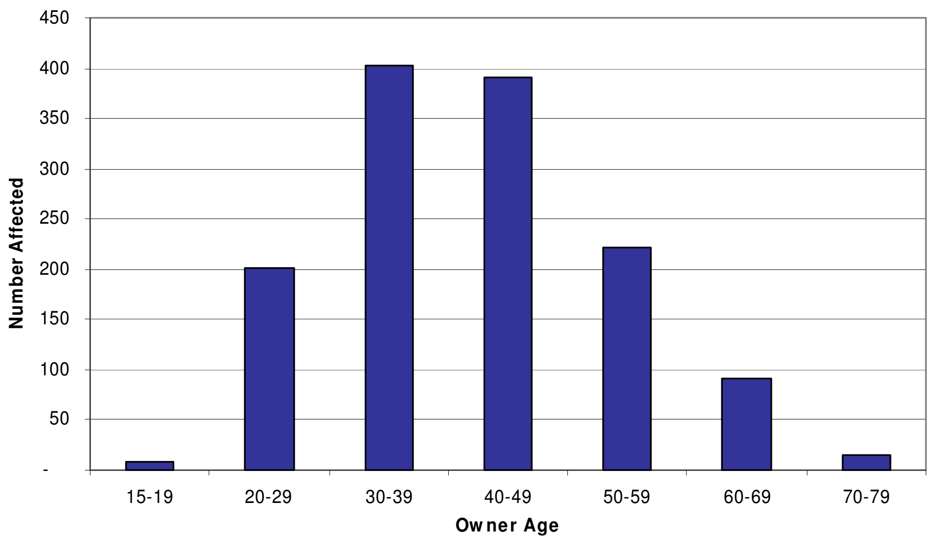
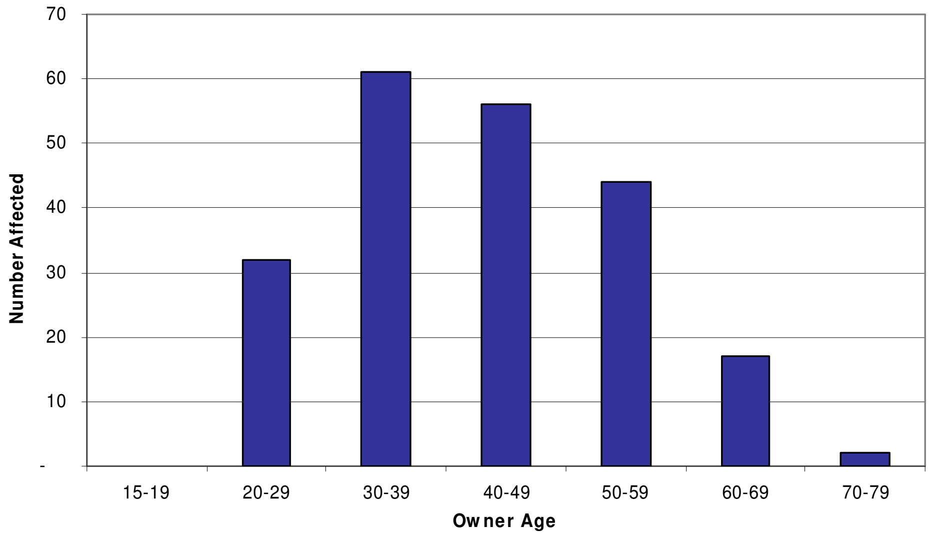


Figure 23: Age Distribution of Group **C**



4.6.3. Geography

Table 10 presents the geographic spread of at-risk groups. Aucklanders lead, accounting for 30% of at-risk consumers. Next is Canterbury (on 22%), followed by Wellington and Waikato (8% each). Table 11 translates these figures into per capita terms (incidence per 100,000 population) to account for differences in regional population.

Table 10: Geographic Spread

Region	Group A	Group B	Group C	Total	(%)
Auckland	1130	397	50	1,577	30%
Bay of Plenty	218	62	8	288	5%
Canterbury	822	286	45	1,153	22%
Gisborne	30	9	1	40	1%
Hawke's Bay	116	33	8	157	3%
Manawatu-Wanganui	183	54	7	244	5%
Marlborough	60	34	9	103	2%
Nelson	60	22	7	89	2%
Northland	29	14	2	45	1%
Otago	235	92	15	342	6%
Southland	101	55	5	161	3%
Taranaki	88	18	7	113	2%
Tasman	52	30	6	88	2%
Waikato	280	118	19	417	8%
Wellington	312	87	15	414	8%
West Coast	64	20	8	92	2%
Total	3,780	1,331	212	5,323	100%

Once population is controlled for, West Coast dominates, followed by Marlborough and Canterbury. This is consistent with the view that older cars tend to reside in the South Island. In fact, the seven highest regions are in the South Island.

As with petrol cars, people in Northland have a significantly lower propensity to own cars that would be banned under the proposed rules than any other region. One possible explanation might be that Northlanders prefer to purchase vehicles from the existing (domestic) fleet rather than purchase a used import, but the precise reason remains unknown.

Table 11: Incidence per 100,000 population

Region	Group A	Group B	Group C	Total
Auckland	98	34	4	136
Bay of Plenty	91	26	3	120
Canterbury	171	59	9	239
Gisborne	68	20	2	91
Hawke's Bay	81	23	6	110
Manawatu-Wanganui	83	25	3	111
Marlborough	152	86	23	260
Nelson	144	53	17	214
Northland	21	10	1	32
Otago	129	51	8	188
Southland	111	60	5	177
Taranaki	86	17	7	110
Tasman	126	73	15	213
Waikato	78	33	5	117
Wellington	74	21	4	98
West Coast	211	66	26	304

4.6.4. Average Household Income

Figure 24 shows the average household incomes of at-risk parties, all of which fall below the New Zealand average.

Figure 24: Average Household Incomes

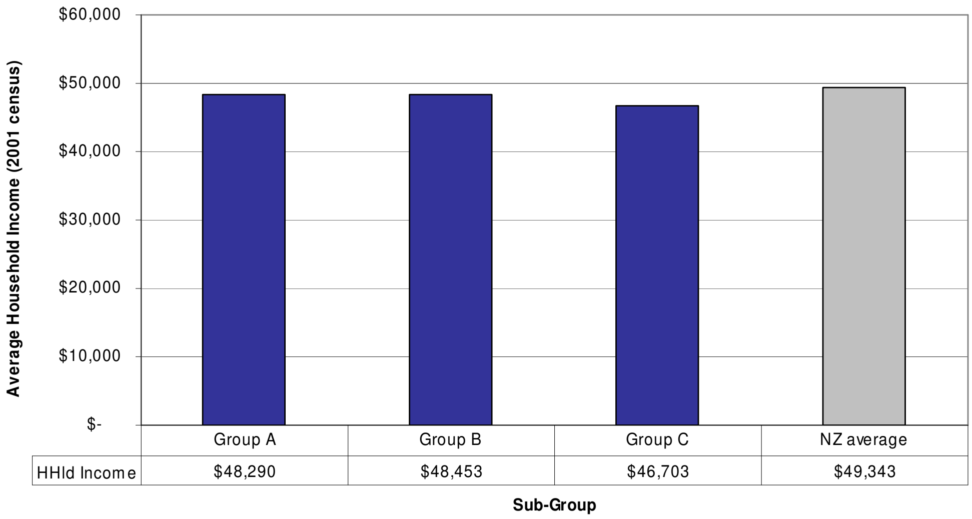


Figure 25 presents the income distributions underlying these averages.

Figure 25: Distributions of Average Household Incomes

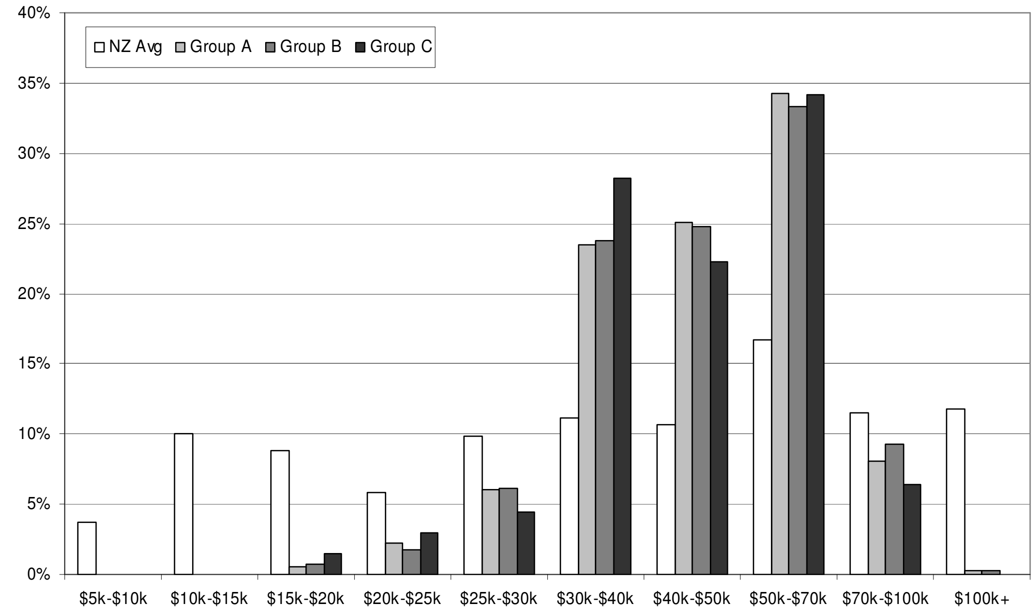
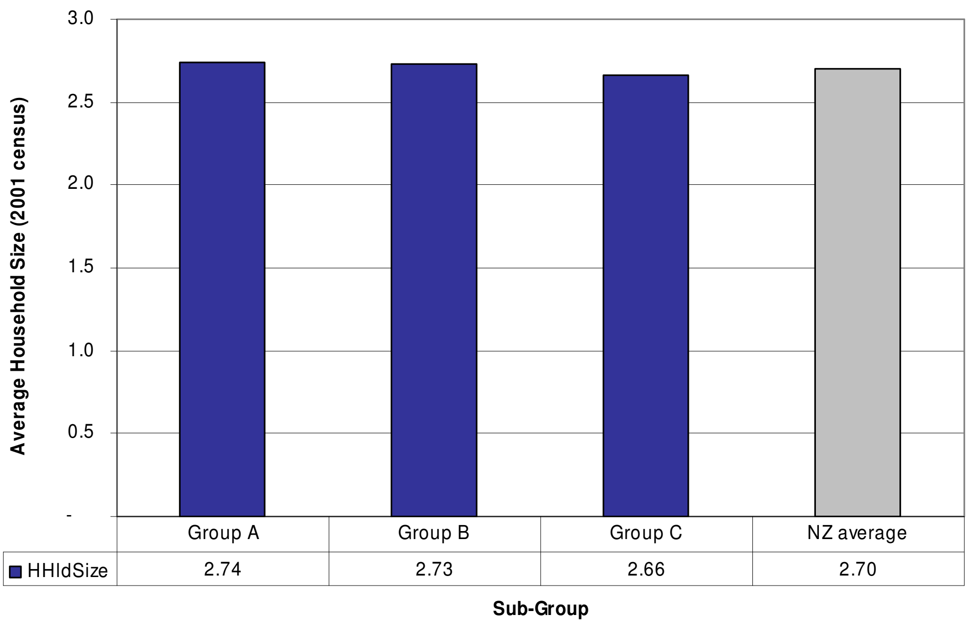


Figure 25 shows that, like households owning at-risk petrol cars, the vast majority of at-risk diesel car household fall near the middle of the income distribution, with very few at either extreme. This once again implies that at-risk households more represent mid-lower socioeconomic groups, not very low socio-economic.

4.6.5. Average Household Size

Average household sizes are compared with the New Zealand average below.

Figure 26: Average Household Size



Group A and Group B households are slightly larger than the New Zealand average, while Group C households are marginally smaller.

4.6.6. Family Composition

The family composition of households owing at-risk diesel cars is representative of the New Zealand average.

4.6.7. Summary

Based on the profiling information outlined above, we conclude that the people/households most likely to be affected by the policy are:

- Middle-aged males
- from all across New Zealand,
- with below-average incomes
- and average household sizes

4.7. Consumer Flow-on Effects

This section has helped identify the characteristics of consumers likely to be directly affected by the policy. However, it is important to recognise that effects will extend well beyond this group. Indeed, a number of other consumers will also be affected. A brief discussion of flow-on effects is provided in section 6.

5. Consumer Response Scenarios

The social, economic and environmental effects of the policy depend critically on the response of consumers.[28] For example, if most 'affected' consumers end up purchasing a newer import than they would have otherwise, the overall effects will be positive. However, if most end up holding on to their existing vehicle instead, the overall effects will be negative.

For any given consumer, the probability of upgrading to a newer import depends on a number of factors. Most importantly, it depends on the expected difference in cost between the import they planned to purchase and an import that meets the standard.

Extending this logic, we have derived a range of response scenarios in which the probability of upgrading varies across consumer groups. The groupings used for this exercise are the 'at-risk' groups identified in section 4. Thus, group A (whose preferred imports were only one or two years older than the standard), are more likely to upgrade than group B (whose preferred imports were three or four years older than the standard) and so on.

Following are definitions of the five response scenarios. Please note that the first two scenarios are somewhat radical, and have been included only to identify extreme outcomes. The remaining three scenarios are more closely aligned with expected outcomes and should thus be given more weight.

The fuel and emissions effects associated with each scenario are modelled in section 7, while a high-level discussion of the effects on vehicle markets and prices is provided in the following section.

5.1. Scenario 1: Complete Upgrade

Under this response scenario, every person prevented from buying a used import upgrades to a newer one. This is represented in the model by the following input parameters.

Table 12: response parameters

Group	Upgrade	Retain
A	100%	0%
B	100%	0%
C	100%	0%

5.2. Scenario 2: Complete Exit from Market

Under this response scenario, every person prevented from buying a used import exits the market and holds on to their existing vehicle. This is represented in the model as follows:

[28] While supply-side responses are also important, supply tends to be shaped by demand. .Focusing on demand-side responses therefore seems reasonable.

Table 13: response parameters

Group	Upgrade	Retain
A	0%	100%
B	0%	100%
C	0%	100%

5.3. Scenario 3: Low Upgrade Rate

Under this scenario, relatively few consumers upgrade, with most choosing to retain their existing vehicle. In addition, a handful of people scrap their existing vehicle without purchasing an upgraded import. This has the effect of reducing overall fleet size.[29] The parameter values underlying this scenario are outlined below.

Table 14: response parameters

Group	Upgrade	Retain	Scrap
A	40%	60%	0%
B	20%	75%	5%
C	0%	90%	10%
Weighted Average	36%	63%	1%

5.4. Scenario 4: Medium Upgrade Rate

This is similar to scenario 3, but with different parameter values (as illustrated below).

Table 15: response parameters

Group	Upgrade	Retain	Scrap
A	70%	30%	0%
B	40%	55%	5%
C	10%	80%	10%
Weighted Average	64%	35%	1%

5.5. Scenario 5: High Upgrade Rate

Under this scenario, there is a high propensity to upgrade, with relatively few retaining their existing vehicle. The proportion of consumers scrapping (without upgrade) is the same as in scenarios three and four.

Table 16: response parameters

Group	Upgrade	Retain	Scrap
A	90%	10%	0%
B	60%	35%	5%
C	25%	65%	10%
Weighted Average	84%	15%	1%

[29] Some of these consumers may purchase a replacement vehicle from the existing fleet. However, total fleet size will still fall as the vehicle being scrapped is not replaced by new entry to the fleet.

6. Effects on Vehicle Markets, Prices & Ages

In this section we sketch the likely effects of the policy on vehicles markets and vehicle prices. For the most part, this discussion is based on response scenarios one and two. The remaining scenarios are ignored as they are basically blends of these.[30]

6.1. Effects of Scenario 1: Complete Upgrade

In this scenario, imports banned under the new rules are offset by an influx of so-called 'replacement imports'. Replacement imports cater for those that would otherwise have bought a 'banned' import. Thus, by definition, they are newer than the vehicles they replace. However, they must also be similarly-priced; otherwise they will not be credible substitutes.

In order to be newer but similarly-priced, replacement imports are typically lower quality, lower spec or smaller engine size than the vehicles that they replace.

6.1.1. Effects on Import Market

Since both the annual volume and average price of imports remain unchanged, effects on the import market will be relatively minor.[31]

In terms of a supply and demand diagram, the basic picture remains unchanged (hence why prices and volumes are unchanged). The key difference is the *characteristics* of vehicles that comprise both curves. They are newer than before, but of a lower overall size and/or quality.

Aside from quality adjustments, the only other way that supply costs can be contained (to facilitate import upgrades) is via a squeeze on margins.[32] The extent of margin squeezes will determine the extent to which the industry becomes more concentrated.[33] Even small reductions in average margins may be enough to put some importers out of business.

6.1.2. Effects on Domestic Market

Since no consumers are displaced from the import market (by definition), there will be little flow-on effect in the domestic market. Overall, the prices of existing vehicles and the rates of scrappage are expected to remain unchanged.

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[30] A discussion of the 'scrap' option embedded in scenarios 3 to 5 is provided at the end of this section.

[31] The assertion that average prices remain unchanged is a necessary condition for the replacement import effect to hold. If average prices increased, for example, not all consumers would upgrade.

[32] In reality, both effects are likely to come into play. In other words, cars will be smaller, of a lower average quality, and sold at lower margins.

[33] Higher concentration means that larger firms account for an increased share of market demand. It often translates to reduced competition and, therefore, less competitive pricing.

6.1.3. Effects on Fleet Age

Since replacement imports are newer than banned imports, and because the scrappage rate remains unchanged, the average age of the fleet will most likely fall relative to the base case. But to what extent?

To find out, we simulated the effects of the scenario using the vehicle fleet emissions model (VFEM). This allowed us to estimate the likely magnitude of age changes, which are presented in the table below.

Table 17: Average Ages of the Fleet by Fuel Type

	Petrol		Diesel	
	Base	Scenario	Base	Scenario
Year 1	11.90	11.82	12.96	12.89
Year 2	11.84	11.72	13.13	13.04
Year 3	11.80	11.66	13.28	13.18

Table 17 shows how average fleet ages are expected to evolve under the base case and under the scenario. For both fuel types – petrol and diesel – age restrictions reduce average fleet ages. The reasons for this are illustrated in the following two diagrams.

Figure 27: Age Distribution of Cars in Year 1

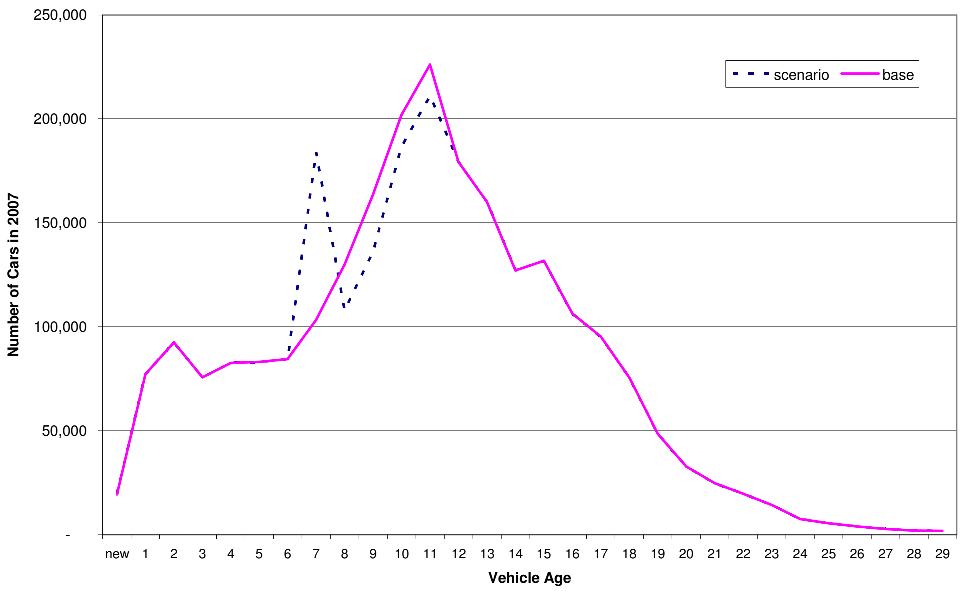
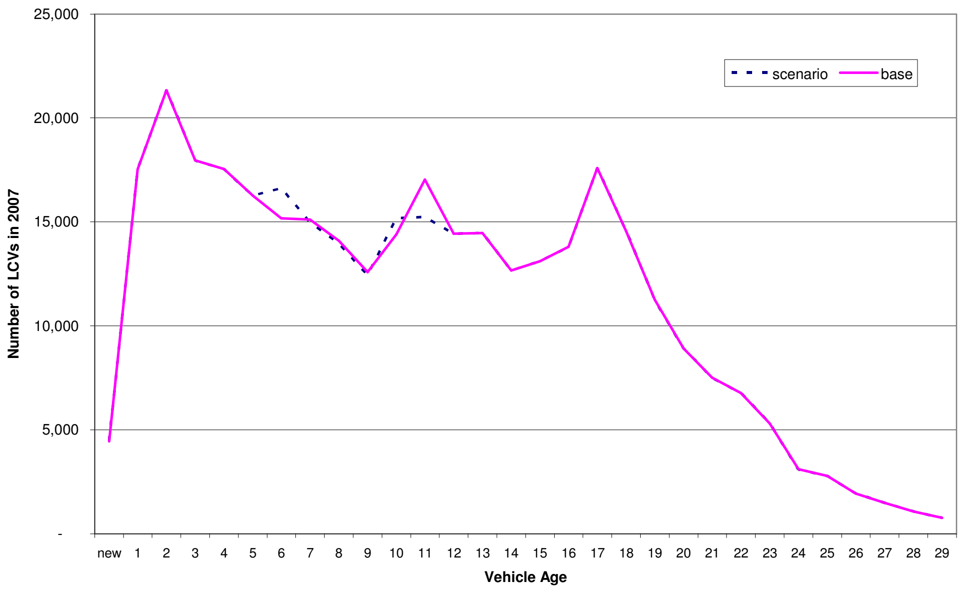


Figure 27 presents the age distribution of cars in 2007 under the base case (the solid line) and under the scenario (the dashed line). Clearly, the scenario causes a pronounced shift in the age distribution, with a much higher concentration of 7-year old cars and a reduction in cars aged 8 to 11. Both are directly attributable to the replacement import effect. The scrappage rate of older vehicles remains unchanged, as shown by near-identical distributions for older cars.

Figure 28 shows the age distribution of LCVs in 2007.

Figure 28: Age Distribution of LCVs in Year 1



Once again, the solid line represents the base case and the dashed line represents the scenario. Clearly, the age impacts are much subtler for LCVs compared to cars. This reflects two factors:

1. The 97/99 diesel standard (which underlies this analysis) has relatively minor impacts on diesel LCVs, which comprise over three-quarters of LCV imports.
2. The VFEM parameters for import ages are fairly coarse, and group all vehicles older than 10 years together. This masks many of the age impacts of the proposed policy.

These issues notwithstanding, there are two fairly noticeable changes in the age distribution – the number of 11-year-old LCVs is lower while the number of six-year old LCVs is higher.

6.1.4. Summary of Expected Effects

The following key effects are expected under this response scenario:

- No change in the overall level of imports
- Relatively static import prices
- No significant changes to import industry concentration
- Little effect on the domestic vehicle market
- Static scrappage rates
- No change to the overall size of the fleet
- Average fleet age decreases

6.2. Effects of Scenario 2: Complete Exit from Market

In this scenario, consumers are unable and/or unwilling to purchase a newer import that meets the standards.[34] Consequently, the number of annual imports drops significantly, as depicted below.

Figure 29: Effect on Imported Vehicle Market

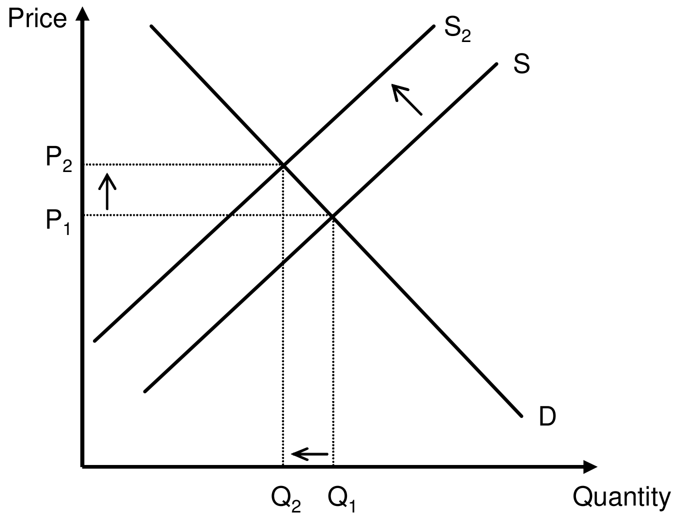


Figure 29 shows the market supply of imported vehicles contracting (from S_1 to S_2) in response to age restrictions. This causes the average price to increase (from P_1 to P_2) and the annual quantity imported to decrease (from Q_1 to Q_2).

6.2.1. Effects on Import Market

The anticipated fall in import volumes may cause some importers to become financially unviable and eventually shut down. If so, the industry will become more concentrated (with potential reductions in competition and consequent increases in market price). Average prices will also rise simply because the average age of imported vehicles is much lower than before.

If the number of importers and their respective market shares remain static, each firm's sales will fall proportionately. In order to maintain profitability in the face of lower volumes (and potentially higher costs), each will need to increase prices.[35] Otherwise they face lower profits and thus the elevated risk of financial failure.

[34] While this phenomenon is characterised as a demand-side response, it could also result from supply-side constraints. In other words, such effects may also arise if importers are unable or unwilling to supply newer imports to replace those banned by the proposed standards. Informal conversations with members of the import industry confirm this possibility and reinforced the point that local importers must compete with several other countries for used vehicles. Importers are therefore not freely able to alter the composition of imports to accommodate a step-change shift in demand.

[35] Lower volumes may cause average prices to increase as scale economies are lost. For instance, average freight costs may increase as volumes fall.

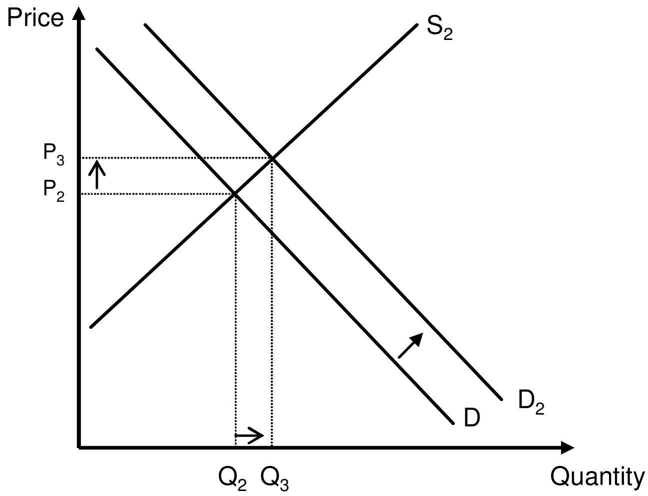
6.2.2. Effects on Domestic Market

Consumers displaced from the import market by higher prices face two options: either look for a car in the domestic market or not purchase at all. The overall effects in the domestic market will be:

- increased demand for existing vehicles, causing prices to rise and a larger number of existing vehicles to be bought and sold (as shown in Figure 30), and[36]

- A reduction in the rate of vehicle scrappage.

Figure 30: Response in the Market for Existing Vehicles

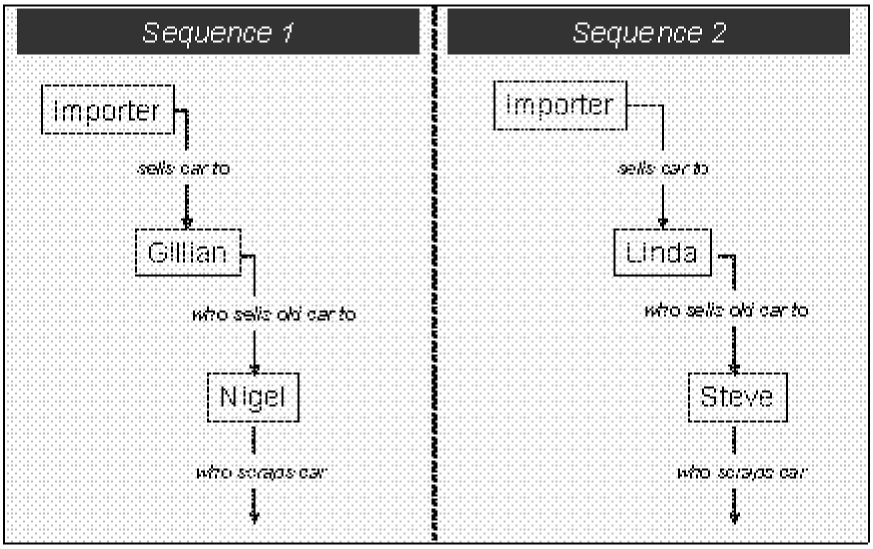


The reduction in scrappage reflects both the higher cost of replacement as a result of because higher domestic prices (see Figure 30) and the cascading effect that a fall in imports has on the wider vehicle market. To see how this second effect works, consider the following highly-stylised example.

First, assume that the following transaction sequences would have taken place in the absence of age restrictions.

[36] Many motorists will be both buyers and sellers in this market and are thus insulated from price rises (at least to some extent). Those most affected are first-time buyers, who do not benefit from a higher selling price on an existing vehicle before buying another.

Figure 31: Two typical transaction sequences



In the first transaction sequence, Gillian purchases an import and sells her existing car to Nigel, who scraps his old car. Similarly, in sequence 2, Linda purchases an import and sells her existing car to Steve, who scraps his old car.

But what happens when age restrictions are imposed?

Assume that Gillian no longer purchases an import. As outlined earlier, she can either hold on to her existing car or buy another from the domestic market.

If she holds on to her existing car, Nigel can't buy her old car and thus is unable to scrap his ==> scrappage rate falls. If, instead, Gillian buys Linda's car in the domestic market, Steve is unable to scrap his car because he can no longer buy Linda's ==> scrappage rate falls.

While highly simplistic, this example shows that the rate of imports and the rate of scrappage are directly linked. Put slightly differently, if the rate of imports falls, so too must the rate of scrappage otherwise the size of the fleet will be smaller than it would have been otherwise.

6.2.3. Effects on Fleet Age

Imported vehicles generally have a lower average age than the existing fleet and scrapped cars generally have a higher age. Thus, if both imports and scrappage rates fall, the average age of the fleet will increase. Once again, we test these assertions by simulating the scenario within the VFEM. The results are presented in Table 18.

Table 18: Average Ages of the Fleet by Fuel Type

	Petrol		Diesel	
	Base	Scenario	Base	Scenario
Year 1	11.90	12.09	12.96	13.13
Year 2	11.84	12.12	13.13	13.40
Year 3	11.80	12.08	13.28	13.52

Unlike the previous response scenario, in which average ages fell, this scenario causes average fleet ages to increase. The underlying reasons are once again illustrated by the following two diagrams.

Figure 32: Age Distribution of Cars in Year 1

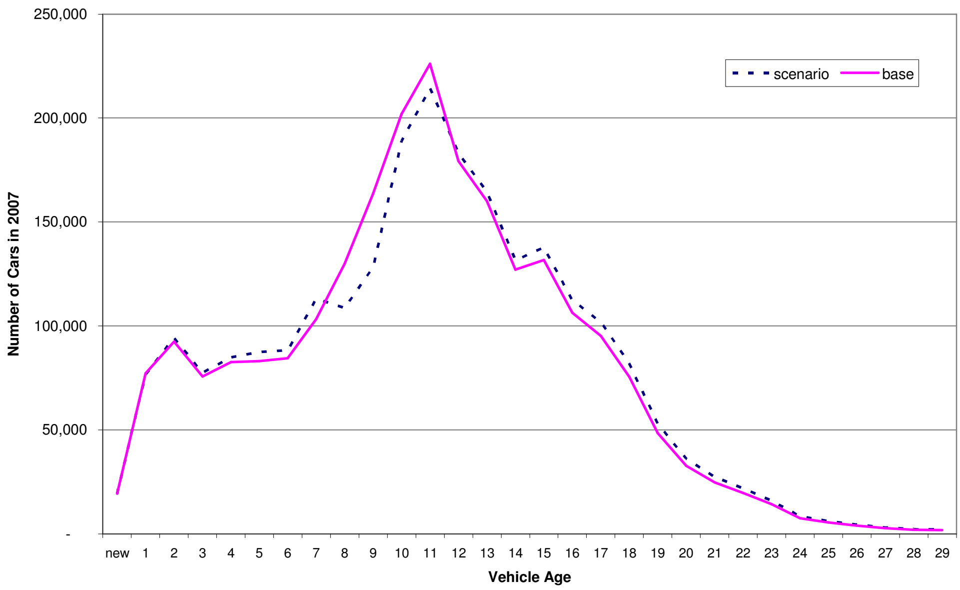
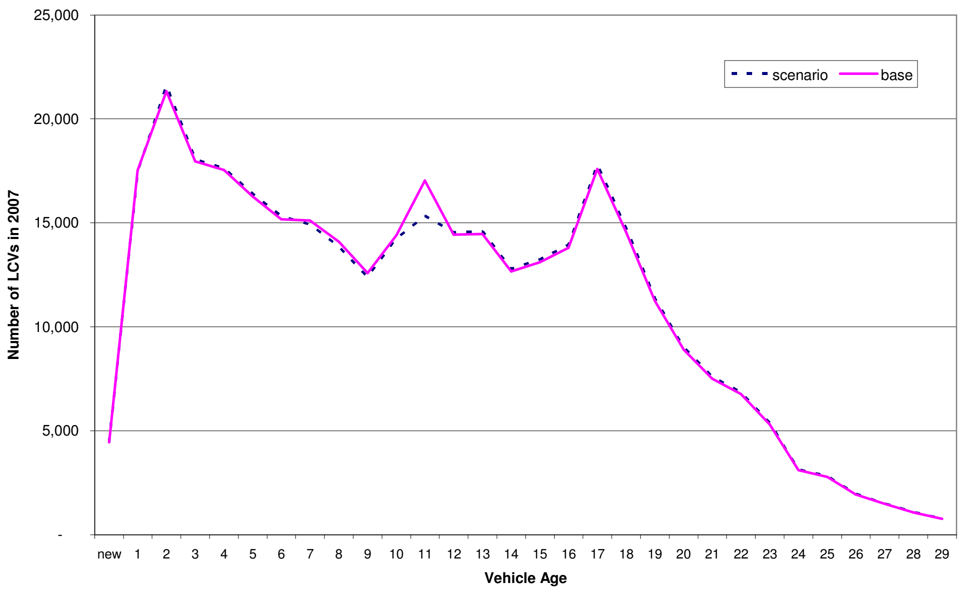


Figure 32 shows that the scenario causes an increase in the number of cars 7 years or younger and a reduction in the number of cars aged 8 to 14. Interestingly, however, the scenario has also caused a larger number of much older cars (15+) to remain in the fleet. This reflects reductions in the scrappage rate of older cars.

Figure 33: Age Distribution of LCVs in Year 1



As under the previous response scenario, the impact on LCVs is less pronounced than for cars (although effects are still discernible). The reasons for this seemingly muted response are the same as articulated earlier. *i.e.* the 97/99 standard is quite unrestrictive and the age categories in the VFEM are too coarse to reflect the true changes in age.

These issues notwithstanding, there is one fairly noticeable change in the age distribution – the number of 11-year-old LCVs is greatly reduced under the scenario.

6.2.4. Summary of Expected Effects

The following key effects are expected under this response scenario:

- Dramatic falls in the overall level of imports
- Higher import prices (and higher import costs)
- Greater import industry concentration
- More activity in the domestic vehicle market (and higher prices)
- Reduced scrappage rates
- Overall size of the fleet will fall (depending on scrappage rates).
- Average fleet age increases

7. Fuel and Emissions Impacts

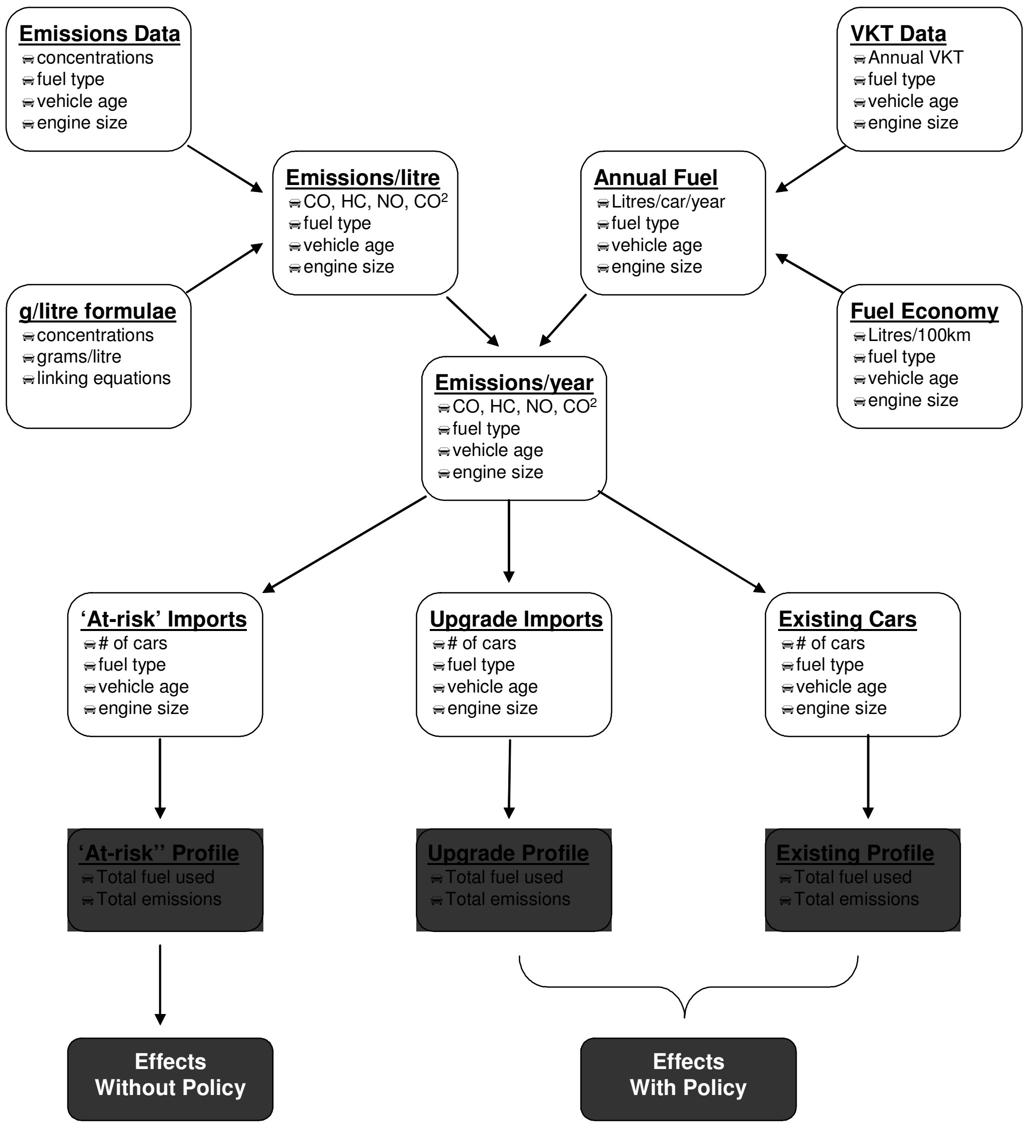
7.1. Objective

The objective of this analysis is to identify impacts on fuel and emissions to 2030. This is done by comparing fuel use and emissions with and without the policy under the five response scenarios, and interpreting any differences as policy impacts.

7.2. Model Overview

This analysis links together a number of disparate datasets and required numerous sub-analyses. The basic structure of the model is presented below.

Figure 34: Fuel and Emissions Model Schematic



7.3. Scope

Ideally, this analysis would have covered all vehicles affected by the policy. However, this was not possible due to data constraints. In particular, as will be explained below, the final version of our analysis required reliable fuel economy data, yet this was available only for petrol cars.

Accordingly, our analysis was based only on petrol cars. The results were then scaled-up to cover all passenger vehicles (*i.e.* to include diesel cars also). Light commercial vehicles were ignored as they comprise only a very minor share of affected vehicles. This omission does not materially influence the results of our analysis.

7.4. Steps in the Analysis

We now walk through the various components of this analysis to explain how they collectively estimate fuel and emissions impacts. We start with the remote sensing (emissions) data supplied by ARC/NIWA in stage 1 of this project.

Step 1: Derive Emissions Profiles

The remote sensing data collected by NIWA for stage 1 of this project was used to derive emissions *concentrations* profiles for CO, HC, NO and CO_2. These profiles varied by vehicle type, fuel type, engine size and year of manufacture.[37]

Step 2: Convert Emissions Profiles to Grams/Litre

One of the difficulties encountered in stage 1 of this project was that the remote sensing project measured emissions as concentrations. These cannot be mapped to other common datasets, such as vehicle kilometres travelled (VKT) or total fuel consumption, and therefore have limited use.

The next step therefore was to translate these data into a more usable form. This was done by converting concentrations to 'grams per litre' using formulae sourced from the international literature.[38] These formulae are reproduced below.

$$CO : gm / litre = \frac{5{,}506 \times CO\%}{15 + 0.285 \times CO\% + 5.74 \times HC\%}$$

$$HC : gm / litre = \frac{17{,}728 \times HC\%}{15 + 0.285 \times CO\% + 5.74 \times HC\%}$$

$$NO : gm / litre = \frac{5{,}900 \times NO\%}{15 + 0.285 \times CO\% + 5.74 \times HC\%}$$

[37] For the sake of manageability, and to help resolve small sample issues, vehicles were grouped into engine size bands before deriving profiles. These bands, which are reproduced in appendix, were used throughout the analysis.

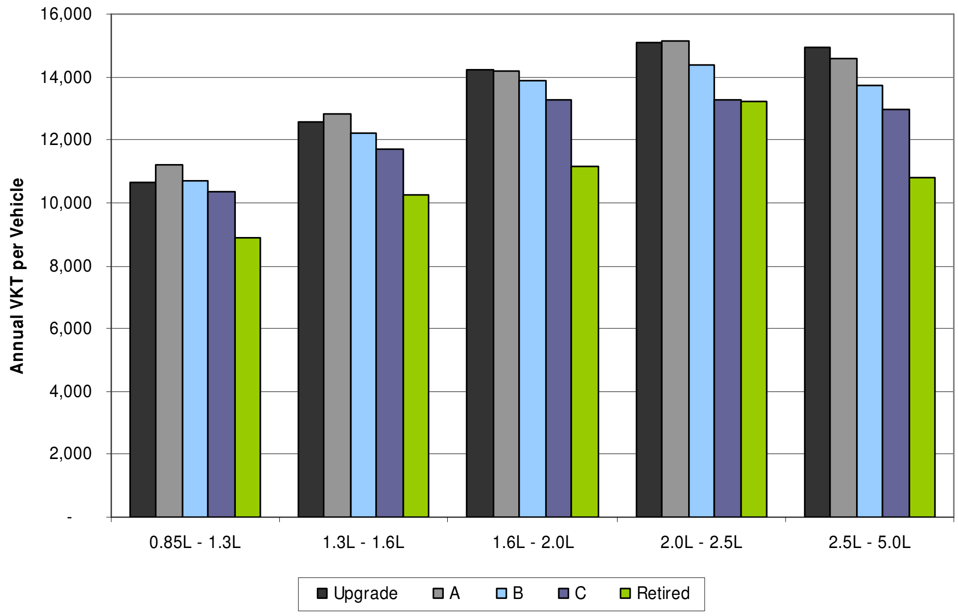
[38] *On-Road Remote Sensing of Automobile Emissions in the La Brea Area: Year 3, October 2003*, G.A. Bishop, D.A. Burgard and D.H. Stedman, Final Report prepared for CRC, May, 2004., pp4.

Step 3: Collate VKT data

Having established emissions in 'per litre' terms, the next obvious step was to obtain data on annual fuel consumption. Together, these would provide direct estimates of annual emissions. Unfortunately, however, no reliable data on annual fuel consumption existed.

Our proposed solution was to estimate annual fuel consumption as a function of annual vehicle activity (VKT) and average fuel economy (litres/100km). The first of these data was sourced directly from MoT's WOF odometer reading project. A summary is provided in Figure 35.

Figure 35: Annual VKTs



Annual VKTs for petrol cars in Groups A, B and C are presented (by engine size) in Figure 35. So too are VKTs for upgraded imports - those that *just* meet the standard, as well as existing vehicles - those currently in the fleet that would be scrapped in the absence of standards.

Two important lessons can be drawn from this data. First, VKTs tend to increase as engine size increases. Second, newer cars tend to travel further than older ones.[39]

Step 4: Derive Fuel Economy Rates

In order to translate VKTs into annual fuel consumption estimates, we also needed data on fuel economy. Unfortunately, however, the motor vehicle register does not provide estimates of fuel economy for each vehicle.

[39] This is reflected by the fact that group A cars have higher VKTs than group B cars, who in turn have higher VKTs than group C cars, and so on.

Our proposed work-around was to estimate an econometric equation that linked average fuel economy to vehicle attributes, such as the year of manufacture (YOM), gross vehicle mass, engine size, and so on. Once estimated, this equation could be applied to the characteristics of each vehicle in our analysis to estimate its fuel economy. The equation was estimated using data supplied by MoT for a separate project. It recorded the fuel economy and vehicle attributes of 11,000 Japanese petrol cars.[40] The final equation estimated was:

$$\text{Litres/100km} = 196 - 0.098 \, x \, \text{YOM} + 1.452 \, x \, \text{Engine Size} + 3.438 \, x \, \text{Weight}$$

where:

- Engine Size is recorded in litres
- Weight is recorded in tonnes
- YOM = 1999, 2001, 2003 etc.

Overall, the model fitted the data very well ($R^2 = 0.75$) and all variables were statistically significant at the 1% level. Moreover, applying this equation to all the petrol cars in the motor vehicle register (as at 1/1/05), we generated an estimate of total petrol consumption for 2004 that was within 1% of the figure published in the Energy Data File. This provided a strong degree of confidence in our model.

For the purposes of illustration, we apply this equation to three common vehicles to calculate their estimated fuel economies.

Table 19: Application of fuel economy regression

Car	YOM	CC	GVM	L/100km
Nissan Pulsar	2000	1600	1350	6.57
Honda Accord	2002	2000	1650	7.99
Toyota Camry	1997	2200	1750	9.11

Thus, according to the regression equation, a 2000 Nissan Pulsar will use just over 6.5 litres/100km, while a 2002 Honda Accord will use nearly 8 litres/100km. A 1997 Toyota Camry is expected to burn around 9.1 litres/100km.

Step 5: Calculate Annual Fuel Consumption

Next, we calculated annual fuel consumption per vehicle as VKT x litres/100km.

Step 6: Estimate Emissions per Vehicle per Year

Having derived emissions per litre and annual fuel consumption, the next step was to derive emissions profiles for each vehicle. These were expressed as kilograms of emissions per vehicle per year and covered CO, HC, NO and CO_2. Estimates differed by year of manufacture, fuel type and engine size.

[40] The project entailed a comparison of Japanese and European fuel economy estimation methods, and was undertaken for MoT earlier this year.

Step 7: Calculate Initial (Year 1) Effects

The final step in the analysis was to apply the emissions information calculated in the previous step to the fleet (with and without the policy). Differences between the two were then taken as direct effects of the policy.

Because of the dynamic nature of the vehicle market, and because changes in one part of the fleet can have quite deep and long-lasting impacts on other areas of the fleet, considerable time was spent figuring out how consumer responses would affect the size and composition of the fleet over time. A discussion of this element of the analysis is provided in the appendix.

Step 8: Extrapolating Initial Effects

Finally, because the analysis to this point identified only the initial policy effects, we next needed to decide how far into the future these would last. For example, any changes in fleet composition this year will cause prolonged changes to the fleet (because most cars last for several years). Thus, initial effects need to be extrapolated.

For simplicity, and in the absence of more concrete data, we assumed that each initial effect would persist for ten years. In other words, the effects of the policy in year one would reach out to year 10, and effects of the policy in year 2 would reach out to year 11, and so on. Alternatively, this means that the aggregate effect of the policy in year 10 equals the sum of all policy effects from years 1 to 10 (see Figure 37 for more on this).

Step 9: Standard Update (Roll Over) Assumptions

Because the underlying emissions standards are tied to a date of manufacture (and not vehicle age), they quickly become less stringent over time. For instance, while 45% of used petrol car imports will be affected in year 1, the proportion affected falls to 30% in year 2 and only 13% in year 3 (if standards are left unchanged).

This observation suggested the need to update (or roll over) the standards, otherwise the policy would become ineffective very quickly. Unfortunately, however, the Ministry could not commit to a schedule of updates at the time of writing this report. We therefore assumed that standards would be updated annually.

The overall impact of this assumption is to amplify policy effects by causing first-year effects (which are the most potent) to be repeated in each subsequent year (*i.e.* years 2 to 10). It does not change the overall structure of results, just their magnitudes.

As a matter of clarification, relaxing this assumption would not change the overall findings of our analysis. It would merely make the results less drastic. Thus, under the most likely scenario (scenario 4), emissions and fuel consumption would still increase, but not quite so much.

7.5. Identifying the number of Imports Affected

The analysis to this point was based on the 2004 fleet. It allowed us to identify the overall effects on a per-vehicle basis. However, in order to become a forward looking analysis, we needed to apply these per-vehicle figures to the rate of *future* imports. In other words, we needed to know the number of prospective future imports that would be affected by the policy. This was calculated as follows.

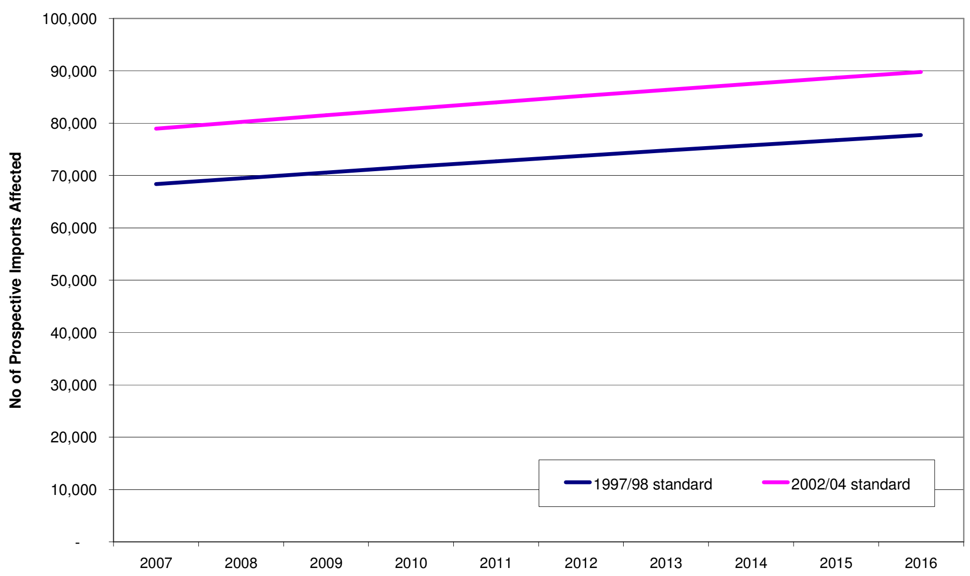
Recall from section 3, that the proposed rule will affect 45% of used petrol car imports and 28% of used diesel car imports (based on the 1997/98 standard) in year 1. Combining these figures with the observation that 90% of historic imports are petrol and 10% are diesel, we calculated the proportion of prospective imports potentially affected each year as:

% Affected = 45% x 90% + 28% x 10% = **43.3%.**

This means that, assuming standards are updated annually, over 43% of all prospective car imports will be affected. But how many used car imports will this apply to each year?

We extracted forecasts of annual used imports from the VFEM, and applied our % affected scalar to these forecasts to estimate the total number of imports affected each year. The results are presented in the figure below.

Figure 36: Number of Used Imports Affected



7.6. Results

This section presents the estimated effects of our modelling based on the methods and assumptions outlined above.

7.6.1. Scenario 1 - Complete Upgrade

Table 20 presents the impacts associated with scenario 1.

Table 20: Scenario 1 Impacts

Year	Fuel (PJs)	CO (tonnes)	HC (tonnes)	NO (tonnes)	CO_2 (tonnes)
2007	-0.1	-842	-104	-112	-4,966
2008	-0.2	-1,698	-210	-225	-10,013
2009	-0.2	-2,568	-318	-340	-15,140
2010	-0.3	-3,451	-427	-457	-20,346
2011	-0.4	-4,347	-538	-576	-25,629
2012	-0.5	-5,256	-651	-696	-30,989
2013	-0.6	-6,178	-765	-818	-36,423
2014	-0.6	-7,112	-881	-942	-41,930
2015	-0.7	-8,058	-998	-1067	-47,508
2016	-0.8	-9,016	-1,116	-1194	-53,156
2017	-0.7	-8,174	-1,012	-1083	-48,190
2018	-0.7	-7,318	-906	-969	-43,144
2019	-0.6	-6,448	-798	-854	-38,017
2020	-0.5	-5,565	-689	-737	-32,811
2021	-0.4	-4,669	-578	-619	-27,527
2022	-0.3	-3,760	-466	-498	-22,167
2023	-0.3	-2,838	-351	-376	-16,733
2024	-0.2	-1,904	-236	-252	-11,226
2025	-0.1	-958	-119	-127	-5,648

Table 20 shows that impacts peak in 2016, with fuel savings of 0.8 PJs and emissions reductions of up to 53,000 tonnes. The timing of this peak - which is the same for all scenarios - is explained in Figure 37.

Figure 37: How effects cascade over time

Years Affected	Year of Initial Effect									
Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
2007	✓									
2008	✓	✓								
2009	✓	✓	✓							
2010	✓	✓	✓	✓						
2011	✓	✓	✓	✓	✓					
2012	✓	✓	✓	✓	✓	✓				
2013	✓	✓	✓	✓	✓	✓	✓			
2014	✓	✓	✓	✓	✓	✓	✓	✓		
2015	✓	✓	✓	✓	✓	✓	✓	✓	✓	
2016	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
2017		✓	✓	✓	✓	✓	✓	✓	✓	✓
2018			✓	✓	✓	✓	✓	✓	✓	✓
2019				✓	✓	✓	✓	✓	✓	✓
2020					✓	✓	✓	✓	✓	✓
2021						✓	✓	✓	✓	✓
2022							✓	✓	✓	✓
2023								✓	✓	✓
2024									✓	✓
2025										✓

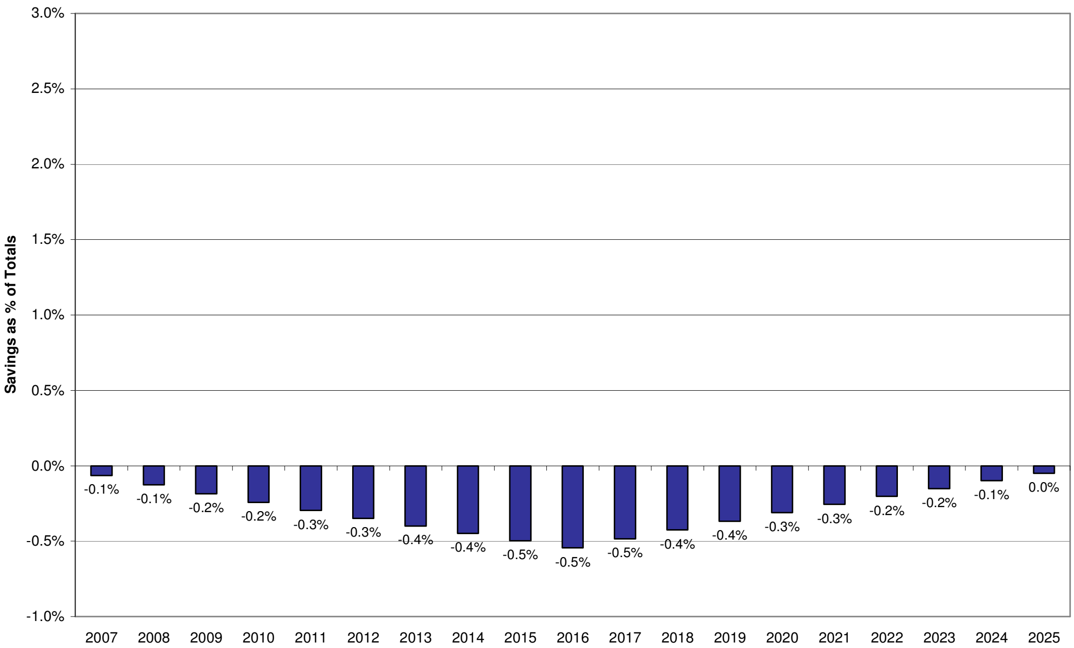
This figure shows the time periods over which each year's initial effects are felt. It is based on the assumption (as noted above) that initial effects last 10 years. Thus, the first column (titled 2007) shows that policy effects initially felt in 2007 last until 2016.

Similarly, the second column (titled 2008) shows that policy effects initially felt in 2008 last until 2017.

The faint blue line through the middle of this diagram shows that, in 2016, 10 years' effects will be in force – the initial effects of the policy in 2016 plus the ongoing effects of the preceding 9 years'. In other words the cumulative effects of the policy peak in 2016.

Ok, but how large are the estimated savings (in Table 20) in context of annual fuel and emissions? Unfortunately, they are small. This is demonstrated in Figure 38, which expresses fuel and CO_2 savings as percentages of annual totals.[41]

Figure 38: Fuel and **CO_2** Savings as % of Totals



This figure shows that fuel and emissions savings would reach only around 0.5% of annual consumption – a fairly insignificant result indeed.

(**note**: we have kept the y-axis scale of all the following charts the same in order to facilitate comparisons across scenarios)

[41] Annual forecasts were drawn from a recent project for EECA, which unfortunately covered only fuel and CO_2. However, we expect percentage savings for the other emissions type to be of a similar magnitude to CO_2 savings.

7.6.2. Scenario 2 - Complete Exit from Import Market

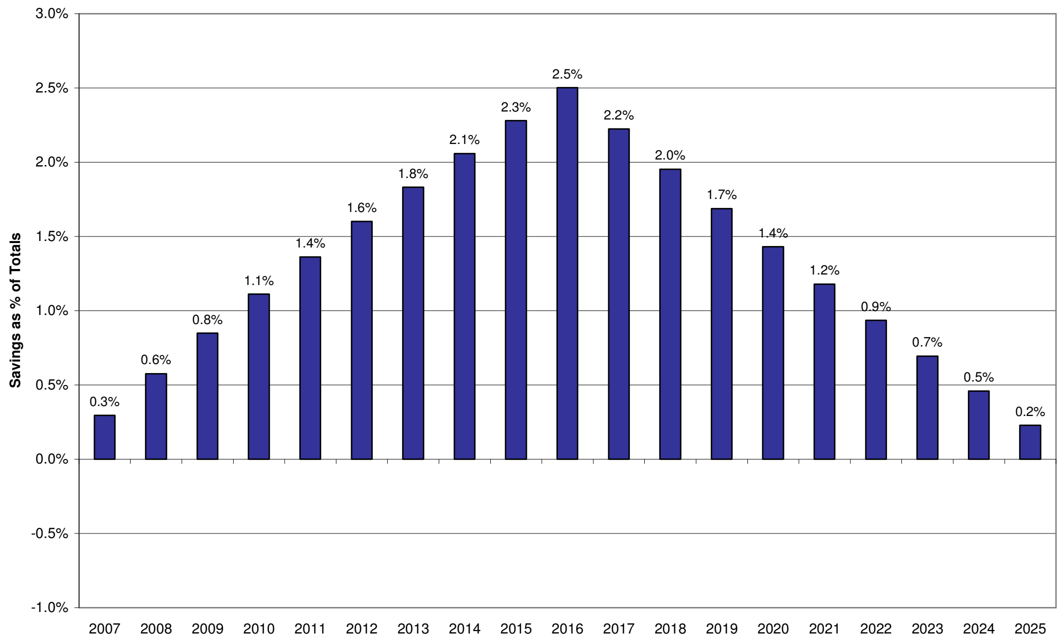
The effects of this scenario are diametrically-opposed to scenario 1, as illustrated below.

Table 21: Scenario 2 Impacts

Year	Fuel (PJs)	CO (tonnes)	HC (tonnes)	NO (tonnes)	CO_2 (tonnes)
2007	0.3	4,548	538	217	22,846
2008	0.7	9,169	1,085	437	46,059
2009	1.1	13,864	1,640	661	69,644
2010	1.4	18,632	2,204	888	93,593
2011	1.8	23,470	2,776	1119	117,898
2012	2.2	28,378	3,357	1353	142,553
2013	2.6	33,355	3,945	1591	167,550
2014	2.9	38,397	4,542	1831	192,882
2015	3.3	43,506	5,146	2075	218,543
2016	3.7	48,678	5,758	2321	244,525
2017	3.4	44,130	5,220	2104	221,679
2018	3.0	39,509	4,673	1884	198,466
2019	2.7	34,814	4,118	1660	174,881
2020	2.3	30,046	3,554	1433	150,933
2021	1.9	25,208	2,982	1202	126,627
2022	1.6	20,300	2,401	968	101,972
2023	1.2	15,324	1,812	731	76,975
2024	0.8	10,281	1,216	490	51,643
2025	0.4	5,172	612	247	25,983

Figure 39 shows that *increases* in fuel and emissions would be around 2.5% of annual levels by 2016. These increases are clearly much higher than the potential savings associated with the previous scenario. This asymmetry of effects – which is explained in the appendix – suggests the policy carries significant economic and environmental risks.

Figure 39: Fuel and CO_2 Increases as % of Totals

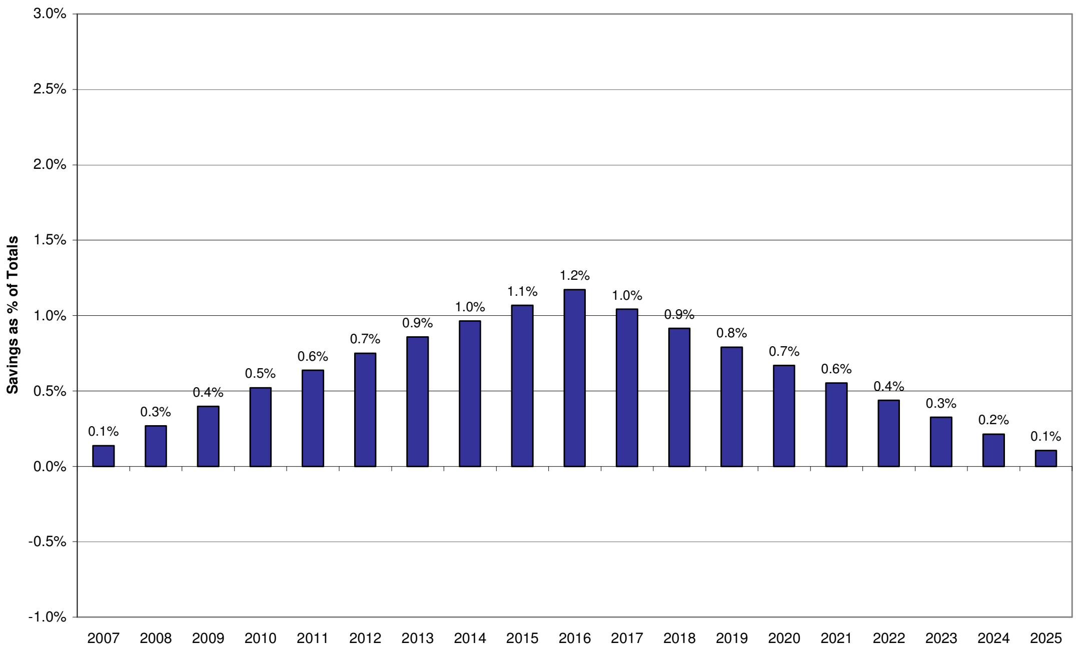


7.6.3. Scenario 3 – Low Upgrade Rate

Table 22: Scenario 3 Impacts

Year	Fuel (PJs)	CO (tonnes)	HC (tonnes)	NO (tonnes)	CO_2 (tonnes)
2007	0.2	2,517	295	92	10,704
2008	0.3	5,075	596	185	21,581
2009	0.5	7,674	901	280	32,632
2010	0.7	10,313	1,210	376	43,853
2011	0.8	12,991	1,525	474	55,241
2012	1.0	15,708	1,844	573	66,793
2013	1.2	18,462	2,167	674	78,505
2014	1.4	21,254	2,494	776	90,375
2015	1.6	24,081	2,826	879	102,398
2016	1.7	26,944	3,162	983	114,572
2017	1.6	24,427	2,867	891	103,867
2018	1.4	21,869	2,567	798	92,991
2019	1.3	19,270	2,262	703	81,940
2020	1.1	16,631	1,952	607	70,719
2021	0.9	13,953	1,638	509	59,331
2022	0.7	11,236	1,319	410	47,779
2023	0.6	8,482	995	310	36,067
2024	0.4	5,691	668	208	24,197
2025	0.2	2,863	336	104	12,174

Figure 40: Fuel and CO_2 Increases as % of Totals

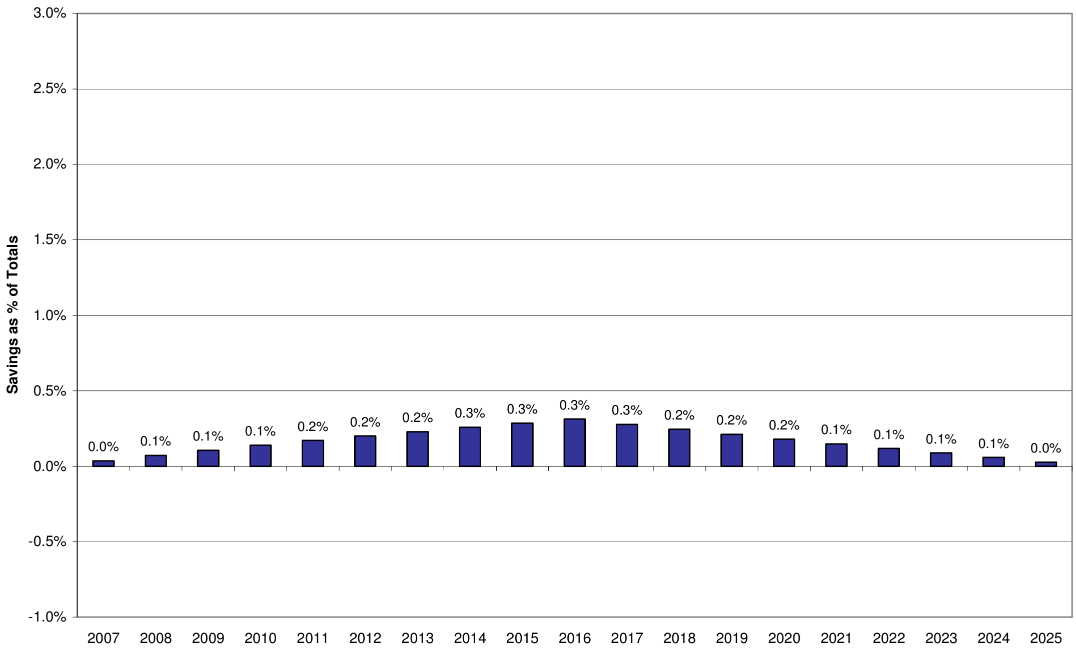


7.6.4. Scenario 4 – Medium Upgrade Rate

Table 23: Scenario 4 Impacts

Year	Fuel (PJs)	CO (tonnes)	HC (tonnes)	NO (tonnes)	CO_2 (tonnes)
2007	0.0	1,002	115	1	2,857
2008	0.1	2,019	232	1	5,759
2009	0.1	3,053	351	2	8,708
2010	0.2	4,103	472	2	11,702
2011	0.2	5,169	595	3	14,741
2012	0.3	6,250	719	3	17,824
2013	0.3	7,346	845	4	20,949
2014	0.4	8,456	973	5	24,117
2015	0.4	9,581	1,102	5	27,325
2016	0.5	10,720	1,234	6	30,574
2017	0.4	9,719	1,118	5	27,717
2018	0.4	8,701	1,001	5	24,815
2019	0.3	7,667	882	4	21,866
2020	0.3	6,617	761	4	18,872
2021	0.2	5,552	639	3	15,833
2022	0.2	4,471	514	2	12,750
2023	0.1	3,375	388	2	9,624
2024	0.1	2,264	261	1	6,457
2025	0.0	1,139	131	1	3,249

Figure 41: Fuel and CO_2 Increases as % of Totals

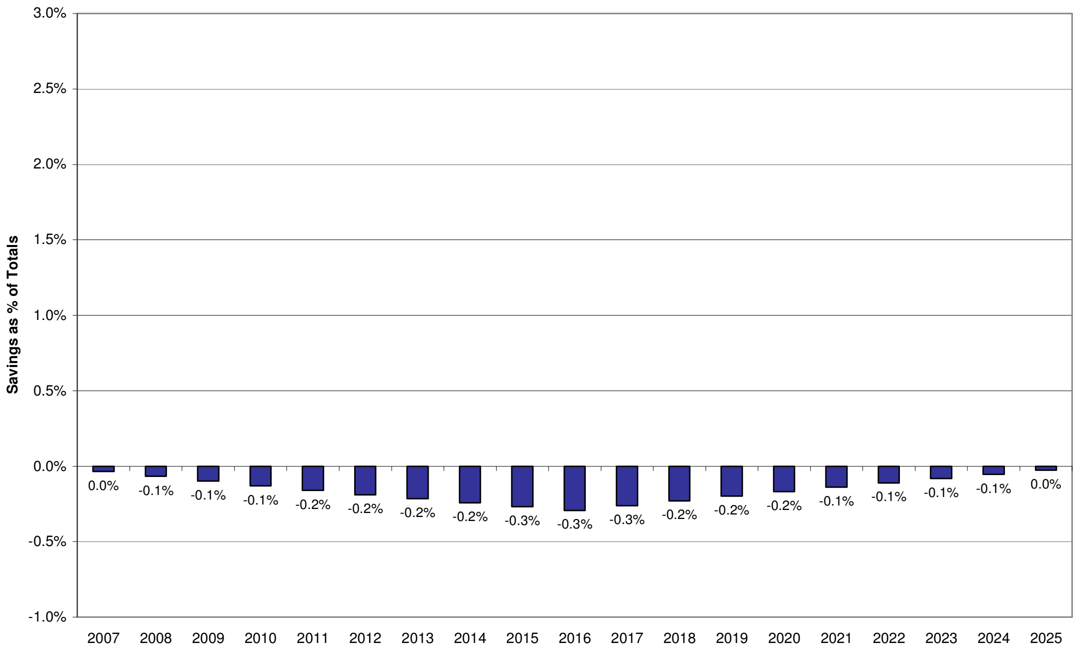


7.6.5. Scenario 5 – High Upgrade Rate

Table 24: Scenario 5 Impacts

Year	Fuel (PJs)	CO (tonnes)	HC (tonnes)	NO (tonnes)	CO_2 (tonnes)
2007	0.0	-79	-14	-66	-2,900
2008	-0.1	-160	-27	-132	-5,847
2009	-0.1	-241	-42	-200	-8,841
2010	-0.2	-325	-56	-269	-11,881
2011	-0.2	-409	-70	-339	-14,967
2012	-0.3	-494	-85	-410	-18,097
2013	-0.3	-581	-100	-481	-21,270
2014	-0.4	-669	-115	-554	-24,486
2015	-0.4	-758	-130	-628	-27,744
2016	-0.5	-848	-146	-703	-31,042
2017	-0.4	-769	-132	-637	-28,142
2018	-0.4	-688	-118	-570	-25,195
2019	-0.3	-606	-104	-502	-22,201
2020	-0.3	-523	-90	-434	-19,161
2021	-0.2	-439	-76	-364	-16,075
2022	-0.2	-354	-61	-293	-12,945
2023	-0.1	-267	-46	-221	-9,772
2024	-0.1	-179	-31	-148	-6,556
2025	-0.1	-90	-16	-75	-3,298

Figure 42: Fuel and CO_2 **Savings** as % of Totals



8. Social Impacts

This section considers social impacts associated with the policy. Overall, these will be minor compared to the social costs associated with the original emissions policy, which included potential sudden loss of a vehicle or unexpected vehicle repair costs. At most, the current policy might impose some restrictions on import choices or raise average vehicle prices. However, any such price effects are likely to go unnoticed in context of recent market trends, where the prices of imported vehicles continue to fall rapidly.

8.1. Impacts facing At-Risk Consumers

Although flow-on effects will be wide-reaching, the main force of the policy will fall upon 'at-risk' consumers *i.e.* people unable to purchase their preferred import as a result of standards.

The social impacts borne by at-risk consumers depend on their responses, which range from:

- Upgrade to a better import (that meets the standard)
- Purchase a vehicle from the domestic market instead
- Exit the market completely and retain their existing vehicle (if they have one).

Following is a discussion of the social impacts associated with each response option.

8.1.1. Upgrade to a Better Import

Upgrading to a better import than originally intended means either:

- increasing expenditure to purchase a newer vehicle with similar features to the vehicle they hoped to purchase, and/or
- maintaining the intended level of expenditure and purchasing a vehicle of lower quality or with fewer features.

Both options erode 'consumer welfare': increasing expenditure to purchase a similar (but newer) vehicle reduces funds available to purchase other goods and services, while sacrificing features to contain expenditure means settling for second-best.

Unfortunately, it is difficult to say much further than this. The magnitude of welfare losses depends on individual budgets and preferences, both of which are unknown. However, as a matter of interest, we have analysed the trade-offs consumers might face if they wish to contain expenditure and sacrifice features. This analysis is presented in appendix 2.

8.1.2. Purchase a vehicle from the domestic market

If consumers are able to purchase a similar vehicle from the domestic market (at a similar price), they will bear no direct impact.

However, to the extent that domestic vehicles substitute for imported ones, the demand for domestic vehicles increases. As demand increases, so too will prices, making domestic vehicle less affordable for other consumers (particularly those in lower socioeconomic groups).

Once again, however, such price pressures are likely to go unnoticed in context of current price trends.

8.1.3. Retain Existing Vehicle

The final option for at-risk consumers is to exit the vehicle market altogether. In most cases, this means holding on to an existing car for longer than planned. Alternatively, it means being without a car for longer than expected. Both scenarios involve social costs.

In both cases, there is a direct social cost from not being able to purchase the preferred vehicle. This is compounded in the latter scenario by the prolonged absence of personal transport, which may give rise to a number of serious social costs, such as social exclusion. See our earlier report for a detailed discussion on social exclusion.

8.2. Comparison with Previous Policy

This section compares the social impacts of this policy with those of the previous policy.

Impact Type	Previous Policy	This Policy
Increases in living costs	Potentially significant for owners of vehicles failing the test. Could be either an unexpected repair bill or the need to purchase another car.	Although car prices may increase slightly, people can opt retain their existing vehicle. Possibly minor impacts on first-time buyers.
Social Exclusion	Owners of failed vehicles unable to pay repair costs may be left without a vehicle. This may result in reduced social contact, particularly in areas with limited public transport. Overall this is most likely to affect rural drivers.	Since the policy will not cause any unexpected loss of vehicles, such effects are not contemplated. However, if first-time buyers can no longer afford a car (which seems unlikely), they may face some degree of prolonged exclusion.
Prevented from buying preferred vehicle	Not applicable	This will affect a fairly large number of people. However, it is likely that substitutes can be found at similar prices (possibly in the domestic fleet). Some will be deeply affected by this, no matter how trivial it may seem.
Forced to retain existing vehicle	Not applicable	This could potentially affect a number of consumers, but the consequences are fairly minor compared to sudden loss of a vehicle, which was possible under the previous policy.

9. Policy Options

A number of studies in New Zealand have demonstrated the impacts of local air pollutants from transport.[42, 43] The impacts are serious and have been the motivation for a policy response. Policy options to tackle these effects include those that:

- remove the worst polluters from the fleet;
- ensure optimum performance of the existing fleet;
- change the fleet over time to less emitting vehicles by changing the characteristics of imports;
- change travel behaviour to reduce aggregate activity or change its location and thus exposure of people.

This study has analysed the expected effects of an emissions standard on imported cars that would be expected to change the structure of the fleet over time by changing what vehicles are imported. The analysis suggests that it will have limited environmental effects, and that these include the potential for some adverse effects. It would also have little adverse social or economic impacts. It is not clear that this is a worthwhile policy intervention.

The government has previously announced policy to introduce a visible smoke test as part of the WoF/CoF test, combined with the 10-second rule. This goes some way towards providing a means for eliminating the worst offenders from the fleet. It also provides some incentives for improving the performance of the fleet, eg through encouraging vehicle tuning to ensure that vehicles meet the simple emissions tests. Because these measures are restricted to visible smoke only, the expected environmental outcome will be small.

There has been no comprehensive cost-benefit analysis of further in-service emissions testing, although preliminary assessments have suggested that low cost testing options have considerable problems associated with accuracy (false positives and false negatives); this was part of the reason given for a decision not to advance this approach. Other options involving more advanced testing methodologies (eg dynamometer tests) are more effective at identifying polluting vehicles and thus have the potential to be more effective environmentally, but they would also pass on higher costs to all vehicle owners, because of the expected costs of the test in addition to the impacts of test failure.

There are no simple solutions that will be effective environmentally and have low costs. And those measures that aim at removing the worst vehicles from the fleet invariably

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[42] Fisher GW, Rolfe KA, Kjellstrom T, Woodward A, Hales S, Sturman AP, Kingham S, Petersen J, Shrestha R and King D (2002) Health effects due to motor vehicle air pollution in New Zealand. Report to the Ministry of Transport

[43] Fisher G, Kjellstrom T, Woodward A, Hales S, Town I, Sturman A, Kingham S, O'Dea D, Wilton E, O'Fallon C, Scoggins A, Shrestha R, Zawar-Rewa P, Epton M, Pearce J, Sturman J, Spronken-Smith R, Wilson J, McLeod S, Dawson R, Tremblay L, Brown L, Trout K, Eason C, Donnelly P (2005) Health and Air Pollution in New Zealand: Christchurch Pilot Study. Prepared for Health Research Council, Ministry for the Environment and Ministry of Transport.

target the older lower-value vehicles that will tend to be owned by poorer households. The social impacts can be significant. What is also clear is that the average age of vehicles is higher in the South Island, away from the major urban centres in which exposure to pollution is greater.

The focus on changes to the fleet is a long haul measure, in which the effects develop slowly in the fleet. But the effects can be perverse, especially if they lead to an increase in the average fleet age.

Considering the impacts (costs and benefits) of a wider range of options would be a useful exercise, but goes beyond the scope of this study. That said, there are a number of conclusions emerging from the work to date, both in this study and the earlier report on the emission screening programme, which can provide some conclusions for policy development.

- As a general statement, older petrol cars have higher emission rates for the targeted pollutants. Older vehicles tend to be of lower value and to be owned by lower-income households. Most measures that directly target the worst emitters will have adverse effects on poorer households.

- The worst emitting vehicles do not necessarily have the highest impacts. There are two other factors involved—utilisation and location. Total impacts associated with a vehicle depend on how much it is used; and in general, newer (and larger) vehicles are used more than older vehicles. In addition, the adverse effects of vehicle pollution depend on location; the impacts are greatest when they occur in densely populated centres.

- Measures that target vehicle imports change the costs of imports (or the quality in other ways). This has effects on vehicle prices elsewhere in the market and can lead to changes in vehicle scrappage decisions.

- It needs to be remembered that the fleet is improving over time in the absence of intervention. New Zealand is a technology taker and although arguably, if it does not have emission standards on imports, the worst emitting vehicles could be imported to New Zealand, in general emission standards introduced in other countries and notably Japan, result in improvements to the fleet that New Zealand receives. Recent increases in oil and transport fuel prices are leading to a shift towards smaller vehicles that will be more fuel efficient and will also have reduced emissions of local air pollutants.

Measures that will have a significant impact on the emissions of local pollutants from the fleet, such as more accurate vehicle testing methods, will have adverse social impacts on lower income households. If choosing these options, the government may want to introduce accompanying measures to alleviate these effects, while noting that they are not easily targeted.

Measures that seek to avoid these impacts are likely to have little positive emissions effect.

Other policy avenues exist.

- One is to consider policies that are more focussed on effects. The effects result from the interaction of emissions and the affected individuals. Measures that targeted these interactions would be more local and would seek to remove vehicles from people through displacing them in space, time or altogether. These options would need to be introduced by local government but there are likely to be ways in which central government can better enable them.

- An alternative, and complementary approach is to focus on measures that target vehicle dependency via changes in urban form that reduce the need to travel, plus improvements in public transport availability, accessibility and utilisation. These are general programmes, consistent with the New Zealand Transport Strategy that would be part of the policy environment anyway. Nevertheless, the benefits of these measures are reinforced by consideration of air pollution.

The government is left with difficult choices. The broad options appear to be to:

- introduce more stringent testing methods and either accept the socio-economic consequences or introduce mitigating polices (although it is unclear that effective mitigating policies can be designed);

- introduce import standards as examined in this study, although the positive environmental effects are limited and uncertain;

- work with local government to design interventions that more directly target problem locations.

Appendix 1: Engine Size Bands

The following engine size bands were used to group vehicles for analytical purposes. They are the same bands as those commonly used by Government agencies for reporting purposes. *e.g.* registration statistics in the New Zealand Yearbook.

Table 25: Engine Size Bands

Band	Engine Size (CC)
1	< 850
2	0851 - 1300
3	1301 - 1600
4	1601 - 2000
5	2001 - 2500
6	2501 - 5000
7	> 5000

Appendix 2: Import Replacement Trade-Offs

Consumer response scenario number two envisaged a world where all banned imports were supplanted by an influx of so-called 'replacement imports.' As discussed earlier, these replacements are newer than the banned imports (by definition), but are similarly-priced.[44]

So what does this actually mean for consumers? In other words, what sort of trade-offs must consumers make to obtain a newer vehicle without increasing their budget?

To answer this question, we used Turners Car Auction sales data to construct a regression relating car prices to various characteristics, such as engine size, odometer readings, age, condition, colour, make, model and so on. This allowed us to directly estimate the sorts of trade-offs that consumers might face when "upgrading" to a newer import. The regression equation is reproduced below.

Table 26: Car Sales Price Regression

Characteristic	Price Impact
Constant	9,412
Engine Size (CCs)	2.34
Odometer reading (000 kms)	-35
ABS Brakes	148
Alloy Wheels	453
CD Player	119
Spoiler	205
Turbo	650
4WD	647
Age (years)	-602
Automatic Transmission	-136
Air Conditioning	200
Below-average condition	-162
Poor condition	-384
NZ New	166
Grey	-100
Green	-264
Blue	-142
White	-110
Suzuki	-1,343
BMW	2,303
Hyundai	-2,064
Holden	-600
Subaru	-856
Ford	-739
Mazda	-786
Mitsubishi	-965
Nissan	-632
Hatchback	153
Station wagon	621

[44] Similar prices are also a 'necessary condition' for replacements to be plausible substitutes.

The regression equation shows that a number of factors influenced the selling price of cars at Turners Auction last year. For instance, holding everything else constant, alloy wheels increased the selling price by $453, while automatic transmission reduced it by $136. Bigger engine sizes and ABS brakes had positive influences on price, while age and poor condition had negative influences.

Interestingly, the colour of vehicles also had a material effect on price, with green, grey, blue and white cars being of a lower value than other colours (everything else being constant).

Now, in order to identify trade-offs that consumers might face, we first used this equation to calculate the average prices of three common vehicles. Then, for each vehicle, we identified what features could be sacrificed to maintain price levels as vehicle age fell.[45]

Car One – 1998 Honda Hatchback

First, we consider the trade-offs for consumers that would have bought a 1998 Honda Civic with the following features:

- 1.5 Litre
- Hatchback
- 70,000 kms
- CD Player
- Alloy Wheels
- ABS Brakes
- Automatic
- Air-conditioning

The average selling price of this vehicle at Turners last year was around $7,200. Once the year of manufacture is increased to 2000 (the minimum possible under the proposed age restrictions), the average selling price of this vehicle would increase to $8,400. So what adjustments must be made to bring the price back to the original level (of $7,200)?

According to this data, the price can be restored by:

- dropping the engine size to 1.3 litre, ***and***
- increasing the odometer reading to 90,000 kms.

Alternatively, the price can be restored by:

- keeping the same engine size and odometer reading, but
- foregoing the CD player and alloy wheels,
- dropping to a poor condition vehicle, ***and***
- switching to green body colour

[45] Please note that the prices shown in this section are likely to understate the cost of imported vehicles, because auction prices tend more towards the wholesale end of the spectrum than retail. Nevertheless, this data can be used to identify how *relative* prices are affected by vehicle characteristics, which is the point of interest here.

Car Two – 1996 BMW

Next, consider the trade-offs facing the buyer of a 1996 BMW with the following features:

- 3.0 Litre
- Sedan
- 65,000 kms
- CD Player
- Alloy Wheels
- ABS Brakes
- Spoiler
- Manual
- Air-conditioning

According to Turners sales data, the average selling price of this vehicle last year was $12,200. Dropping the age to 5 years (*i.e*. a manufacture date of 2000), the price increases to around $14,600. In order to bring the price back to its original level, the buyer could:

- reduce the engine size to 2 litres, ***or***
- buy a Japanese car rather than a BMW, ***or***
- drop the engine size to 2.5 litres, lose the spoiler and increase the odometer to 90,000kms.

Car Three – 1999 Holden Commodore

Finally, we explore the trade-offs for consumers that would have bought a 1999 Holden Commodore with the following features.

- 3.8 Litre
- Station wagon
- 80,000 kms
- CD Player
- Alloy Wheels
- ABS Brakes
- Air-conditioning

The average selling price of this vehicle last year was $12,700. Dropping the age to 5 years (*i.e*. a manufacture date of 2000), the price increases to around $13,300. In order to bring the price back to its original level, the buyer could:

- drop the alloy wheels and CD player, ***or***
- increase the odometer to 95,000 kms, ***or***
- buy a sedan rather than a station wagon

Summary

As these three examples demonstrate, there is considerable scope for the purchase of replacement imports provided that consumers are willing to make sacrifices. In addition, there must be a sufficient supply of such vehicles for import. Both issues will be considered in more detail in the final version of this report.

Appendix 3: Potential Savings vs Increases

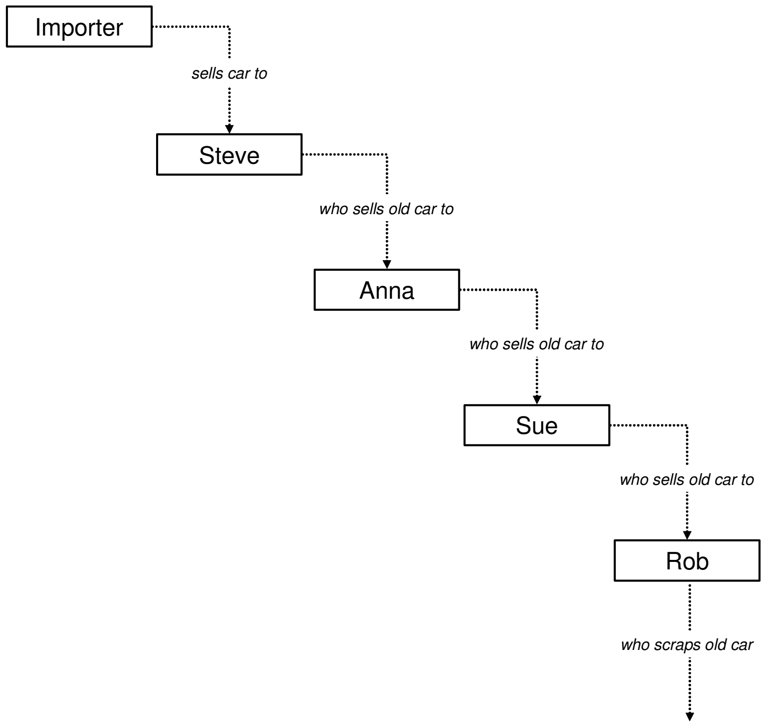
Section 7 showed that potential fuel and emissions *savings* pale in comparison to potential *increases*. This appendix provides an explanation.

To begin, first assume (without loss of generality) that the world comprises only four consumers. Their existing fuel economies and annual travel distances (VKTs) are set-out below.

Table 27: Consumer Characteristics

Consumer	Existing L/100km	Annual VKT
Steve	8.00	15,000
Anna	10.00	12,000
Sue	12.00	10,000
Rob	14.00	8,000

Furthermore, assume that in the absence of an emissions policy, the following transaction sequence would have occurred.



Finally, assume that the import purchased by Steve in this sequence would have had a fuel economy rate of 7 litres/100km.

Based on this information, we can calculate the total fuel consumed in the absence of any policy as:

$$\text{Fuel (w/out policy)} = \frac{15{,}000 \times 7}{100} + \frac{12{,}000 \times 8}{100} + \frac{10{,}000 \times 10}{100} + \frac{8{,}000 \times 12}{100} = 3{,}970 \text{ litres} \quad \textbf{Eqn 1}$$

Now, assume that an emissions standard is imposed and that scenario one materialises. In other words, once restricted from buying his preferred import, Steve upgrades to a slightly better one and the rest of the transaction sequence continues unchanged.

Assuming that the fuel economy attached to the upgraded import is 6 litres/100km, the total fuel consumption under these conditions is:

$$\text{Fuel (upgrade)} = \frac{15{,}000 \times 6}{100} + \frac{12{,}000 \times 8}{100} + \frac{10{,}000 \times 10}{100} + \frac{8{,}000 \times 12}{100} = 3{,}820 \text{ litres} \qquad \textbf{Eqn 2}$$

Finally, assume that once faced with restrictions, Steve abstains from buying a new car and holds on to his existing one. This completely halts the transaction sequence and causes every downstream consumer to also retain their existing vehicle. Consequently, total fuel consumption is:

$$\text{Fuel (retain)} = \frac{15{,}000 \times 8}{100} + \frac{12{,}000 \times 10}{100} + \frac{10{,}000 \times 12}{100} + \frac{8{,}000 \times 14}{100} = 4{,}720 \text{ litres} \qquad \textbf{Eqn 3}$$

In this example,

- potential savings = 3,820 litres – 3,970 litres = 150 litres, while
- potential increases = 4,720 litres – 3,970 litres = 750 litres

Thus, potential increases are five times greater than potential savings. But why? The answer lies in these two statements:

"The rest of the transaction sequence continues unchanged" – when Steve upgrades.

"This completely halts the transaction sequence and causes every downstream consumer to also retain their existing vehicle" – when Steve does not upgrade.

Put differently, the benefits of upgrading are confined to only the consumer that upgrades, while the costs of not upgrading fall upon every consumer in the transaction sequence. This is why potential savings pale in comparison to potential increases.

Appendix 4: Modelling Consumer Choices

The previous appendix showed that the impacts of 'upgrading' are limited to only consumers directly affected, while the impacts of 'not upgrading' are far more widespread.

This observation raises an important question: Given that the impacts of not upgrading depend on the depth/nature/scale of the underlying transaction sequences (which are completely unknown), how were these modelled in the analysis?

Perhaps the easiest way to answer this is with reference to an example. Let us return to the example in the preceding appendix.

First, note that the total increase in fuel, which is simply the difference between equations (1) and (3) is just:

$$Increase = \frac{15{,}000 \times 8}{100} + \frac{12{,}000 \times 10}{100} + \frac{10{,}000 \times 12}{100} + \frac{8{,}000 \times 14}{100}$$

$$- \frac{15{,}000 \times 7}{100} + \frac{12{,}000 \times 8}{100} + \frac{10{,}000 \times 10}{100} + \frac{8{,}000 \times 12}{100}$$

This can be expressed notationally as:[46]

$$\begin{aligned} Increase = {} & VKT_1(OFE_1 - NFE_1) \\ & + VKT_2(OFE_2 - NFE_2) \\ & + VKT_4(OFE_4 - NFE_4) \\ & + VKT_4(OFE_4 - NFE_4) \end{aligned}$$

The trick to modelling this sequence (without knowing anything about it) lies in the fact that: $OFE_1 = NFE_2$, $OFE_2 = NFE_3$ and so on. *i.e.*

$$\begin{aligned} Increase = {} & VKT_1(OFE_1 - NFE_1) \\ & + VKT_2(OFE_2 - NFE_2) \\ & + VKT_4(OFE_4 - NFE_4) \\ & + VKT_4(OFE_4 - NFE_4) \end{aligned}$$

[46] Where VKT = vehicle kilometres traveled, OFE = old fuel economy, NFE = new fuel economy.

Now, if everyone had the same VKT, all the intermediate terms in this equation would cancel out, and the whole thing could be expressed quite simply as:

$$\text{I}ncrease = VKT_4 \times OFE_4 - VKT_1 \times NFE_1$$

However, VKTs differ by consumer.

Our workaround involved assigning each consumer an average VKT. This ensures that, the intermediate terms in the equation continue to cancel out, and allows the overall to be calculated as:

$$\text{I}ncrease = VKT^* \times (OFE_4 - NFE_1)$$

where:

VKT* = average VKT across the fleet
OFE = the average fuel economy of scrapped vehicles
NFE = the average fuel economy of 'upgraded' imports

Now let us apply this approach to our example. Based on an average VKT across these consumers of 11,250, we approximate the overall increase in fuel as:

Increase = 11,250 x (14 – 7)/100 = 787.50 litres.

Recall from the previous appendix, that the actual increase was 750 litres. Thus, in this example, our estimate overstates the true increase by 5%.

Overall, we believe this approach provides accurate enough numbers to robustly estimate the fuel increases associated with the 'no upgrade' scenario. Although it often under- or overstates the true effect, any deviations are fairly minor.