Vehicle Licensing Reform

> Annual vehicle licensing
> Warrant of fitness/certificate of fitness
> Transport services licensing

INTERIM COST BENEFIT ANALYSIS REPORT
WARRANT OF FITNESS REFORM OPTIONS

SEPTEMBER 2012

Preface

The Vehicle Licensing Reform (VLR) is a joint project undertaken by the Ministry of Transport and the NZ Transport Agency looking at the Annual Vehicle Licensing (AVL), Warrant of Fitness and Certificate of Fitness (WOF and COF) and Transport Services Licensing (TSL) regimes. The primary purpose of the review is to reduce compliance and administrative costs, while achieving similar or improved safety and environmental outcomes.

This report documents the interim national cost benefit analysis (CBA) used to inform the development of policy options for changing the frequency of WOF. The report covers most of the core components of the regulatory impact assessment required by the Treasury. The CBA model is also being used, with some modifications, to evaluate proposed changes to the COF regime for light and heavy commercial vehicles.

Important qualifications

The CBA model does not include as yet some policy ideas contained in the public discussion document. Nor does it include mitigation of the potential safety costs of changing the WOF frequency, although provision is made for such implementation costs. The report does not include social economic impacts, such as potential revenue reductions to the motor vehicle repair and service industries, which will form part of the final Regulatory Impact Statement. Further refinements to the CBA model will be made in the light of new and material information emerging from the public consultation process.

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Executive Summary

Introduction

This report details the costs and benefits of regulatory options for warrant of fitness (WOF) regime for light vehicles. The cost benefit analysis (CBA) model provides information to support evaluation of policy reform options, in the context of the Ministry of Transport's and the NZ Transport Agency's Vehicle Licensing Reform work programme.

The policy issue

Most of New Zealand's light vehicle fleet is subject to regular vehicle inspections intended to reduce road crashes that may result from vehicle defects, and any consequent death or injury. For most vehicles, inspections are annual up to six years-old and then six-monthly after that. This is the most frequent inspection regime in the OECD. The relative stringency of the regime and the substantial improvements in vehicle technology and durability since its inception (1937) raise the question as to whether the regime could be relaxed and the likely consequent costs and benefits of doing so.

A key question for the CBA is to what extent would people maintain their vehicle safety standard in a more relaxed regulatory environment? Many countries with less frequent inspection regimes than New Zealand do not appear to have a higher contribution to accidents from vehicle defects and many have much better overall safety outcomes than New Zealand. However, this experience may not translate into the New Zealand context due to differences such as vehicle servicing culture, fleet age and on road enforcement environments.

The scope of options evaluated

The CBA assesses four less frequent WOF vehicle inspection regimes:

- Option 1: Annual inspections to vehicles under the age of 12 years, with six-monthly inspections thereafter
- Option 2: No inspection for first three years of vehicle age, and then once a year thereafter
- Option 3: Inspection frequency based on vehicles kilometres travelled (first inspection at 50,000 km and then once every 12,000 km) or every three years (whichever comes first)
- Option 4: Inspection only on change of ownership (similar to some Australian States). This implies an inspection frequency of two years on average for vehicles up to six years of age, and every three years for older vehicles.

The options are coupled with safety mitigation measures, including education and advice, changes to penalties for drivers with vehicle defects and increased roadside enforcement. At this stage the CBA does not evaluate these measures and thus the safety impacts are not mitigated. However, our assessment of the likely costs of such measures would not significantly change the overall conclusions of the CBA.

The cost benefit methodology

The CBA approach considers the following costs and benefits of vehicle inspection:

- consumer charges, compliance costs and avoidable repair costs
- safety and the associated traffic delay impacts from road crashes
- environmental and fuel saving benefits from emission reduction policies
- justice and enforcement costs.

A more detailed description of the components covered in the CBA model is outlined in Figure 1 on the next page.

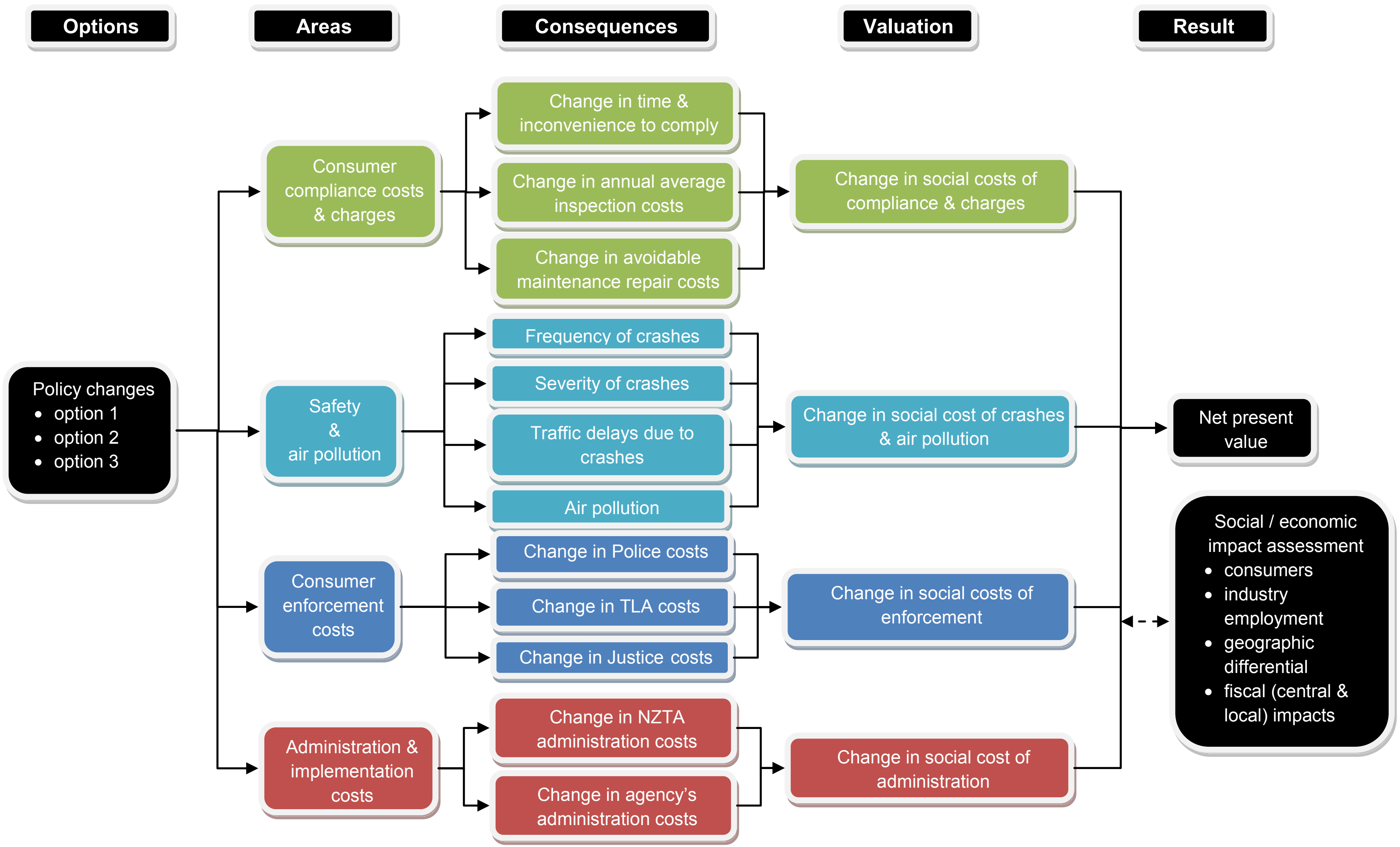
An important source of benefits from reduced regulatory burdens associated with a reduction in inspection frequency is an overall reduction in WOF charges paid by customers. Estimation of these burdens needs to be adjusted for the fact that vehicle owners themselves benefit from operating a safe vehicle. Thus many owners would likely maintain the safety of their vehicles to some extent, at least when servicing their vehicle. The more that an inspection regime is bundled with activities that would have occurred anyway, such as vehicle servicing, then the lower the inconvenience costs and charges to consumers.

We developed a vehicle servicing model based on actual travel distribution by vehicle age to estimate people's vehicle servicing behaviour and their willingness to obtain a standard safety check during a vehicle service. The model then enables us to:

- estimate the net consumer burden by subtracting from WOF inspection charges consumers' willingness to voluntarily obtain safety checks
- adjust the net cost of the regulation by considering cases where the mandated WOF inspection frequency of an option coincides or is then 'bundled' with a voluntary service visit, thereby lowering inconvenience costs for vehicle owners
- adjust inspection charges to reflect the real use of national resources. There are 'economies of scope' where providers bundle servicing and safety inspections together, and these savings are reflected in lower costs to providers that are not necessarily passed onto consumers
- adjust the estimates of safety impacts of each option by accounting for vehicle owners voluntarily obtaining safety checks over time.

The model does not count the compliance and repair costs of re-inspection where vehicles fail a WOF as it is assumed these are required to achieve safety outcomes. Nor does the model count the compliance costs for people who choose to 'unbundle' inspection and repair services, as it is assumed these consumers are making rational choices to unbundle and gain from doing so.

Figure 1 Schematic of the Warrant of Fitness CBA and social economic impact assessment



Consumer charges, compliance costs and avoidable repair costs

Table 1 below summarises the net effect on consumer costs and charges of the four options analysed. Reducing the frequency of inspections initially saves between $43 million and $172 million on ‘charges’, which measure the economic resources saved. The figures below do not represent estimates of the impacts on industry revenue; these will be reported as part of the economic impact assessment. There are also estimated to be between $18 million to $68 million in annual savings in inconvenience and compliance costs. This represents the value of time saved by vehicle owners, which could be used for productive use (i.e. at work), or could be used for leisure (from which people benefit).

Table 1 Consumer charges, compliance costs and avoidable repair cost

Annual savings	Option 1	Option 2	Option 3	Option 4
Savings in charges[1]	$43m	$117m	$116m	$172m
Savings in compliance costs	$18m	$48m	$48m	$68m
Savings in avoidable repair costs	$6m	$17m	$16m	$27m
Total consumer savings	$67m	$182m	$180m	$267m

It is not uncommon for cost-benefit appraisals of mandatory vehicle inspections to allow for ‘over-serving’ by vehicle inspectors as this increases costs and provides no benefit to consumers. Over-serving occurs when vehicle owners are asked to unnecessarily replace or prematurely repair items, and our research indicates this occurs in the New Zealand WOF market. The CBA only accounts for the change in the opportunity for this behaviour to occur as a result of varying the regulated inspection frequency. Table 1 summarises the estimated annual savings in these avoidable repair costs of $6 million, $17 million, $16 million and $27 million for options 1 to 4 respectively, for repairs not necessary in order for vehicles to be at WOF standard.

‘Under-serving’ may also occur where inspectors do not identify defects and this raises safety concerns. Under-serving is already factored into the safety analyses through the underlying crash data which includes vehicles involved in accidents that have a current WOF.

Safety and environmental effects

In New Zealand, vehicle factors (WOF and non-WOF related) *contributed* to (but did not necessarily cause) about 6% of fatal crashes and 3.5% of all fatal and injury crashes for the three years to 2011. WOF-related defects contributed to 2.5% of fatal and injury crashes over this period. Approximately 0.4% of all injury crashes were those with such defects cited as the “sole” cause of the crash.

[1] Including NZTA administration fees.

A literature review found mixed results regarding the effectiveness of periodic inspection. Some research finds that periodic motor vehicle inspections reduce crashes, whilst other papers find no evidence of such effects. International comparison is inherently difficult due to differences between countries in many aspects (e.g. with and without roadside inspection enforcement). One consistent finding is that vehicle defects only contribute to a small proportion of crashes, when compared to human and other factors.

The CBA provides for the risk of an increase in crash rates, and associated social costs, from reduced inspection frequencies. Table 2 summarises the estimated annual social costs of road crashes of $5 million, $17 million, $21 million and $63 million for options 1 to 4 respectively. These estimates include the likely benefits from voluntary uptake of safety checks under the policy options. The estimated increase in annual total social cost of road crashes for option 4 is the highest. This is because under this option the entire WOF vehicle fleet would be affected, and because the average inspection frequency for vehicles over six years of age would be three years — one sixth of the current six-monthly frequency.

Table 2 Estimated safety impacts (with no added safety mitigation)

Annual costs	Option 1	Option 2	Option 3	Option 4
Estimated increase in annual total social cost of road crashes	$5m	$17m	$21m	$63m
Percentage increase in annual total social cost of road crashes	0.1%	0.4%	0.5%	1.6%

Sensitivity analysis has been carried out to understand if the level of under-recording of WOF-related safety factors in crash reports will affect the conclusions. It is also important to note the safety cost estimates have not been adjusted for policy responses such as social marketing and enforcement to mitigate risks; although provision for such expenditure has been provided for as a potential implementation cost.

Traffic delays due to crashes

Some overseas cost-benefit appraisals also include costs of traffic delays due to crashes. There is currently a lack of New Zealand-specific data to estimate this accurately. Estimates from overseas work indicate that any such cost is likely to be less than 1% of the estimated safety impacts, or even lower if we take into account the fact that many crashes occur in rural areas in New Zealand and hence cause minimal traffic delay.

Environmental social costs

At present vehicles fail a WOF if smoke can be visually detected. In some overseas jurisdictions, vehicles are required to undergo more sophisticated emissions testing. The current WOF options do not propose specific changes relating to vehicle emissions testing. There could be additional social costs, in principle, if relaxing the frequency of inspections increases emissions because maintenance issues are not identified and are not addressed in normal vehicle servicing.

Emissions tests overseas generally only see the need for such inspections every two to three years. This is a more relaxed timing requirement than the WOF policy options modelled here. Hence there is a question as the likely effectiveness of a more frequent emission test within context of the options modelled. Moreover, the environmental effects may be small. A European cost-benefit appraisal assessing a potential increase in inspection frequency from 24 months to 12 months estimated these benefits (including fuel savings) to be equivalent to 1% of safety and congestion benefits[2].

Justice and enforcement costs

Many vehicle owners do not comply with the inspection requirement by the WOF due date – in fact 25% of people have still not complied by one month after the due date. Some of the unwarranted vehicles may be taken out of the fleet temporarily due to repairs. However, survey evidence and crash reports suggest that many of the unwarranted vehicles may still be in use, at least for a short period of time. When detected, infringement notices can be issued by NZ Police and territorial local authorities.

Infringements have significant flow-on costs for the justice system. Our analysis takes into account the private and public resource costs (excluding fine revenues as these are transfer payments) associated with offence detection, infringement processing, collection and enforcement. Estimates of likely savings assume the volume of infringements is proportionate to the inspection frequency and vehicle defect infringements will increase with a reduction in inspection frequency.

Table 3 Estimated net reduction in social cost of WOF and vehicle defects-related infringements

Annual savings	Option 1	Option 2	Option 3	Option 4
Estimated net reduction	$2m	$6m	$7m	$10m
% reduction status quo	-16%	-44%	-51%	-68%

Table 3 summarises the estimated annual reduction in social cost of WOF and vehicle defects-related infringements of $2 million, $6 million, $7 million and $10 million for options 1 to 4 respectively. These estimates are provisional only because some information was not available when preparing this document. For example, information on the volumes and the costs associated with waiver applications and community work (in lieu of paying fines) is currently unavailable, and estimated savings may be understated.

[2] Autofore 2007

Key results

As shown in Table 4 below, the net present values (NPVs) for options 1 to 4 respectively are $800 million, $2.1 billion, $2.1 billion and $2.8 billion (8% discount rate and 30-year time period). The benefit-cost ratios (BCRs) are reported as ratios of benefits to increased crash costs, and are 16, 13, 11 and 5 respectively.

Table 4 Summary of net present values and benefit-cost ratios

	Option 1	Option 2	Option 3	Option 4
Present value of benefits	$0.8b	$2.3b	$2.3b	$3.4b
Present value of costs	$54m	$174m	$212m	$630m
Net present value (NPV)	**$0.8 billion**	**$2.1 billion**	**$2.1 billon**	**$2.8 billion**
Benefit cost ratio (BCR)	**16**	**13**	**11**	**5**

NPVs are the preferred report measure and are recommended in the Treasury's Regulatory Impact Analysis handbook. While BCRs are helpful to convey 'bang for buck', a higher BCR of one option over another does not necessarily mean it is better, because BCRs fail to convey the absolute size of benefits and costs. Figure 2 provides a summary of the relative impacts of the different sources of costs and benefits across the options.

Figure 2 Net present values for WOF options (2013/14 to 2042/43)

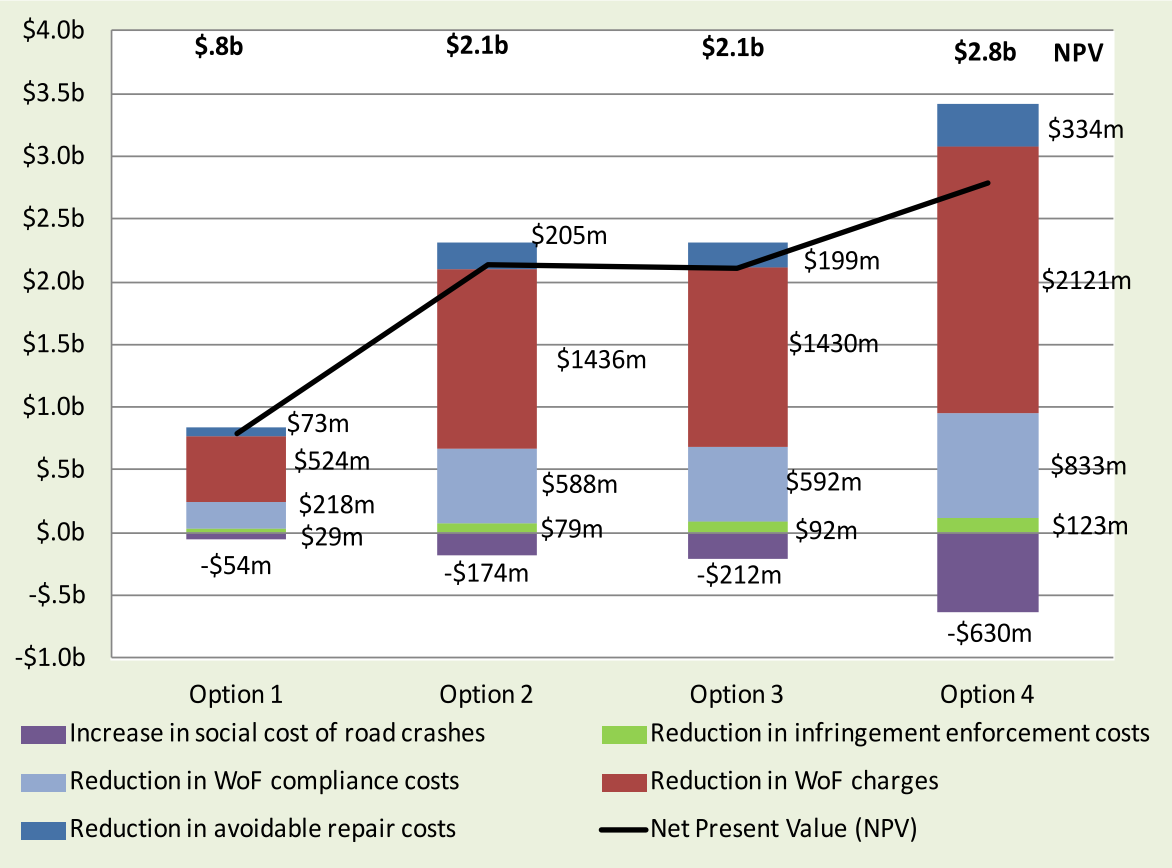


Table 5 below provides the percentage contributions of each benefit and social cost to the NPV for each option.

Table 5 Contributions of impact areas to option NPVs

Impact area	Option 1	Option 2	Option 3	Option 4
Reduction in WOF charges[3]	66%	67%	68%	76%
Reduction in WOF compliance costs	28%	28%	28%	30%
Increase in social cost of road crashes	-7%	-8%	-10%	-23%
Reduction in avoidable repair costs	9%	10%	9%	12%
Reduction in infringement enforcement costs	4%	4%	4%	4%
Total	**100%**	**100%**	**100%**	**100%**

While the high benefit-cost ratios (BCRs) may appear surprising, they are not inconsistent with international studies that do and do not support periodic inspection. For instance the 1999 Australian Federal Office of Road Safety Study estimated a BCR of 0.35 for introducing annual inspections. A comparable estimate here is to move from Option 4 to Option 2, which results in a smaller incremental BCR.

And equally the results can be adjusted to reflect studies supporting inspection, if we only include *like* considerations. In particular, studies that support more frequent inspections have often not considered issues such as enforcement costs, inconvenience costs and avoidable repair costs. There are also significantly lower charges for inspection in most of these studies, which may reflect a more limited scope of safety inspections than the WOF regime or more competitive vehicle servicing markets.

Sensitivity analysis

<u>Overall sensitivity of results</u>

Table 6 Confidence intervals of NPVs

	Option 1	Option 2	Option 3	Option 4
Minimum	$0.5b	$1.3b	$1.3b	$1.5b
5th percentile	$0.6b	$1.6b	$1.6b	$2.0b
Mean	**$0.8b**	**$2.1b**	**$2.1b**	**$2.8b**
95th percentile	$0.9b	$2.4b	$2.4b	$3.3b
Maximum	$1.1b	$2.8b	$2.8b	$3.9b

[3] Including NZTA administration charges.

Monte Carlo simulation was used to estimate the range of the NPV results. The broad orders of magnitude of net-benefits for each option are relatively stable. With 90% confidence, the range of NPVs for options 1 to 4 respectively are $0.6–$0.9 billion, $1.6–$2.4 billion, $1.6–$2.4 billion and $2.0–$3.3 billion.

Relative importance of parameters and assumptions

The most important parameter in terms of benefits is the savings from reductions in WOF charges that account for between 67% and 76% of the NPVs as presented in Table 5 above. Sensitivity to changes in these charges is not reported because they are based on regular industry surveys and there is very little uncertainty concerning their estimation.

Sensitivity assessments for some of the other key assumptions are listed in Table 7 below. Although some assumptions appear to be important in absolute terms, many are unimportant over the range tested relative to the total NPVs estimated. These include:

- servicing frequency assumptions
- value of time used for obtaining a WOF adjusted for work leisure split assumptions
- savings from avoided maintenance costs associated with over-serving

One aspect in particular that may cause some contention is the use of 2.5% of crashes with WOF-detectable defects as the contributing factor to crashes, rather than a higher figure. Thorough sensitivity analysis has been undertaken on this assumption to determine a plausible range based on the detailed data in the New Zealand crash database. Table 7 shows that accounting for plausible levels of under-recording of safety-related vehicle defects in crash reports does not materially affect the estimated net-benefits.

The NPVs are most sensitive to the inconvenience time taken to obtain a WOF, although under no scenario would this come near to materially changing the results. As shown in Table 7, the analysis is very sensitive to applying a discount rate that is higher or lower than the Treasury default rate of 8%.

Table 7 Sensitivity analysis of key assumptions (NPVs)

CBA Attribute	Option 1 NPVs		Option 2 NPVs		Option 3 NPVs		Option 4 NPVs	
	Low	High	Low	High	Low	High	Low	High
Servicing frequency Low 10,000 km; high 15,000 km	-$37m; (-4.7%)	+$23m; (+3.0%)	-$91m; (-4.3%)	+$57m; (+2.7%)	-$94m; (-4.5%)	+$56m; (+2.7%)	-$224m; (-8.1%)	+$182m; (+6.5%)
Willingness to voluntarily obtain safety checks at service Low ($7 & 37% WOF outcome) High ($25 & 100% WOF outcome)	+$9m; (+1.1%)	-$10m; (-1.3%)	+$37m; (+1.7%)	-$41m; (-1.9%)	+$27m; (+1.3%)	-$30m; (-1.4%)	+$116m; (+4.2%)	-$131m; (-4.7%)
Work/leisure split Low 30:70 ; high 50:50	-$26m; (-3.3%)	+$26m; (+3.3%)	-$71m; (-3.3%)	+$71m; (+3.3%)	-$71m; (-3.4%)	+$71m; (+3.4%)	-$100m; (-3.6%)	+$100m; (+3.6%)
Inconvenience time Low 30 min ; high 1.25 hr	-$105m; (-13.3%)	+$52m; (+6.6%)	-$282m; (-13.2%)	+$141m; (+6.6%)	-$284m; (-13.5%)	+$142m; (+6.8%)	-$400m; (-14.4%)	+$200m; (+7.2%)
Adjustment factor for under-reporting of WOF-related factors Low 1.05 ; high 1.3 ** For non-fatal crashes only*	-$1m; (-0.2%)	-$7m; (-0.9%)	-$4m; (-0.2%)	-$22m; (-1.0%)	-$4m; (-0.2%)	-$27m; (-1.3%)	-$13m; (-0.5%)	-$80m; (-2.9%)
Avoided maintenance costs Low 5% ; high 15%	-$37m; (-4.6%)	+$37m; (+4.6%)	-$102m; (-4.8%)	+$102m; (+4.8%)	-$100m; (-4.7%)	+$100m; (+4.7%)	-$167m; (-6.0%)	+$167m; (+6.0%)
Discount rate Low 4% ; high 10%	+$449m; (+56.8%)	-$135m; (-17.0%)	+$1,213m; (+56.9%)	-$363m; (-17.0%)	+$1,198m; (+57.0%)	-$359m; (-17.1%)	+$1,605m; (+57.7%)	-$479m; (-17.2%)

Conclusion

The key findings of the analysis include:

- there are significant consumer savings from reduced WOF charges, compliance cost and avoidable repair costs. In total, these savings are estimated at between $66 million per year for option 1 and $267 million per year for option 4.
- while reducing the inspection frequency risks an increase in road crashes, the effects are relatively small. The estimated increase in the total social cost of crashes of the options ranges from $5 million for option 1 to $63 million for option 4 per year. This represents 0.1% to 1.6% of the current annual total social cost of road crashes.
- the savings associated with enforcing and managing WOF-related infringements is estimated at between $2 million for option 1 and $10 million for option 4 per year.
- the NPVs of the options range between $0.8 billion for option 1 and $2.8 billion for option 4, discounted at 8 percent.
- Sensitivity analysis found that:
    - the NPVs are most sensitive to the discount rate used; but even under the highest discount rate the NPVs continue to be significantly greater than zero
    - the NPVs are also sensitive to the inconvenience time taken to obtain a WOF but the NPVs continue to be high under all scenarios
    - allowing for under-recording of WOF-defects in crash reports does not materially impact on the overall NPVs

The results of the cost-benefit analysis unambiguously support reducing the current frequency requirement of WOF inspections for light vehicles. The results are robust, with the most substantial benefits flowing from firm estimates of savings in charges, adjusted to reflect the expenditure on safety checks that likely would occur anyway. On the risk side of the ledger, we have adjusted for potential under-recording of safety related vehicle defects in crash reports and this has an insignificant impact on the results.

Overall the results are unsurprising in the context of New Zealand having the most frequent vehicle inspection regime in the OECD and the mixed results of overseas studies assessing the value of inspection regimes.

1. The cost-benefit methodology

1.1. Introduction and the policy problem

The policy and economic argument for mandatory vehicle inspections relies on the idea that vehicle maintenance (of safety features) reduces accident rates and hence lowers the social cost of road crashes. The proposition is that vehicle owners might not capture the full benefits of safety servicing or lack sufficient incentive to take account of the crash risk they impose on others from insufficient maintenance. Thus there is a potential safety externality and one regulatory response is to require mandatory periodic safety inspections.

The policy problem is whether the costs of the frequency and scope of the current WOF inspection requirements are equal to, or exceed, the benefits obtained from avoiding the social cost of crashes. There are several reasons to believe the current policy setting might not be optimal. These include the fact that New Zealand has the most stringent inspection frequency in the world, and that several states in Australia only require inspections at vehicle sale and do not appear to record higher crash rates attributed to vehicle factors than New Zealand.

1.2. The policy options

The warrant of fitness (WOF) is a vehicle inspection that is designed to make sure vehicles meet minimum roadworthiness standards to reduce the incidence and severity of crashes caused by vehicle defects. Inspections check things like tyre tread depth, brake systems, and lights and ensure other safety features like seatbelts are working.

Annual inspections are required by law for light vehicles up to six years of age and 6-monthly inspections thereafter. Vehicles subject to the WOFs include cars, vans, motorcycles and trailers. Around 7.6 million WOF inspections are carried out each year (including re-inspections where vehicles have failed).

The Vehicle Licensing Reform project includes a range of reform options for the WOF regime. The options are based on using the current state objectives of the WOF regime as a starting point and aiming to best achieve a set of future state objectives with any particular option. The range of reform policy options is shown in Table 8 below, and more fully discussed in the public discussion document.

Table 8 Policy options

Option one: annual inspections for vehicles up to 12 years old, six-monthly thereafter, with measures to encourage safe vehicles
• annual inspections for vehicles up to 12 years, with six-monthly inspections thereafter
• information and advice programme • changes to how vehicle infringements are dealt with • introduction of demerit points for operating an unsafe vehicle
Option two: first inspection at three years, annual thereafter, improved test with measures to encourage safe vehicles
• improved test for all vehicles
• first inspection at three years of age, with annual inspections thereafter
• information and advice programme • greater use of compliance technology • better targeted compliance and enforcement activities • changes to how vehicle infringements are dealt with • introduction of demerit points for operating an unsafe vehicle
Option three: inspection based on distance travelled, with measures to encourage safe vehicles
• improved test for all vehicles
• first inspection at 50,000km, then every 12,000km thereafter • a default inspection for vehicles that have not had an inspection within three years
• information and advice programme • increased and better targeted compliance and enforcement activities • changes to how vehicle infringements are dealt with • introduction of demerit points for operating an unsafe vehicle
Option four: inspection on change of ownership with measures to encourage safe vehicles
• improved test for all vehicles
• no periodic inspection
• inspection at change of ownership[4] or if required following an inspection order
• more comprehensive information and advice programme • increased and better targeted enforcement and compliance • improvements to how we deal with vehicle infringements • introduction of demerit points for operating an unsafe vehicle

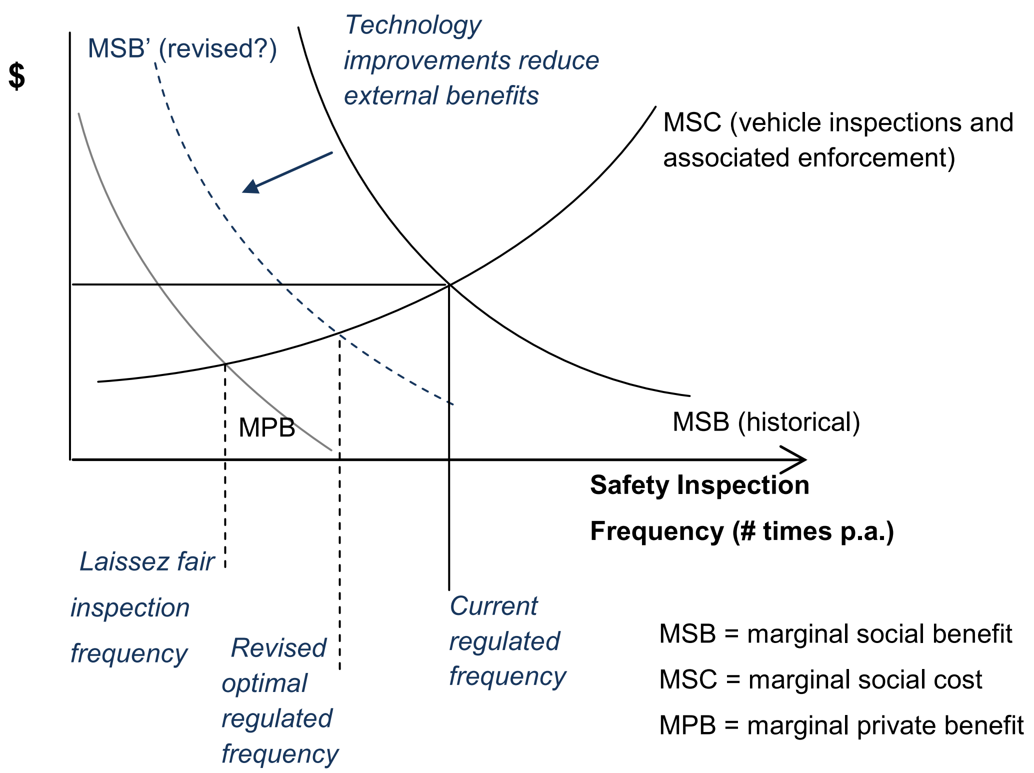
[4] Currently private buyers and sellers can contract out of this requirement. For Option 3, the expectation is that there will be 100% to the requirement to have a 'recent' (to be defined) certified WOF inspection.

1.3. Objectives and evaluation approach

The intended outcome against which the CBA assesses policy options is to achieve an *optimal* level of investment in vehicle safety maintenance. This occurs at the point where further investment in vehicle safety maintenance and its enforcement no longer generate net benefits to society through reductions in the social costs of road crashes.

This desired policy outcome forms the basis of our national cost-benefit approach (CBA) to appraising policy options and is illustrated[5] in Figure 3.

Figure 3 Policy problem framework-social costs and benefits of regulating for safety inspections



The conceptual framework in Figure 3 is illustrative and intended to provide insights into the methodology used in developing the CBA outlined in this report:

1. Marginal social benefits (MSB) of inspection (from crash reductions) fall with the improved roadworthiness which results from increased inspection frequency.

2. The safety analysis component of the CBA estimates the social cost of road crashes and potential increases that may result from changes in inspection frequency to help establish the MSB of inspection.

[5] The stylised illustration tries to show how major changes to the size of the *overall market* can have an effect on the market price (rather than for a given inspection site). The slope of the curves should not be interpreted as implying the size of elasticities.

3. Changes in technology can affect the MSB of a given inspection frequency. For example, technology improvements have extended the life of lights and the durability of tyres over the last 50 years. In Figure 3 this shifts the marginal social benefit curve of inspection from MSB historical to MSB'.

4. The CBA recognises that there are consumer benefits from safety inspections represented in the marginal private demand curve (MPB). This *laissez faire* inspection frequency might be less than the socially desirable (MSB' curve).

5. The revised optimal frequency occurs where the MSC (vehicle inspection and its enforcement) equates to MSB of inspection.

Recognition of consumer benefits in CBA model is important to ensure that we do not overestimate the compliance costs and charges of inspection regulation. People benefit from knowing their cars are safe and hence are willing to obtain a safety check, although this may not be at the same frequency or to the same depth as to what is socially desirable.

Figure 3 depicts an upward sloping supply curve (i.e. short-run marginal social cost curve). This suggests that if inspection volumes fall as a result of a relaxation in the regulated inspection frequency, then there will be downward pressure on prices.[6] For simplicity the model assumes the average WOF charge is unaffected by the regulatory regime. This simplification is relaxed when considering industry and social impacts in rural areas where monopoly provision might arise from industry rationalisation.

1.4. Simplifying assumptions

A key principle in our methodology is to exclude costs that are not net-costs to society. The key instances of these are as follows:

- *The costs to undertake necessary repairs is not included in the CBA*. Owners voluntarily invest in maintenance to sustain vehicle performance and vehicles are required to be maintained to WOF standards at all times whilst on the road. Any technical defects of the vehicle identified during inspections are required to have been repaired irrespectively. Excluding these costs reduces the benefits of relaxing the required frequencies of inspection.
- *We do not include any escalated repair costs because of possible delay*. Any cost escalation is likely to be immaterial because most WOF-related repair costs are for consumable items (i.e. sacrificial, such as tyres, lights and brake pads) and the cost to repair them does not change over time. Also individuals may rationally choose to defer other performance-related maintenance investment while recognising the risk of occurring added future maintenance costs.
- *The inconvenience cost to vehicle owners to re-inspect vehicles is excluded*, as it is necessary to ensure that vehicles on the road are up to WOF standard at all times (a feature of regulations that are not subject to review).

[6] If a regulation makes a market much bigger, then it needs to compete for resources (mainly labour in this instance) from other sectors by paying a higher price (assuming a competitive market). In that case the opportunity cost of the resources, at the margin, is higher the larger the market.
A supporting observation is that the cost to undertake a WOF appears to be high compared to overseas periodic motor vehicle inspections.

- *There is consumer willingness to pay, to an extent, for safety checks*. Expenditure on safety checks that is expected to be paid in any case needs to be netted off from the imposed cost from various regulatory settings in order to describe the net social cost of regulation, so as not to overstate costs.
- *Any preference for vehicle owners to unbundle servicing and inspection does not increase net social costs*. Where the broad timing of vehicle servicing and a required WOF inspection coincide, it is assumed that the two are bundled together, which reduces inconvenience costs and provides cost efficiencies. Where rational and informed owners prefer to incur more costs upon themselves, by, say, unbundling, then society as a whole is not worse off for it, and the additional costs are ignored.

The impact of making these simplifying assumptions on results, if anything, may favour the continued regulation through implying it has lower costs (e.g. ignoring costs of re-inspection). However, we believe there are good reasons for making these assumptions as outlined above and there is considerable benefit in simplifying complex analytical tasks.

1.5. Overseas cost-benefit appraisal learnings

Relatively few studies have been undertaken overseas into the costs and benefits of mandated 'Periodic Motor Vehicle Inspections' (PMVI), which is the general term for WOFs.

Table 9 below highlights some of the key contributions to this literature since 1990 relating to cost and benefit estimation of different required inspection frequencies. Key observations from review of these studies are that:

- there are mixed results, with some studies suggesting positive benefit cost ratios while others conclude the opposite for PMVI
- the mix of private incentives on vehicle owners and regulatory sanctions such as fines and on-road enforcement varies widely across jurisdictions
- there is no common approach to applying national cost benefit methodology to PMVI, as this is dependent on the regulatory context and available data
- the starting point for overseas studies is different to New Zealand as other jurisdictions typically have lower inspection frequencies or no inspection at all

In New Zealand, for much of the vehicle fleet, the intervals between mandatory inspections are shorter than the 'natural' servicing intervals for cars. In most other countries the opposite applies. This difference has motivated the need for us to develop a methodology that takes into account of people's vehicle service habits and how they might approach safety checks in a *laissez faire* environment.

The studies cited have provided guidance on the key components of such analyses, as well as a reality check on key assumptions and results. In our section on results, we compare and contrast the results of some studies against our approach and findings.

Table 9 Summary of some previous cost-benefit appraisals

Author, Year, Title	CBA results, other key findings
NZIER (1999)	NZIER concludes (p 21) that "However, these analysis results do indicate that although the choice of option may be dependent on judgments as to the value placed on additional casualties, it is more likely than not that a change [a *relaxation*] in the WOF timing regime will produce net social benefits."
Kuniyoshi *Saito Evaluating Automobile Inspection Policy Using Auto Insurance Data* (April, 2009)	Saito concludes (p.214) that 'it might be fair to say that the safety inspection was more or less effective, at least several decades ago, but it has had little significance in recent years 'presumably because various kinds of inspections on autos and improvements in car quality rapidly reduce the effectiveness of the regulation.'
Pennsylvania Department of Transportation *Pennsylvania's Vehicle Safety Inspection Program Effectiveness Study* (Cambridge Systematics, March, 2009)	'The results of the statistical analysis are clear and consistent…Using all three model formulations, states with vehicle inspection safety programs have significantly less fatal crashes than states without safety programs. (p. ES-2). Comparisons between the potential safety benefits of the vehicle inspection program in Pennsylvania and the costs of inspections reveal that 'in no instance does the calculated cost to owners exceed the calculated safety benefit.' (p. 4-12)
CITA[7] *Cost-benefit analysis for roadworthiness options* (WP 700, January 2007)	'The total benefits for the introduction of annual inspections for passenger cars older than seven years are 2.1 billion Euro, which represents an amount equal to a one percent reduction of external costs of road traffic in EU-15.' (p.47) 'However, the structural underestimation of the accident number in the official accident has to be considered…Applying the values as given by the ICF-Study[8] means that the benefits have to be multiplied with the factor 1.3. This adjustment is widely accepted, and is justified until the data problems in the European accident statistics are solved. However, the adjustment leads to the final benefit-cost ratio of 2.1, which demonstrates that a change in the frequency of inspections of passenger cars is highly beneficial from a societal point of view.'(pp. 47, 48)
Federal Office of Road Safety (FORS) *Cost effectiveness of periodic motor vehicle inspection. (*Keatsdale Pty, April 1999)	In summary the benefit cost ratios based on full costs range from 0.22 to 0.38 …i.e. annual PMVI for light vehicles commencing at 4 years is unlikely to prove cost effective. (p. 82)
The effectiveness of vehicle safety inspections: an analysis using panel data. David Merrell, Marc Poitras and Daniel Sutter (Jan. 1999)	'If inspections are ineffective, their cost represents a net social loss.' (p.581) (For the US) 'The total annual cost of inspections nationally is thus $1.032 billion, plus the cost of additional repairs. As a basis for comparison, this sum amounts to about half of total annual road and highway maintenance expenditures in California and exceeds total maintenance expenditures summed across 11 small states. Our results suggest that these resources could be more efficiently invested elsewhere. (p.582)

[7] Comité International de l'Inspection Technique Automobile (CITA) (International Motor Vehicle Inspection Committee.)
[8] ICF Consulting *Cost-benefit analysis of road safety improvements.* London, 2003.

1.6. Cost-benefit model components

Figure 4 illustrates the various aspects of the CBA that are described in the chapters of this report. It shows the range of impacts from each area considered in the CBA. The various aspects considered include:

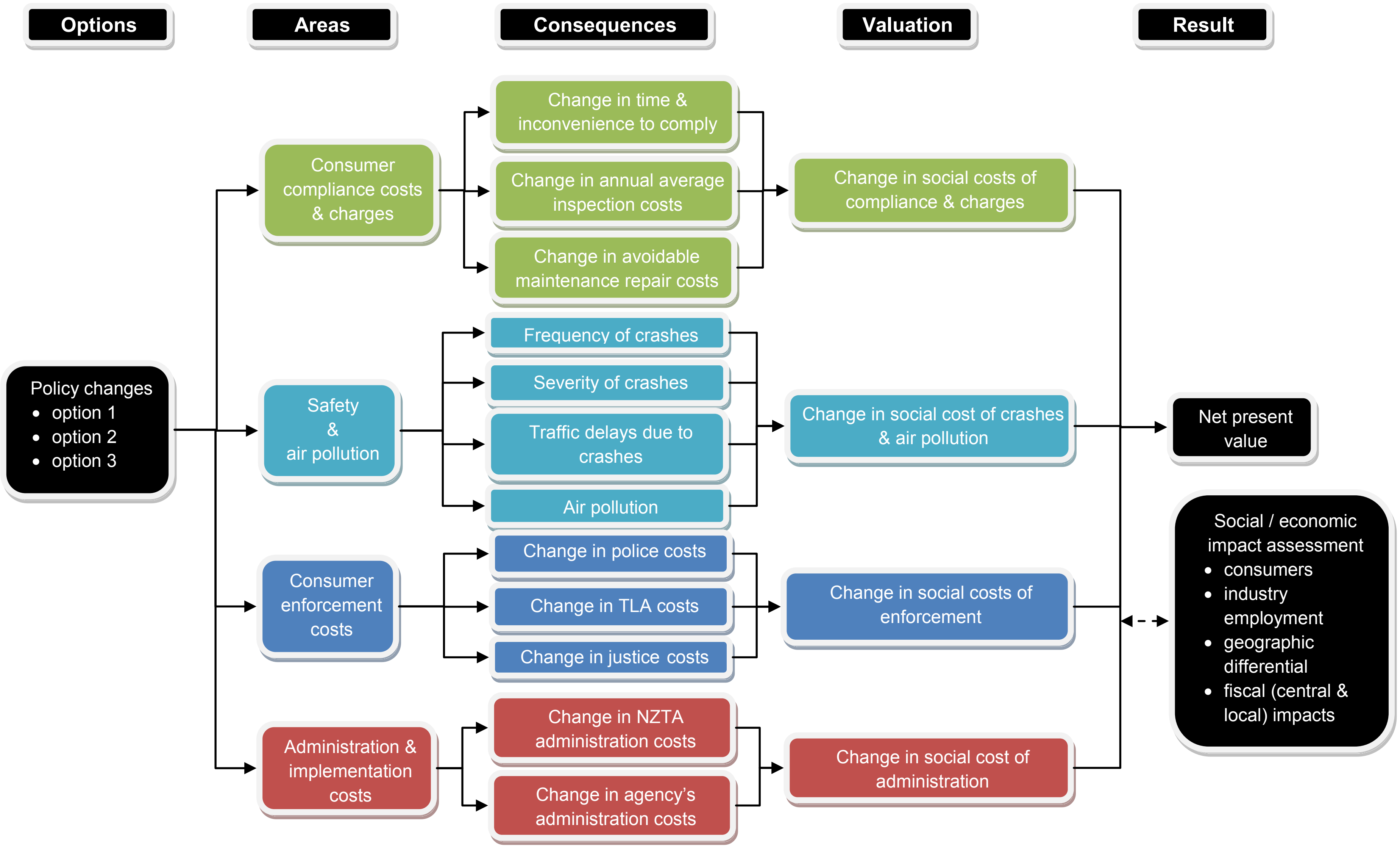
- Chapter 2: Consumer compliance costs and charges
- Chapter 3: Avoidable repair costs
- Chapter 4: Safety and air pollution
- Chapter 5: Justice and enforcement costs

The cost-benefit analysis work will also feed into a social/economic impact assessment, which considers factors that are excluded from the narrower range of impacts that a CBA would validly consider. Examples of additional issues considered in the social/economic impact assessment are impacts on employment, industry revenues, geographical disaggregation, and the effect of transfer payments from one group of people to another (such as tax and infringement notices).

Note that some aspects of the impact assessment may feedback into the CBA considerations. This is represented with a two-way dotted arrow in, however they are not expected to be significant.

The CBA uses an 8% discount rate over a 30-year horizon. The growth in future benefits and applies the Ministry of Transport's fleet growth projection forecasts to calibrate future benefits. The annual safety costs are extrapolated into the future using forecasts of the road toll (fatal and injury crashes) continuing to decline and flatten out.

Figure 4 Schematic of the Warrant of Fitness CBA and social economic impact assessment

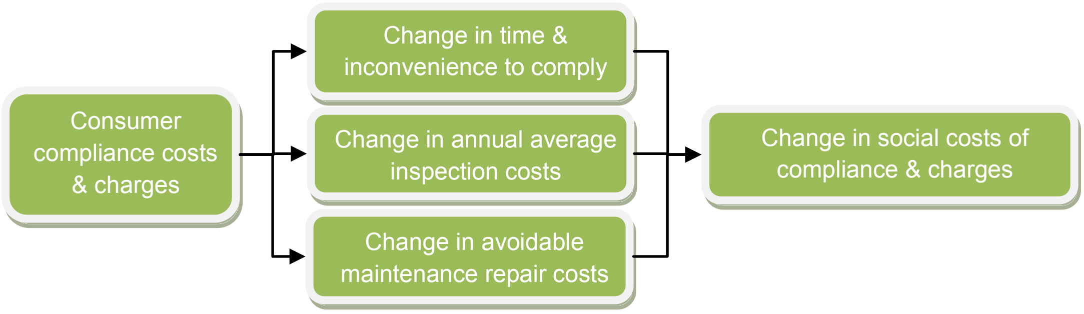


2. Estimating impacts on consumer costs and charges

2.1. Introduction

This chapter outlines the approach and results for the estimated impacts of WOF regulation changes in the costs to consumers for inspections and inconvenience costs.

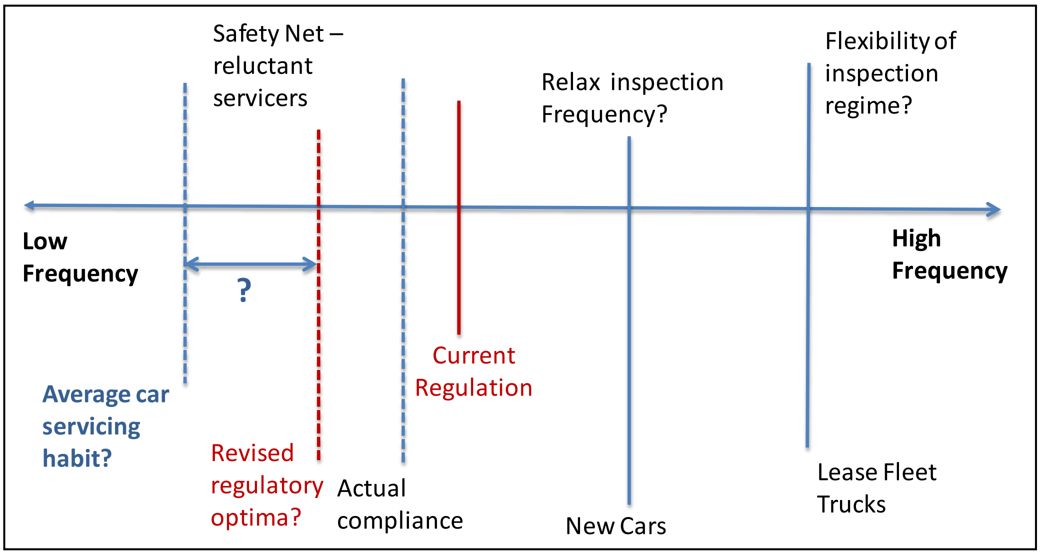
Figure 5 Outline of the appraisal of consumer costs and charges



The approach to estimate the impact on compliance and charges needs to account for the fact that people do obtain a benefit themselves from operating a safer vehicle, and that people will go out of their way to visit garages, etc, to replace consumables such as tyres. The more that a regulatory regime aligns with, or is bundled with, activities that would have occurred anyway, the less binding it is and the lower its overall social compliance cost.

Achieving this coincidence between vehicle services habits and safety inspection frequency is challenging because of the wide variety of servicing behaviours across the vehicle fleet. Figure 6 illustrates a wide range of potential servicing frequencies for young, old cars and other vehicles such as trucks, and the degree to which this might or might not align with current regulated inspection frequency.

Figure 6 Coincidence of vehicle servicing regulatory interventions



As a consequence, the CBA model needs to take account of factors such as:

- the more that mandated WOF inspections coincide with routine service visits, then the lower the net cost of the regulation (because inconvenience costs are lower). Moreover, any bundling of servicing and safety inspections will reduce the cost of the latter through 'economies of scope'[9]
- the extent to which owners *voluntarily* obtain some standard of safety checks under a more relaxed inspection frequency will offset some of the negative safety impacts from relaxed inspection frequency

Thus it would be too simplistic to multiply the assumed total inspection costs by the reduction in the number of inspections to estimate the net compliance and charge impacts of relaxed inspection frequency.

2.2. Compliance cost and charges assumptions

A range of estimates need to be made for unit costs, time incurred (including travel time prior to and after inspection), and charges.

The Ministry and NZTA convened a working group of industry experts to aid with the identification of technical issues, to advise on the scope of appraisal methodologies and assumptions, and to provide data and information. This group is called the 'Technical Advisory Group' (or 'TAG') and includes representatives from the Motor Trade Association (MTA), Transport Service Delivery Agents (TSDAs, i.e. VTNZ, VINZ, and AA), and the Road Transport Forum (RTF). The Ministry retained the right to make the final judgement on assumptions, and members may not necessarily agree with the final judgements made. These assumptions are listed in Appendix 9.2.

For instance, it is estimated that the average resource cost of a WOF is $44 (excluding GST) and that it takes one hour out of an average person's day that is valued at $19.23.[10] This makes the total (gross) cost of a WOF inspection that is not bundled with a service $63.23.

2.3. Estimating the consumer willingness to obtain safety inspections

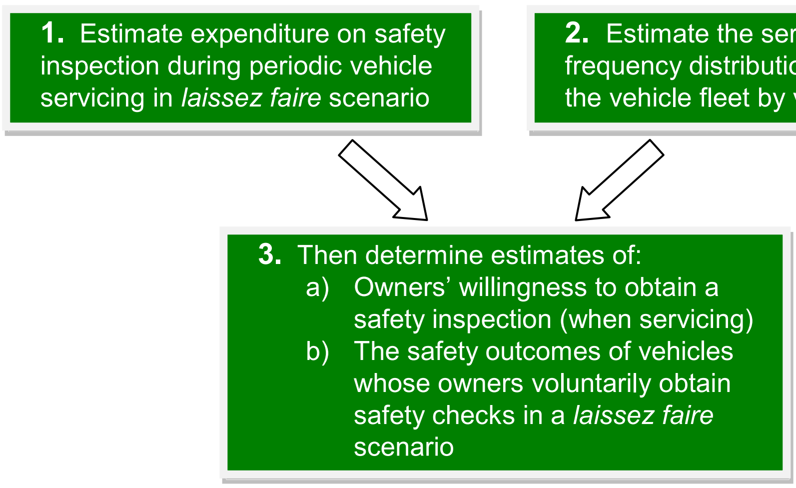
The analysis commences by establishing how vehicle owners may maintain the safety performance of their vehicles in a *laissez faire* scenario, where there is no requirement to have a WOF. This provides a baseline, different from business as usual, with which to compare alternative regulatory scenarios.

To estimate the extent to which vehicle owners obtain safety inspections in the *laissez faire* scenario we separately estimate the propensity for vehicles to be serviced, and the propensity for owners to pay for a safety check — given their vehicle was being serviced

[9] Whether or not inspection agencies pass on any savings in resource cost from bundling servicing and inspections is ignored in the cost-benefit analysis as it does not affect total net costs.
[10] This also includes an allowance of $0.77 for additional vehicle operating costs for travelling to and from testing agents — the cost of time alone is estimated to be $18.46 per hour.

anyway. This framework is illustrated in Figure 7 below and is explained further in the following subsections.

Figure 7 Outline of establishing willingness to voluntarily obtain safety checks



2.3.1. *Estimating voluntary safety checks at the time of a major service*

All vehicle owners are expected to be willing to obtain some degree of safety checks at the time of a major periodic vehicle service. It is unlikely that a vehicle would escape having at least some aspects of its tyres, glazing, lights and brakes checked over at the time of a 'major' (e.g. one- or two-yearly) service.

Moreover, customers would most likely expect a 'core safety check' at the time of a major vehicle service given that drivers would be liable for penalties if found driving a vehicle not to WOF standard (even in the *laissez faire* scenario assumed here). The sorts of faults most likely to be spotted by a police road-side 'walk-around' inspection would be tyres, lights and glazing.

The preferences of vehicle owners would vary. Some vehicle owners would want a bare minimum of safety checks done at the time of servicing; some would want the core safety features checked; and some would want a very thorough check done. To estimate the average standard and expenditure of a safety check (bundled with servicing) we consider the possible range of standards of checks as follows:

- Minimum: we assume that the minimum level of a safety check is 20% of the effectiveness of a WOF inspection when vehicles are undergoing a major periodic service.
- Most likely: we assume that most owners would opt for a 'basic safety check' of features such as tyres, lights, and brakes. Such a basic safety check is estimated to provide about 80% of the effectiveness (in terms of safety outcomes) of a full WOF

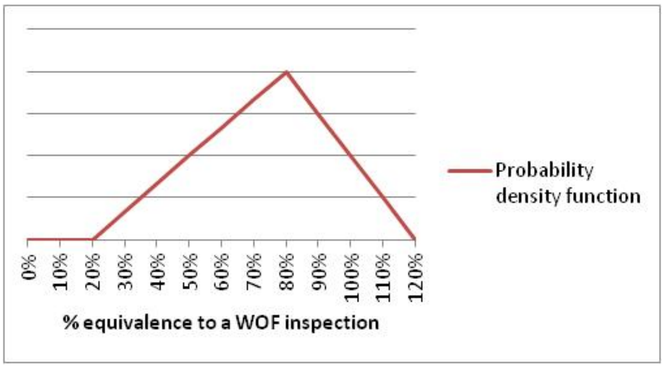
inspection,[11] and to incur an incremental[12] cost about $15 when bundled with a service inspection.[13]

- Maximum: The upper limit of the distribution is assumed to be 120% effectiveness of a WOF inspection. [14] As it is assumed that a WOF inspection costs $25 when bundled with a service, it is assumed that the incremental cost of this higher standard of safety check would be 20% more (i.e. $30)

The incremental cost estimate for a minimum check is one quarter the cost of a 'basic safety check' ($3.75) on the basis it is assumed to be one quarter as effective for safety outcomes.

Having estimated the minimum, most likely and maximum WOF equivalent safety checks and marginal costs, we use a triangle distribution (Figure 8) to estimate the average expenditure on a s afety checks at $15.32. The average expected expenditure on s afety checks results in a v alue three fifths of the assumed cost of a full WOF bundled with a (major) service of $25. The weighted average safety outcome (relative to a WOF inspection) is about 75%. These assumptions are also used in the safety analysis to be discussed in the 'Safety and air pollution' chapter.

Figure 8 Probability distribution of safety checks with servicing in *laissez faire*



2.3.2. Estimating servicing frequencies

To estimate the expected annual frequency of servicing we:

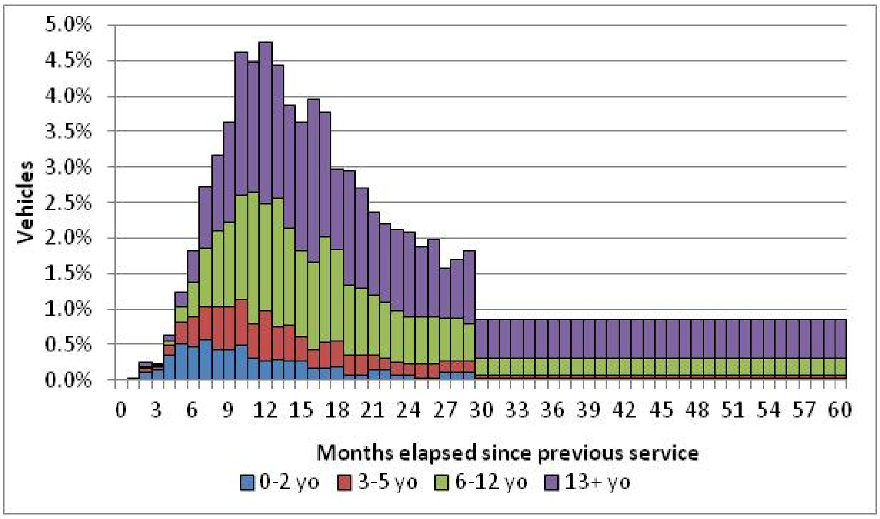
- used data on the age and vehicle kilometres travelled from the WOF vehicle fleet

[11] Tyres, lights and brake faults are cited as contributing factors in around 80% of the total number of injury crashes relating to WOF related vehicle faults.
[12] That is, over and above the cost of the general vehicle service.
[13] The average hourly retail charge out rate is $66.41 for a light vehicle technician (MTA Repairer salary & wage survey 2011). Thus a $15 safety check would correspond to about 14 minutes worth of work, which should be sufficient to undertake a basic check at the time of servicing.
[14] There is evidence that vehicle owners are willing to obtain safety-related work in excess of the WOF standard. For instance, *Pit Stop* provides a range of safety checks in excess of a WOF equivalent check (www.pitstop.co.nz/carservicing/Servicing.html). Discussions with *Pit Stop* confirm that many of their customers are indeed paying more to have their vehicle serviced to (amongst other things) what they believe to be a higher safety standard than that required by the WOF.

- estimated the average distance travelled between vehicle services based on average servicing frequencies (12,500 km) and a propensity for vehicles to be late (e.g. MTA (2011) estimate that 61% of the fleet is late in servicing by an average of 6,145 km)[15]
- estimated the expected number of vehicles (of various ages) that undertake periodic vehicle servicing at and associated frequencies.

An example of the resulting servicing distribution is illustrated below, in which about 50% of the fleet services by 18 months, and 80% by 36 months. Newer vehicles represent a small proportion of the fleet and are estimated to service frequently because they are highly travelled on average. Older cars make up the bulk of the fleet and travel less, and thus are expected to be serviced less frequently.

Figure 9 Percentage of vehicles by expected service frequency and age of vehicle



This servicing distribution is applied to the light vehicle fleet excluding trailers (which are accounted for slightly differently), which Table 10 shows is 3.04 million in 2011. A small number of specialised vehicles (5,585) are excluded from this appraisal. This is because the assumptions made for the bulk of the light fleet may not apply, and they are too few in number to be material to the net results.

15 The average km overdue differs by age, and this is applied in accordance with supplementary data kindly supplied direct to the Ministry by MTA from their 2011 survey.

Table 10 The WOF fleet treatment for this appraisal

Treatment	Vehicle type	Number of unique vehicles that attempted vehicle inspections in 2011
Included in WOF calculations	Passenger car/van	2,584,091
	Goods van/truck/utility	365,470
	Motorcycle	71,421
	Bus	8,740
	Motor caravan	7,083
	Sub-total	3,036,805
Separate WOF calculations undertaken	Trailer/caravan	360,038
Excluded from WOF calculations	Tractor	2,839
	Mobile machine	2,207
	Trailer not designed for h/way use	212
	Moped	194
	Special purpose vehicle	63
	Agricultural machine	48
	ATV	22
	Sub-total	5,585
	Grand total	3,402,428

Data source: NZTA. Note this data represents only the owners of vehicles that attempted one or more WOF inspections in 2011. It excludes any vehicles on the register whose owners did not attempt a WOF, such as vehicles that were temporarily exempt from paying road user charges because they were off the road.

2.3.3. Estimating the total value of voluntary for safety checks

The estimated fleet servicing distribution is incorporated with the estimated expenditure on safety checks. Including the inconvenience cost to obtain a safety check (one hour at $19.23 per hour) the resulting estimated aggregate voluntary payments for safety checks at the time of servicing is $82 million in the first year.[16]

[16] This will be adjusted slightly to account for the timing of the first year benefits, and any ramp-up assumptions needed. Moreover, the inclusion of the $19.23 inconvenience cost for a bundled service and safety check does not affect the benefits of the options, as it is applied to all scenarios and thus nets off from all scenarios.

2.4. Estimating the regulatory burden

2.4.1. <u>The fleet excluding trailers</u>

Where a mandated inspection coincides with when a vehicle would be serviced, for the purposes of the cost-benefit appraisal it is assumed that the two would be bundled. (This assumption is discussed further below). In those instances, vehicle owners do not incur an inconvenience cost, and the inspection costs are only higher by $9.68, which is the cost difference between a WOF inspection ($25, bundled with servicing) and a safety check they are expected to have paid for ($15.32).

Where a mandated inspection does not coincide with a service then the vehicle owner incurs the full cost of $63.23 ($44 charge plus $19.23 inconvenience).

For the cost-benefit appraisal any preference to unbundle servicing and a formal WOF inspection is ignored in the estimation of total costs and benefits.[17] As described further below, the assumption of full bundling is relaxed in other aspects of the modelling to estimate the impact on industry revenues.

Table 11 below outlines how this rationale applies to a vehicle that is serviced annually on average:

(a) the *laissez faire* scenario, whereby an example vehicle owner services annually, paying $15.32 for a safety check each time

(b) the business as usual (BAU) regulatory regime, whereby inspections alternate between incurring the full cost ($63.23) and an incrementally higher cost of $9.68

the ‘excess burden’ of the BAU scenario is the difference between (b) and (a)

(c) an alternative regulatory regime of annual inspections, where the owner only incurs the incrementally higher cost ($9.68)

the ‘excess burden’ of the alternative regulatory scenario is the difference between (c) and (a)

(d) the benefits of moving from the BAU to the alternative scenario is the difference in the excess burdens.

For simplicity it is assumed that any inconvenience associated with repairing a vehicle following a failed WOF attempt is not included in this appraisal. This is because it is a cost of ensuring a vehicle is up to WOF standard whilst on the road, and that is a feature of the regulations that is not currently subject to change.

[17] If people choose to unbundle servicing and inspections and incur more cost, then they do so of their own volition and thus they are not worse off by doing so (i.e. the benefits to them are at least as great as the higher costs). Consumers may wish to do this for a range of reasons; e.g. they may value the independence that a TSDA provides, or they may want to separate their expenses for their own budgetary purposes. Unbundling would increase the economic resource costs to do both transactions, because of economies of scope. This is accounted for separately in the economic impact assessment.

Table 11: Stylised example of the workings of the regulatory burden

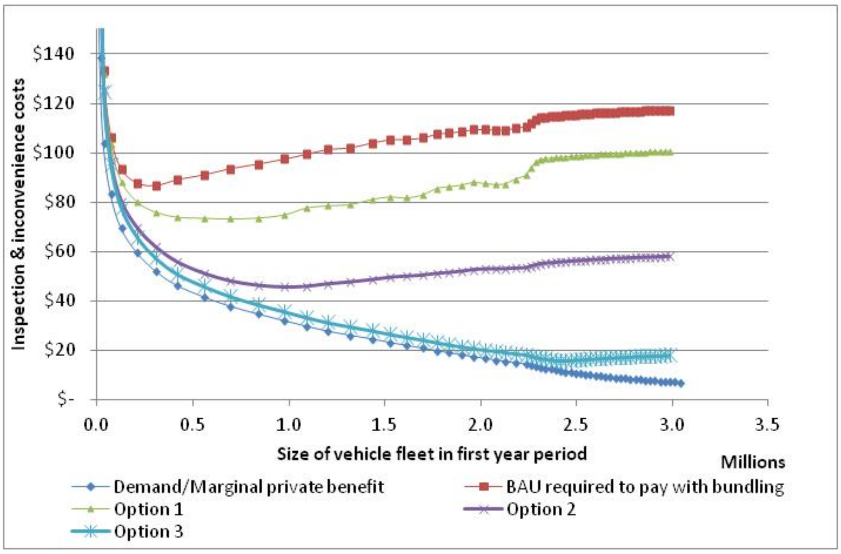
Key:	Symbol	Overall cost	Inspection cost	Inconvenience for consumers
Servicing	S	N/a	N/a	N/a
Basic check bundled with servicing	b	$15.32	$15.32	N/a
WOF, bundled with servicing	Bundled	$25.00	$25.00	N/a
WOF unbundled from servicing	Unbundled	$63.23	$44.00	$19.23

Vehicle age			Years of age									
	p.a.	...	6	6.5	7	7.5	8	8.5	9	9.5	10	...
Natural servicing frequency	1		S		S		S		S		S	
Basic check bundled with servicing			b		b		b		b		b	
Voluntary expenditure		**∑ = $76.60**	**$15.32**		**$15.32**		**$15.32**		**$15.32**		**$15.32**	...
BAU												
Required WOF frequency	2		S		S		S		S		S	
WOF, bundled and unbundled			Bundled	Un-bundled	Bundled	Un-bundled	Bundled	Un-bundled	Bundled	Un-bundled	Bundled	
Required to pay		∑ = $377.91	$25.00	$63.23	$25.00	$63.23	$25.00	$63.23	$25.00	$63.23	$25.00	...
Excess burden (required to pay – voluntary expenditure)		**∑ = $301.31**	**$9.68**	**$63.23**	**$9.68**	**$63.23**	**$9.68**	**$63.23**	**$9.68**	**$63.23**	**$9.68**	
Option (example)												
Required WOF frequency	1		S		S		S		S		S	
			Bundled		Bundled		Bundled		Bundled		Bundled	
Required to pay		∑ = $125.00	$25.00		$25.00		$25.00		$25.00		$25.00	...
Excess burden (required to pay – voluntary expenditure)		**∑ = $48.40**	**$9.68**		**$9.68**		**$9.68**		**$9.68**		**$9.68**	
Benefit		**$252.91**										

The example above holds for the special case of a vehicle owner that would service annually on average. As per Figure 9, vehicle owners are estimated to have a range of servicing behaviours. The modelling accounts for different required inspection frequencies by age of vehicle for the various regulatory scenarios.

Figure 10 illustrates the impact of various regulatory settings on (gross) cost burdens. The horizontal aspect to the graph is the light vehicle fleet ranked by their estimated annual expenditure on voluntary safety checks. The vertical aspect represents the annual average cost (charges plus inconvenience costs) for each vehicle. The BAU curve trends upwards towards about $120, which is near the cost of twice annually incurring a $63.23 cost for those that service highly infrequently.

Figure 10: Regulatory burdens



The area under the lowest curve in Figure 10 (the ‘marginal private benefit’ curve) is the $82m figure reported earlier. The area under the BAU curve is about $317m, which represents the imposed burden of costs and charges on vehicle owners. The difference is the first-year ‘excess burden’ of compliance costs and charges of the BAU regulation, which is about $234m.

2.4.1. The trailer and caravan fleet

The analysis for the trailer fleet is simpler than for the total WOF fleet. The 360,000 trailers are subject to the same WOF inspection frequencies as other vehicles, and about half of the fleet is aged 13 years plus. The number of actual inspections is lower than what would be implied by the WOF inspections frequencies, because trailers may not be continuously used, they are not subject to continuous licensing like cars are, and WOF non-compliance may be greater than for other vehicles.

A WOF fee of $30.43 is assumed ($35 less GST) and the compliance costs are assumed to be half of that for other vehicles, at $9.61, because owners are able to have their trailer inspected at the same time as their primary vehicle. It is assumed that non-compliance would reduce under a more relaxed regime, which moderates the costs and charges benefits estimated.

For simplicity it is assumed there is no material willingness to voluntarily obtain a safety check for a trailer from a professional inspector, and that the regulation is entirely an impost on trailer owners.

The first-year 'excess burden' of compliance costs and charges of the BAU regulation for trailers is about $19m, which brings the total BAU to about $253m.

2.5. Determining net impact on costs and charges separately

The estimates of inconvenience costs and charges for the main light fleet are jointly determined in the first instance. In order to report these separately, we first determine what the model implies about the share of WOF transactions that are bundled with a service. Table 12 below reports these splits.

Table 12 Proportion of WOFs that are bundled with servicing

	BAU	Option 1	Option 2	Option 3	Option 4
Unadjusted	39%	46%	64%	66%	94%
Adjusted (accounting for preferences to unbundle)	31%	36%	51%	53%	75%

For the cost-benefit appraisal, any preference to unbundle is ignored in the total costs and benefits. However, the modelling makes an adjustment to account for a propensity to unbundle for two reasons:

- to help calibrate the assumptions in the model so that observed propensities to bundle (in the real world) can be consistently explained by the model, and
- to more accurately estimate the direct effect on the industry revenues for the purpose of understanding the impact on employment and firms etc.

A recent MTA survey[18] found that 31% of WOF inspections are bundled with vehicle servicing. The second row of Table 12 above shows the results of assuming that 20% of those that have a WOF inspection due at the same time that they would have serviced would prefer not to bundle, with forecast bundling at about 31%.

Using the unadjusted bundling shares (as appropriate for the cost-benefit appraisal) the impact of the regulation changes on costs and charges are as summarised below in Table 13.[19]

18 *www.mta.org.nz/f3267,102838/2012_MTA_Warrant_of_Fitness_Vehicle_Safety_Research_Report.pdf*

19 These dollar figures are then escalated slightly in line with vehicle fleet growth projections.

Table 13 Summary of first-year impacts on consumer costs and charges (including trailers)

Scenario	Impact	Charges	Inconvenience costs	First year	Required[20] frequency per year			
					0-2	3-5	6-12	13+
No regulation	Total WTP	44%	56%	$82m				
BAU	Required to pay Excess burden	 73%	 27%	$336m $253m	1	2	2	2
Option 1	Required to pay Excess burden: Costs/charges benefit	 73% 70%	 27% 30%	$277m $194m $59m	1	1	1	2
Option 2	Required to pay Excess burden: Costs/charges benefit	 76% 71%	 24% 29%	$175m $92m $161m	0	1	1	1
Option 3	Required to pay Excess burden: Costs/charges benefit	 76% 70%	 24% 30%	$175m $93m $161m	0.4	1.3	1.1	0.9
Option 4	Required to pay Excess burden: Costs/charges benefit	 87% 71%	 13% 29%	$101m $19m $234m	0.5	0.5	0.33	0.33

The estimated impact on industry revenues is calculated separately and reported independently of this document.

Table 14 summarises the assumptions made for modelling servicing behaviours and obtaining safety checks in the absence of regulated frequencies.

[20] For Option 3 this is an average frequency estimate, rather than a required frequency.

Table 14 Summary of assumptions for servicing behaviour and safety checks

	Description	Simplifying Assumptions	What does the assumption apply to?	Explanation	Reference	Remarks
1	Vehicle servicing behaviour: a. the proportion of vehicle owners who do/would have their vehicle serviced	100% (by five years)	All cars/vans	These are key assumptions to be used in conjunction with assumptions 2 and 3 below.	n/a	Based on assumptions 1a to 1c, ~80% service their vehicles within 3 years.
	b. theoretical servicing frequency	12,500 or 12 months (whichever comes first)			Estimated from MOT's VKT estimates	
	the proportion who do/would do so on time (based on theoretical servicing frequency)	39% (on time) 61% (lateness – see MTA's survey)			MTA's 2011 survey	
2	Bundling servicing and WOF					
	Where servicing and WOF inspection requirements coincide, the proportion that would get both done at the same time (and at the same place). NB – often service visits and WOF do not coincide – see remarks	a. 100% where a service visit and WOF coincide for the CBA	When WOF and servicing year coincide -- e.g. annual servicing and annual WOF.	This assumption is for refining compliance costs and WOF charges. This assumption is not required for the safety analysis.	n/a	Assumed that people who decide to unbundle and incur additional compliance costs are not worse off as this is a rational consumer choice.
		b. 80% for the industry impact analysis		This assumption is made for calibrating the model to observed data, and for refining the impact on industry output.	MTA survey found that 31% of WOFs have a service bundled at the same time.	Unbundling reduces economies of scope, which increases the resources needed by industry to implement checks. This increases the impact of regulated frequency change.

3. Avoidable repair costs

3.1. Introduction

Changing certain features of WOFs, such as their required frequencies, may affect how the transport fleet is maintained. This section considers the issue of whether WOFs are associated with any excessive maintenance cost requirements that can, say, be avoided if the inspections are less frequent.

Asymmetric information can lead to a risk of incorrect level of repairs (i.e. overtreatment). However, overtreatment is not in itself a sufficient reason for government intervention in a market. This issue is considered in detail for this appraisal of WOF reforms because of the regulatory imposition for vehicle owners to be subjected to such risks, and because the risk varies under different regulatory scenarios.

Any possibility of 'under-serving', by being too lenient in inspections, is problematic, but is captured in the safety analysis.

Note that for simplicity it is assumed that the costs to repair a vehicle as appropriately required by an inspection (i.e. 'necessary repairs') are not net-social costs in the CBA of policy options considered here. This is an assumption that can be reconsidered if and where needs be in any future analysis.

3.2. Previous studies on avoidable repairs

There is an academic literature on 'credence goods and services', which repair services sits within. A general description of such goods and services is that although consumers can observe the utility they derive from them after the fact, they cannot judge exactly what they need beforehand.[21] The issue comes about because the seller of the repair service is also the expert who diagnoses how much service is needed.

In principle the problems that can arise are overtreatment (unnecessary repairs or repairs that use more labour or parts than necessary), under-treatment (neglect of defects that require urgent attention), and overcharging (billing for parts and labour not provided, which suppresses the number of repair service checks).

The literature shows that in order to understand whether a problem actually exists, one needs to obtain data on real-world behaviours; theoretical predictions are of limited relevance.[22] What happens in practice can vary widely. Experimental evidence on credence goods shows that these markets are prone to under-treatment, overtreatment and overcharging. However 'honesty' plays a major role in mitigating possible problems, which might be explained by social or moral norms, guilt aversion and/or 'distributional preferences' (i.e. altruism).[23]

[21] Dulleck, U, R Kerschbamer, and M Sutter (2011) "The Economics of Credence Goods: An Experiment on the Role of Liability, Verifiability, Reputation, and Competition." *American Economic Review*, 101(2): 526–55.
[22] Ibid, p553
[23] Ibid, p547–548

A 2006 American study[24] of 163 undercover garage visits found evidence of over- and under-treatment. An Australian Federal Government commissioned appraisal (Keatsdale 1999, p74)[25] reviewed literature on the 'cost of unwarranted repairs'. Keatsdale assumed 32% of the total repair costs of vehicles were excessive (which Keatsdale "conservatively" estimated at $200 per 'failed' vehicle, corresponding to about $60 of unwarranted repairs per 'failed vehicle'). The Keatsdale assumption of 32% is a strong one given the lack of modern (as at that time) authoritative data sources they quote.[26]

3.2.1. A previous New Zealand cost-benefit appraisal on WOF frequencies

A cost-benefit appraisal of different WOF frequencies was undertaken by the NZIER in 1999. 'Avoidable repair costs' (overtreatment) had a large influence on the results.[27] These were described as 'repairs that are suggested as being desirable by the WOF procedure even though they are not necessary at that point in time to pass the test' (p11).

The 1999 study supposed that some proportion of the maintenance costs required by inspectors related to overtreatment. Overtreatment is a net-social cost because society would gain by reducing its incidence and using the resources consumed elsewhere. The 1999 study quoted figures from the MTA that across all age ranges of vehicles the average repair bills for vehicles failing the WOF were in the region of $145 per vehicle (in 1999 dollars). The core assumption of the 1999 study was that 15% of this fee was excessive, and this was sensitivity tested across a range of 8%–60%. No evidence was available as to the proportion of repair costs that were 'avoidable'. Nor was it discussed whether or not the entirety of the 'avoidable repair' cost had no social benefit.

The assumption of avoidable repair costs had a large effect on the analysis. For instance, a net present value of 'Option 2'[28] was reported as $1.02 billion, of which about two thirds (65%, or $658 million) was attributed to avoidable repair costs.[29]

3.3. Differences in pass-fail rate for WOF in the New Zealand Market

In New Zealand the market for providing WOFs can be broadly divided into Transport Service Delivery Agents (TSDAs), who can inspect vehicles but not repair vehicles, and other providers – typically vehicle service and repair businesses. There are three privately owned TSDAs

[24] Schneider, H (2006) A Field Experiment to Measure Agency Problems in Auto Repair. Unpublished. http://editorialexpress.com/cgi-bin/conference/download.cgi?db_name=IIOC2006&paper_id=440

[25] Keatsdale Pty Ltd (1999) *Cost effectiveness of periodic motor vehicle inspection.* A report for the Federal Office of Road Safety

[26] The most extensive piece of literature referenced contained a sample of 15,000 vehicles, but was dated 1977.

[27] NZIER (1999) *Review of Warrant of Fitness (WOF) regime*, Report to the Land Transport Safety Authority

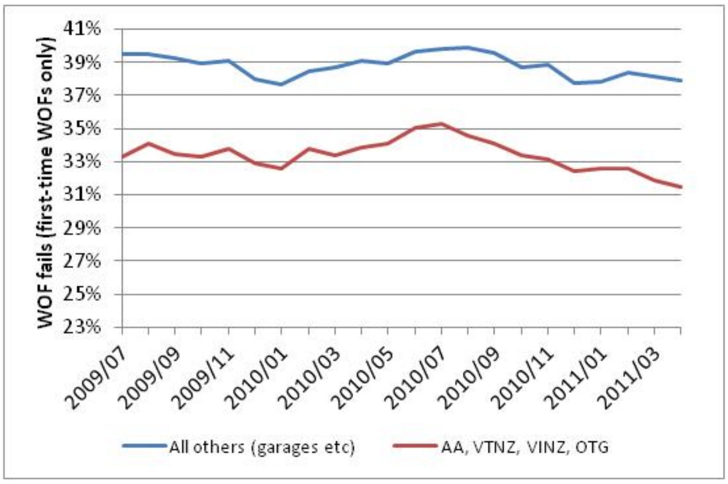
[28] Specifically, this was for annual WOFs for cars over 3 years old and no WOFs for cars less than 3 years old.

[29] This related to a willingness to pay value for crashes. The study itself did not decompose the total net benefits by category of benefit and cost. The figure reported here is estimated by comparing the net present values when only the 'avoidable repair cost' proportion is varied. The NPV changes approximately linearly with this assumption across the sensitivity test scenarios. The remaining net benefit of $353,000 is assumed to be the savings on WOF costs, less the increased social costs of crashes.

which together account for around 20% of WOF inspections Vehicle Testing NZ (VTNZ), Vehicle Inspection NZ (VINZ) and the NZ Automobile Association (AA).

TSDAs differ from non-TSDAs principally because they specialise in testing and do not provide repair services. Data on the rate of failures for first-time WOF attempts indicates that garages (and other inspection agents that undertake repairs) fail WOFs more often than TSDAs. Figure 11 illustrates this trend for the period July 2009 to March 2011, whereby non-TSDAs sustain a WOF failure rate that is about six percentage points higher than for TSDAs.

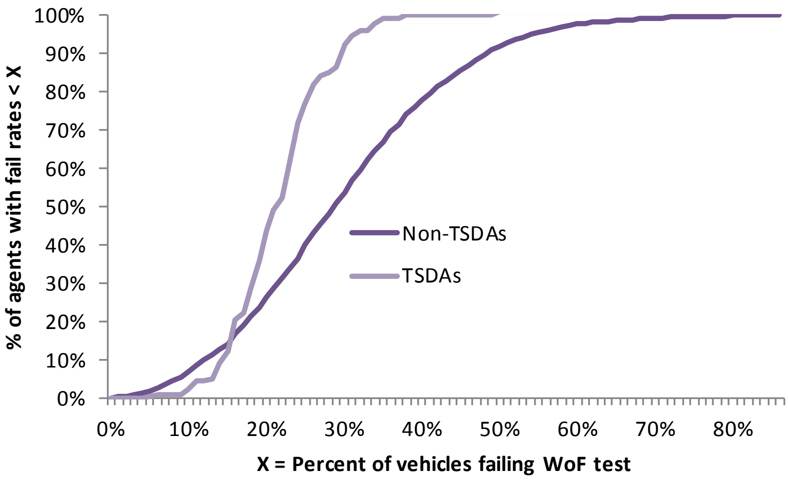
Figure 11 Summary of maintenance-specific issues arising from WOF fail/pass analysis



Source: NZTA

Further analysis of the range of inspection agents (Figure 12) shows that there is high variability in fail rates for non-TSDAs, as shown by the long ‘s-shaped’ curve. Some non-TSDAs fail over 50% of the vehicles they inspect.[30] There is a smaller variance in fail rates across the population of TSDA agents, with 90% of them with fail rates between 13% to 31%.

Figure 12 Distribution of fail rates by TSDA and non-TSDA

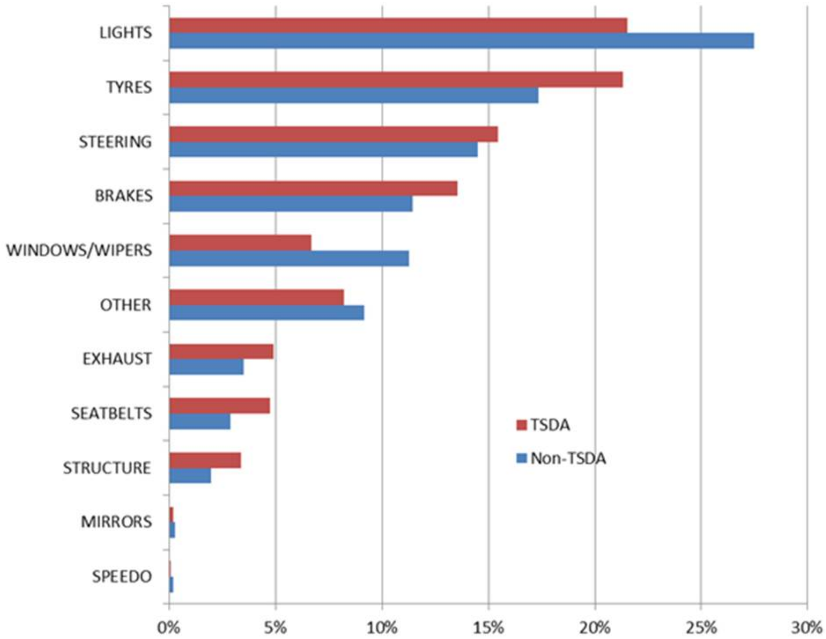


Source: NZIER, based on NZTA data

[30] However, some of the particularly high fail rates could be skewed by some repair agents only inspecting a small handful of vehicles annually.

Figure 13 shows the differential fail rates for various fault types between TSDAs and non-TSDAs. Non-TSDAs only exhibit a 'disproportionate' share of diagnoses in lights and windows/wipers.

Figure 13 Percentage of failed WOF by fault type (2011) by TSDA and non-TSDA



Source: NZTA

3.4. Accounting for the differences in WOF pass/fail rates

Three broad hypotheses are suggested below for why non-TSDAs may have a m aterially higher fail rate:

1. It is as one would expect, given that the owners of vehicles that are more likely to fail (because of age, high use, or a noticeable fault) choose to have their vehicles inspected by garages

2. Overtreatment: Excessive stringency on WOF standards by garages to generate work for the inspectors and cross-sell repairs

3. Under-treatment: leniency by TSDAs because:

   - it reduces the incidence of having to re-inspect without charge (transport rules do not provide for charging for re-inspection within a prescribed time), without scope for the subsequent work to offset this cost

   - lower incentives than non-TSDAs to identify all valid faults as there are no cross-selling service repair opportunities

   - a need to attract repeat customers from a more limited scope of services offered than non-TSDAs.

To inform this work, the NZIER undertook analysis, including regressions, of the 3.7 million data records for each first-time WOF inspection undertaken in the 2011 calendar year. (The full report is in Appendix 9.2.) The objective of the analysis was to see if any of these issues could be discounted out of hand on the basis of evidence in the data.

NZIER's exploratory analysis was based on two approaches. One was to focus on individual vehicles and to examine the extent to which vehicle attributes and an owner's choice of testing agent (TSDA vs non-TSDA) could explain variation in fail rates. The other focussed on individual testing agents and examined whether variation in fail rates could be explained by differences in the kinds of vehicles that agents are testing and the different markets in which they operate.

The vehicle level analysis showed that:

- vehicles tested at a non-TSDA fail more often, even when adjusting for the age and distance travelled by vehicles. A vehicle tested by a TSDA agent has a 7% lower probability of failing.
- vehicles which fail a WOF at a non-TSDA are more likely to have exhibited faults which are noticeable to vehicle owners than vehicles which are failed at a TSDA. This is suggestive of self-selection-owners seeing a problem so taking a vehicle to a non-TSDA.

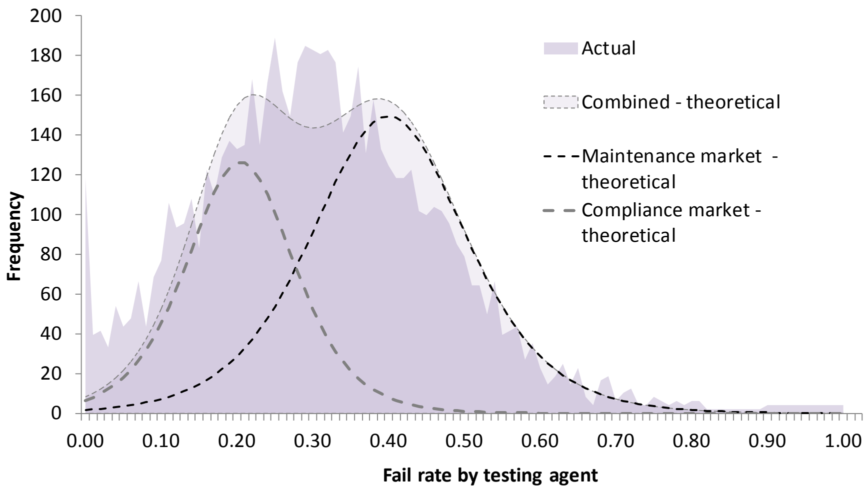
Analysis of testing agent fail rates showed:

- much of the variation in fail rates amongst testing agents can be explained by the existence of two distinct business models operating in the WOF testing market:
    1. a 'compliance model', where firms focus on generating revenue from testing activities and therefore customers whose main interest is in complying with regulations and who have a reasonably low expectation of their vehicle requiring repair services
    2. a 'maintenance model, where firms focus on generating revenue from maintenance services and bundling WOF testing with other services for customers who want or need repair and maintenance services
- the existence of distinct business models can go a long way to explaining differences in fail rate between TSDAs and non-TSDAs
- evidence of strategic behaviour in the market, especially over-serve, because high fail rates (e.g. over ~45%), cannot be explained by variation in agent characteristics and differences in the kinds of vehicles they test.

3.4.1. Two different markets

Exploratory analysis reveals that much of the difference in fail rates between TSDA and non-TSDA fail rates could be due to different markets for WOF tests, with TSDAs serving a compliance market and non-TSDAs serving both compliance and maintenance markets. It is not possible to directly observe these two markets but, as shown in Figure 13, it is easy to see how observed fail rates could come from two underlying distributions which reflect two different markets. Figure 14 shows one example of a twin-peaked distribution which is precisely what we observe in some regional markets (such as Dunedin City).

Figure 14 Non-TSDA fail rates and sub-markets



Source: NZIER

3.5. Predicting fail rates from observed factors

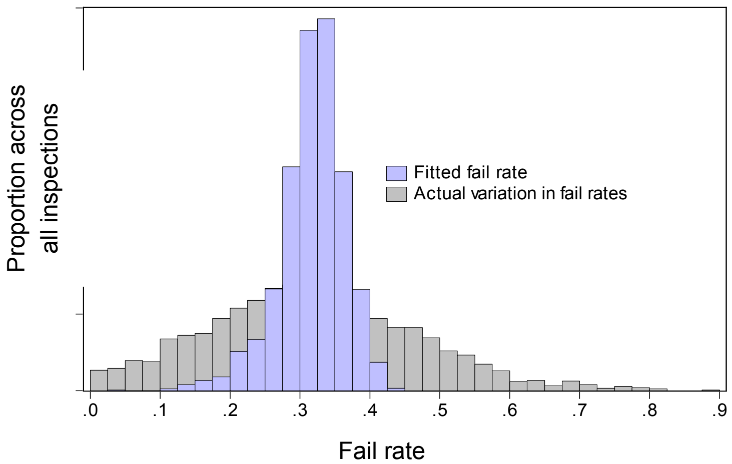
NZIER used a statistical model of fail rates at the agent level to see if variation in fail rates could be explained. The model used the following factors to predict fail rates[31]:

- odometer readings
  - the average odometer reading for vehicles tested at each agent
  - as an indication of whether an agent tests vehicles with above average probability of failure
- TSDA/non-TSDA status
  - to control for the fact that TSDAs are by definition compliance market operators and so should have a lower average fail rate than a typical non-TSDA operator
- Market share
  - tests performed as a share of total tests in the agents resident TLA
  - as a proxy for (non-TSDA) operators who are pursuing a compliance market business model
- Average local household income
  - defined at the TLA level, helps to control for geographical differences
  - partially controls for the fact that the probability of a vehicle failing a WOF will depend on both vehicle wear (odometer readings) and any offsetting maintenance expenditure – which will be some function of income.

[31] Vehicle age was excluded from the predictive model on the basis it did not have sufficient explanatory power over and above odometer readings (as the two are closely correlated). Also excluded were subjective assessments of the visibility of faults (which would drive 'self selection' to repair agents), because of problems of 'identification' discussed earlier. The first (bottom) decile of agents by volume were excluded from this analysis (0.7% of all tests).

Figure 15 shows fail rates predicted by the model against actual fail rates. This shows that both low and high fail rates are hard to explain. Something irregular seems to be going on. For example, testing agents which fail more than 45% of the vehicles they test cannot be explained by the factors listed above.

Figure 15 Predicted fail rates (model fitted)



Source: NZIER

Fail rates in excess of 45% relate to 557 agents (17% of agents) who tested 688,000 vehicles (13% of tests). These figures provide a sense of the extent of possible over-serving, and are of use for the WOF CBA, but they are not definitive. Further analysis would be required to make these estimates more definitive.

3.6. Conclusion

The initial analysis of the data on New Zealand WOF inspections indicates that there is likely to be a problem of over-treatment in the enforcement of WOF standards. Table 15 summarises the assumptions made to estimating the value of avoidable repair costs.

Table 15 Assumptions for CBA of avoidable repair costs

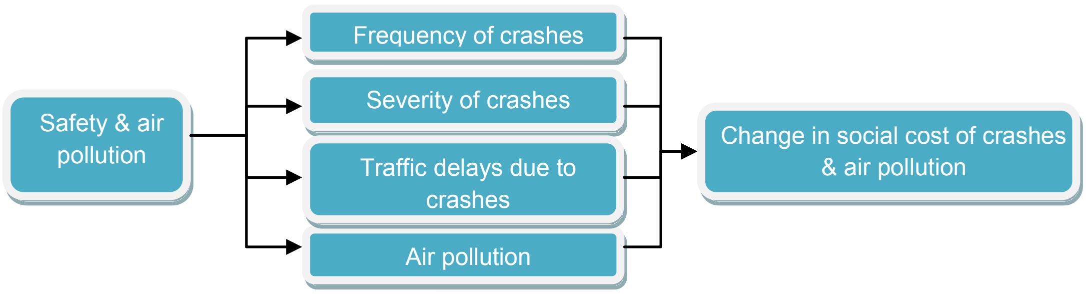
Assumption	**Low**	**Mid**	**High**
Average repair costs		$210[32]	
% of average repair costs that are unnecessary at that time to pass the WOF test (applied to the mid-point estimate of repair costs)	5%	10%	15%
Assumed avoidable repair cost per WOF failure from a non-TSDA agent	$10	$20	$30

[32] The NZIER (1999) report quotes MTA figures of $145 average repair costs. With 45% price inflation since this corresponds to $210.

4. Estimating the safety and air pollution costs

4.1. Introduction

Figure 16 Outline of the appraisal of safety and air pollution costs



Road crashes have financial and economic impacts through factors like direct medical costs, loss of output and reduced quality of life, vehicle damage, justice and crash investigation.

Road crashes that occurred during peak hours at urban centre can cause traffic delays to road users. AUTOFORE (2006a)[33] used congestion cost of €10,000 per crash (€5,000 per injury crash and €15,000 per fatal crash) in their analysis. If these figures (converted to NZ$7,700 and NZ$23,100 respectively) were used for the analysis, the total congestion costs would be around 1.6% of the safety impacts (between $0.1 million for option 1 and $0.9 million for option 4). However, these are likely to be on the high side, as not all crashes result in delays. In our opinion, the traffic delay cost is likely to be less than 1% of the estimated safety impacts. Due to the uncertainties involved, we have not included traffic delay costs in the final estimates.

Furthermore, the overall quality of the vehicle fleet can have influence on emissions and have health impacts to the society. However, the effect of inspection on air pollution is negligible and therefore can be ignored (also see section 4.7).

To help estimate the incremental change of the social costs[34] of crashes from alternative inspection frequency, we need to estimate the change in the number of crashes and the severity of those crashes. This chapter explains how this assessment was carried out.

A rationale for the WOF inspection is to ensure car owners maintain their vehicles to the minimum safety standards and therefore reduce the risk of crash involvement. However, having periodic inspections does not necessary remove all vehicle safety risk since vehicles defects can develop between each inspection.

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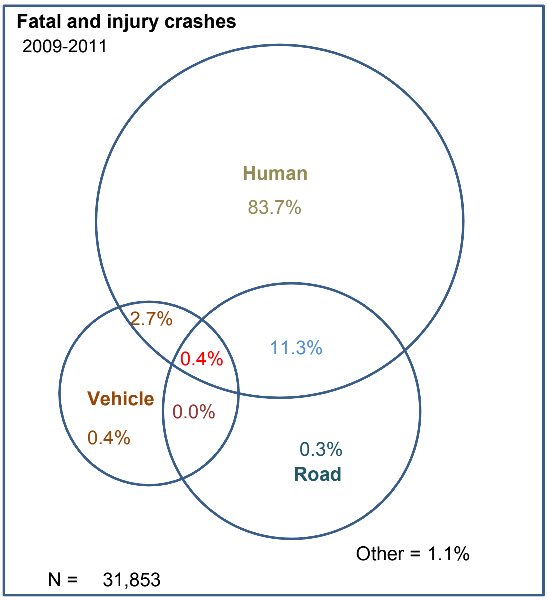
[33] Autofore (2006), "Development of an economic assessment tool", *Study on the Future Options for Roadworthiness Enforcement in the European Union*, WP #400, pp.16.
[34] Social cost of road crash or road injury is a measure of the total cost that occurs as a result of the crash or injury. It includes loss of life and life quality, loss of output, medical costs, legal costs and property damage costs. For details about social cost, please refer to "The Social Cost of Road Crashes and Injuries: June 2011 update", Ministry of Transport.

Vehicle defects generally play a small role in road crashes. For example, in Australia only around 5% of all fatal crashes that occurred in 2006 have vehicle defects as contributing factors[35]. In the United Kingdom, the percentage of all injury crashes occurred in 2009 with vehicle factors was between 2 and 3%[36].

Figure 17 Contributing factors to fatal and injury crashes in New Zealand, 2009-2011



Data source: Crash Data Analysis system, Ministry of Transport

In New Zealand, vehicle factors contributed to about 6% of fatal crashes and 3.5% of all fatal and injury crashes[37] for the three years to 2011 (Figure 17). Approximately 0.4% of all injury crashes were those with such defects cited as the "sole" cause of the crash.

Over the same three-year period, the average annual number of at-fault injury crashes [38] involving vehicles with WOF-related safety defects (as contributing factors) was 155. Table 16 summarises the average annual total social cost[39] of these crashes by severity and the presence of WOF-related defects. The average annual total social cost of fatal and injury crashes with WOF-related defects is $73.8 million or $82.1 million including non-injury crashes. This represents around 3 percent of the total social cost of all at-fault crashes. Of this total, around 68 percent (or $55.6 million) involved vehicles with a valid WoF at the time of the crash.

[35] Bureau of Infrastructure, Transport and Regional Economics (2011), "Fatal road crashes in Australia in the 1990s and 2000s: crash types and major factors", Department of Infrastructure and Transport.
[36] TRL (2011), "Effects of vehicle defects in road accidents".
[37] The corresponding percentages of crashes with WOF-related defects are 6% (fatal crashes) and 2.5% (all injury crashes).
[38] For the period from 2008 to 2010, around 86 percent of all injury crashes were at-fault crashes.
[39] Social cost of road crash or road injury is a measure of the total cost that occurs as a result of the crash or injury. It includes loss of life and life quality, loss of output, medical costs, legal costs and property damage costs. For details about social cost, please refer to "The Social Cost of Road Crashes and Injuries: June 2011 update".

Table 16 Social cost of at-fault road injury crashes in New Zealand (annual average 2009 to 2011)

Social cost of at-fault passenger cars and vans injury crashes		Annual average social cost of at-fault crashes, June 2011 prices			
		Injury crashes $m	Non-injury crashes $m	Total $m	%
Vehicles with WOF-related safety defects	with a valid WOF	49.4	6.2	55.6	1.9
	without a valid WOF (note 1)	24.4	2.2	26.5	0.9
Other at-fault crashes (without WOF-related safety defects)	with a valid WOF	2,066.8	396.7	2,463.5	82.0
	without a valid WOF (note 1)	391.9	65.1	457.0	15.2
Total at-fault crashes		**2,532.5**	**470.2**	**3,002.6**	**100.0**

Data source: Crash Data Analysis system, Ministry of Transport
Notes:
(1) These items include those with unknown WOF status.
(2) This table excludes crashes where vehicle age was not recorded.

The purpose of this analysis is to estimate the likely impact of the WOF frequency change on road crashes and injuries. This analysis will not correctly predict how many additional crashes will actually occur. Rather, this analysis utilises the best information currently available and a simple approach to gauge the direction and scale of the effect. Different countries have different regulations and rules in place, so the effects inferred from similar change overseas are generally non-transferrable for New Zealand use.

4.2. The approach[40]

Figure 18 Key steps to estimate the safety impacts

1. estimate the risk line using empirical data
2. estimate the incremental change in the number of injury crashes
3. disaggregate the estimated number of injury crashes by crash severity
4. estimate the increase in the social cost of road crashes (including allowance for non-injury crashes)

[40] This section is extracted from Appendix 1.

Figure 18 outlines the key steps involved to estimate the safety impacts of policy options. Steps 3 and 4 are based on the standard appraisal procedure used by the Ministry (for details, see Appendix 1).

To complete steps 1 and 2 requires information about how the ratio of at-fault crashes with WOF-detectable defects links to the time since last inspection. To illustrate, let us consider the scenario where the in-service inspection frequency reduces from annual for the first 3 years to first inspection in year 3 (i.e. Option 2).

Figure 19 Graphical illustration of the estimation approach

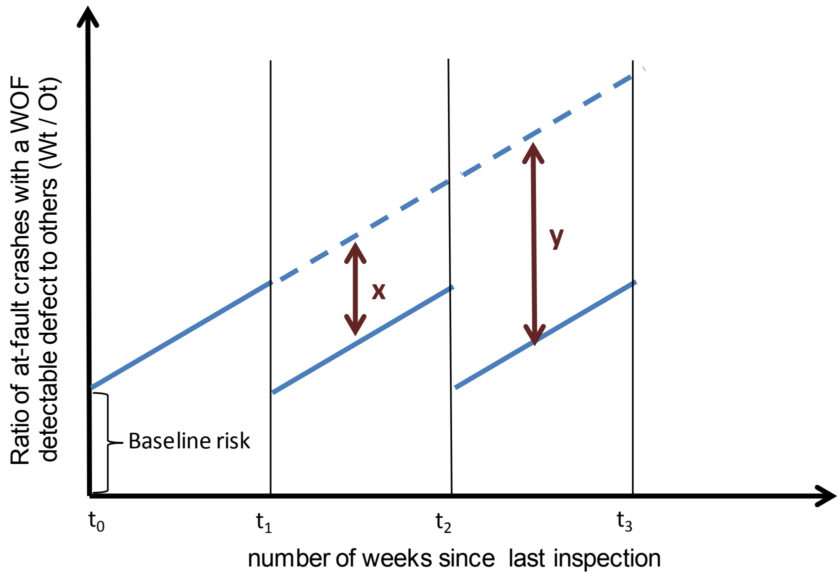


Figure 19 shows three time segments over time periods from year 0 (t0) to year 3 (t3). The first solid blue line represents the relationship between the share of WOF related crashes relative to other at-fault crashes and the number of weeks since last inspection. Let us call this the 'risk line'. The distance between the origin and the point where the risk line intersects with the axis represents the baseline risk that is not related to the timing of inspection. This includes, for example, the risk associated with hidden defects that are missed at inspection.

Under the current inspection frequency, the risk line should be 're-set' back to the baseline risk level after each inspection and i ncreases with time thereafter. In other words, assuming everything else remain constant, the risk line should repeat itself for the three years. Under the new inspection frequency regime, we can extend the risk line forward to the full 3-year period (i.e. the dotted line). The likely increase in the number of crashes can then be estimated based on the estimated increase in the ratio of at-fault crashes with WOF detectable faults to other at-fault crashes – represented by the vertical difference between the solid and the dotted lines (i.e. x or y).

4.3. Estimate the risk line

This is based on the regression analysis used by NZIER (1999)[41]. We have used historical data on the share of crashes with WOF-detectable vehicle defects relative to crashes without WOF related factors to estimate the likely increase in risk from an inspection frequency change. The crashes we are interested in are at-fault (either driver or vehicle) crashes only. For this analysis, data from 2002 to 2011 has been used. This analysis considers light passenger vehicles (including cars and vans) that are subject to WOF and excludes motor cycles and light trailers.

As the random variations in crash involvement for each vehicle age would be too large to provide a good indication of the crash risk, the analysis is carried out by vehicle age group (under 3 years, 3-5 years, 6-12 years, 13 years and over).

Results show that the slope of the risk line increases with vehicle age and the baseline risk (the intercept) is generally higher for older vehicles (see Table 17). Attempts to separate vehicles over 21 years were abandoned as the crash risk is more difficult to identify due to a lower number of crashes. Therefore, vehicles aged 13 and over are assessed as a group.

Table 17 The slope coefficient by vehicle age group (cars and vans)

Vehicle age group (cars and van)	Intercept	Slope of the risk line		
		Low limit estimate	Central estimate	Upper limit estimate
Under 3 years	0.0064	0.00000	0.00024 *	0.00052
3 to 5 years	0.0108 ***	0.00000	0.00011	0.00033
6 to 12 years	0.0120 ***	0.00022	0.00039 ***	0.00055
13 years and over	0.0165 ***	0.00015	0.00043 ***	0.00072

Note: * denotes statistically significantly different from zero at 10% level and *** denotes statistically significantly different from zero at 1% level.

4.4. Estimate the incremental change in the number of crashes

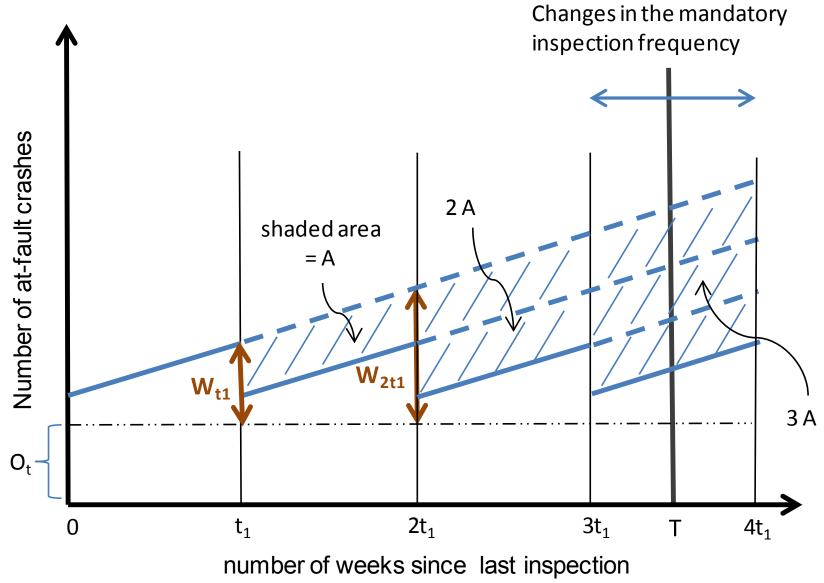
Once the risk line is estimated, it is useful to re-plot the graph in a different scale to facilitate estimation of the incremental change in the number of crashes (Figure 20). By definition, at-fault crashes that do not have WOF detectable defects do not vary with time since last inspection. Therefore, we can plot the total number of at-fault crashes against the number of weeks since last inspection simply by adding constant O_t (a weekly average of O_t) and variable W_t (a linear function of time since last inspection as estimated in section 0). The patterns are identical to Figure 19 except this time we have the number of at-fault crashes in the vertical axis instead.

The total increase in the number of crashes is represented by the shaded areas. To estimate this, we need to first estimate area A. This equals the difference between the estimated number of crashes with WOF-detectable defects with an extended duration between

41 NZIER (1999), "Review of Warrant of Fitness regime", Report to the Land Transport Safety Authority, Wellington.

inspections and the expected number of crashes under existing frequency. This can be estimated using the regression results.

Figure 20 The effect of changes in mandatory inspection frequency



4.5. Over-/under-recording of crashes

Not all injury crashes are recorded in the official traffic crash reports (TCRs). This happens when some crashes are not reported to the police or when the injured road users are admitted to hospital prior to the arrival of a police officer to record the details. The Ministry uses hospital and accident compensation claims data to supplement TCRs data and incorporate the under-reported serious and minor injury crashes into the final estimates[42]. In this section, we deal with a different kind of recording issue.

Not all police officers are trained to determine the cause of a crash. Assessments made at the crash scene based on visual or verbal evidence obtained can be imprecise. There are three potential recording errors:

- including non-WOF related crashes as WOF-related
- over recording of WOF-related factors
- under recording of WOF-related factors

A critical parameter for the safety impact analysis is the slope of the risk line. Therefore, any over- or under-recording of crash contributing factors that can influence the slope of the risk line can affect the results.

[42] Based on the Ministry's "The social cost of road crashes and injury: June 2011 update", the scaling factors for serious and minor injury crashes used are 1.64 and 3.08 respectively.

Because non-WOF related crashes do not vary with the time since last inspection, it can be shown that such recording errors have no effect on the estimated safety impacts. However, the case of under recording of WOF related crashes is slightly different from the other two cases. Here, under recording could occur if the vehicle defects are too difficult to detect. The probability for these defects to occur is likely to increase over the time since last inspection. It can be shown that to adjust the safety impacts for under recording of WOF-related crashes, the estimates will need to be scaled up by the level of under-recording (see Appendix 1).

Table 18 International comparison of vehicle defects in road crashes

Source	Country	Inspection frequency	Time period of crash data	% of crashes	
				Fatal crashes	Fatal and injury crashes
CAS	NZ	Annual to year 6, 6-monthly thereafter	2009-2011	6%	2.5%
TRL, 2011 (p.27, p.35)	UK	Annual from year 3	2005	n/a	2 - 2.5% (3% *)
TRACE (2008)[43]	France, Spain, UK, Germany and Czech Republic	Mixed but typically every 2 years after year 3 or year 4	2004	n/a	2%
DEKRA[44] (2008)	Germany	First in year 3, every 2 years thereafter	2002-2007	n/a	6.6%*
AUTOFORE (2007)[45] (p.27)	Germany	First in year 3, every 2 years thereafter	Pre-2000	n/a	2.5 - 9.1% (ave =5.8%)
Monash (2000)[46] (p.31)	Australia	Vary with States	1995 - 1996	n/a	3%
Road Safety Committee, Parliament of Victoria (2001) (p.12)	Australia (average)	Vary with States	1988,1990 and 1992	2.3%	n/a
	New South Wales	First in year 4, annual thereafter		2.0%	n/a
	Queensland	At change of ownership		2.2%	n/a
	Victoria	At change of ownership		1.2%	3.55% *
Keatsdale Pty[47] (1999), p.48	Australia	Vary with States	1988, 1990 and 1992	2.3%	n/a

* based on in-depth crash data analysis

In New Zealand, official statistics shows that of the 3.5% of all fatal and injury crashes with vehicle factors as a contributing factor, around 2.5% were WOF-related defects (the rest relates to vehicle use errors). The WOF-related percentage could be higher if police under-

[43] Schick S, Eggers A, Pastor C, van Elslande P, Fouquet K, Banos A, Plaza J, Naing C, Tomasch E and Hell W (2008), "Traffic Accident Causation in Europe (TRACE), Trip related factors", Deliverable 3.3.
[44] DEKRA (2008), "Road Safety Report 2008".
[45] Autofore (2007), "Cost-benefit analyses for roadworthiness options", Study on the Future Options for Roadworthiness Enforcement in the European Union, working paper number 700.
[46] Rechnitzer, G, Haworth, N and Kowadlo, N [Monash] (2000), "The effect of vehicle roadworthiness on crash incident and severity", Monash University Accident Research Centre, Report No. 164.
[47] Keatsdale Pty Ltd (1999), "Cost effectiveness of periodic motor vehicle inspection: A report for the Federal Office of Road Safety", Queensland Australia.

record vehicle defects in crash reports. However, it is difficult to compare international findings of under-recording of crashes with WOF-related factors in crash reports with New Zealand data. This is because the level of under-recording between countries can vary significantly due to factors like the current inspection requirement and the characteristics of the vehicle fleet.

Table 18 provides a summary of the literature around the role of vehicle defects in crashes. Notwithstanding the inherent difficulties with international comparison, the role of vehicle defects in New Zealand crashes is not too dissimilar to major overseas jurisdictions. In the UK, between 2 and 2.5% of all injury crashes were related to vehicle defects (TRL 2011). In the final analysis, TRL used 3% to allow for under-reporting of vehicle defects in crash reports. It is unclear what the rationale behind the 3% estimate was but the adjustment represents between 25% and 50% of the official figure (or a multiplying factor of 1.25 and 1.5). In Victoria, an in-depth analysis of crash reports found only 3.55% of those vehicles were found to have any form of defect and the official percentage was 2.2% (Keatsdale, 1999)[48]. Adjusting the more recent estimates, by TRACE (2008) and DEKRA (2008), to account for differences in inspection frequency yields an average of 3.2%. All these estimates are not significantly higher than our official figure of 2.5%. This means only a small adjustment for under-recording, if any, may be required.

The level of under-recording of crashes with WOF-related safety defects is directly related to the ease of detection of these defects and the probability of crash involvement. According to crash data, tyres or lights are cited as contributing factors for nearly 80% of vehicles with WOF-related safety defects. These items are also frequently failed at WOF inspection (e.g. 32% and 21% of vehicles failed lights and tyres respectively in 2011).

Since tyre- or light-related vehicle defects are generally easy to identify, the level of under-recording of these factors is likely to be small. It is uncertain whether non-tyre- or non-light-related vehicle defects are frequently under-recorded. For the purposes of the sensitivity analysis, we include two scenarios to gauge the likely impacts of under-recording on the overall results. Under the low scenario, none of the tyre- or light-related crashes are under-recorded and 25% of non-tyre- or non-light-related crashes are under-recorded. These give a weighted average under-recording level of 5% and a multiplying factor 1.05 is used. Under the high scenario, the two percentages increase to 10% and 100% respectively. These yield a multiplying factor of 1.3. Since fatal crashes require detailed crash investigation, an adjustment is therefore not required. Therefore, the multiplying factors of 1.05 and 1.3 only apply to non-fatal crashes only.

The effects of under-recording of vehicle defects in crash report are considered in the sensitivity analysis section.

48 Keatsdale Pty Ltd (1999), Cost effectiveness of periodic motor vehicle inspection: A report for the Federal Office of Road Safety".

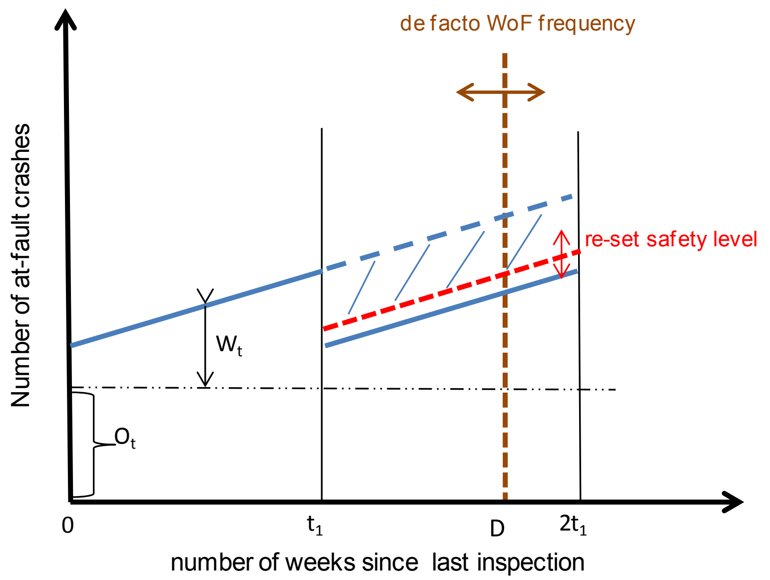
4.6. Effects of change of ownership inspections and uptake of voluntary safety checks at vehicle servicing

Vehicles are required to have a WOF that is no more than one month old when the buyer takes possession. Therefore, the effect of fleet turnover can impact on de facto WOF inspection frequency.

Furthermore, with a less frequent inspection regime, safety-conscious car owners could continue to get their vehicles inspected and repaired at regular intervals. This means the above analysis can over-state the potential negative impacts of inspection frequency on road safety.

There are two key steps involved to adjust for the above effects (Figure 21). The first step requires estimation of the de f acto WOF inspection frequency. The second step involves adjusting for the level of safety outcomes relative to that obtained from a WOF inspection.

Figure 21 Effects from change of ownership inspections and the uptake of voluntary safety checks



To estimate the effects of change of ownership inspections on safety outcomes for options 1 to 3, we utilise the distribution of change of ownership by the number of valid months remaining on existing WOF to estimate the de facto WOF inspection[49]. With a less frequent inspection requirement, the propensity of getting a pre-purchase or WOF inspection prior to the change of ownership will increase[50]. We assume vehicles that are sold with a new WOF or have pre-purchase inspections will achieve the same level of safety outcomes as standard WOF inspections.

Under option 4, a WOF is compulsory at change of ownership. In this case, we assume there is a system in place to ensure 100% compliance (eg the change of ownership process cannot be

[49] In 2011, only around one-third of vehicles were sold with a WOF of less than one month old.

[50] The analysis assumes between 35% and 75% of buyers of vehicles sold with an older WOF (around 47% of total sales in 2011) will obtain a pre-purchase inspection and also 35% and 75% of buyers of vehicles that do not have a valid WOF (around 20% of total sales in 2011) will get vehicles inspected and repaired to WOF standards.

completed without a new WOF). According to the data for 2011, on average, vehicles that are 6 years or under change hands every 2 years, whereas vehicles over 6 years change hands every 3 years. These are used as the de facto frequency for the analysis.

Past studies have generated mixed results of the effectiveness of periodic inspections. Poitras and Sutter (2002)[51] argued that the benefit from periodic inspection would be submarginal because car owners might voluntarily maintain their vehicles closer to, or exceeding, the level mandated.

The inspection frequency in New Zealand is one of the highest in the world. For countries in Europe, a typical inspection frequency is every two or more years. In Germany, analysis found that while crash risk tends to increase with time since last inspection, the rate of increase starts to level off from around 12 months (AUTOFORE, 2007a)[52]. This shows either vehicles do not deteriorate linearly over time or some deterioration has been moderated by voluntary maintenance (eg through vehicle servicing). The latter is highly likely because most vehicles are subject to regular servicing.

To account for the safety benefits from vehicle servicing, we have utilised the distribution of *laissez faire* servicing frequency (Figure 9) and the probability distribution of safety checks uptake with servicing (see Figure 8) to estimate (i) the de facto frequency and (ii) the new re-set level of safety. The key assumptions are tabulated in Table 19. These are discussed in detail in Appendix 1. Coincidentally, this adjustment yields a levelling out result similar to AUTOFORE's (2007a).

Table 19 Assumptions about voluntary safety checks behaviour

<table>
<tr><th>Description</th><th>Assumptions</th><th>What does the assumption apply to?</th><th>Explanation</th><th>Reference</th><th>Remarks</th></tr>
<tr><td>(1) % safety outcomes met by the basic safety checks (relative to WOF checks) when bundled with a service (when a WOF is not required for that period)</td><td>Low standard: 20%
Mode (basic test): 80%
WOF equivalent: 120%</td><td>All cars/vans but based on servicing frequency</td><td rowspan="3">These assumptions help to adjust the estimated safety impacts by controlling for the safety improvements that would have happened, even when a WOF is not required.

They also enable us to recognise people are willing to obtain safety checks and thereby recognise consumer benefits.</td><td>n/a</td><td rowspan="3">A 'basic safety' check covers:
• tyres
• brakes
• lights
• glazing (incl. mirrors)

"Incremental" costs of the basis test, refers to the situation where this test is undertaken in conjunction with a service visit.</td></tr>
<tr><td>(2) 'Failure rate' of voluntary basic safety check</td><td>0-2 year: 10%
3-5 years:23%
6-12 years: 32%
13 years+: 44%</td><td>To those who would get the basic check done only.</td><td>NZTA WOF failure rate data (initial fail)</td></tr>
<tr><td>(3) % of people get repairs done if faults detected</td><td>Low: 75%
Medium: 85%
High: 95%</td><td>To those with defects detected only.</td><td>n/a</td></tr>
</table>

[51] Poitras, M and Sutter, D (2002), "Policy Ineffectiveness or offsetting behaviour? An analysis of Vehicle Safety Inspections", Southern Economic Journal 2002, 68(4), pp. 922-934.
[52] AUTOFORE (2007a) Analysis of pass/fail rates and accidents for different vehicle types in relation to PTI – frequency and vehicle age. WP540 Study on the Future Options for Roadworthiness Enforcement in the European Union, University of Cologne, Institute for Transport Economics. Prepared for CITA. pp.13

4.7. The social costs of air pollution

The recently updated Health and Air Pollution Study (HAPINZ 2012) estimates social costs of anthropogenic (man-made) sources of air pollution at around $4.28 billion per year, or $1,061 per person.

The motor vehicle contribution to this social cost contribution comes to $940 million per year. The question arises as to whether, and if so how, we should take account of these social costs in the WOF CBA.

The current WOF test includes an excess smoke assessment. However, there is no correlation between visible emissions and the PM_{10} and NO_x emissions that are responsible for the bulk of the harmful effects from vehicle pollution. In modern cars, emissions are governed by the software controlling electronic engine management systems. The maintenance of these systems is the key to optimising fuel economy, power and emissions.

Starting from around the mid-1990's, the vast majority of vehicles have been built with engines incorporating electronically controlled fuel injection systems. These systems include sensors and control systems that precisely meter the fuel/air mixture that is delivered to the engine, which in turn largely removes any need for external adjustment or intervention to ensure the engine is operating at peak efficiency. The extent to which engine performance can be influenced at service is largely limited to ensuring that the air filter is clean so that the engine is receiving sufficient airflow. However, even if it is not, the engine management system will compensate and ensure that emissions are not adversely affected.

It is only when excessive engine wear occurs (i.e. to the extent where a significant volume of oil is burnt in the combustion process), or when the vehicle is modified, that emissions are substantially affected.

We have addressed the following cost-benefit modelling questions:

(i) Does altering the frequency of the WOF inspection influence maintenance habits and in turn affect engine performance and emissions?

(ii) If there is an effect on maintenance habits, what changes in WOF inspection frequency would influence emissions?

(iii) Should an emission test be included in the WOF inspection?

It is arguable as to whether maintenance, especially of the parts of the vehicle that would affect its on-road emissions, is affected by inspection frequency. For new cars under warranty the buyer can enter into a maintenance contract for up to 5 years or more to ensure continued validity of their warranty. For older cars, a WOF inspection may prompt an owner to service their vehicle and we know around 33% of WOF visits are also accompanied by non-WOF related repairs being done. An equally valid concern, however, is that some people mistakenly treat a *'warrant of fitness'* as vehicle service check. Indeed, overseas research suggests inspections have no impact on vehicle service industry repair revenue.[53]

[53] Marc Poitras and Daniel Sutter, Southern Economic Journal 2002, "Policy Ineffectiveness or Offsetting Behaviour? An Analysis of Vehicle Safety Inspections".

If we take the worst-case scenario that inspections do act as a prompt for maintenance of older vehicles, it is still not clear that changing WOF frequency would have a material impact on emissions:

- The PM_{10} emissions come principally from diesel motors and only around 20% of the light vehicle fleet have diesel motors.
- In the first instance, in countries that have emission testing, this typically occurs at more relaxed frequencies than the status quo, option 1 and option 2.[54]

Sensors are (in theory) designed to last for the life of the vehicle. However, failures occur pretty much randomly. Some that last 250,000km without problems, and some fail at 10,000km.

It is uncertain how widely it has been used for periodic inspection, but modern cars (Euro 3 onwards) have on-board diagnostic systems that record and store faults with sensors (and any other issues that affect emissions). A mechanic with the appropriate scan tool can plug into the car's computer and find out whether any sensors have failed. There may be a few jurisdictions in Europe doing this, but it is uncertain whether it has become particularly common yet. In future, it will be the primary way of inspecting for emissions.

Hence the introduction of an emission test is potentially only relevant in the CBA model for option 4 (Inspection at point of sale). Also, it is likely that many cars would undergo servicing inside what would typically be a 3-year frequency window in Option 4. Hence while additional emissions and associated social costs might occur in Option 4, they are likely to be small and very difficult to quantify. Moreover, the environmental effects may be small. A European cost-benefit appraisal assessing a potential increase in inspection frequency from 24 months to 12 months estimated these benefits (including fuel savings) to be equivalent to 1% of safety and congestion benefits[55].

On the question about whether an emission test should be included in the WOF inspection, we note that expansion of the scope of the WOF inspection regime to include such testing is not within the scope of the proposed policy change being considered. Hence the model has not been developed to evaluate such a policy option, although it could be modified to do so.

[54] For example, the California Smog Check Program requires vehicles that were manufactured in 1976 and later to participate in the biennial (every two years) Smog Check program. The program's aim is to reduce air pollution from vehicles by ensuring that cars with excessive emissions are repaired.

[55] Autofore 2007

4.8. Results and sensitivity analysis – road safety

Table 20 summarises the potential safety impacts of changing the WOF inspection frequency for light passenger vehicles, prior to adjusting the estimates for voluntary safety checks.

Table 20 Estimated annual safety impacts (base estimate)

	Estimated increase in the number of reported crashes p.a.			Estimated increase in annual social cost (SC), $m 2011 prices		
	Fatal	Serious	Minor	$m (including non-injury crashes)	% increase in total SC $m	% increase in SC $m of at-fault crashes with WOF-related safety defects
Option 1	0.7	1.6	7.7	$5.4	0.1%	6.5%
Option 2	2.3	5.0	24.7	$17.4	0.4%	21.2%
Option 3	2.8	6.1	30.1	$21.2	0.5%	25.8%
Option 4	12.1	26.0	128.7	$91.0	2.3%	110.8%

Note: This table includes effects from change of ownership inspections. The social cost estimates have been adjusted to include all injuries recorded in traffic crash report, hospital and ACC databases.

The estimated increase in annual total social cost of road crashes for option 4 is the highest. This is because under this option the entire WOF vehicle fleet would be affected, and because the average inspection frequency for vehicles over six years of age would be three years — one sixth of the current six-monthly frequency.

Table 21 Annual safety impacts after adjusting for effects from voluntary safety checks

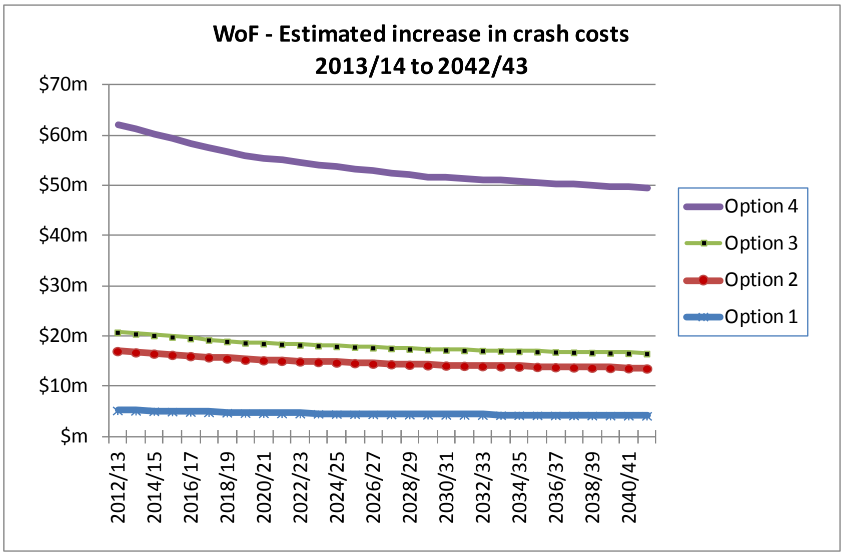
	Estimated increase in the number of reported crashes p.a.			Estimated increase in annual social cost, $m 2011 prices		
	Fatal	Serious	Minor	$m (including non-injury crashes)	% increase in total SC $m	% increase in SC $m of at-fault crashes with WOF-related safety defects
Option 1	0.7	1.6	7.7	$ 5.4	0.1%	6.5%
Option 2	2.3	5.0	24.7	$ 17.4	0.4%	21.2%
Option 3	2.8	6.1	30.1	$ 21.2	0.5%	25.8%
Option 4	8.4	17.9	88.5	$ 62.9	1.6%	76.6%

Note: This table includes effects of change of ownership inspections and the uptake of voluntary safety checks bundled with vehicle servicing. The social cost estimates have been adjusted to include all injuries recorded in traffic crash report, hospital and ACC databases.

Table 21 summarises the potential safety impacts of the four options after adjusting for the effects from voluntary safety checks with vehicle servicing. These estimates include the effects of change of ownership inspection and include all injuries recorded in traffic crash report, hospital and ACC databases. The number of non-injury crashes is estimated using the standard ratio of minor injury crashes to non-injury crashes and is estimated at between 10 and 13% of the social cost of injury crashes.

Figure 22 shows the estimated increase in the social cost of road crashes (including non-injury crashes) to 2042/43. The estimates take into account the effects of voluntary safety checks bundled with vehicle servicing and the likely effects of vehicle technology improvement and the downward road trauma trend over time estimated by the Ministry of Transport.

Figure 22 Estimated increases in the social cost of road crashes (in nominal terms)



The estimated increases in the total social cost of road crashes to 2042/43 (Net Present Values) are set out in Table 22. These range from $54 million for option 1 to $630 million for option 4.

Table 22 Estimated increase in the social cost of road crashes to 2042/43 (in present values)

	Option 1	Option 2	Option 3	Option 4
Estimated total increase in social cost of road crashes to 2042/43, in present value terms	$54 million	$174 million	$212 million	$630 million

Sensitivity analysis has been carried out on the following:

- the lower and upper limits of the slope of the risk line using the 95% confidence interval estimates obtained from the regression analysis
- an adjustment for under-recording of vehicle defects in crash reports (scaling factors of 1.05 and 1.3)

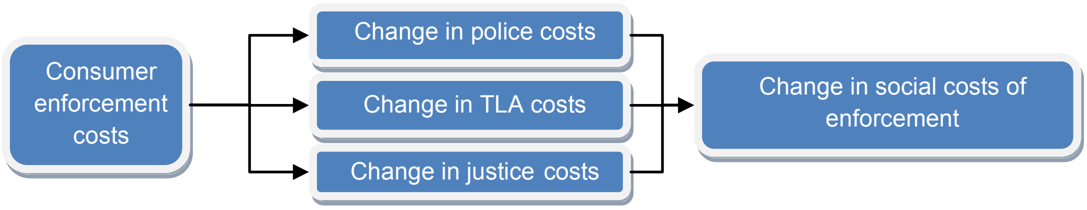
Results (Table 23) show that the safety impact can range from $3 million to $8 million for option 1, $7 million to $28 million for option 2, $8 million to $35 million for option 3 and $26 million to $100 million for option 4. Even under the upper range of the estimates, the overall NPVs for the options continue to be high.

Table 23 Sensitivity analysis of safety impacts

	Estimated increase in total annual social cost of road crashes, $m			
	Option 1	**Option 2**	**Option 3**	**Option 4**
Original estimates (from Table 21)	$5.4	$17.4	$21.2	$62.9
Slope of the risk line:				
95% lower limit coefficient estimates	$3.1	$6.9	$8.2	$25.6
95% upper limit coefficient estimates	$8.2	$27.9	$34.5	$100.5
Under-recording of vehicle defects in crash reports				
Low: adjustment factor for non-fatal crashes = 1.05	$5.5	$17.8	$21.6	$64.3
High: adjustment factor for non-fatal crashes = 1.3	$6.1	$19.6	$23.9	$70.9

5. Justice and enforcement impacts

Figure 23 Outline of the appraisal of justice and enforcement impacts



5.1. Introduction

In New Zealand, an in-service private vehicle can be operated on the road legally if the vehicle is inspected for a WOF. Further, vehicle owners are required to ensure their vehicles are up to minimum vehicle safety standards at all time. Infringement notices can be issued by prosecuting authorities NZ Police and territorial local authorities (TLAs) for vehicle owners who do not comply with these requirements.

Vehicles in use or parked on a public road and in breach of their WOF due date risk receiving an infringement notice. The associated fine varies but is typically in the order of $200. However, prosecuting authorities can apply discretion to waive or exempt certain individual offences under special circumstances (such as while the vehicle is en-route to a garage or within 28 days of the due date).

Infringements have significant flow-on costs for the justice system. With alternative inspection frequencies, this cost may reduce. Our analysis takes into account the national resources costs of supporting the WOF regulatory regime; including:

- enforcement and collection resources for TLAs and police
- costs to the Justice system (Courts and Corrections)
- costs to offenders

As fine revenues are transfer payments, these are not included in the cost-benefit assessment.

The remainder of this chapter explains the current cost to the justice system and provides some estimates of a likely reduction under each of the four options analysed.

5.2. Key assumptions

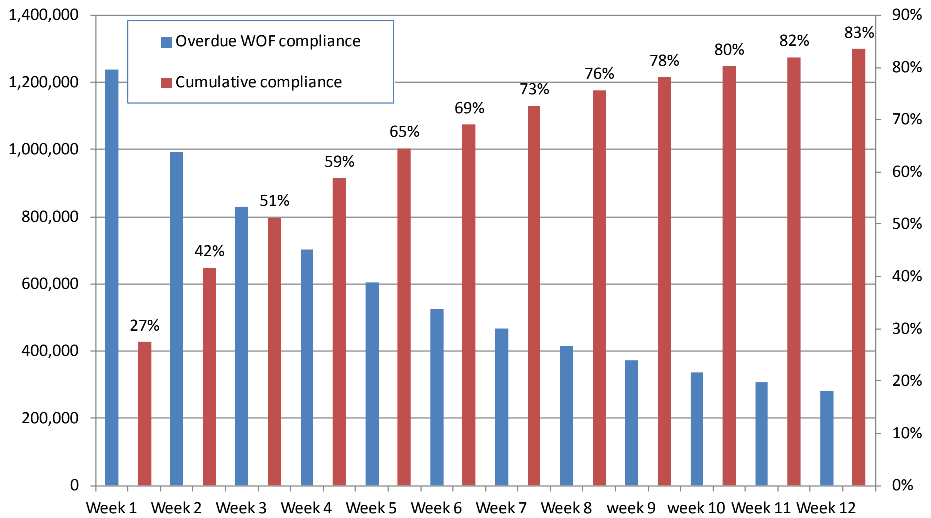
The key assumptions in modelling the regulatory changes to justice enforcement costs are:

- all else equal, the volumes of fines for non-display of current WOF will fall in proportion to the change in inspection volume (resulting from a change in inspection frequency). We also assume the average lateness would remain the same
- there may be some increase in infringements associated with vehicle defects, or vehicles not up to WOF standards, particularly if selection of an option is accompanied by increased enforcement activity. For the purpose of the analysis, we assume these infringements will increase with the estimated increase in the social cost of at-fault crashes with WOF-related factors
- the net changes in the number of infringements are assessed at the same unit costs as in the current system.

5.3. Levels of compliance lateness

A large proportion of vehicle owners are late in obtaining a WOF and this late compliance profile is presented in Figure 24.

Figure 24 Compliance profile for the 1.7 million cars late for WOF inspection in 2011



Survey evidence[56] and crash reports[57] suggest that many of the vehicles with overdue warrants may still be in use, at least for a short period of time.

In 2011, 1.7 million cars[58] (64% of the car fleet) did not have inspections completed by the due date with an average lateness of 55 days. Around 20% (just over 0.5 million cars) obtained their WOF over 10 weeks late (Figure 24).

[56] For example, MTA's 2011 survey found 9% of respondents (total = 500) did not have a current WOF.
[57] Crash statistics shows 16% of vehicles that are at-fault did not have a valid WOF.
[58] This excludes vehicles on exemption.

Table 24 Level of non-compliance and lateness of light fleet (2.6 m vehicles)

Transactions p.a.	Level of non-compliance in 2011 (% of the fleet)			
	1 day or more	Average lateness	Over 28 days	Average lateness
5.5 million	1.7 million	55 days	702,211	118 days
(+ 2m re-tests)	(64%)		(26%)	

Table 24 summaries the degree of average lateness according to the number of days overdue. If the level of lateness changes under the new inspection frequency regime, it will impact on the justice enforcement cost estimates under the options.

5.4. Detection and enforcement

For the two years to 2010/11, we estimated that approximately 190,300 infringement notices were issued each year by police and TLAs to road users who do not comply with the vehicle inspection regime[59]. Around 181,200 (or 95%) of all vehicle inspection-related infringements were issued to vehicles without a valid WOF, with the remaining issued to vehicles that do not meet WOF standards. On top of these, police and TLAs also issued around 8,000 infringement notices for vehicles with defect in their tyres, lights or brakes.

The above totals exclude 27,000 waiver applications approved for WOF related offences and 2,000 waiver applications approved for tyres, lights and brakes related offences per annum. These waivers incur significant administrative costs for prosecuting authorities and compliance burdens for offenders. There is no national policy for granting waivers, with this left to NZ Police and territorial authority discretion. While the police have a general policy of waiving warrant of fitness fines if a warrant of fitness is obtained within one month, this depends on awareness and discretion of individual officers.

5.5. Infringement related social costs

We estimate that the infringement-related social costs are in the order of $14.6 million per annum (Table 25), which is made up of the following components:

- issuing and processing of infringements by prosecuting authorities (i.e. police and TLAs)
- handling of waiver applications by prosecuting authorities
- collection of fines by prosecuting authorities
- implementation of enforcement actions and collection of outstanding fines by Courts
- fine settlement by non-financial arrangements by Corrections
- compliance costs to offenders

[59] Estimates for infringements issued by TLAs are based on data obtained from Courts and Auckland Council.

Table 25 Summary of infringement-related social cost (in thousand dollars)

Annual costs ($000)	WOF	Tyres, lights, brakes	SUB-TOTAL
Police administrative and enforcement costs	1,678	128	1,806
TLAs administrative and enforcement costs	1,273	18	1,291
Justice collections cost	7,753	228	7,981
Corrections – community sentences	792	30	822
Compliance costs to offenders	2,599	145	2,744
Total	**14,095**	**549**	**14,644**

The assumptions used in the above assessment include:

- the cost of issuing and processing each infringement by police[60] is $14.32 and the collection cost is estimated at $1 per successful collection
- the estimated cost of issuing, processing and collection of infringement fines by TLAs is $0.24 per dollar of revenue collected[61]
- the cost to prosecuting authorities of handling waivers is assessed based on each waiver application taking 0.3 hour for initial processing plus 1 hour per unsuccessful application, at an average hourly wage rate of $24.78. We assume only 2/3 of applications are successful[62]
- the cost of collection by Courts is assessed at $0.24 per dollar of revenue collected (source: Ministry of Justice)
- each payment arrangement takes offenders 20 minutes[63] and each waiver application takes offenders an hour to complete, both value at an average hourly wage rate of $24.78
- for the two years to 2010/11, around 41,700 WOF-related infringements resulted in enforcement actions imposed by Courts. This analysis assumes 2% (or 834) of those with enforcement actions imposed will be resolved by community sentences. In 2005, Ministry of Justice estimated each community sentence cost $825, which roughly equals $950 in 2011 prices.

[60] This is based on an average police officer hourly rate of $111.83 (including overheads) and 5 minutes per infringement issued plus a $5 back office processing cost per infringement.
[61] Earlier communication with TLAs suggests the cost to TLAs could be as high as 50 cents per dollar of revenue collected. However, this cost could represent a mix of fixed and variable costs. For our analysis, we are interested in variable cost that could be avoided. Therefore, we have used the estimate from Justice instead. The higher cost estimate is used in the sensitivity analysis to test the impact.
[62] Recent communications with police suggests the volume of waiver applications may be higher than assessed here. Therefore, the estimated reduction in infringement related social cost is likely to be on the low side.
[63] Some offenders may choose to pay by instalments or to settle by non-financial arrangements. The additional time costs involved for either of the scenarios are not included in this analysis.

5.6. Estimation of justice enforcement costs avoided

With a less frequent inspection requirement, we would expect the chance of missing the inspection requirement per year to reduce. Therefore, the analysis assumes the total number of infringements issued for those without a valid WOF is directly proportional to the inspection volume (which is affected by option frequency).

However, it is likely that the number of infringements related to 'not up to WOF standards' or related to tyres, lights and brakes defects may increase. As discussed earlier, we assume these infringements will increase with the estimated increase in the social cost of at-fault crashes with WOF-related factors.

Based on the same unit cost as in the current regime, the estimated annual reduction in justice enforcement costs range from $2.3 million for option 1 to $9.9 million for option 4 (Table 26).

Table 26 Estimated reduction in justice enforcement-related social costs ($000)

Annual savings ($000)	Option 1	Option 2	Option 3	Option 4
Police administrative and enforcement costs	$266	$733	$852	$1,104
TLAs administrative and enforcement costs (based on total cost of $0.24/$1 revenue collected)	$223	$621	$724	$1,006
Justice collections cost	$1,264	$3,501	$4,075	$5,459
Corrections – community sentences	$129	$356	$415	$553
Compliance costs to offenders	$419	$1,159	$1,349	$1,778
Total	**$2,302**	**$6,371**	**$7,415**	**$9,899**

If the unit cost to TLAs is $0.50 per dollar of revenue collected, this means of current cost to TLAs is higher than estimated. So the potential reduction in costs to TLAs resulting from the policy options will be higher. The estimated annual reduction in justice enforcement costs increase to $2.5 million for option 1, $6.9 million for option 2, $8 million for option 3 and $10.8 million for option 4 (
Table 27).

Table 27 Estimated reduction in justice enforcement-related social costs ($000)

Potential cost reductions (annual)	Option 1	Option 2	Option 3	Option 4
TLAs administrative and enforcement costs (based on total cost of $0.5/$1 revenue collected)	$415	$1,155	$1,347	$1,871
Total	**$2,494**	**$6,905**	**$8,037**	**$10,764**

5.7. Safety mitigation enforcement costs

The options anticipate the potential need to invest funds to mitigate safety risks during option implementation. While these mitigation actions have not been scoped in detail they potentially involve:

- provision of public information and advice
- social marketing campaigns
- enhanced and better targeted enforcement focused on vehicle defects.

At this stage, these initiatives have not been developed to the point where their costs can be assessed. However, we do have information we can use to broadly benchmark likely costs of such initiatives so we can consider whether policy the economic viability or the relative NPV ranking of the policy options may change.

Relevant fully-costed benchmark information includes:

- the cost of running television campaigns for the recent right-hand rules change was in the order $1 - $3 million
- the cost of operating the NZ Police CVIU which stops and checks heavy vehicles is in the order of $20 million (NB this is a proportion of the existing heavy fleet)
- the cost of running mobile breath testing (around 1 million mobile tests annually) is in the order of $20 million (including overhead)
- the current cost of vehicle safety related enforcement is around $5 million per annum.

The estimated cost of safety related enforcement is the most relevant to assessing the likely implementation cost of enhanced enforcement measures for option 4, which involves the most substantial policy change. Other options may only require expenditure on information provision and social marketing for a limited period. We conclude making provision for this kind of expenditure in the model would not change the relative ranking of the options.

6. Results and sensitivity analysis

6.1. Summary of results

The key findings of the analysis are as follows:

- there are significant consumer savings from reduced WOF charges, compliance costs and avoidable repair costs. In total, these consumer savings are estimated at between $66 million under option 1 and $267 million under option 4 per year.
- while reducing the inspection frequency may increase the number of road crashes in New Zealand, the effects are relatively small. The estimated increase in the annual total social cost of road crashes of the four options ranges from $5 million under option 1 to $63 million under option 4. These represent between 0.1% and 1.6% of the current annual total social cost of road crashes.
- the current system imposes not only a burden onto consumers, it also adds extra costs to the justice system for the detection and enforcement of user compliance. The estimated annual reduction in the social cost associated with WOF-related infringements has been estimated at between $2 million under option 1 and $10 million under option 4. Around 70% of such cost is incurred by central government, with the remaining is incurred by local government and users.

Table 28 Summary of annual costs and benefits

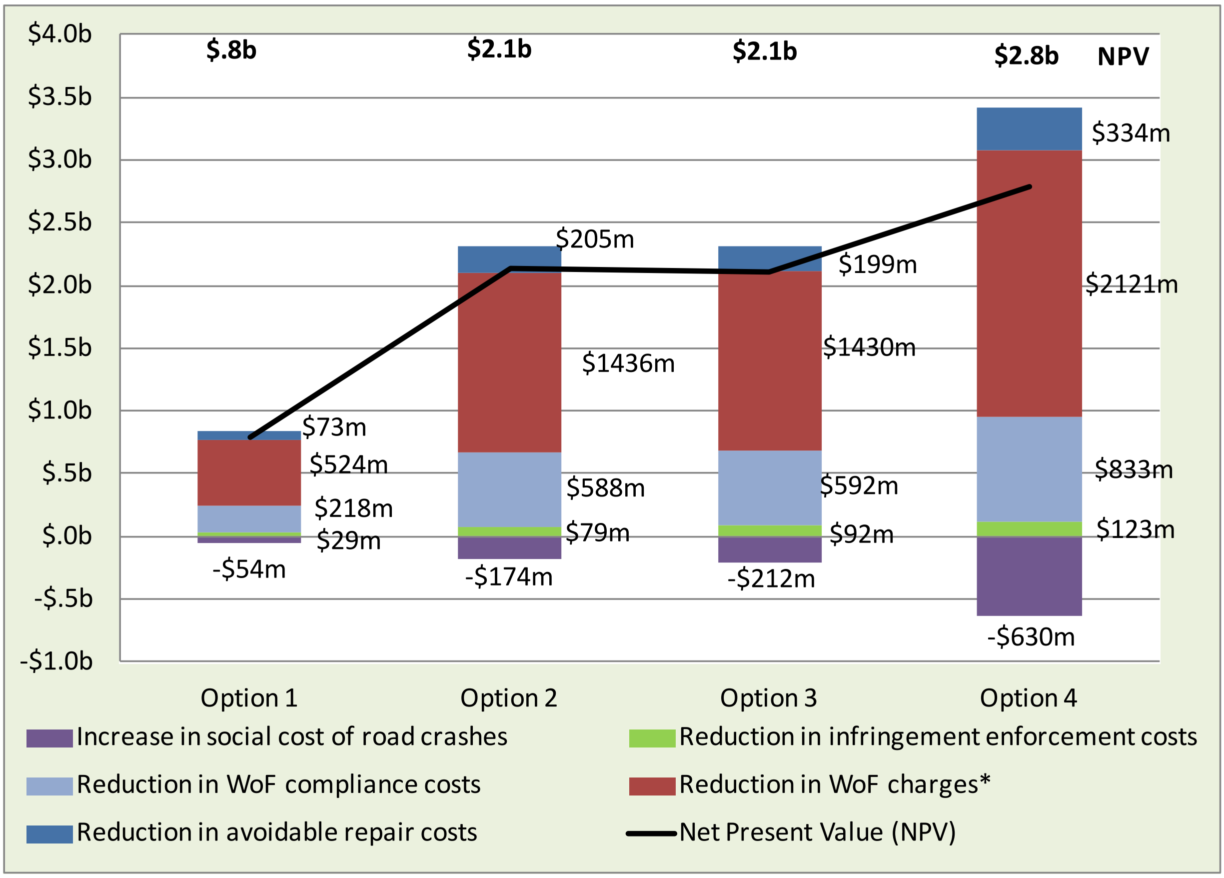
Costs and benefits		Option 1	Option 2	Option 3	Option 4
Safety	Estimated increase in social cost of road crashes in year 1 (after adjusting for benefits from safety checks at servicing)	$5m	$17m	$21m	$63m
	Corresponding % increase in total social cost of road crashes	0.1%	0.4%	0.5%	1.6%
Consumer	Savings in WOF charges (including NZTA fee)	$43m	$117m	$116m	$172m
	Savings in compliance costs	$18m	$48m	$48m	$68m
	Savings in avoidable repair costs	$6m	$17m	$16m	$27m
Enforcement	Savings in justice and enforcement costs	$2m	$6m	$7m	$10m
Total		**$63m**	**$170m**	**$167m**	**$214m**

Table 29 Summary of present value costs and benefits

Costs and benefits	Option 1	Option 2	Option 3	Option 4
Reduction in avoidable repair costs	$73m	$205m	$1994m	$334m
Reduction in WOF charges*	$524m	$1,436m	$1,430m	$2,121m
Reduction in WOF compliance costs	$218m	$588m	$592m	$833m
Reduction in infringement enforcement costs	$29m	$79m	$92m	$123m
Sub-total of benefits (i.e. excluding crashes)	$0.8b	$2.3b	$2.3b	$3.4b
Increase in social cost of road crashes	-$54m	-$174m	-$212m	-$630m
Net present value (NPV)	**$0.8b**	**$2.1b**	**$2.1b**	**$2.8b**
Benefit cost ratio (BCR)	**16**	**13**	**11**	**5**

NPVs are the preferred report measure and are recommended in the Treasury's Regulatory Impact Analysis handbook. While BCRs are helpful to convey 'bang for buck', a higher BCR of one option over another does not necessarily mean it is better, because BCRs fail to convey the absolute size of benefits and costs. Figure 25 provides a summary of the relative impacts of the different sources of costs and benefits across the options.

Figure 25 Net present values for WOF options (2013/14 to 2042/43)



6.2. Comparison to overseas appraisals

While high benefit-cost ratios (BCRs) may appear surprising, they are not inconsistent with international studies that do, and do not, support periodic inspection. For instance:

- **Keatsdale 1999**: the Keatsdale study for the Australian federal government estimated a **BCR of 0.35** for introducing annual inspections. A comparable estimate here is to move from a baseline of Option 3 to Option 2, which saves crash costs of $458 million PV, but increases consumer and enforcement costs by $1,103 million. This implies a **BCR of 0.41**, which is very similar to Keatsdale's.
- **CITA 2007**: this European cost-benefit appraisal estimated a **BCR of 2.1** for moving to annual inspections from a range of more relaxed inspection frequencies across European countries. The average inspection charge is about half of that of New Zealand's, which may reflect a more limited scope of safety inspections than the WOF regime or more competitive vehicle servicing markets. If the closest relevant comparison is to move from a baseline of Option 4 to Option 2, then this saves present value crash costs of $456 million. CITA ignored consumer inconvenience costs, avoidable repairs, and enforcement. Thus the present value net cost would be $343 million (with a halving of the WOF fee), which implies a **BCR of 1.33**. This is fairly close to the CITA estimate, which implies the modelling undertaken here forecasts similar results if only like considerations are made.
- **Pennsylvania Department for Transport 2009**: they estimated **BCRs between 1.9–2.7** for retaining its policy of periodic motor vehicle inspections.[64] It is not clear what their scenario specifications are precisely. But presuming it is comparing retaining annual inspections against a baseline of no mandated inspections, this would not be dissimilar to comparing Option 2 against Option 4, as above. They included consumer inconvenience, but excluded avoidable repair costs and enforcement. They have inspection costs of about half of the value of ours, and the value of a statistical life is 60% higher than New Zealand's. Accounting for all of this results in a **BCR of 1.2** which, like the study's conclusions, would imply that continuing to mandate for inspections is advised.

6.3. Sensitivity analysis

Monte Carlo simulation was used to estimate the range of the NPV results, using the range of estimates listed in the assumptions table in Appendix 9.2. The broad orders of magnitude of net-benefits for each option are relatively stable. It is unlikely that the central estimates of NPVs will be negative. With 90% confidence, the range of NPVs for options 1 to 4 respectively are $0.6–$0.9 billion, $1.6–$2.4 billion, $1.6–$2.4 billion and $2.0–$3.3 billion.

[64] A BCR was not reported. However, they estimate between $736.6 million and $1,084.6 million in safety benefits, and a mid-point estimate of $397.9 million in consumer costs and inconvenience.

Table 30 Confidence intervals of NPVs

	Option 1	Option 2	Option 3	Option 4
Minimum	$0.5b	$1.3b	$1.3b	$1.5b
5th percentile	$0.6b	$1.6b	$1.6b	$2.0b
Mean	**$0.8b**	**$2.1b**	**$2.1b**	**$2.8b**
95th percentile	$0.9b	$2.4b	$2.4b	$3.3b
Maximum	$1.1b	$2.8b	$2.8b	$3.9b

Tornado plots are a helpful output from Monte Carlo software, as they rank the importance of judgements that involve some uncertainty. The tornado plots below indicate that the most influential assumptions (that have a degree of uncertainty to them) are:

- the $44 WOF fee
- the one hour taken to obtain a WOF
- the propensity for crashes to increase for cars 13+ years old (for Option 4, and for Options 2 and 3 to a lesser extent)
- the avoidable repair costs (10% of average repair bills)
- the value of time used for obtaining a WOF adjusted for work/leisure split assumptions
- best practice service frequency (12,500km)
- the propensity for crashes to increase for cars between 6–12 years old.

Sensitivity assessments for some of the other key assumptions are listed in Table 31. Although some assumptions appear to be important in absolute terms, many are unimportant over the range tested relative to the total NPVs estimated.

One aspect in particular that may provide some contention is the use of 2.5% of crashes with WOF-detectable defects as contributing factor to crashes, rather than a hi gher figure. Thorough sensitivity analysis has been undertaken on this assumption to determine a plausible range based on the detailed data in the New Zealand crash database.

Table 31 shows that accounting for plausible levels of under-recording of safety related vehicle defects in crash reports does not materially affect the estimated net-benefits.

Furthermore our Sensitive analysis found that:

- the NPVs are most sensitive to the discount rate used; but even under the highest discount rate the NPVs continue to be significantly greater than zero
- the NPVs are also sensitive to the inconvenience time taken to obtain a WOF but the NPVs continue to be high under all scenarios

- the NPVs are moderately sensitive to the assumptions around the split between work and leisure time and around the willingness to obtain bundled safety check at vehicle servicing but their effects on NPVs are relatively small

Figure 26 Tornado plots for the NPVs of each option

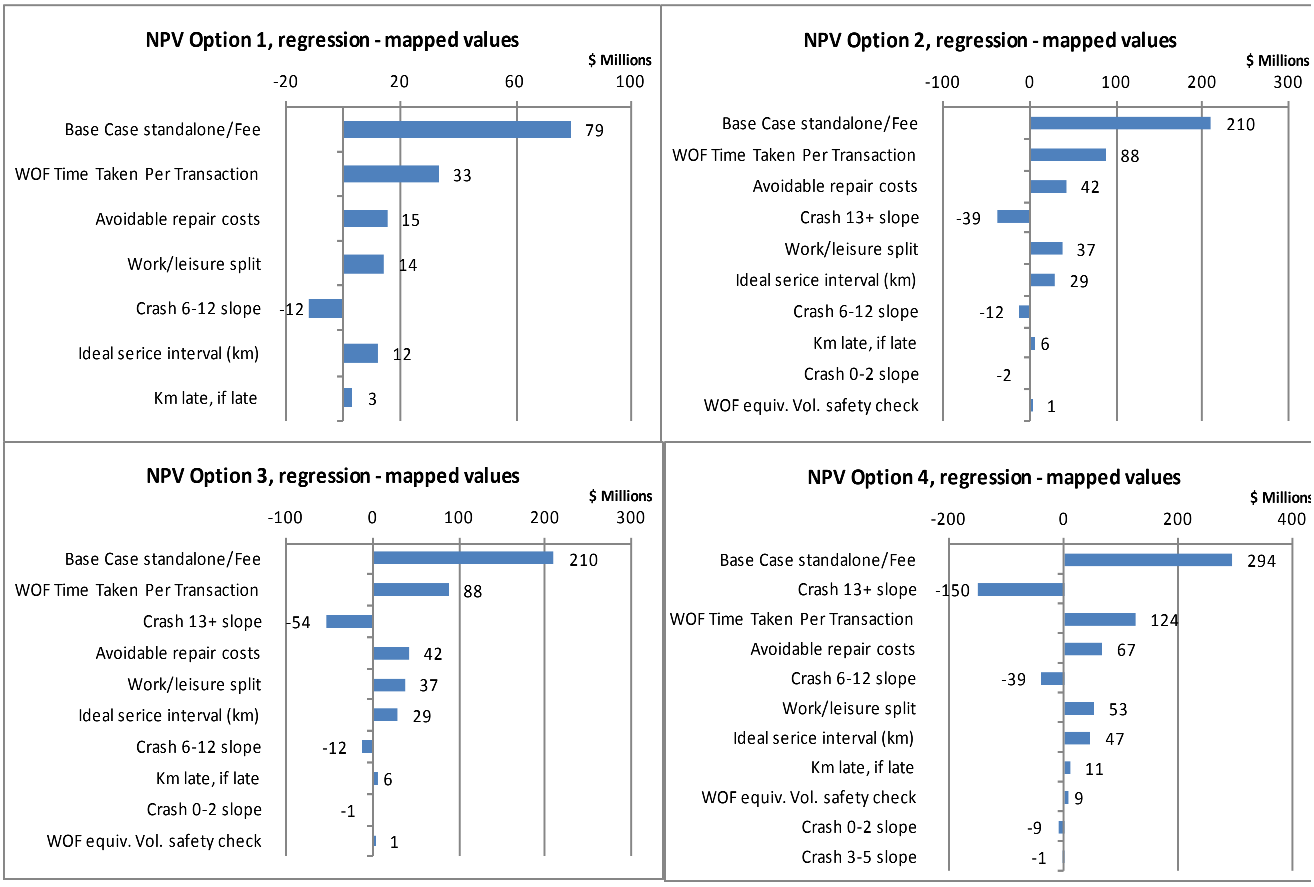


Table 31 Sensitivity analysis of key assumptions (NPVs)

CBA Attribute	Option 1 NPVs		Option 2 NPVs		Option 3 NPVs		Option 4 NPVs	
	Low	High	Low	High	Low	High	Low	High
Servicing frequency Low 10,000 km; high 15,000 km	-$37m; (-4.7%)	+$23m; (+3.0%)	-$91m; (-4.3%)	+$57m; (+2.7%)	-$94m; (-4.5%)	+$56m; (+2.7%)	-$224m; (-8.1%)	+$182m; (+6.5%)
Willingness to voluntarily obtain safety checks at service Low ($7 & 37% WOF outcome) High ($25 & 100% WOF outcome)	+$9m; (+1.1%)	-$10m; (-1.3%)	+$37m; (+1.7%)	-$41m; (-1.9%)	+$27m; (+1.3%)	-$30m; (-1.4%)	+$116m; (+4.2%)	-$131m; (-4.7%)
Work/leisure split Low 30:70 ; high 50:50	-$26m; (-3.3%)	+$26m; (+3.3%)	-$71m; (-3.3%)	+$71m; (+3.3%)	-$71m; (-3.4%)	+$71m; (+3.4%)	-$100m; (-3.6%)	+$100m; (+3.6%)
Inconvenience time Low 30 min ; high 1.25 hr	-$105m; (-13.3%)	+$52m; (+6.6%)	-$282m; (-13.2%)	+$141m; (+6.6%)	-$284m; (-13.5%)	+$142m; (+6.8%)	-$400m; (-14.4%)	+$200m; (+7.2%)
Adjustment factor for under-reporting of WOF-related factors Low 1.05 ; high 1.3 ** For non-fatal crashes only*	-$1m; (-0.2%)	-$7m; (-0.9%)	-$4m; (-0.2%)	-$22m; (-1.0%)	-$4m; (-0.2%)	-$27m; (-1.3%)	-$13m; (-0.5%)	-$80m; (-2.9%)
Avoided maintenance costs Low 5% ; high 15%	-$37m; (-4.6%)	+$37m; (+4.6%)	-$102m; (-4.8%)	+$102m; (+4.8%)	-$100m; (-4.7%)	+$100m; (+4.7%)	-$167m; (-6.0%)	+$167m; (+6.0%)
Discount rate Low 4% ; high 10%	+$449m; (+56.8%)	-$135m; (-17.0%)	+$1,213m; (+56.9%)	-$363m; (-17.0%)	+$1,198m; (+57.0%)	-$359m; (-17.1%)	+$1,605m; (+57.7%)	-$479m; (-17.2%)

6.4. Conclusion

The results of the cost-benefit analysis unambiguously support reducing the current frequency requirement of WOF inspections for light vehicles. The results are robust with the most substantial benefits flowing from firm estimates of savings in charges, adjusted to reflect the expenditure on safety checks that likely would occur anyway. On the risk side of the ledger we have adjusted for potential under-recording of safety related vehicle defects in crash reports and this has an insignificant impact on the results. Overall the results are unsurprising in the context of New Zealand having the most frequent vehicle inspection regime in the OECD and the mixed results of overseas studies assessing the value of inspection regimes

7. Appendices

7.1. Safety impact analysis — Warrant of Fitness reform options report

Preface

This appendix documents the Safety Impact Analysis of the Warrant of Fitness Reform options as part of the Vehicle Licensing Reform project, a joint project undertaken by the Ministry of Transport and the NZ Transport Agency looking at the Annual Vehicle Licensing (AVL), Warrant of Fitness and Certificate of Fitness (WOF and COF) and Transport Services Licensing (TSL) regimes. This appendix should be read in conjunction with the Interim Cost Benefit Report: Warrant of Fitness Reform Options.

Remarks

This report does not include the effects of the safety mitigations being considered to reduce the negative safety impacts. For details of these mitigation options please refer to the discussion document.

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1. Executive summary

The Ministry and the New Zealand Transport Agency are currently working on a package of proposals to improve the efficiency of the vehicles/operators licensing and certification regime. This appendix investigates the safety implications of reducing the warrant of fitness inspection frequency.

The policy options analysed include:

- Option 1: Annual inspections to vehicles under the age of 12 years, with six monthly inspections thereafter
- Option 2: No inspection for first three years of vehicle age, and then once a year thereafter
- Option 3: Inspection frequency based on vehicles kilometres travelled (first inspection at 50,000 km and then once every 12,000 km) or every three years (whichever comes first)
- Option 4: Inspection only on change of ownership

Our analysis considered the relationship between crash involvement and time since last inspection (referred as the slope of the risk line) to estimate the likely impacts of alternative inspection frequency regimes on road injury crashes.

The road injury crash estimates were then adjusted for the effects of change of ownership inspection on vehicle safety performance and for the effects from the uptake of voluntary safety checks with vehicle servicing.

The resulting estimates were then converted to social cost of road crashes incorporating all injuries recorded in the traffic crash reports, hospital database and Accident Compensation Corporation's database. An allowance for non-injury crashes was then added.

The final estimates are summarised in Table S1 below.

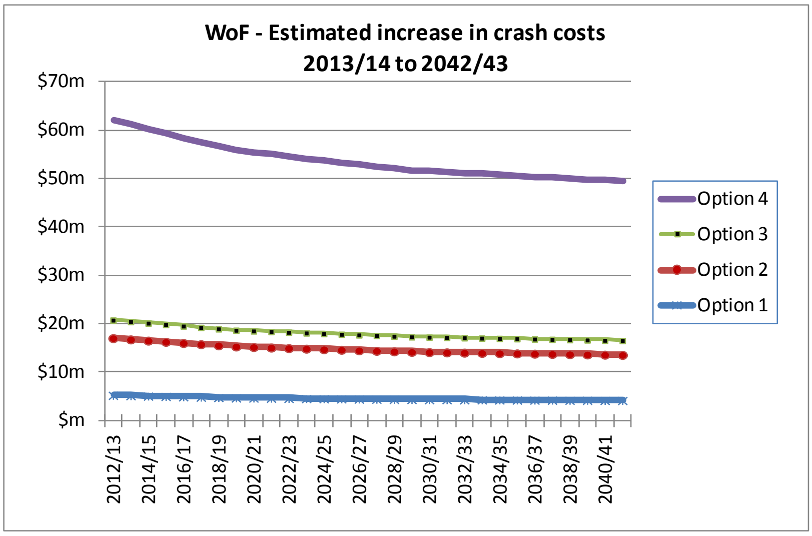
Table S1: Estimated annual safety impacts

	Estimated increase in the number of reported crashes p.a.			Estimated increase in annual social cost, $m 2011 prices		
	Fatal	Serious	Minor	$m (including non-injury crashes)	% increase in total SC $m	% increase in SC $m of at-fault crashes with WOF-related safety defects
Option 1	0.7	1.6	7.7	$ 5.4	0.1%	6.5%
Option 2	2.3	5.0	24.7	$ 17.4	0.4%	21.2%
Option 3	2.8	6.1	30.1	$ 21.2	0.5%	25.8%
Option 4	8.4	17.9	88.5	$ 62.9	1.6%	76.6%

Note: This table includes effects from change of ownership inspections and voluntary safety checks with vehicle servicing. The social cost estimates have been adjusted to include all injuries recorded in traffic crash report, hospital and ACC databases.

Table S1 shows that Option 4 has the highest negative safety impacts (estimated at around $63 million pa or 1.6 percent of the annual total social cost). The negative safety impacts from Options 1 and 3 are relatively small (at $5-$21 million pa or less than 0.5 percent of the annual total social cost).

Figure S1: Estimated increase in the social cost of road crashes to 2042/43 (in nominal terms)



After considering the likely reduction in road trauma over time, the report estimated the estimated increase in the social cost of road crashes to 2042/43 (Figure S1).

Table S2: Estimated increase in the social cost of road crashes to 2042/43 (in present values)

	Option 1	Option 2	Option 3	Option 4
Estimated total increase in social cost of road crashes to 2042/43, in present value terms	$54 million	$174 million	$212 million	$630 million

Option 1 has the lowest increase (estimated at $54 million in present value) in the total social cost of road crashes over a 30-year evaluation period (see Table S2). Options 2 and 3 have a moderate increase (estimated at $174 million and $212 million in present value respectively) and option 4 has the highest increase (estimated at $630 million in present value).

The report also demonstrated that including non-WOF-related factors in crash reports will not affect the estimated safety impacts because crashes non-WoF related factors do not vary with the time since last inspection.

Finally, sensitivity analysis was carried out to test the effect of (i) changing the slope of the risk line based on the 95 percent upper and lower limit estimates; and (ii) different levels of under-recording of WoF-related factors in crash reports.

2. Introduction

This appendix investigates the safety implications of reducing the warrant of fitness inspection frequency. The policy options being considered are summarised in Table 1 below.

Table 1: Inspection frequency options for in-service private light passenger vehicles

<table>
<tr><th>Inspection frequency by vehicle age group</th><th>Status Quo</th><th>Option 1</th><th>Option 2</th><th>Option 3</th><th>Option 4</th></tr>
<tr><td>under 3 years old</td><td>Annual</td><td>Annual</td><td>None</td><td rowspan="4">First at 50,000 km and once every 12,000 km OR every three years (whichever comes first)</td><td rowspan="4">At change of ownership only</td></tr>
<tr><td>3 to 5 years old</td><td>Annual</td><td>Annual</td><td>Annual</td></tr>
<tr><td>6 to 12 years old</td><td>6-monthly</td><td>Annual</td><td>Annual</td></tr>
<tr><td>13 years old and over</td><td>6-monthly</td><td>6-monthly</td><td>Annual</td></tr>
</table>

The purpose of this analysis is to estimate the likely impact of the WoF frequency change on road crashes and injuries. This analysis will not correctly predict how many additional crashes will actually occur. Rather, this analysis utilises the best information currently available and a simple approach to gauge the direction and scale of the effect. Different countries have different regulations and rules in place, the effects of similar change overseas are generally non-transferrable for New Zealand use. Where appropriate, however, reference to overseas studies is made to better inform the assessment.

2.1 Background

In New Zealand, an in-service vehicle[65] can be operated on the road legally only if the vehicle is inspected for a warrant of fitness (WoF) every 6 to 12 months (depending on vehicles age). The WoF inspection is a general safety check. The key safety aspects[66] checked include tyre condition, brake performance, steering and suspension, light and safe operation of occupant protection equipment. There are around 3,200 WoF agents[67] in New Zealand which handle nearly 7.5 million inspections (including re-checks) each year.

A rationale for the WoF inspection is to ensure car owners maintained their vehicles to the minimum safety standards and therefore reduce the risk of crash involvement. However, having periodic inspections does not necessary remove all vehicle safety risk since vehicles defects can develop between each inspection.

Vehicle factors generally play a small role in road crashes. For example, in Australia only around 5 percent of all fatal crashes occurred in 2006 have vehicle defects as contributing factors[68]. In the United Kingdom, the percentage of all injury crashes occurred in 2009 with vehicle factors was between 2 and 3 percent[69].

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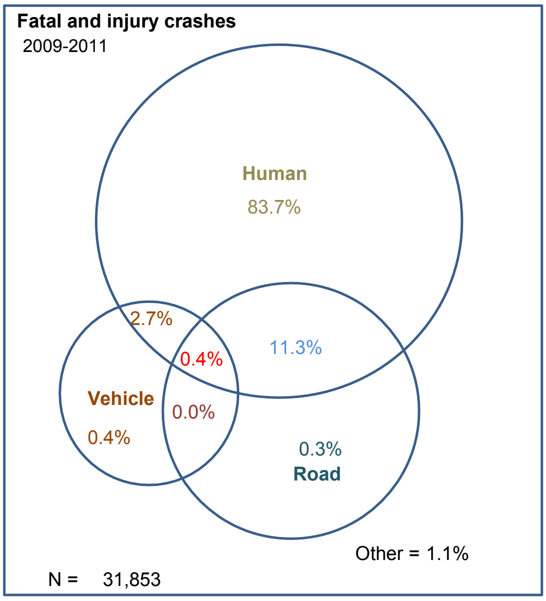
[65] All vehicles (other than light trailers) are subject to entry certification inspection before first registration. An in-service vehicle is a registered vehicle.
[66] The aspects checked are set out in the Vehicle inspection requirements manual.
[67] Sources: http://www.nzta.govt.nz/vehicle/warrants-certifications/getting-wof/about.html
[68] Bureau of Infrastructure, Transport and Regional Economics (2011), "Fatal road crashes in Australia in the 1990s and 2000s: crash types and major factors", Department of Infrastructure and Transport.
[69] TRL (2011), "Effects of vehicle defects in road accidents".

For the three years to 2011, vehicle factors have contributed to about 6 percent of fatal crashes and 3.5 percent of all injury crashes[70] in New Zealand (Figure 1). Approximately 0.4 percent of all injury crashes with such defects cited as the "sole" cause of the crash.

Figure 1: Contributing factors to fatal and injury crashes



Data source: Crash Data Analysis system, Ministry of Transport

Note: The relative sizes of the circles are not drawn to scale.

Over the same three-year period, the average annual number of at-fault injury crashes [71]involving vehicles with WoF-related safety defects (as contributing factors) was 155. Table 2 summarises the average annual total social cost[72] of these crashes by severity and the presence of WoF-related defects. The average annual total social cost of fatal and injury crashes with WoF-related defects is $73.8 million or $82.1 million including non-injury crashes. This represents around 3 percent of the total social cost of all at-fault crashes. Of this total, around 68 percent (or $55.6 million) involved vehicles with a valid WoF at the time of the crash.

[70] The corresponding percentages of crashes with WoF-related defects are 6 percent (fatal crashes) and 2.5 percent (all injury crashes).
[71] For the period from 2008 to 2010, around 86 percent of all injury crashes were at-fault crashes.
[72] Social cost of road crash or road injury is a measure of the total cost that occurs as a result of the crash or injury. It includes loss of life and life quality, loss of output, medical costs, legal costs and property damage costs. For details about social cost, please refer to "The Social Cost of Road Crashes and Injuries: June 2011 update".

Table 2: Social cost of at-fault road injury crashes (annual average 2009 to 2011)

Social cost of at-fault passenger cars and vans injury crashes ($ million)		Annual average social cost of at-fault crashes, $m June 2011 prices			
		Injury crashes	Non-injury crashes	Total	%
Vehicles with WoF related safety defects	with a valid WOF	49.4	6.2	55.6	1.9
	without a valid WoF (note 1)	24.4	2.2	26.5	0.9
Other at-fault crashes (without WoF-related safety defects)	with a valid WOF	2,066.8	396.7	2,463.5	82.0
	without a valid WoF (note 1)	391.9	65.1	457.0	15.2
Total at-fault crashes		**2,532.5**	**470.2**	**3,002.6**	**100.0**

Data source: Crash Data Analysis system, Ministry of Transport

Notes:

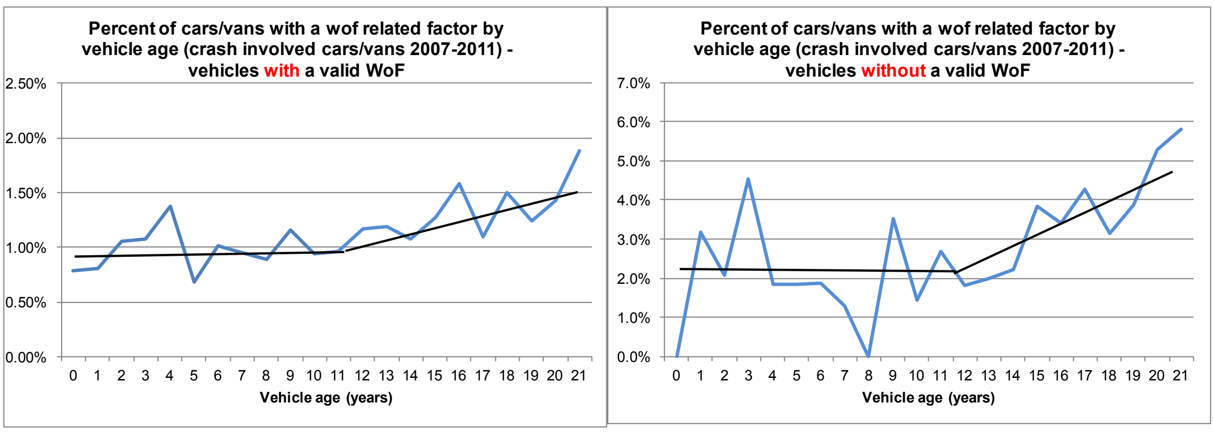
(1) These items include those with unknown WoF status.

(2) This table excludes crashes where vehicle age was not recorded.

2.2 Scope

Crash data shows that the share of vehicles with a WoF-related safety defects is generally higher for those without a valid WoF (Figure 2). This phenomenon is consistent for all age groups. Due to financial reason some vehicle owners could delay expensive repairs to WoF standards for a short period and others could delay repairs for an extended period. However, the inspection frequency is unlikely to affect these crashes although some of these vehicles would have been classified as having a valid WoF under the new frequency regime (although in this case there will be no change in the risk).

Figure 2: Share of vehicles with a WoF-related safety defects by vehicle age



While the new frequency regime could encourage compliance and improve safety for those who would not have complied under the current regime, we do not expect this to be significant. This is because the majority[73] of vehicle owners do comply with the WoF inspection requirement and the change is unlikely to affect vehicle owners who do not comply for an extended period.

For the reasons outlined here, this paper only considers cases where the at-fault vehicles have a valid WoF.

3. Literature review

Rechnitzer et al (2000) provided a good literature review of studies conducted before 1999. Their literature review indicated mixed results in the United States crash rates between states with different inspection frequencies. Such observation, however, is not directly transferrable to other jurisdictions due to potential differences in driver behaviour, variation in the equipment items inspected and the procedures, rules and regulations for inspections.

In terms of the effectiveness of a periodic inspection programme, evidence appears to be more consistent. Of the ten studies reviewed by Rechnitzer et al (2000)[74], eight studies found periodic inspections reduces crash rate (and the number of defects), with one study found an opposite result and one study found no difference.

When examining the effect of periodic vehicle inspections, it is important that the analysis does not assume the inspection is effective in detecting and repairing all defects that may at some stage contribute to a crash. Such an assumption is unlikely to hold as not all defects can be identified and defects can develop after an inspection, eg tyre tread depth will reduce with use.

NZIER (1999) looked at the effects of several less frequent inspection options using a regression analysis of the crash risk due to WoF-related safety defect with time since the WoF test. They estimate the likely increase in crash risk by extending the time since the WoF test forward.

NZIER found that shifting from annual inspection to no inspection for vehicles under 3 years of age will increase crash involvement risk by between 0.6 and 1.3 percent and changing from bi-annual inspections to annual inspections for vehicles over 6 years of age will increase crash involvement risk by between 0.1 and 0.6 percent.

This regression approach links crash risk directly with the timing since the last inspection and therefore does not rely on the assumption of whether inspections can pick up all defects. However, a disadvantage of this approach is that the small sample size in the number of crashes for certain vehicle age groups or vehicle types can make it difficult to identify their safety risk associated with the timing of WOF. One way to overcome this limitation is to reduce the number of vehicle age groups for the analysis.

More recently, several European studies (eg TRL 2011, Schulz, 2011, Autofore 2007 and Baas et al, 2006)[75] use initial inspection failure rate to estimate the effect of a change in

[73] In 2011, around 70% of vehicle owners complied with the WoF inspection requirement on or before the due date, plus a further 17% complied within 28 days after the due date.
[74] Rechnitzer, G, Haworth, N and Kowadlo, N (2000), "The effect of vehicle roadworthiness on crash incidence and severity", Report No. 164, Monash Accident Research Centre.
[75] Schulz, W (2011), "Cost-Benefit Analysis for Transport Policy Considerations: A European Trade-off between Consumer Benefits, Welfare Effects and Administrative Burden".
Baas, P, Baum, H and Schulz, W (2006), "Study on the Future Options for Roadworthiness Enforcement in the European Union", report WP400, University of Cologne.

inspection frequency. This approach assumes less frequent inspections will cause an increase in the number of vehicles with undetected defects, which in turn will have a proportionate effect on defects related crashes. A key disadvantage is that the relationship between initial inspection failure and crashes has not been substantiated empirically. Therefore, it is not recommended for this analysis.

4. Methodology

4.1 Overview

The methodology for this analysis requires information about how the ratio of at-fault crashes with WoF-related safety defects links to the time since last inspection. To illustrate, let us consider the scenario where the in-service inspection frequency reduces from annually for the first 3 years to first inspection in year 3.

Figure 3: Graphical illustration of the estimation approach

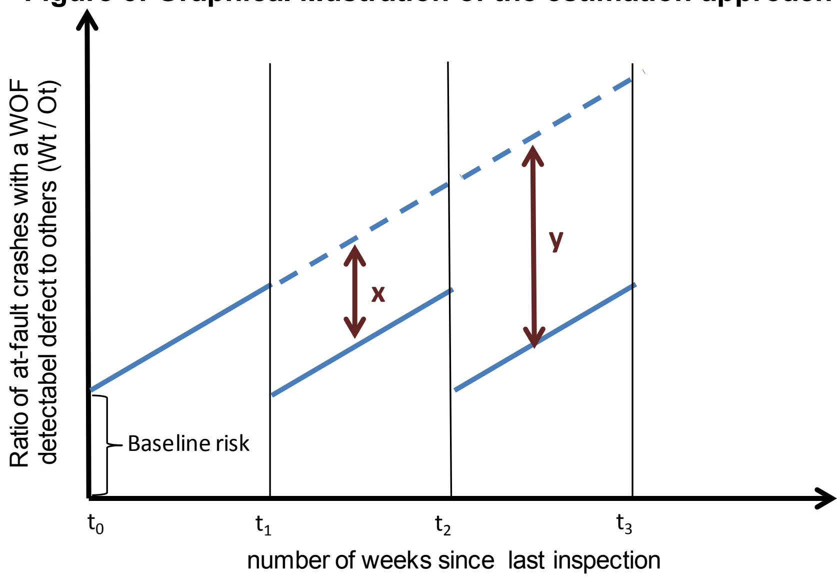


Figure 3 shows three time segments over time periods from year 0 (t0) to year 3 (t3). The first solid blue line represents the relationship between the share of WoF related crashes relative to other at-fault crashes and the number of weeks since last inspection. Let us call this the ‘risk line’. The distance between the origin and the point where the risk line intersects with the axis represents the baseline risk that is not related to the timing of inspection. This includes, for example, the risk associated with hidden defects that are missed at inspection or random failure of equipments which appeared to be sound at the time of inspection

Under the current inspection frequency, the risk line should ‘re-set’ back to the baseline risk level after each inspection and increases with time thereafter. In other words, assuming everything else remain constant, the risk line should repeat itself for the three years. Under the new inspection frequency regime, we can extend the risk line forward to the full 3 years period (ie the dotted line). The likely increase in the number of crashes can then be estimated based on the estimated increase in the ratio of at-fault crashes with WoF detectable faults to other at-fault crashes – represented by the vertical difference between the solid and the dotted lines (ie x or y). The underlying assumption is that the observed linear trend up to t_1 would continue beyond t_1.

The key steps involved to estimate the safety impacts are:

(i) estimate the risk line using empirical data (Section 4.2)
(ii) estimate the incremental change in the number of injury crashes using results from step (i) (Section 4.3)
(iii) adjust the over- or under-recording of crash contributing factors (section 5)
(iv) adjust the effects of safety checks at servicing (section 6)
(v) disaggregate the estimated number of injury crashes by crash severity (section 7)
(vi) estimate the annual increase in social cost of road crashes (including allowance for non-injury crashes) over a 30-year evaluation period (section 7)

4.2 Estimate the risk line

This is based on the regression analysis used by NZIER (1999). We have used historical data on the share of crashes with WoF detectable vehicle defects relative to crashes without WoF related factors to estimate the likely increase in risk from an inspection frequency change. The crashes we are interested in are at-fault (either driver or vehicle) crashes only. For this analysis, data from 2002 to 2011 has been used. This analysis considers light passenger vehicles (including cars and vans) that are subject to WoF and excludes motor cycles and light trailers.

The regression equation can be written as:

$$\frac{W_t}{O_t} = a + b * t + \varepsilon \qquad (1)$$

where W = number of crashes with WoF-related safety defect (or WoF related crashes); O = number of crashes without a WoF-related safety defects; t = number of weeks after the last WoF inspection; a and b are coefficient estimates; ε is a random error.

After running the regression model and estimating the coefficient estimates, we can re-arrange the above equation as:

$$\widehat{W_t} = (\hat{a} + \hat{b} * t)O_t$$

Therefore, to estimate the number of WoF related crashes with a longer time period t, we only need the total number of at fault crashes without a WoF-related safety defect (ie O_t).

As the random variations in crash involvement for each vehicle age would be too large to provide a good indication of the crash risk, the analysis is carried out by vehicle age group (under 3 years, 3-5 years, 6-12 years, 13 years and over).

Results show that the slope of the risk line increases with vehicle age and the baseline risk (the intercept) is generally higher for older vehicles (see Table 3). Attempts to separate vehicles over 21 years were abandoned as the crash risk is more difficult to identify due to a lower number of crashes. Therefore, vehicles aged 13 and over are assessed as a group.

Table 3: The slope coefficient by vehicle age group (cars and vans)

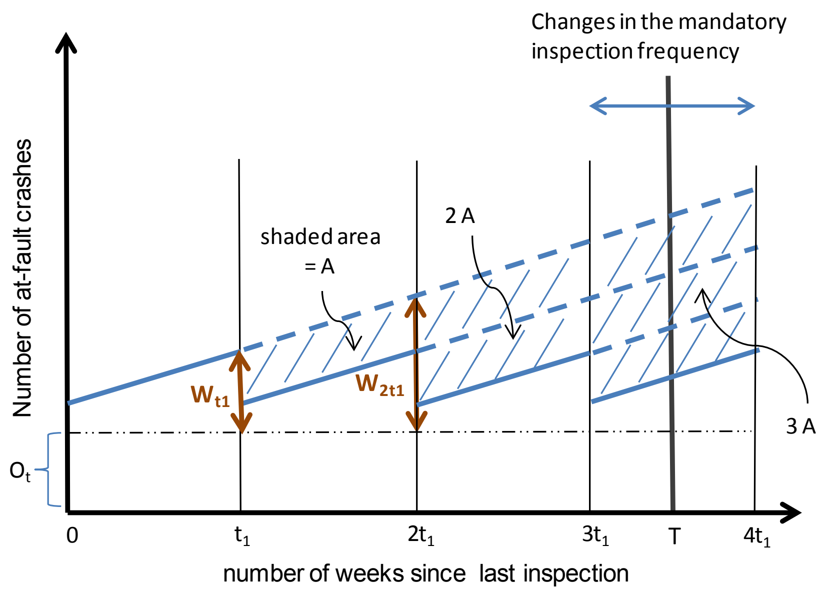
Vehicle age group (cars and van)	Intercept	Slope of the risk line		
		Low limit estimate	Central estimate	Upper limit estimate
Under 3 years	0.0064	0.00000	0.00024 *	0.00052
3 to 5 years	0.0108 ***	0.00000	0.00011	0.00033
6 to 12 years	0.0120 ***	0.00022	0.00039 ***	0.00055
13 years and over	0.0165 ***	0.00015	0.00043 ***	0.00072

Note: * denotes statistically significantly different from zero at 10% level and *** denotes statistically significantly different from zero at 1% level.

4.3 Estimate the incremental change in the number of crashes

Once the risk line is estimated, it is useful to re-plot the graph in a different scale to facilitate estimation of the incremental change in the number of crashes (Figure 4). By definition, at-fault crashes that do not have WoF-related safety defects do not vary with time since last inspection. Therefore, we can plot the total number of at-fault crashes against the number of weeks since last inspection simply by adding a constant O_t (a weekly average of O_t) and a variable W_t (a linear function of time since last inspection as estimated in section 4.2). The patterns are identical to Figure 3 except this time we have the number of at-fault crashes in the vertical axis instead.

Figure 4: Estimating the increase in the number of crashes



The total increase in the number of crashes is represented by the shaded areas. To estimate this, we need to first estimate area A. This equals the difference between the estimated number of crashes with WoF-related safety defects with an extended duration between inspections and the expected number of crashes under existing frequency. This can be estimated using the regression results as follow:

$$A = \sum_{t1}^{2t1} \widehat{W}_t - \sum_{0}^{t1} \widehat{W}_t$$

$$A = O_t \left[\sum_{t1}^{2t1} (\hat{a} + \hat{b}t) - \sum_{0}^{t1} (\hat{a} + \hat{b}t) \right]$$

$$A = \hat{b}\, O_t \left[\sum_{t1}^{2t1} t - \sum_{0}^{t1} t \right] = \hat{b}\, O_t\, K$$

where K = 676 for t_1=26 weeks and 2704 for t_1=52 weeks.

The formulae for estimating the shaded areas under different time period extensions are summarised in Table 4.

Table 4: Formulae for estimating total increase in the number of crashes

Changes in WoF duration (T)	Total additional number of crashes (shaded area)
$t_1 < T < 2t_1$	$\mathbf{A} * \frac{\mathbf{T} - \mathbf{t_1}}{\mathbf{t_1}}$
$T = 2t_1$	A
$2t_1 < T < 3t_1$	$\mathbf{A} + \mathbf{2A} * \frac{\mathbf{T} - \mathbf{2t_1}}{\mathbf{t_1}}$
$T = 3t_1$	3A
$3t_1 < T < 4t_1$	$\mathbf{3A} + \mathbf{3A} * \frac{\mathbf{T} - \mathbf{3t_1}}{\mathbf{t_1}}$
$T = 4t_1$	6A
$T = 5t_1$	10A
$T = 6t_1$	15A

4.4 Diagnostic tests

- **Causality test** – For most regression analysis, testing the direction of causality is important to ensure that (i) there is no feedback effect between the dependent and independent variables; and (ii) the regression is not spurious; and (iii) if the focus is to understand the cause of any changes in a variable. Causality test is not particularly useful in this analysis because
    - the objective of the regression is to understand the relationship between the share of crashes with WoF-related safety defect and time since last inspection and not about understand the cause of such crashes; and
    - the time since last inspection is independent of the share of crashes with WoF-related safety defects (ie the time since last inspection do not vary because the share varies).
- **Heterogeneity of variance** – As the number of crashes increase with time since last inspection, the variance decreases with increasing time since inspection. The potential issues with non-constant variance are not severe as the lease square estimate would still

be unbiased and consistent. But the estimates will be less reliable because the variances will be inaccurate. To correct for such effect, the heteorskedasticity-consistent covariance matrix has been used in the estimation process.

- **Goodness of fit** – The slope coefficients for vehicle age groups 6-12 and 13 and above are statistically significant at less than 1 percent level indicating a positive relationship between crash involvement risk for vehicles with WoF-related safety defects and time since last inspection. The slope coefficient for vehicle age group 0-2 is statistically significant at less than 10 percent level and the slope coefficient for vehicle age group 3-5 is not statistically significant.

5. Over-/under-recording of crash contributing factors

Not all injury crashes are recorded in the official traffic crash reports (TCRs). This happens when some crashes are not reported to the Police or when the injured road users are admitted to hospital prior to the arrival of a police officer to record the details. The Ministry uses hospital and accident compensation claims data to supplement TCRs data and incorporate the under-reported cases into the average social cost of road injury crash estimates. In this section, we deal with a different kind of recording issue.

Not all police officers are trained to determine the cause of a crash. Assessments made at the crash scene based on visual or verbal evidence obtained can be imprecise. There are three potential recording errors:

i. including non-WoF related crashes as WoF related
ii. over recording of WoF-related factors in crashes
iii. under recording of WoF-related factors

A critical parameter for the safety impact analysis is the slope of the risk line. Therefore, any over- or under-recording of crash contributing factors that can influence the slope of the risk line can affect the results. The following sections discuss their impact on the safety estimates.

5.1 Recording errors that do not vary with the time since last inspection

Because non-WoF related crashes do not vary with the time since last inspection, it can be shown that such recording errors (recording error i) have no effect on the estimated safety impacts. The slope of equation (1) can be obtained by taking the first order differentiation with respect to time since last inspection (t).

$$y = \frac{W(t)}{O(t)} = a + b * t \qquad \text{(where a and b are the coefficient estimates)}$$

The slope of the risk line is therefore given by:

$$\frac{dy}{dt} = \frac{W'O - O'W}{O^2} = b$$

Since the number of non-WoF related crashes do not vary with the time since last inspection, we have $O' = \frac{dO}{dt} = 0$. Thus, $b = \frac{W'}{O}$.

If non-WoF related crashes have been mistakenly included as WoF related, this means W(t) should be smaller and O(t) should be higher. Let us assume the difference is Δ, which is a constant and is independent of time since last inspection. Then, the actual ratio of WoF-related to non-WoF related crashes should be expressed as follows:

$$z = \frac{W(t)-\Delta}{O(t)+\Delta} = c + d * t \qquad \text{(where c and d are the coefficient estimates)}$$

In this case, the slope of the risk line is given by:

$$\frac{dz}{dt} = \frac{W'(O+\Delta)-O'(W-\Delta)}{(O+\Delta)^2} = d \qquad (\text{since } O' = \frac{dO}{dt} = 0)$$

$$d = \frac{W'(O+\Delta)}{(O+\Delta)^2} = \frac{W'}{(O+\Delta)} = b * \frac{O}{O+\Delta}$$

In other words, if non-WoF related crashes have been included as WoF related, the actual slope of the risk line should be adjusted by the ratio of the estimated to actual number of non-WoF related crashes.

In this case, the shaded area A will be equal to:

$$A_{adjusted} = d * (O_t + \Delta) * K$$

➔ $$A_{adjusted} = b * \frac{O_t}{O_t+\Delta}(O_t + \Delta) * K = b * O_t * K = A$$

Since the adjusted area A is exactly the same as before, errors in recording non-WoF related crashes as WoF related have no impact on the safety impact estimates. The estimated ratio would be lower but the number O_t would be higher keeping the estimate of number of WoF related crashes the same.

For errors in over recording of WoF related effects (ie recording error ii) eg incorrect use of tyres has been classified as tyre factor) can occur at any time irrespective of when the vehicle was last inspected. In other words, these recording errors do not vary with the time since the last inspection. The results would be the same as including non-WoF related crashes as WoF related because if these crashes are genuinely non-WOF related they would occur independent of time since last inspection.

5.2 Recording errors that vary with the time since last inspection

The case of under recording of WoF related crashes (recording error iii) is slightly different from the other two cases. Here, under recording could occur if the vehicle defects are too difficult to detect. The probability for these defects to occur is likely to increase over the time since last inspection.

Suppose we have miscounted the number of non-WoF related crashes as $O_t = N_t + \alpha W_t$, the correct ratio of WoF-related to non-WoF related crashes should be written as:

$$z = \frac{(1+\alpha)W(t)}{[N(t)+\alpha W(t)]-\alpha W(t)} = \frac{(1+\alpha)W(t)}{N(t)} = c + d * t$$

where c and d are the coefficient estimates and $\frac{dN}{dt} = 0$.

In this case, the slope of the risk line is given by:

$$\frac{dz}{dt} = \frac{(1+\propto)W'(N) - N'(1+\propto)W}{N^2} = d$$

$$d = \frac{(1+\propto)W'}{N} = (1+\propto) * \frac{W'}{O} * \frac{O}{N} = b * (1+\propto) * \frac{O}{N}$$

In this case, the shaded area A will be equal to:

$$A_{adjusted} = d * (N_t) * K$$

➔ $$A_{adjusted} = b * (1+\propto) * \frac{O_t}{N_t} * N_t * K = b * (1+\propto) * O_t * K = (1+\propto) * A$$

Thus, to adjust the safety impacts for under recording of WoF-related crashes, the estimates will need to be scaled up by the level of under-recording.

5.3 Scenarios of under-recording of WoF-related factors in crashes

There is a clear distinction between police-reporting and recording errors. As noted in earlier, we have already dealt with under-reporting of crashes to Police when we estimate the average social cost of road crashes using hospital and accident compensation claims data to supplement TCRs data. In this scenario analysis, we deal with the under-recording of vehicle factors in crash reports.

Tables 5 and 6 provide a summary of the percentages of crashes and vehicles with vehicle factors and safety related vehicle defects cited as contributing factors in crashes observed in overseas jurisdictions. In New Zealand, around 3.5 percent of all fatal and injury crashes have vehicle factors as a contributing factor. Approximately 0.4 percent of all fatal and injury crashes with such factors cited as the "sole" cause of the crash. However, not all vehicle factors are WoF-related (eg dirty windscreen or incorrect loading). Around 2.5 percent of vehicles have WoF-related safety factors as a contributing factor.

An initial glance suggests NZ's experience is not too dissimilar to that of Australia and United Kingdom.

Table 5: Percentage of crashes and vehicles with *vehicle factors* cited as contributing factors

Source	Country	Time period of crash data analysed	% of crashes		% of vehicles	
			Fatal crashes	Fatal and injury crashes	in fatal crashes	in fatal and injury crashes
CAS	NZ	2009-2011	6%	3.5%	3.6%	1.9%
Cambridge Systematics (2009)	US	2004–2007	2%	n/a	n/a	n/a
BiTRE (2011)	Australia	2006	5%	n/a	n/a	n/a

Table 6: Percentage of crashes and vehicles with *safety related vehicle defects* cited as contributing factors

Source	Country	Inspection frequency	Time period of crash data	% of crashes	
				Fatal crashes	Fatal and injury crashes
CAS	NZ	Annual to year 6, 6-monthly thereafter	2009-2011	6%	2.5%
TRL, 2011 (p.27, p.35)	UK	Annual from year 3	2005	n/a	2 - 2.5% (3% *)
TRACE (2008)[76]	France, Spain, UK, Germany and Czech Republic	Mixed but typically every 2 years after year 3 or year 4	2004	n/a	2%
DEKRA[77] (2008)	Germany	First in year 3, every 2 years thereafter	2002-2007	n/a	6.6%*
AUTOFORE (2007)[78] (p.27)	Germany	First in year 3, every 2 years thereafter	Pre-2000	n/a	2.5 - 9.1% (ave =5.8%)
Monash (2000)[79] (p.31)	Australia	Vary with States	1995 - 1996	n/a	3%
Road Safety Committee, Parliament of Victoria (2001) (p.12)	Australia (average)	Vary with States	1988,1990 and 1992	2.3%	n/a
	New South Wales	First in year 4, annual thereafter		2.0%	n/a
	Queensland	At change of ownership		2.2%	n/a
	Victoria	At change of ownership		1.2%	3.55% *
Keatsdale Pty[80] (1999), p.48	Australia	Vary with States	1988, 1990 and 1992	2.3%	n/a

* based on in-depth crash data analysis

Some vehicle defects are difficult to detect at crash scenes, and not all Police officers are trained to determine the causes of a crash. Assessments made at a crash scene based on visual and verbal evidence obtained can be imprecise. Therefore, there is potential for under-reporting of vehicle defects as contributors to crash, in particular for factors other than tyres or lights.

[76] Schick S, Eggers A, Pastor C, van Elslande P, Fouquet K, Banos A, Plaza J, Naing C, Tomasch E and Hell W (2008), “Traffic Accident Causation in Europe (TRACE), Trip related factors”, Deliverable 3.3.
[77] DEKRA (2008), “Road Safety Report 2008”.
[78] Autofore (2007), “Cost-benefit analyses for roadworthiness options”, Study on the Future Options for Roadworthiness Enforcement in the European Union, working paper number 700.
[79] Rechnitzer, G, Haworth, N and Kowadlo, N [Monash] (2000), “The effect of vehicle roadworthiness on crash incident and severity”, Monash University Accident Research Centre, Report No. 164.
[80] Keatsdale Pty Ltd (1999), “Cost effectiveness of periodic motor vehicle inspection: A report for the Federal Office of Road Safety”, Queensland Australia.

In the UK, official data recorded 2% of all injury crashes were related to vehicle defects (TRL 2011, p25). However, based on the results of an in-depth accident research "*On The Spot*", it was estimated that 2.5% of vehicles had a defect that may be detectable at inspections (TRL 2011, p27). In the final analysis, TRL used 3% (p.35). The adjustment represents between 25% and 50% of official figure (or multiplying factor of 1.25 and 1.5). In Victoria, an in depth analysis[81] of crash reports found only 3.55 percent of those vehicles was found to have any form of defect and the official percentage was 2.2 percent[82].

However, because the level of under-reporting between countries can vary significantly due to factors like the characteristics of the vehicle fleet and the attitude of car owners towards maintenance, it is not appropriate to adopt the same share of vehicle factors observed overseas. Further, the timing of the data used in the analysis can also affect the results because newer vehicles have better technology and studies conducted during different periods may not be directly comparable.

The level of under-recording of crashes with WoF-related safety defects is directly related to the ease of detection and the probability of crash involvement. According to crash data, tyres or lights are cited as contributing factors for nearly 80 percent of vehicles with WoF-related safety defects. These items are also frequently failed at WoF inspection (in 2011, 32 percent failed lights and 21 percent failed tyres at WoF inspections).

Since tyre- or light-related vehicle defects are generally easier to identify, the level of under-recording of tyre- and light-related factors is likely to be small. The level of under-recording of other vehicle factors is currently unknown but is unlikely to be more than doubled.

For the purposes of the sensitivity analysis, we include two scenarios to gauge the likely impacts of under-recording on the overall results (Table 7). Since fatal crashes require detailed crash investigation, there is no under-recording of WoF-related factors in such crashes. Hence, the following only applies to non-fatal crashes. Results of these scenarios are given in section 8.

Table 7: Under-recording of WoF-related factors scenarios

	Low	High
Under-recording of tyre and light factors	0%	10%
Under-recording of non-tyre/light related WoF factor	25%	100%
Overall level of under-recording	5%	28%
Adjustment factor for non-fatal crashes	1.05	1.30

[81] Road Safety Committee, Parliament of Victoria Inquiry into Victoria's Vehicle Roadworthiness System. (2001).
[82] Keatsdale Pty Ltd (1999), Cost effectiveness of periodic motor vehicle inspection: A report for the Federal Office of Road Safety".

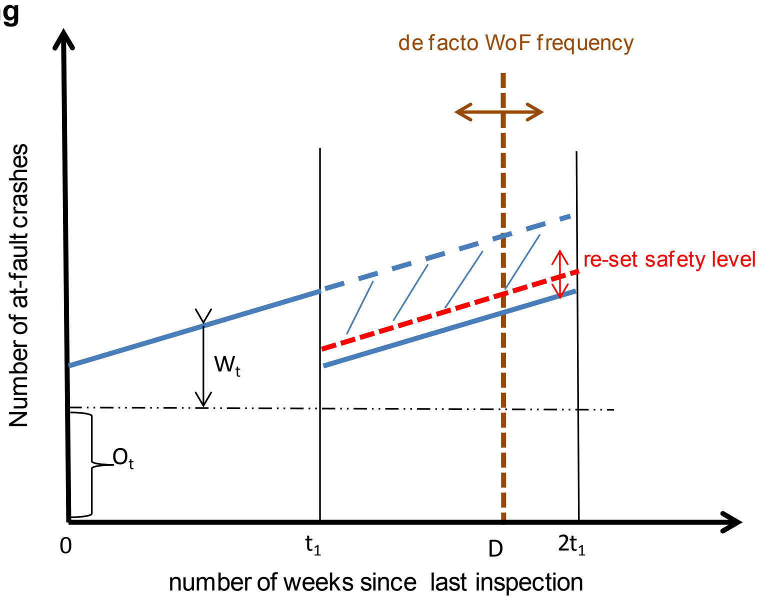
6. Effects of change of ownership inspections and safety checks with vehicle servicing

To buy or sell a vehicle, the law require the vehicle to have a WoF that is no more than one month old when the buyer takes possession. Therefore, the effect of fleet turnover can impact on *de facto* WOF inspection frequency.

Furthermore, with a less frequent inspection regime, safety conscious car owners could continue to get their vehicles inspected and repaired at regular intervals. This means the above analysis can over-state the potential negative impacts of inspection frequency on road safety.

There are two key steps involved to adjust for the above effects (Figure 5). The first step requires estimation of the *de facto* WoF inspection frequency. The second step involves estimating the level of safety outcomes relative to a WoF inspection.

Figure 5: Effects from change of ownership inspections and safety checks with vehicle servicing



6.1 Effects of change of ownerships on vehicle safety

6.1.1 Options 1 to 3

The law require the vehicle to have a WoF that is no more than one month old before a change of ownership of vehicles can take place[83]. Vehicles with WoF older than one month or without a current WoF must be sold "as is, where is"[84]. Figure 6 and Table 8 show the distribution of valid months remaining on WoF for vehicles sold in 2011. Only around one-third of vehicles sold with a WoF of less than one month old.

[83] Source: http://www.nzta.govt.nz/resources/factsheets/41/buying-and-selling.html
[84] Source http://www.consumeraffairs.govt.nz/for-consumers/motor-vehicles/before-you-buy-a-motor-vehicle

Table 8: WoF status of cars sold in 2011 – private and dealer sales combined

WoF status	Under 3 years	4-6 years	7-11 years	12 years & over	total
WOF less than 1 month old	49%	37%	46%	27%	33%
WOF 1 month and older	45%	61%	48%	46%	47%
no WOF	6%	2%	6%	27%	20%
Total	**100%**	**100%**	**100%**	**100%**	**100%**
2011 car sales as a % of current fleet by age group	**42%**	**32%**	**26%**	**35%**	**33%**

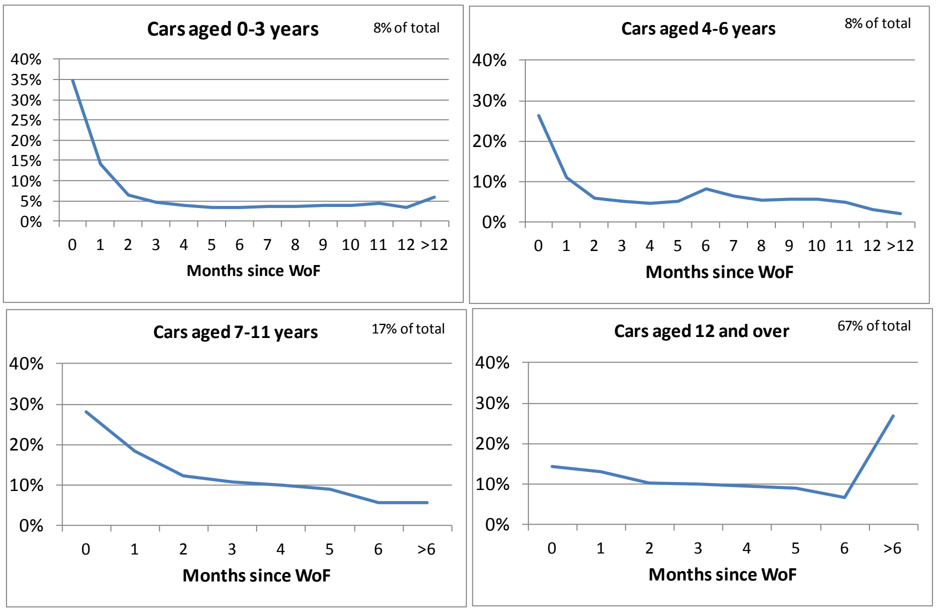
The effect of fleet turnover can impact on *de facto* (or actual if the level of compliance improves) WOF inspection frequency. Using the distribution of change of ownership by the number of valid months remaining on existing WoF, we can adjust the safety effects accordingly.

Some buyers would carry out pre-purchase inspections irrespective of the WoF status and have any defects remedied before taking possession. When the inspection frequency reduced, buyers are less likely to rely on the WoF status and therefore more buyers will carry out pre-purchase inspections or demand a new WoF to be issued. The safety effects estimated in section 4 will need to be adjusted for effects from any changes in propensity to obtain pre-purchase inspection or a new WoF.

The key assumptions required to carry out this analysis include the following:

- the increase in the proportion of vehicles with a WoF older than one month and vehicles without a current WoF to receive a pre-purchase inspection or a new WoF when the inspection frequency is reduced
- pre-purchase inspection will achieve similar effects of a WoF inspection and that vehicles will be restored to WoF standard before the buyer takes possession
- not many vehicles are being sold more than once within a year (if many vehicles are being sold more than once within a year, this analysis will overestimate the positive effects of change of ownership)

Figure 6: Distribution of cars sales by number of months since WoF



The analysis can be summarised briefly as follow:

- Using the distribution of change of ownership by the number of valid months remaining on existing WoF, we estimate the weighted average weeks since WoF for vehicles being sold at point of sale.
- For vehicles that would receive a pre-purchase inspection or a new WOF, the *de facto* or actual weeks since WoF will be re-set at the point of the inspection. This will give us the adjusted maximum number of weeks since WoF (relative to status quo).
- Based on the distribution of vehicles by WoF status, we can obtain the weighted average maximum number of weeks since WoF under the new scenario.
- Obtain the scaling factors by comparing the original maximum number of weeks since WoF with the adjusted estimate.

Results show that changes in propensity to obtain pre-purchase inspection (or a new WoF) will reduce the *de facto* maximum number of weeks since WoF. In other words, the vehicles in the fleet will be slightly safer than the previous fleet and such improvement is equivalent to moving the maximum number of weeks since WoF backward by 2-3 weeks. This represents a 7 percent reduction in the estimated increase in risk (Table 9). Although the estimate is slightly higher for older vehicle, given the uncertainty around the proportion of vehicles would choose to pre-inspect their vehicles (and a larger proportion would be sold for parts), we recommend a constant 7 percent adjustment for all age groups (in other words, the safety estimates obtained from the regression analysis should be multiplied by 0.93).

Table 9: Scaling factors for adjusting the effects of changes in pre-purchase inspection habits resulting from changes in inspection frequency

	Status quo	Scenario 1	Scenario 2	Scenario 3
% increase in pre-purchase inspection relative to Status Quo				
WoF 1 month and older		**35%**	**50%**	**75%**
No WoF		**35%**	**50%**	**75%**
Weighted average weeks since WoF or *de facto* WoF (based on current inspection frequency)				
0-3 years	52	49.5	49	48.2
4-6 years	52	50.1	49.4	48.3
7-11 years	26	25.2	25.1	24.8
12 years and over	26	23.7	23.8	23.9
Scaling factors				
0-3 years		0.95	0.94	0.93
4-6 years		0.96	0.95	0.93
7-11 years		0.97	0.96	0.95
12 years and over		0.91	0.91	0.92
All age groups		0.931	0.930	0.928

6.1.2 Option 4

For option 4, a WoF is compulsory at change of ownership. Therefore, the analysis in 6.1.1 does not apply. In this case, we only need to estimate the de facto WoF frequency. In this case, we assume there is a system in place to ensure 100 percent compliance (eg the change of ownership process cannot be completed without a new WoF).

According to the data for 2011, on average, vehicles that are 6 years or under change hands every 2 years, whereas vehicles over 6 years change hands every 3 years.

6.2 Effects of voluntary safety checks with vehicle servicing

With a less frequent inspection regime, safety conscious car owners could continue to get their vehicles inspected and repaired during the period when a WoF is not required. This means the above analysis can over-state the potential negative impacts of inspection frequency on road safety. An adjustment to the results obtained in section 4 can be made pro-rated to the proportion of car owners who would carry out voluntary safety checks.

For the effects from vehicle servicing, we have utilised the distribution of *laissez faire* servicing frequency and the probability distribution of safety checks uptake with servicing to estimate (i) the *de facto* frequency and (ii) the new re-set level of safety.

The analysis assumes the probability distribution of safety checks uptake follows a triangular distribution with a minimum of 20 percent, mode of 80 percent and maximum of 100 percent. This gives a weighted average of 69 percent to carry out various levels of safety checks. Based on the distribution of vehicle kilometre travelled by year of manufacture and the proportion and level of vehicle servicing lateness (based on MTA 2011 survey results), we stimated that the average servicing frequency is between 0.9 year and 1.44 years (Table 10).

Table 10: Estimated servicing frequency by vehicle age group

Vehicle age group	Weighted average number of years between vehicle services	Estimated reduction in area A (for those that carry out voluntary safety checks with vehicle servicing)
Under 3 years	0.9	74%
3-5 years	1.12	73%
6-12 years	1.30	72%
13 years & over	1.44	72%

To adjust for the safety effects, a triangular probability distribution has also been used to estimate the average safety outcomes relative to WoF inspections. Since a small number of car owners would be willing to pay for extensive safety checks, in this case the maximum is 120 percent (ie achieving 120 percent of WoF equivalence outcomes). This gives a weighted average safety effect of 75 percent (of WoF equivalence). Applying the current initial failure rate and an assumed 85 percent of those failed would do the repairs, it is estimated that area A will reduce by between 72 and 74 percent (Table 10). These percentages apply to the proportion that would obtain voluntary safety checks during vehicle servicing and subsequently get the vehicle repaired (if defects are detected).

7. Social cost estimates

7.1 Estimating the number of crashes by severity type

To disaggregate the estimated increase in the number of crashes by crash severity, we utilise the distribution for crashes with WoF-related safety defects for the three years to 2011 (Table 11):

Table 11: Distribution of WoF related injury crashes by severity – cars and vans

	Share of crashes with WoF-related safety defects
Fatal	7%
Serious	16%
Minor	77%

NB: The above proportions are based on all vehicle age groups.

7.2 Converting crash numbers into social cost of road injury crashes

Estimates of average social cost per reported crash by severity (at June 2011 prices) are summarised in Table 12. These estimates include an allowance for cases that were not attended by Police.

Table 12: Average social cost per reported crash

Crash type	Average social cost per reported crash, $m June 2011 prices
F	4.322
S	0.749
M	0.080

7.3 Effect of road trauma trend on predicted safety impacts

Considering the road toll trend since 2011, we assume we will achieve a similar proportional reduction to what we did in the 1990s and get down to 240 deaths by 2020 (it was 284 in 2011). This gives an annual reduction in road toll of around 1.9 percent (Table 13). As good policy interventions start to exhaust, it will get increasingly difficult to reduce road toll at the same rate over time. Therefore, we have assumed the rate of reduction will reduce by half every ten years. Historical data also shows that the rate of decline in injury crash risk has not reduced at the same rate as that for fatal crashes. For the purposes of the analysis, we assume they are half of those applied to fatal crashes.

Note that the road trauma trend includes the effects of vehicle technology improvements. The uptake of such technologies by the imported fleet will get filtered through to the vehicle fleet over time.

Table 13: Road trauma trends to 2042/43

	Road toll (fatal crash) trend	Non-fatal crash trend
2012/13-2020/21	-1.91% p.a.	-0.95% p.a.
2021/22-2030/31	-0.95% p.a.	-0.48% p.a.
2031/32-2042/43	-0.48% p.a.	-0.24% p.a.

8. Summary of results and sensitivity analysis

8.1 Summary of results

Table 14 summarises the potential safety impacts from changing the WoF inspection frequency for light passenger vehicles. Table 15 summarises the potential safety impacts after adjusting for the effects from voluntary safety checks with vehicle servicing. These estimates include the effects from change of ownership inspection and include all injuries recorded in traffic crash report, hospital and ACC databases.

The number of non-injury crashes are estimated using the standard ratio between reported minor injury crashes to non-injury crashes and are estimated at between 10 and 13 percent of the social cost of injury crashes.

Table 14: Estimated annual safety impacts (base estimate)

	Estimated increase in the number of reported crashes p.a.			Estimated increase in annual social cost, $m 2011 prices		
	Fatal	Serious	Minor	$m (including non-injury crashes)	% increase in total SC $m	% increase in SC $m of at-fault crashes with WOF-related safety defects
Option 1	0.7	1.6	7.7	$5.4	0.1%	6.5%
Option 2	2.3	5.0	24.7	$17.4	0.4%	21.2%
Option 3	2.8	6.1	30.1	$21.2	0.5%	25.8%
Option 4	12.1	26.0	128.7	$91.0	2.3%	110.8%

Note: This table includes effects from change of ownership inspections. The social cost estimates have been adjusted to include all injuries recorded in traffic crash report, hospital and ACC databases.

The estimated increase in annual total social cost of road crashes for option 4 is the highest. This is because the entire WOF vehicle fleet would be affected, and because the average inspection frequency for vehicles over six years of age would be three years — one sixth of the current six-monthly frequency

Figure 7 shows the estimated increase in the social cost of road crashes (including non-injury crashes) to 2042/43. The estimated increased in the total social cost of road crashes to 2042/43 in present value are tabulated in Table 16. These estimates include the effects from voluntary safety checks with vehicle servicing.

Table 15: Annual safety impacts after adjusting for effects from voluntary safety checks

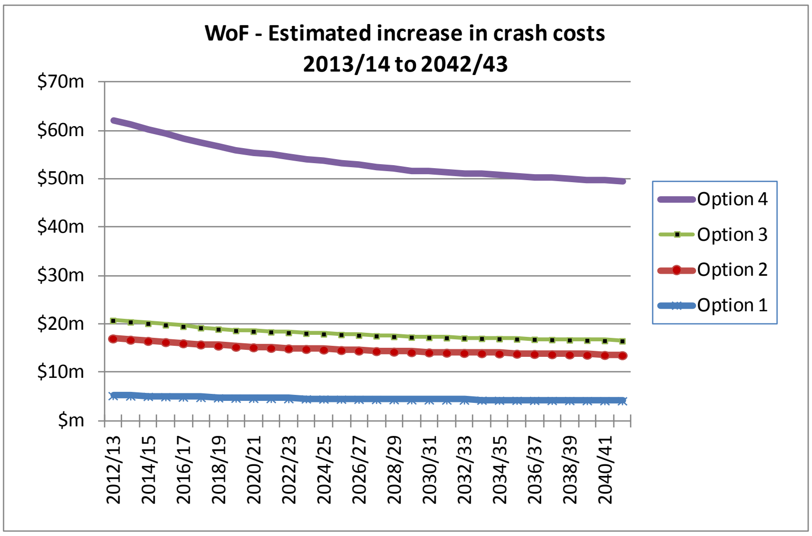
	Estimated increase in the number of reported crashes p.a.			Estimated increase in annual social cost, $m 2011 prices		
	Fatal	Serious	Minor	$m (including non-injury crashes)	% increase in total SC $m	% increase in SC $m of at-fault crashes with WOF-related safety defects
Option 1	0.7	1.6	7.7	$ 5.4	0.1%	6.5%
Option 2	2.3	5.0	24.7	$ 17.4	0.4%	21.2%
Option 3	2.8	6.1	30.1	$ 21.2	0.5%	25.8%
Option 4	8.4	17.9	88.5	$ 62.9	1.6%	76.6%

Note: This table includes effects from change of ownership inspections and voluntary safety checks with vehicle servicing. The social cost estimates have been adjusted to include all injuries recorded in traffic crash report, hospital and ACC databases.

Table 16: Estimated increase in the social cost of road crashes to 2042/43 (in present values)

	Option 1	Option 2	Option 3	Option 4
Estimated total increase in social cost of road crashes to 2042/43, in present value terms	$54 million	$174 million	$212 million	$630 million

Figure 7: Estimated increase in the social cost of road crashes (in nominal terms)



8.2 Sensitivity Analysis

Sensitivity analysis has been carried out on the following:

- the lower and upper limits of the slope of the risk line using the 95% confidence interval estimates obtained from the regression analysis
- an adjustment for under-recording of vehicle defects in crash reports (scaling factors of 1.05 and 1.3)

Results (Table 17) show that the safety impact can range from $3 million to $8 million for option 1, $7 million to $28 million for option 2, $8 million to $35 million for option 3 and $26 million to $100 million for option 4. These estimates represent an increase in the percent of the annual total social cost of road crashes from 0.13 to 0.21 percent for option 1, 0.2 to 0.7 percent for option 2, 0.2 to 0.9 percent for option 3 and 0.6 to 2.5 percent for option 4.

Table 17: Sensitivity analysis of safety impacts

	Estimated increase in total annual social cost of road crashes, $m			
	Option 1	Option 2	Option 3	Option 4
Original estimates (from Table 15)	$5.4	$17.4	$21.2	$62.9
Slope of the risk line:				
95% lower limit coefficient estimates	$3.1	$6.9	$8.2	$25.6
95% upper limit coefficient estimates	$8.2	$27.9	$34.5	$100.5
Under-recording of WoF related factors:				
Low: adjustment factor for non-fatal crashes = 1.05	$5.5	$17.8	$21.6	$64.3
High: adjustment factor for non-fatal crashes = 1.3	$6.1	$19.6	$23.9	$70.9
	Estimated percentage increase in total annual social cost of road crashes, $m			
Original estimate (from Table 15)	0.13%	0.4%	0.5%	1.6%
Slope of the risk line:				
95% lower limit coefficient estimates	0.08%	0.2%	0.2%	0.6%
95% upper limit coefficient estimates	0.21%	0.7%	0.9%	2.5%
Under-recording of WoF related factors:				
Low: adjustment factor for non-fatal crashes = 1.05	0.14%	0.4%	0.5%	1.6%
High: adjustment factor for non-fatal crashes = 1.3	0.15%	0.5%	0.6%	1.8%
	Estimated percentage increase in social cost of at-fault road crashes with WoF-related factors, $m			
Original estimate (from Table 15)	6.5%	21.2%	25.8%	76.7%
Slope of the risk line:				
95% lower limit coefficient estimates	3.8%	8.4%	10.0%	31.1%
95% upper limit coefficient estimates	10.0%	33.9%	42.0%	121.8%
Under-recording of WoF related factors:				
Low: adjustment factor for non-fatal crashes = 1.05	6.7%	21.7%	26.3%	78.3%
High: adjustment factor for non-fatal crashes = 1.3	7.4%	23.9%	29.1%	86.4%

7.2. Warrant of Fitness fail rates report

Report

nzier
authoritative analysis

Warrant of Fitness fail rates

Exploration of the variation amongst testing agents

NZIER report to Ministry of Transport

14 August 2012

About NZIER

NZIER is a specialist consulting firm that uses applied economic research and analysis to provide a wide range of strategic advice to clients in the public and private sectors, throughout New Zealand and Australia, and further afield.

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NZIER was established in 1958.

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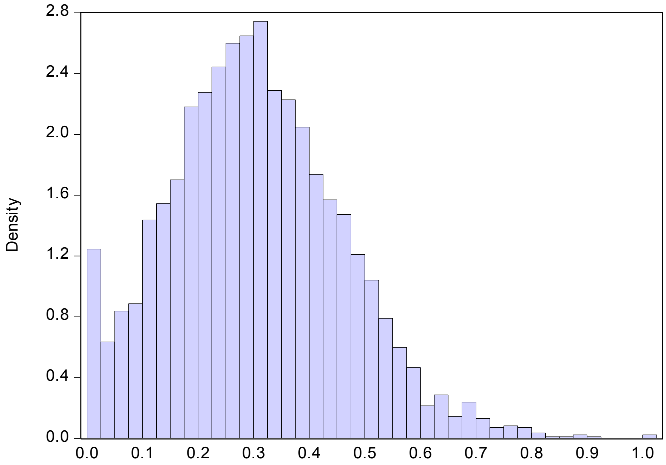
Summary

This report discusses reasons for the wide variation in Warrant of Fitness (WoF) fail rates across testing agents.

Initial analysis has shown that divergence in fail rates across testing agents is significant. We pick apart possible reasons for this divergence by looking at differences in characteristics amongst testing agents and the kinds of vehicles they test.

Figure 1 Distribution of fail rates by testing agent[1]

2011, fail rates on bottom axis



Source: NZIER

The key insights from the analysis are that:

- the data supports a hypothesis that there are two distinct business models operating in the WoF testing market:
  - the compliance based models where profits are earned on throughputs and WoF is the principle service provided and
  - the maintenance market where WoF is an adjunct service to the principle profit-making enterprise
- distinct business models can go a long way to explaining differences in fail rate between TSDAs and non-TSDAs, but
- there is evidence of strategic behaviour in the market, especially over-serve, because high fail rates (e.g. over ~45%), cannot be explained by variation in agent characteristics and differences in the kinds of vehicles they test.

This analysis is exploratory. It should be used to further develop and refine questions about how the WoF market works and why we see the kinds of fail rates we do.

1 Data shown here and used throughout this report is for all 3340 testing agents who tested cars for WoFs during 2011. The full data set covers over 5.3 million tests at an average of 1500 tests per agent. All fail rate analysis in this report is conducted on the 3.7 million tests which are first tests rather than re-checks.

Sources of variation

High level reasons for variation can be divided into four sources:

- local differences in condition of vehicles (whether old or young, well-maintained or poorly-maintained)
- business models e.g. firms choose whether to focus on
  - generating revenue from testing activities and therefore customers whose main interest is in complying with regulations and who have a reasonably low expectation of their vehicle requiring repair services i.e. a **compliance market**
  - generating revenue from maintenance services and bundling WoF testing with other services for customers who want or need repair and maintenance services i.e. a **maintenance market**
- strategic behaviour e.g.
  - passing vehicles to secure or grow market share, hereafter referred to as ***under-serve***
  - failing vehicles to gain or avoid losing repair work, hereafter referred to as ***over-serve***
- random differences.

Note that what the term strategic behaviour is used to describe systematic errors as well as potentially deliberate attempts to under or over-serve.

These sources of variation can be expected to be seen in the data. The most obvious example is testing agents operating in areas with better maintained or newer vehicles are likely to have lower fail rates on average and potentially lower variation in fail rates compared to the population as a whole.

Similarly, we should expect that different market segments, caused by different business models in conjunction with tendencies to over serve or under serve, should result in observable differences in both average fail rates and variation in fail rates. Likely features of such WoF market segments are described in Table 1.

Table 1 Hypothesised features of WoF market segments

	Compliance market	Maintenance market
Under-serve	High volume, younger vehicles on average, below average fail rate with narrower than average within group variation.	Low volume, older vehicles vehicle on average, below average fail rate with narrower than average within group variation.
Over-serve	Very low volume (if any), fail rate above average, wide within group variation.	Low volume, *slightly* older vehicles on average, above average fail rate with wider than average within group variation.

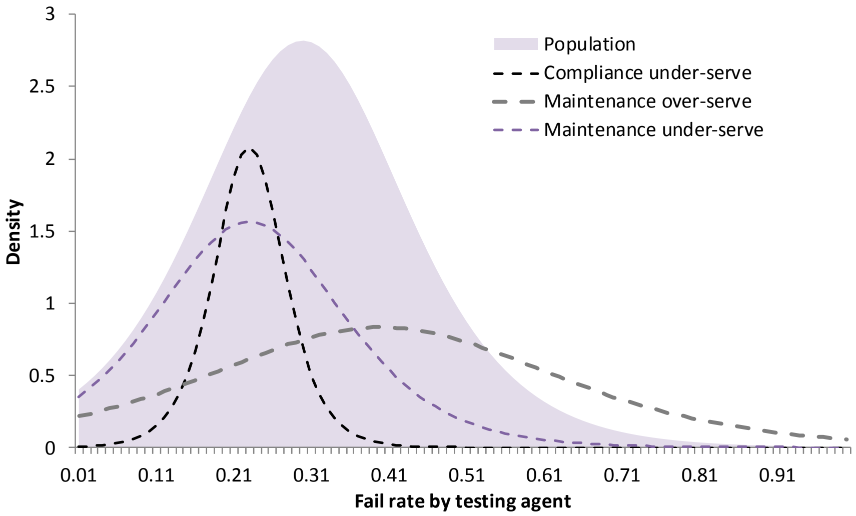
Source: NZIER

Figure 2 shows how these sub-markets, with their different characteristic distributions of fail rates, can in theory combine to form what we observe in overall market fail rates.

The distributions in Figure 2 are theoretical distributions and therefore only illustrative, however they have been constructed using theoretical distributions fitted to the actual data on fail rates.

Figure 2 Illustrative sub-markets and fail rates

By testing agent



Source: NZIER

TSDAs and non-TSDAs

The maintenance and compliance markets might, in principle, be distinguished by whether a testing agent is an independent Transport Service Delivery Agent (TSDA) or not. TSDAs specialise in testing and do not provide repair services.

We would expect TSDAs to have lower fail rates than non-TSDAs, because customers with vehicles that are more likely to be faulty would self-select to firms offering repair services. Indeed this is what we see in see Figure 3 – a lower average fail rate at TSDAs than at other outlets.

Different fail rates may reflect different markets

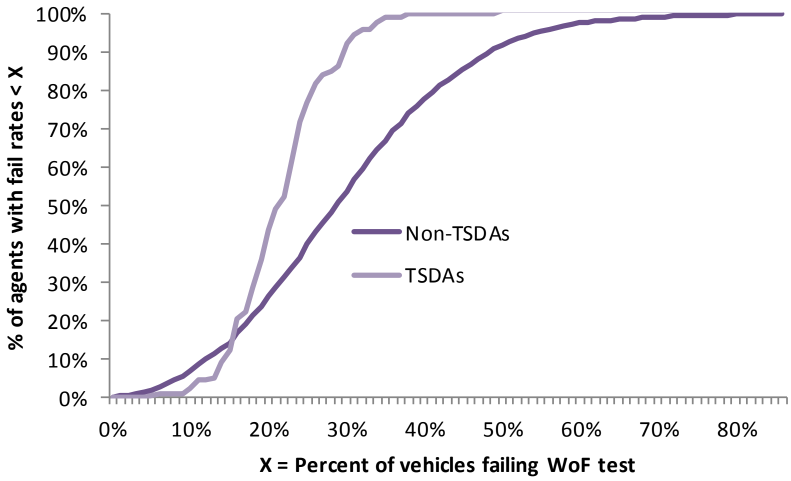
A simple model of fail rates shows that differences between TSDA and non-TSDA fail rates could be due to different markets for WoF tests, with TSDAs serving a compliance market and non-TSDAs serving both compliance and maintenance markets.

It is not possible to directly observe underlying distributions of fail rates within compliance and maintenance markets but, as shown in Figure 4, it is feasible that the observed range of fail rates across non-TSDA agents could come from two underlying distributions of fail rates which reflect two different markets.

There are two underlying theoretical distributions shown in Figure 4. One assumes that the compliance market has fail rates which are the same as for TSDAs ("compliance market – theoretical"). The second assumes that fail rates are distributed with a higher average fail rate of 0.4 (40%) and a variation (variance) which is half way between what we observe for fail rates amongst non-TSDAs overall and what we observe for TSDAs.[2]

Figure 3 Distribution of fail rates by TSDA and non-TSDA

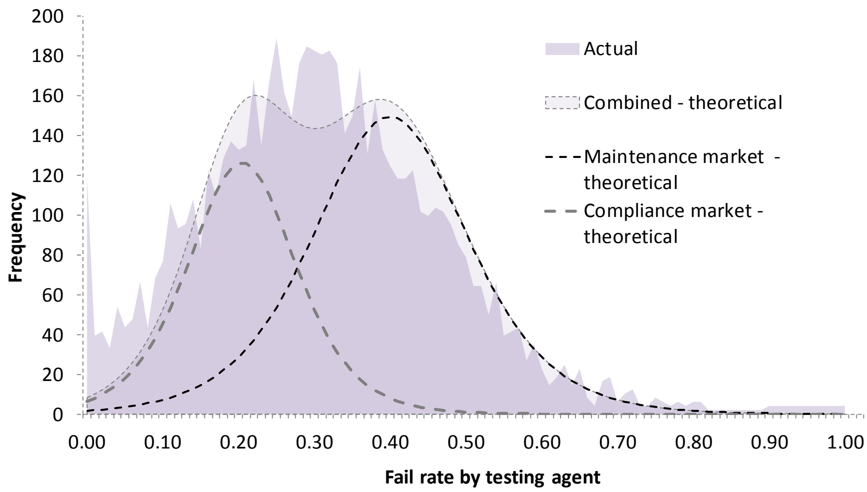
For 130 TSDAs and 3210 non-TSDAs. Calendar year 2011.



Source: NZIER

The two hypothetical distributions come reasonably close to describing the actual data we observe. It is probable that other distributions would fit the data better and this could be further explored. However, the main reason for our analysis here is to demonstrate the feasibility of separate markets causing differences in fail rates across TSDAs and non-TSDAs.

Figure 4 Non-TSDA fail rates and sub-markets



[2] For this illustrative analysis we have fitted fail rate distributions to actual data using a logistic probability density function.

Source: NZIER

The value we have used for the average fail rate in the maintenance market (0.4) comes from an analytical model of fail rates which finds possible combinations of maintenance market fail rates and the (unobserved) share of non-TSDA business which is the maintenance market (*s_r*) which could explain the overall non-TSDA fail rate and the overall (TSDA plus non-TSDA) fail rate.

Our analytical model of fail rates and market shares is:

$$f_t = c$$
$$f_n = s_c.c + (1 - s_c).m$$
$$f_{mkt} = s_t.f_t + s_n.f_n$$

Where *f* denotes fail rates for TSDAs, non-TSDAs, and the overall market (subscripts *t*, *n*, and *mkt* respectively). Sub-market specific fail rates are *c* in the compliance market and *m* in the maintenance market. Market shares are labelled *s*.

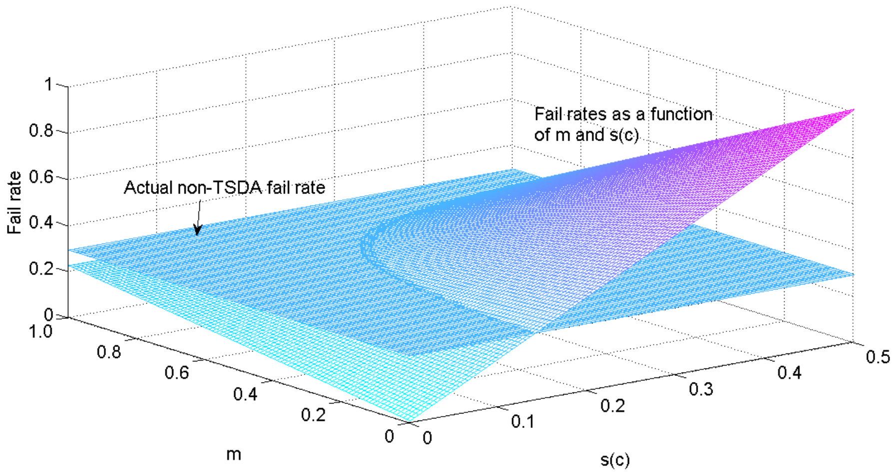
In this model there are only two entirely unknown values: compliance market share for non-TSDAs (s_c) and maintenance market fail rates (*m*).[3] The other values can be observed from the data. This provides use with adding up constraints and reduces the model to:

$$17.8.s_c + 0.83.(1 - s_c).m - 23.1 = 0$$

We then find values of s_c and *m* which can solve this equation.[4] This gives a reasonably wide range of possible combinations of values for both numbers – shown in the intersection of the two planes in Figure 5.

Figure 5 Feasible sub-market parameters

Given observed market share and fail rate data



Source: NZIER

3 Strictly speaking *c* may not be the same for TSDAs and non-TSDAs but we assume it is for the sake of this analysis. The reason we do this is that the goal is to test the feasibility of solutions with non-TSDAs serving a sub-market that has precisely the same attributes as the market served by TSDAs (which is observed directly in the data).

4 Some obvious constraints are imposed (i.e. $s \in [0,1]$).

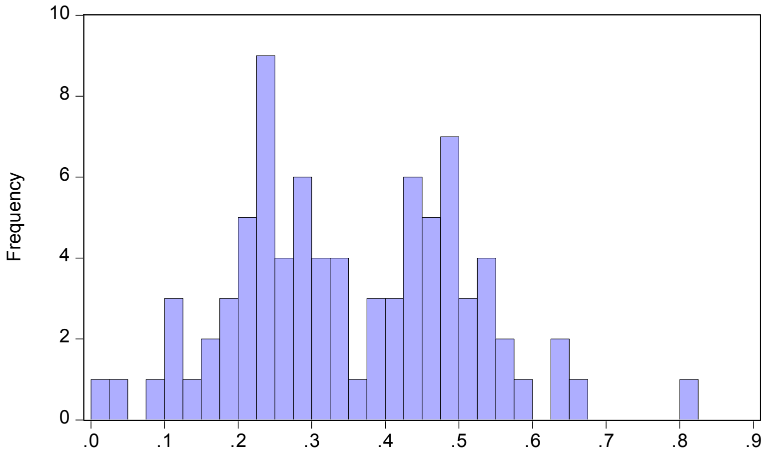
The average or peak in the combined distribution (*Combined – theoretical* in Figure 4) is different to what we observe in the data. However the actual data will include some randomness not captured in our theoretical distributions. The key question is whether or not the data could have actually come from these hypothetical distributions, and it probably could.

Note that the existence of two peaks in the theoretical *combined* distribution in Figure 4 reflects our particular assumptions about the variance in each of the sub-markets as well as the market share we have posited for the maintenance market - 63% of non-TSDA operators and 50% of the overall WoF market. A smaller market share or different variation has the ability to remove these peaks.

The possibility of two peaks in the distribution of fail rates has some empirical precedent. Fail rates in Dunedin City (and Otago more generally), for example, following a "bi-modal or twin-peaked distribution. [5]

Figure 6 Dunedin City WoF fail rates

Distribution across agents



Source: NZIER

This illustrative analysis is quite simplistic in so far as it only seeks to test feasible averages but have not considered (analytically) what reasonable variance values might be.[6] However it does demonstrate the extent to which multiple markets is arithmetically as a well as intuitively reasonable.

Note that this says nothing about the existence or otherwise of over-serve and under-serve – which may still exist in these multiple markets.

5 This is consistent with a hypothesis that the maintenance market is a reasonably large share of WoF testing market in Dunedin because of the number of students in the population who likely to have vehicles of relatively low quality.

6 The analysis could be improved upon with further econometric analysis (specifically a full-blown Bayesian econometric analysis).

There is evidence of a material "selection" bias[7]

Another approach to identifying the existence of different market segments is to consider the kinds of faults observed in vehicles which fail WoFs and to see if there is any systematic variation in the kinds of faults found.

In principle, we would expect that agents serving the repair market would test vehicles with visible faults because owners would be aware of a higher likelihood that their vehicles will fail a WoF and need repair and therefore they will self-select to repair agent.

The visibility of vehicle faults does indeed raise the probability that a vehicle is tested by a non-TSDA. This assessment is based on a model of the probability that a vehicle which fails a WoF and has a visible fault has been tested by a TSDA or a non-TSDA.[8]

Our measure of fault visibility is based on a subjective assessment of visibility on a scale of 1 to 5 (see Table 2). Visibility of faults enters the model as the maximum score per failed test (VISIBL_MAX_ALT).

Table 2 Fault visibility scores

5 = Highly visible

Fault category	Score
Brakes	2.7
Exhaust	2.7
Windows	4.7
Lights	3.8
Mirrors	4.5
Other	3.2
Seatbelts	2.9
Speedo	3.3
Structural	1.6
Steering	2.5
Tyres	3.6

Source: MoT, NZIER

Model results are shown in Figure 7. This model provides good evidence for rejecting our third hypothesis i.e. that:

(3) non-TSDAs do not see a disproportionate number of vehicles with observable faults.

The model does not provide a good basis for quantifying the effect of fault visibility. The overall explanatory power of this model is poor and, unlike the fail rates model, the marginal effects of the model are sensitive to model specification. Further analysis would

7 Results shown here are updates from earlier analysis. The earlier analysis used an assumed scoring regime determined based on the views of two officials. This analysis uses a scoring regime based on the combined opinions of 7 industry stakeholders. The updated regime has improved the fit of the model and enabled estimation of the marginal effects of fault "noticeability".

8 The term *visibility* is used in very general terms to mean whether or not a fault is noticeable.

be needed to scope the size of the effect of fault visibility on whether or not vehicles are tested at TSDAs.

Figure 7 Model results: fault visibility

Dependent Variable: TSDA
Method: ML - Binary Extreme Value (Quadratic hill climbing)
Sample: 1 723822 IF FAIL_FLAG=1
Included observations: 281880
Convergence achieved after 12 iterations
Covariance matrix computed using second derivatives

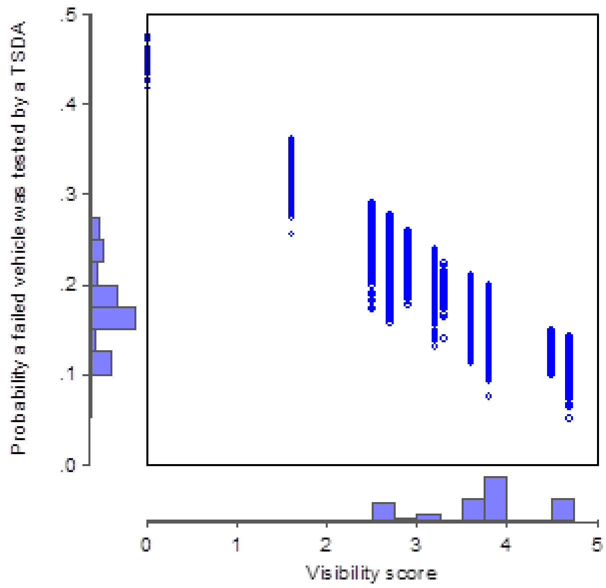
Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-7.646036	0.874791	-8.740419	0.0000
VISIBL_MAX_ALT	-0.210036	0.003611	-58.16893	0.0000
YR	0.003959	0.000437	9.050738	0.0000
ODO	-2.64E-07	3.39E-08	-7.794559	0.0000

McFadden R-squared	0.014014	Mean dependent var	0.176426
S.D. dependent var	0.381183	S.E. of regression	0.378677
Akaike info criterion	0.918831	Sum squared resid	40420.02
Schwarz criterion	0.918981	Log likelihood	-129496.0
Hannan-Quinn criter.	0.918874	Deviance	258992.1
Restr. deviance	262673.1	Restr. log likelihood	-131336.6
LR statistic	3681.084	Avg. log likelihood	-0.459401
Prob(LR statistic)	0.000000		
Obs with Dep=0	232149	Total obs	281880
Obs with Dep=1	49731		

Source: NZIER

Figure 8 Marginal effects of fault visibility

Change in probability of vehicle being tested by a TSDA



Source: NZIER

In addition, testing for the effects of fault visibility on the selection of testing agent is confounded by the fact that the fault visibility measure we use is declared by the agent and is contingent on a vehicle failing a WoF. This "identification" problem has not been controlled for in this exploratory analysis. Definitive empirical analysis would need to tackle this issue.

Furthermore, the large degree of variation amongst testing agents is likely to be confounding this kind this analysis.

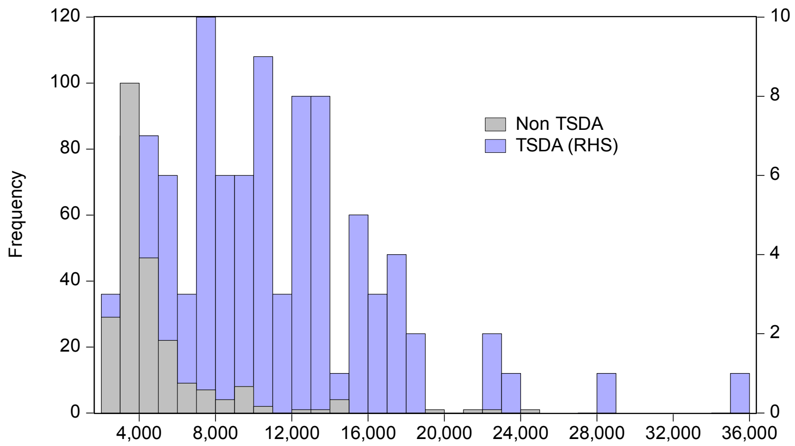
But selection bias cannot fully explain differences

It is apparent that TSDAs are only a small proportion of the high volume market which we hypothesise as the compliance market.

Moreover, it is questionable whether people with a vehicle with noticeable faults would send that vehicle to a repair agent so that it could be failed on a first test and subsequently repaired.

Figure 9 High volume testing agents (TSDA vs. Non)

Volume of tests (x axis) and number of agents within top decile by transactions

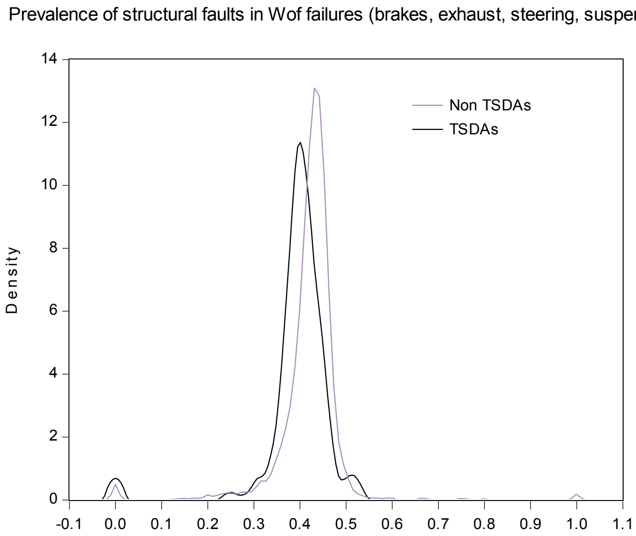


Source: NZIER

And what appears selection bias may be under-serve

There is a material (statistically significant) difference between the kinds of faults found by TSDAs and non-TSDAs. TSDAs appear less likely to find structural, as opposed to cosmetic, faults.

Figure 10 Proportion of faults which reflect structural issues



Source: NZIER

Under- and over-serve

This all suggests that more analysis is required of the variation within testing agents and especially within non-TSDA testing agents to determine whether wide variations in fail rates across agents can be explained in terms of market fundamentals which account for both these different business models as well as the kinds of vehicles and local markets served by different testing agents – variation which may well explain the overall variation in fail rates.

We have explored these issues using a model to predict agent-level fail rates which takes accounts of:

- odometer (ODO) readings i.e.
  - the average odometer reading for vehicles tested at each agent
  - as an indication of whether an agent tests vehicles with above average probability of failure
- TSDA status (TSDA_FLAG)
  - to control for the fact that these are by definition compliance market operators and so should have a lower average fail rate than a typical non-TSDA operator
- Market share (MKT_SHR) i.e.
  - tests performed as a share of total tests in the agents resident TLA
  - as a proxy for (non-TSDA) operators who are pursuing a compliance market business model
- Average local household income (INC)[9]
  - defined at the TLA level, helps to control for geographical differences

[9] The data used here is from the 2006 census but despite being somewhat out of date it still helps to control for geographical "fixed effects".

- partially controls for the fact that the probability of a vehicle failing a WoF will depend on both vehicle wear (ODO) and any offsetting maintenance expenditure – which will be some function of income.

The model results are shown in Figure 11. This shows the standard statistical results of a model of this kind, however the marginal effects of each of the explanatory variables cannot be read directly from the model results because they are subject to a functional transformation. Marginal effects are shown in Table 3. This shows, for example, that a 1% increase in average ODO reading is associated with 0.17 increase in fail rate. Note that this and other effects shown in Table 3 are evaluated at the average fail rate and they vary by agent characteristic (see e.g. Figure 12).

Figure 11 Agent fail rate prediction model

First decile of agents by volume excluded (0.7% of all tests)

Dependent Variable: FAIL_RATE
Method: Generalized Linear Model (Quadratic Hill Climbing)
Sample: 1 37 39 3340 IF TESTS>249
Included observations: 3005
Family: Binomial Proportion (trials = 1)
Link: Logit
Dispersion fixed at 1
Coefficient covariance computed using the Huber-White method with
observed Hessian
Convergence achieved after 6 iterations

Variable	Coefficient	Std. Error	z-Statistic	Prob.
LOG(ODO)	0.827340	0.042650	19.39829	0.0000
TSDA_FLAG	-0.425059	0.047445	-8.958961	0.0000
LOG(MKT_SHR)	-0.044574	0.005043	-8.839241	0.0000
LOG(INC)	-1.075918	0.051131	-21.04240	0.0000

Mean dependent var	0.309557	S.D. dependent var	0.146558
Sum squared resid	56.46904	Log likelihood	-1277.796
Akaike info criterion	0.853109	Schwarz criterion	0.861106
Hannan-Quinn criter.	0.855985	Deviance	280.0183
Deviance statistic	0.093308	Pearson SSR	264.1315
Pearson statistic	0.088014	Dispersion	1.000000

Source: NZIER

The model does a reasonably good job of describing the typical fail rates we see in the data. In particular it predicts higher fail rates at non-TSDAs compared to TSDAs.

The inability of the model to describe observed variation in fail rates means that the model must be missing important explanatory factors and therefore many of the specific values or effects found by the model cannot be taken at face value. However, this imprecision is useful in pointing out that fail rate variation cannot be easily explained. Something irregular seems to be going on.

The model cannot explain the tails of the distribution i.e. testing agents who fail a much larger or much smaller proportion of vehicles than on average. This can be seen in Figure 13.

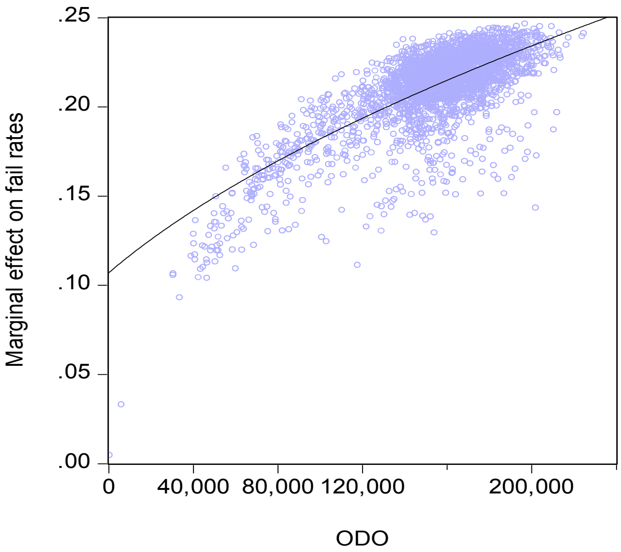
Table 3 Modelled effects on agent-level fail rates

Average change in fail rates from % change in predictors

	Non-TSDA	TSDA	Overall
Average ODO reading	0.176	0.137	0.175
Market share	0.0033	0.0026	0.0033
TSDA	na	na	-0.074
Income	-0.0036	-0.0028	-0.0036

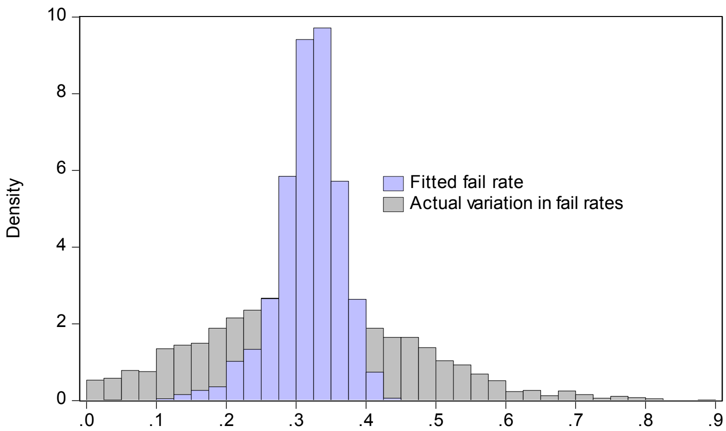
Source: NZIER

Figure 12 Marginal effects of ODO on fail rates



Source: NZIER

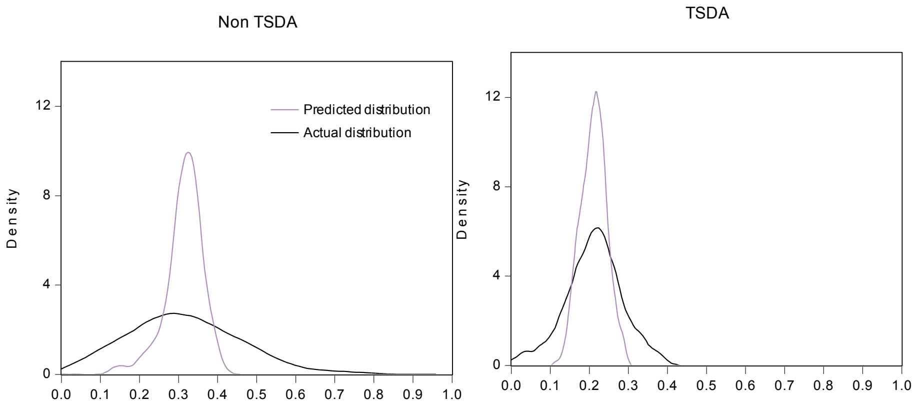
Figure 13 Predicted fail rates (model fitted)



Source: NZIER

Further investigation of the model fit shows that the variation in agent characteristics (i.e. the factors captured in the model) explains a lot of the variation in fail rates for high volume testing operations (the top decile of agents by throughput) but is poor at explaining the very wide variations in fail rates that exist amongst testing agents with lower throughput. This is suggestive of strategic behaviour.

Figure 14 Fitted fail rate distributions for TSDAs and non TSDAs



Source: NZIER

For example, testing agents which fail 45% or more of the vehicles they test cannot be explained by the model – 44% is the highest fail rate predicted by the model. Yet a reasonably large number of agents do indeed fail 45% or more of the vehicles they test: 557 agents (17% of agents) who tested 688,000 vehicles (13% of tests).

7.3. Table of assumptions of charges and compliance costs in cost-benefit model for WOF

Type of effect	Current value	Factors and assumptions to consider	Data sources	Typical low; median; high (minutes)
Total time for each WOF inspection (1st attempt)	1 hour	How long does it take? Include time out of the way prior and after inspection. TSDA TAG members to indicated that inspection volumes on Saturday are not different to weekdays. Garages are not expected to be open on a Saturday on as widespread a basis as VTNZ. Although industry-supplied estimates of 32 minutes for the inspection itself, there are no standardised estimates of the total time that owners are impacted by. The approach taken is to assume a broadly plausible duration and to apply a broad range of alternative assumptions in the sensitivity analysis.	Consultation with industry experts. VTNZ advise 32 minutes for inspection alone	30 min; 60 min; 75 min
Total time for each WOF recheck	0 hours	Ignore for ‘necessary repairs’ on the basis that: a) the policy to require vehicles to be at WOF standard at all times on the road is assumed to not change b) society’s overall gains are at least as much, if the standards are appropriately set Different assumption required for ‘unnecessary repairs’.	VTNZ advise 15 min for recheck Judgement made by VLR team	

Type of effect	Current value	Factors and assumptions to consider	Data sources	Typical low; median; high (minutes)
Value of consumers' time used	$18.46 per hour	Are people forgoing work or leisure? Consider: • % of people that wait/pick-up/drop-off during normal business hours • % of people that are employed vs not working • include the opportunity cost of time for the vehicle itself A 40/60 work/leisure split is assumed, using values in the NZTA's Economic Evaluation Manual. This is in light of the bulk of inspections occurring during work time, and the majority of the light commercial fleet requiring WOFs (only taxis and lease fleets make up the bulk of COF-A). On the other hand, there are many that are not in the paid labour force, such as retired people and stay-at-home parents. (The labour force participation rate for ages 15+ was 68.4% in June 2012.) A wide range of sensitivity analysis is undertaken to account for the wider range of uncertainty on the work/leisure split.	The NZTA's prescribed values of work and leisure time savings VTNZ data shows 99% inspections between 8am–5pm, 6 days a week	$16.14; $18.46; $20.78 corresponds to work/leisure splits of 30/70; 40/60; 50/50 respectively
WOF repair $ (time, costs and charges)	$0	Ignore for 'necessary repairs' on the basis that: a) the policy to require vehicles to be at WOF standard at all times on the road is assumed to not change b) society's overall gains are at least as much if the standards are appropriately set Note the safety benefits from repairs is accounted for in the safety analysis module of the analysis.	2.08 million fails p.a. on 1st attempt 2009–2010 (NZTA data) Average estimated repair costs $210 ($145 in 1998 from MTA figures, 45% price inflation since).	

Type of effect	Current value	Factors and assumptions to consider	Data sources	Typical low; median; high (minutes)
Vehicle travel costs	3 km @ $0.256 = $0.77	• Average distance to travel to/from 1st inspection • 25.6 cents per km ($2011) travelled as per the NZTA's Economic Evaluation Manual (EEM) (cars, 50 kph) • Travel distance could range between 1km–5km on the most part, and some journeys might achieve multiple purposes – e.g. to and from work on the same day There has not been detailed analysis on the national average distance to travel to/from an inspection site. No survey has been undertaken. It has not been estimated from data on where people live and where inspection agents are located, as this is a substantial piece of work in its own right. Moreover, it would be complicated by the need to account for people preferring to drive further to a favoured inspection site, and the extent to which people combine other purposes and destinations with the overall journey.	Cost per km from NZTA's default guidance for transport appraisals There is an absence of data to help estimate the average distance travelled	2km ; 3km ; 5km
WOF (only) first inspection	$44	• Exclude GST, include NZTA admin charge TAG members did advise that standalone WOF tests can be advertised for as low as $25, and as such this is the minimum value used in the sensitivity testing of that assumption. There was scepticism amongst TAG members that such a fee would not represent the underlying economic resource cost of the inspection, in part because it could be related to higher incidences of 'overserving' to recoup the loss.	VTNZ survey April 2012: $46.32 MTA survey 2011: $42.56 Simple average taken, and rounded	$25, $44, $60

Type of effect	Current value	Factors and assumptions to consider	Data sources	Typical low; median; high (minutes)
WOF, when bundled with servicing	$25	The bundling of inspections and servicing is likely to affect average WOF inspection costs • Cost of WOF only (not the servicing) • Assume there are economies of scope when WOF is bundled with servicing. This may, or may not be, passed down to consumers. It is highly unlikely that there would be no economics of scope from bundling servicing (of a 10,000–15,000km variety) and inspection.		$15; $25; $35

7.4. New Zealand regulatory experience on over and under serving

One of the roles of the NZTA's Access and Use division is to oversee those that provide WOF and COF inspections. Between the period 2008 and 2010, NZTA staff operated a system called 'Mystery Shopper', where a car with 5–6 faults was provided to inspectors to check how well they were spotted. (The faults were relatively minor, such as misaligned headlights and an insecure seatbelt latch, rather than brake or steering faults.) Data from exercises such as Mystery Shopper are useful because they provide more than one expert's opinion on a particular alleged fault. Some of the key features are:

- 20% of the useable inspection data relate to TSDAs Vehicle Testing NZ (VTNZ), Vehicle Inspection NZ (VINZ), and the Automobile Association (AA), which is consistent with their market share
- all inspections should have failed the test car, but TSDAs and non-TSDAs both only failed it 72% of the time
- TSDAs identified about 42% of all faults, whereas non-TSDAs identified only 34% (the figures are lower than the 72% above because only one fault is necessary for a vehicle to fail)
- of 92 full inspections carried out, only three were recorded as failing for additional faults to the 5–6 known, and these three instances of possible 'overtreatment' were by TSDAs.

The results provide insight, but are not statistically significant because of the small size of the Mystery Shopper dataset and because of the possibly selective sampling approach used (given the work was for the purpose of auditing).

Some senior NZTA Access and Use staff that audit inspection agents were engaged as part of this work. They were of the view that, by and large, inspectors 'manufacturing work' does not generally happen. Moreover, the view of Access and Use staff is that, with the economic downturn inspectors may be more inclined to fail items that they might have let through a few years ago. They cautioned that this is not to say they are exceeding the criteria for failure; rather, they are adhering to them more closely to gain the subsequent work.

NZTA administer customer complaints about WOF and COF vehicle inspectors. There are about 350–400 such complaints annually. About 10% (35–40 annually) of the complaints NZTA receive relate to the vehicle inspector being allegedly overzealous,[85] and nearly all of these relate to garages rather than TSDAs. This type of complaint normally arises when the vehicle is rejected for a WOF and the presenter of the vehicle pays to obtain a second opinion from another inspecting organisation and a WOF is successfully issued. NZTA normally inspect the vehicle to determine which inspecting organisation was correct and take corrective action where required.

[85] Essentially all of the remaining 90% of complaints are in regard to vehicles that are below the required standard. Of these about 20% are against TSDAs and 80% are against garages, which is about what would be expected given the market shares of each. (NZTA advise that it is very rare for them to receive a complaint about a vehicle inspector being rude, swearing or unprofessional (or all three).)

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