A review of methods for analysis of regulatory effectiveness January 2017

T Denne and L Wright
Covec Ltd

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NZ Transport Agency
Private Bag 6995, Wellington 6141, New Zealand
Telephone 64 4 894 5400; facsimile 64 4 894 6100
research@nzta.govt.nz
www.nzta.govt.nz

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Background

This project aimed to develop a framework for assessing the effectiveness of regulatory interventions in the road transport sector. Specifically it sought to determine 'the best approach for determining and monitoring the contribution that government regulatory interventions in New Zealand make to mitigate the major risks associated with the land transport system'.

Regulation includes a broad range of government actions to influence behaviour, including legislation, rules, education and social norms.[1] Regulations of the transport system have developed over time and include those that address the safety of drivers and other road users, and those that reduce the environmental impacts of the transport system. It is useful to periodically examine the existing set of regulations to understand whether they are still justified and/or are the best way to tackle existing transport risks. This is especially so in the face of significant changes in technology and in the New Zealand population.

The New Zealand Government has an expectation that regulations are regularly checked to see if they are fit for purpose and there are processes to improve regulations, taking account of historical performance against objectives and emerging circumstances that might affect that performance. It has systems in place for ex-ante analysis of regulations but there is no systematic approach to the review of regulations. This contrasts with systems in place in a number of other countries; a recent OECD survey suggests that 17 countries and the EU have a mandatory requirement for ex-post evaluation of regulations.

The Productivity Commission suggests that New Zealand appears to be biased in favour of more regulation and that many regulations have been introduced and not revisited: 'set and forget'. The Commission has also noted there appears to be a greater public demand for regulation, particularly to reduce risks that might reflect shifts in preferences but also might be individuals seeking to obtain the benefits of lower risks while passing costs on to the wider community.

Current transport regulation

The scope of this study is the regulation of risks associated with the land transport system. However, not all risks are included. It includes the regulation of risks associated with 1) road construction impacts on the environment and 2) road use, including safety and environmental impact risks. It does not include financial risks, which might include funding risks (eg revenues from fuel excise taxes and road user charges being insufficient) and anti-competitive behaviour (eg market behaviour of transport companies).

Regulatory analysis in other countries

International experience is informative with respect to: 1) choosing which regulations to review; and 2) the components of the review. The international practice includes:

- sunset clauses that require a re-regulation to be made after a specified period of time, ie the default is for regulations to end and continuation requires a deliberate decision
- scheduled reviews in which a review is to be conducted after a specified period, but without the default position of discontinuation. This might apply to significant regulations only

[1] www.transport.govt.nz/ourwork/keystrategiesandplans/strategic-policy-programme/

- unscheduled reviews that might occur in response to monitoring of regulatory outcomes or public comment.

This report is focused on the components of regulatory review rather than its scheduling.

Regulatory rationale

Although regulations are introduced to tackle safety or environmental problems, the reasons for intervention, rather than leaving these issues to be solved by individuals, is because of the existence of market failures. Behind the concept of market failure is the assumption that markets exist to serve the community in achieving its objectives, ie that the best choice in any decision is that which maximises utility or wellbeing. From this perspective, when markets do not help to maximise community wellbeing, they are regarded as failures.

Market failures exist where markets, or the private decisions of individuals and companies, are different from what they would be in an ideal world. However, market failures relating to road transport are widespread, particularly because of:

- Imperfect information – people use roads with information gaps that include the safety risks they face as a result of their driving behaviour, the road conditions or other drivers, the performance expectations of their vehicle and so on.
- Externalities – the actions of an individual that result in a safety or environmental problem are not borne only by the decision maker. They are also borne by others, including those involved in a crash or affected by emissions.

As a result of these failures, private decision may not be optimal in limiting the effects on safety and the environment.

Risk analysis

In addition to the analysis of market failures as the justification for regulation, more detailed analysis of physical safety and environmental problems can be used to examine the underlying causes of these problems and the effectiveness of regulation in addressing them. Impact evaluation methodologies generally use regression techniques to estimate the statistical relationship between road safety and environmental risk and key explanatory factors (such as speed, alcohol, weather and interventions). Such analyses must be thorough, ie acknowledge all possible explanatory variables, to attribute a specific factor as the cause of change to a relevant road safety or environmental outcome.

Regulatory options

Because they are so widespread, market failure analysis may not provide useful advice on whether to intervene to regulate the causes of road transport crashes and environmental effects. However, market failure analysis may be useful in pointing towards the kinds of regulations or policy responses that are most suitable.

Where the market failure is limited to incomplete information, information provision regulations most directly address the problem while providing those regulated with considerable freedom of response. Examples include the vehicle fuel economy label. However, in some instances there may be a combined information and externality problem, eg vehicle emissions. Here regulations introduced to address the externality may restrict choice so that information provision provides little value.

The theoretical best approach to tackling an externality is to introduce a market-based instrument that ensures those who cause the problem face a charge equal to the expected external cost ‘at the margin’,

eg each time they drive one more kilometre they face the full costs associated with that kilometre of travel. However, charges only operate efficiently where the impacts are predictable and limited to a single factor. They are not suitable where the impacts are uncertain (as they tend to be with crashes) and multiple factors may be involved (eg driving behaviour, plus road condition).

A methodology for regulatory evaluation

We have examined the different components that might go into an ex-post evaluation of regulation in land transport. Building on international approaches, we suggest an alternative set of components of regulatory analysis. These are summarised in table ES.1. This provides the basis for a systematic ex-post analysis of transport regulation. It would enable the NZ Transport Agency and the government to have greater confidence that existing regulations were fit for purpose or if there was scope for regulatory change or regulatory improvement to increase the net benefits of regulation.

Table ES.1 Elements of ex- post evaluation

Component	Question(s)	Analytical tasks
1 Problem definition	Q1 (a) What is the problem, the underlying justification for the regulation? (b) Has it changed? This includes new scientific developments, changed social trends, etc?	A.1 (a) Market failure analysis. Is there a market failure and of what form? (b) Analysis of trends in the physical problem and the underlying causal factors.
2 Effectiveness of current regulation	Q2 (a) How effective is the regulation in addressing the problem(s)? (b) Were expected benefits achieved? (c) Have there been unintended consequences?	A.2 (a) Analysis of outcomes compared with some counterfactual with no regulation (or some alternative) to isolate the effects of regulation. (b) Comparison of expected and actual outcomes.
3 Regulatory options	Q3 (a) Is regulation still the best way to achieve objectives? (b) Are there regulatory and non-regulatory options?	A.3 (a) Analysis of regulatory response suggested by market failure identification. (b) Regulatory review – literature review and international comparative review.
4 Regulatory analysis	Q4 (a) Do the benefits still exceed the costs? (b) Do alternatives exist with lower costs for the same objective? Can greater cost-effectiveness be achieved?	A.4 (a) Cost benefit analysis (CBA) (or review of existing CBA) of current regulation and alternatives (initial high-level analysis).
5 Regulatory improve-ment	Q5 (a) Can the regulation be modified to better partner with other regulatory areas or levels of government? (b) Does it have time-consuming requirements, eg paperwork, that can be reduced? (c) Flexibility: is it highly prescriptive?	A.5 Transaction cost analysis.

Abstract

This project aimed to identify the best approach for determining and monitoring the contribution that government regulatory interventions in New Zealand make to mitigate the major risks associated with the land transport system. It analysed the safety and environmental risks in the New Zealand road transport sector, and reviewed the local and international literature to provide a framework for assessing the effectiveness of regulatory interventions aimed to mitigate these risks.

The literature shows a preference for regulation that is less interventionist and provides greater freedom of choice to those regulated. Findings also suggest that many New Zealand transport regulations have been introduced and not revisited. This calls for a more periodic and systematic approach to ex-post (after-the-event) analysis to ensure that land transport regulation is fit for purpose.

A suggested approach to evaluation of existing regulations includes the following components: 1) definition of the problem justifying the regulation, based on the identification of market failures and the underlying causes; 2) review of the effectiveness of the regulation in achieving targeted outcomes; 3) identification of options including no regulation; 4) cost-benefit analysis of regulations and alternatives; 5) identification and analysis of opportunities for regulatory improvement.

1 Introduction

1.1 Background

This project aimed to develop a framework for assessing the effectiveness of regulatory interventions in the road transport sector. Specifically it sought to determine 'the best approach for determining and monitoring the contribution that government regulatory interventions in New Zealand make to mitigate the major risks associated with the land transport system'.

Regulation includes a broad range of government actions to influence behaviour, including legislation, rules, education and social norms.[2] Regulations of the transport system have developed over time and include those that address the safety of drivers and other road users, and those that reduce the environmental impacts of the transport system. It is useful to periodically examine the existing set of regulations to understand whether they are still justified and/or are still the best way to tackle existing transport risks. This is especially so in the face of significant changes in technology and in the New Zealand population.

This report examines methodologies for regulatory review to address questions that include whether existing regulations should still be there and whether other regulations should be there but are not. It is not concerned primarily with evaluating the performance of regulations relative to their objectives, but in methodologies that examine whether they are still 'fit for purpose', an expectation that the government has set for regulation in New Zealand (NZ Treasury 2013b). The performance of existing regulations is also of interest where good regulations are performing poorly, ie the regulatory failure is related to implementation or performance issues. The focus is illustrated in table 1.1; the interest in methodologies that can distinguish the regulations that fall under the 'good regulation' category from 'poor regulation'.

Table 1.1 Focus of the regulatory review methodologies

Performance	Good regulation	Poor regulation
Performing well	✓	×
Not performing well	✓	×
Does not exist	✓	×

In taking this wide perspective on the task, the project addressed the risks of the transport sector to the achievement of broad social objectives (community wellbeing) rather than a narrower definition of the risks of fatalities, injuries and so on. The concern was with risks both on the side of costs and benefits.

Such a task involved taking a step back to re-examine the underlying problems that regulations address and what is the best way to tackle them. To evaluate the performance of existing regulations, there is an initial requirement for an ex-ante (before the event) analysis of transport problems and their solutions. It is 'before the event' in the sense that we first evaluate problems as though there was no regulation. This allows an existing regulation to be compared with an ideal approach.

Some of these same questions are addressed in the strategic policy programme of the Ministry of Transport (MoT). The Regulation 2025 project[3] considered how the need for regulation might be different in the future and what tools would be available to shape behaviour. In the same way as this research, the

[2] www.transport.govt.nz/ourwork/keystrategiesandplans/strategic-policy-programme/

[3] www.transport.govt.nz/ourwork/keystrategiesandplans/strategic-policy-programme/

Regulation 2025 project considered ‘regulation’ in its broadest sense; however, it examined all transport modes (road, rail, aviation, maritime and active transport) whereas this project was limited to regulation of the road transport system. The difference between this project and Regulation 2025 is that the focus of this work was on developing evaluation methodologies. However, it also built on the research undertaken for Regulation 2025.

1.2 Scope

The scope of the work was the regulation of risks associated with the land transport system as follows:

- road construction impacts on the environment
- road use, including safety and environmental impact risks.

It did not include financial risks, which might include funding risks (eg revenues from fuel excise taxes and road user charges (RUC) being insufficient) and anti-competitive behaviour (eg market behaviour of transport companies).

Table 1.2 Risks covered in scope for this study

	Crash and safety risk	Environmental risk	Financial risk
Road construction	×	✓	×
Road use	✓	✓	×

1.3 This report

This report has a number of components. It first sets out the transport regulations current in New Zealand. It examines the subject of regulatory analysis and the Government’s programme of regulatory reform (chapter 3). It then addresses the rationale for regulation on the basis of market failure (chapter 4) and uses this to analyse existing regulations (chapter 5).

Chapter 6 analyses the current set of risks or problems in the transport sector that are the subject of regulation, including explaining techniques for identifying the effectiveness of regulation versus the impacts of other factors.

Chapter 7 sets out analytical techniques that might be used in identifying regulatory options.

Chapter 8 summarises a proposed approach to ex-post evaluation of regulation that can be used to address the questions identified above regarding the fitness of purpose of the regulation and scope for improvement.

2 Transport regulation

As a background to a discussion of methodologies for regulatory analysis, in this chapter we summarise New Zealand's current transport regulatory framework relating to crashes and the environment.

2.1 Types of regulation

Regulation 'refers to deliberate actions taken by government or government agencies to influence the behaviour of producers and/or consumers' (Meade and Evans 2015, p1). It can cover a broad range of actions of government from persuasion to coercion.

The following types of regulation exist (Barker et al 2015):

- Acts of Parliament or legislation
- regulations made by the Governor-General as Orders in Council
- common law rules made by judges using the judicial power to create law, or interpret and apply legislation and regulation
- delegated powers and functions of local and regional governments
- state ownership and control of assets, involving public production of services
- co-regulation
- social marketing or advertising
- collective action, involving non-market production by private individuals.

MoT administers a number of laws and regulations and rules including (Barker et al 2015):

- 22 Acts of Parliament
- 102 regulations, made by the Governor-General as Orders in Council.
- 146 rules made by the Minister. Ordinary transport rules made by the Minister are administered by:
  - the NZ Transport Agency ('the Transport Agency')
  - Maritime New Zealand
  - the Civil Aviation Authority.

MoT is also responsible for preparing changes to any legislation within the transport portfolio, and collaborating with relevant departments on changes to legislation that may relate to the wider transport law area. It also advises on the development of regulations and rules.

Table 2.1 presents a timeline of the key road safety legislation introduced in New Zealand since 1965.

Table 2.1 Timeline of major road safety legislation in New Zealand

Year	Legislation	Target[1]
1965	All new motor cars, station wagons and light trucks must be fitted with safety belts.	V
1969	Introduction of breath and blood alcohol tests.	D
1973	Safety helmets became compulsory for motor cyclists and pillion riders at all speeds, previously (from 1956) they were only compulsory if travelling in excess of 30mph (50km/h). Maximum open road speed limit was reduced from 55mph to 50mph (80km/h) as part of fuel	D D

Year	Legislation	Target[1]
	conservation measures.	
1978	The legal blood alcohol limit was lowered from 100 milligrams of alcohol per 100 millilitres of blood to 80 milligrams per 100 millilitres. Evidential breath testing was introduced.	D
1979	New Zealand introduced carless days in response to the international oil crisis. Age for compulsory safety belt use lowered to 8 years old.	D D
1983	Legislation was introduced allowing courts to require repeat drink or drugged drivers to attend an assessment centre, and to be disqualified from holding or obtaining a licence.	D
1985	The open road speed limit was increased from 80km/h to 100km/h for all vehicles except heavy motor vehicles (speed limit now 90km/h).	D
1987	A graduated driver licensing system was introduced, creating a staged process for gaining a full licence.	D
1988	The legal breath alcohol level was lowered from 500µg/l to 400µg/l	D
1990	Introduction of the Transport (Vehicle Standards) Regulations with which vehicles must comply in order to be registered in New Zealand. These regulations targeted vehicle safety items such as safety belts, anchorages, glazing and lighting equipment.	V
1993	Compulsory breath testing (CBT) commenced in April and the legal blood and breath alcohol limits for those under 20 years were lowered to 30mg/100ml and 150mg/l, respectively. Speed cameras operational October 1993.	D D
1994	Cycle helmets were made compulsory.	D
1995	Compulsory child restraints were introduced for under 5 year olds.	V
1999	Vehicle impoundment became compulsory for driving while disqualified, suspended or revoked or for driving while forbidden. Roadside licence suspension was introduced for driving over 50km/h above the posted speed limit, for driving with a blood alcohol level above 160mg/100 ml or a breath alcohol level above 800µg/l, or for refusing a blood test.	D D
2002	Legislation was passed requiring all imported passenger cars to conform to an agreed, overseas frontal impact standard.	V
2003	Offences were created for street racing, wheel spinning and pouring slippery substances on the road to allow wheel spinning. Offenders could have their vehicles impounded for 28 days.	D
2009	A ban was introduced on the use of hand-held mobile phones, and all texting, while driving. Riders of mopeds and motorcycles must switch their headlamps on during daylight hours, unless manufactured before 1 January 1980.	D V
2011	Age for obtaining a driver licence was increased from 15 to 16 years. Zero alcohol limits for youth and repeat offenders were introduced, as well as alcohol interlocks and increased penalties for dangerous driving causing death.	D
2014	Legal breath alcohol limit for adult drivers (aged 20 and over) was reduced from 80mg to 50mg of alcohol per 100ml of blood.	D

[1] Key: D = driver behaviour, V = vehicle safety

Source: www.transport.govt.nz/assets/Uploads/Research/Documents/Motor-Vehicle-Crashes-2014/Legislation.xlsx

2.2 New Zealand's transport regulatory framework

Table 2.2 summarises current transport regulations in New Zealand relating to crashes and the environment. These include regulations for vehicles, the behaviour of road users and road construction. Further detail is provided under safety and environment sections below.

Table 2.2 Transport regulation in New Zealand

Risk and cost	Cause	Regulation	Regulatory approach
Crashes • Loss of life and life quality • Loss of output • Legal costs • Vehicle damage • Medical costs • Temporary incapacitation	Speed	Land Transport Rule: Setting of Speed Limits (2003)	Establishes procedures whereby road controlling authorities may set enforceable speed limits on roads within their jurisdictions.
	Road quality/ safety	Land Transport Management Act (2003)	Ensures roads are designed with effective signage and distractions at intersections are minimised.
	Vehicle quality/safety	Land Transport Act (1998) (LTA); Land Transport Rule: Vehicle Equipment 2004 (and amendments)	Sets national standards regarding safety and maintenance requirements for equipment fitted to motor vehicles: warning devices, speedometers, sun visors, mudguards, footrests on motorcycles and mopeds, child restraints, televisions, fuel tanks and fuel lines.
	Driver quality/ safety	LTA	Sets nationally standardised set of regulatory requirements pertaining to driver licensing, transport service licensing, offences related to driving and vehicle registration.
Environmental/health • Noise • Water pollution • Habitat fragmentation • Exhaust emissions	Road noise	NZS 6806 [4]	Standard for measuring, predicting, assessing and, where required, determining appropriate mitigation for road traffic noise. The Environment Court, Boards of Inquiry and the Transport Agency may apply this standard but it is not a legal requirement.
	Exhaust emissions	Land Transport Rule: Vehicle Exhaust Emissions 2007 (and amendments)	Sets minimum exhaust emissions standards that all new and used vehicles when first entering the fleet must meet before they can operate on New Zealand roads.
	Greenhouse gas emissions	Climate Change Response Act 2002 Motor Vehicle Sales Act	Establishes the Emissions Trading Scheme (ETS) Vehicle fuel economy labelling.

2.3 Safety regulation and strategy

Table 2.3 lists road safety related Land Transport Rules and their application and purpose. More detail is provided in appendix A.

[4] NZS 6806:2010 Acoustics – Road-traffic noise – New and altered roads

2.3.1 Safety regulation – Land Transport Rules

Table 2.3 Land Transport Rules relating to road safety

Cause	Problem	Regulation	Target
Driver behaviour	Speed	Setting of Speed Limits (2003)	All vehicles meet road-specific limits.
	Tiredness, distraction	Work Time and Logbooks (2007)	Limits driving hours and breaks for workers.
	Inexperience, immaturity	Driver Licensing (1999)	All drivers of vehicles – sets age limits and competency requirements.
	Traffic rules	Road User (2004)	Rules for driver behaviour including passing, turning, signalling, wearing safety belts, using mobile phones.
	Transport operators	Operator Licensing (2007)	Sets requirements for drivers and liabilities for offences.
Vehicle safety	Crashworthiness (safety in a crash)	Passenger Service Vehicles (1999)	Public transport vehicles – requirements for safe design and construction.
		Door Retention Systems (2001)	Safety of doors – differs by vehicle class.
		Head Restraints (2001)	If fitted, head restraints must meet quality requirements.
		Frontal Impact (2001)	Applies to vehicles on first entry/registration.
		Interior Impact (2001)	Vehicles to meet international standards throughout life.
		Steering Systems (2001)	Safety of contact with steering systems in an accident.
		Seatbelts and Seatbelt Anchorages (2002)	Must meet international standards. Apply throughout life.
		Seats and Seat Anchorages (2002)	Security of vehicle seats.
		Road User (2004)	Includes regulations on helmets.
	Vehicle condition (likelihood of a crash)	Vehicle Repair (1998)	All vehicle repairs – quality control.
		Glazing, Windscreen, Wipe and Wash, and Mirrors (1999)	Minimum safety levels – differ by vehicle class.
		Steering Systems (2001)	Safe control of vehicles.
		Tyres and Wheels (2001)	Safety of tyres.
		Light Vehicle Brakes (2002)	Types of brakes installed and safety requirements.
		Vehicle Standards Compliance (2002)	Sets requirements for inspection and warrant or certificate of fitness.
		Vehicle Dimension and Mass (2002)	Limits vehicle size to increase safety.
		Vehicle Lighting (2004)	Regulates vehicle lighting requirements.
		Vehicle Equipment (2004)	Requirements relating to warning devices, speedometers, sun visors, mudguards, footrests, child restraints, TVs, fuel tanks and fuel lines.
		Heavy Vehicles (2004)	Safety requirements for heavy vehicles.

Cause	Problem	Regulation	Target
		Heavy Vehicle Brakes (2006)	Regulates brakes of heavy vehicles.
	Safety of others	External Projections (2001)	All vehicles throughout life.
		Dangerous Goods (2005)	Requirements for safe transportation.
	Helmets	Operator Safety Rating (2008) + amendments	Enables rating of operators so that enforcement focuses on worst performers.
Road condition and safety	Traffic control devices	Traffic Control Devices (2004)	Requirements for and specification of road markings, signs, pedestrian crossings etc.

Source: NZ Transport Agency (2012)

2.3.2 Safety strategy

There is currently a focus on transport safety, which is one of three priorities in MoT (2015g) *Statement of intent 2015–2019*.

The Government's safety strategy, *Safer journeys,* was developed and implemented by the National Road Safety Committee (NRSC), a group of government agencies with responsibilities for road safety. The members include MoT, the Transport Agency, Police and the Accident Compensation Corporation (ACC), plus associate members Local Government NZ, the Energy Efficiency and Conservation Authority, the Ministries of Justice, Health, Education and the Ministry of Business, Innovation and Employment (Department of Labour).

The strategy notes that the benefits of improving road safety included fewer deaths and injuries, reduced impact on productivity, reduced demand in the health sector, lower ACC costs and quality of life improvements. The strategy has an overall vision of a safe road system increasingly free of death and serious injury. The Safe System approach recognises:

- People make mistakes and it is inevitable there will be some crashes.
- People are vulnerable and have a limited ability to crash without being seriously injured or killed.
- We need to share responsibility – system designers and people who use the roads must all share responsibility for creating a road system where crash forces do not result in death or serious injury.
- We need to improve the safety of all parts of the system – roads and roadsides, speeds, vehicles and road use all need to be strengthened so that if one part fails, other parts will still protect the people involved in a crash.

Safer journeys has objectives to:

- make the road transport system more accommodating of human error
- manage the forces that injure people in a crash to a level the human body can tolerate without serious injury
- minimise the level of unsafe road user behaviour.

There are four prongs to the strategy (NRSC 2013):

1 Safe roads that are predictable, forgiving of mistakes and encourage safe user behaviour.

2 Safe speeds that suit the function and level of safety of the road, with road users understanding and complying with speed limits and driving to the conditions.

3 Safe vehicles that help prevent crashes and protect road users from crash forces that cause death or serious injury.

4 Safe road use ensuring road users are competent, alert, unimpaired, comply with road rules, choose safer vehicles, take steps to improve safety and demand safety improvements.

These were the focus areas for addressing a set of areas of concern that differed in priority (table 2.4).

Table 2.4 Aims of the *Safer journeys* strategy and contribution to outcomes

Areas of concern	Aims	Safe roads and roadsides	Safe speeds	Safe vehicles	Safe road use
High concern					
Reducing alcohol/drug impaired driving	Reduce the level of fatalities caused by drink and/or drugged driving, from 28 to 22 deaths per one million population, a rate similar to that in Australia.			✓	✓
Increasing the safety of young drivers	Reduce the road fatality rate of our young people from 21 per 100,000 population to a rate similar to that of young Australians of 13 per 100,000.	✓	✓	✓	✓
Safe roads and roadsides	Significantly reduce the crash risk on New Zealand's high-risk routes.	✓			
Safe speeds	Significantly reduce the impact of speed on crashes by reducing the number of crashes attributed to speeding and driving too fast for the conditions.	✓	✓	✓	
Increasing the safety of motorcycling	Reduce the road fatality rate of motorcycle and moped riders from 12 to 8 per 100,000 population, similar to that of the best-performing Australian state, Victoria.	✓	✓	✓	✓
Medium concern					
Improving the safety of the light vehicle fleet	Have more new vehicles enter the country with the latest safety features. The average age of the New Zealand light vehicle fleet will also be reduced from over 12 years old to a level similar to that of Australia, which is 10 years.			✓	✓
Safe walking and cycling	Achieve a reduction in the crash risk for pedestrians and particularly cyclists, while at the same time encouraging an increase in use of these modes through safer roading infrastructure.	✓	✓	✓	✓
Improving the safety of heavy vehicles	Reduce the number of serious crashes involving heavy vehicles.	✓	✓	✓	✓
Reducing the impact of fatigue	Make New Zealanders' management of driver distraction and fatigue a habitual part of what it is to be a safe and competent driver.	✓	✓	✓	✓
Addressing distraction		✓		✓	✓

Areas of concern	Aims	Safe roads and roadsides	Safe speeds	Safe vehicles	Safe road use
Reducing the impact of high-risk drivers	Reduce the number of repeat alcohol and speed offenders and incidents of illegal street racing.		✓	✓	✓
Areas of continued and emerging focus					
Increasing the level of restraint use	Achieve a correct use and fitting rate of 90% for child restraints and make the use of booster seats the norm for children aged 5 to 10.			✓	✓
Increasing the safety of older New Zealanders	Reduce the road fatality rate of older New Zealanders from 15 per 100,000 population to a rate similar to that of older Australians of 11 per 100,000.	✓	✓	✓	✓

Source: MoT (2010)

The strategy builds on the analysis of identified problems as the basis for identifying solutions. For example, the identification of speed as a significant contributor to crashes was behind the identification of a number of actions to address speed problems:

- Improve the cost effectiveness of enforcement by increasing the use of speed cameras and red light cameras. This would free up Police to focus on high-risk drivers.
- Investigate the use of point-to-point (section control) speed cameras.
- Change the penalty system to deter speeding (higher demerit points and lower fines).
- Apply demerit points to speed camera infringements.
- Help people understand the benefits of travelling at safer speeds.
- Create more speed zones on high-risk rural roads to make roads more self-explaining and help establish the criteria for what roads with different speeds should look like.
- Increase the adoption of lower speed limits in urban areas.
- Investigate the requirements to support intelligent speed assistance.
- Improve data on speed-related crashes.

The analysis appears to have been from problem identification through to analysis of effective measures. For example, with respect to speed cameras, the strategy notes that:

> *If the chance of being caught speeding and being penalised is high, most people will comply with the speed limit. Enforcement works best when it is highly visible and where drivers can expect speed limits to be strongly enforced on an 'anytime, anywhere' basis.*
>
> *There are several proven methods that could be used to enforce speed limits. These include manual enforcement by police officers and automated enforcement by cameras. Technologies are now available to allow speed enforcement to be much more automated and efficient. The international trend is towards more automated enforcement.*
>
> *International evidence shows that additional cameras can reduce the number of road deaths significantly and cost effectively. They are expensive to install, but their effectiveness has*

> *been well demonstrated. Speed cameras are also more accurate than hand-held devices, so enforcement tolerance levels can be minimised.*
>
> *Over time, making more use of speed cameras will free up Police resources so they can concentrate on enforcing other high risk behaviour.*

The strategy sees the Safe System approach as being a philosophy underlying the response to road safety. The philosophy sees a safety culture affecting all road decisions:

> *Changes to the legal and technical aspects of road safety remain useful road safety tools, but can only take us some of the way toward a safe road system. We want to have engaged with all system designers, and to have built a sense of shared responsibility and purpose. A shift in public understanding, perception of, and demand for road safety is needed. In particular we need the public to actively demand a more forgiving road system. We want the public to understand that they can expect better planning, design and engineering for road safety, cheaper and more widely available safety technologies, and a community and business climate that discourages intentional rule violations. Overall, moving towards more active community support for a safer road system will help achieve the Safer Journeys vision.* (NRSC 2013, p8)
>
> *A key step will be to increase community understanding that compliance alone will not guarantee safety on the roads. This conversation may include incentives to promote a higher level of driver and rider performance – in effect to encourage New Zealanders to become five-star users of the road.* (p9)

The 2013 review includes progress on the different elements of the strategy (in terms of actions and outcomes) towards the 2020 goal and a statement of aims for 2016.

In terms of our approach to regulation being tested in this document, we note that:

- The *Safer journeys* strategy is concerned with making the road system safer without testing whether any interventions are justified as market failures or in terms of costs and benefits.
- The factors analysed, which provided an evidence base as input to the development of the strategy, have changed in several circumstances, eg trends in vehicle kilometres travelled (VKT) and vehicle age.

2.4 Environment

There is no specific strategy relating to environmental impacts of transport, but a number of regulations (Land Transport Rules) address environmental issues from transport:

- The Vehicle Exhaust Emissions Rule (2007) sets emission standards for vehicles on first registration in New Zealand. The rule sets standards based on those that have been adopted in manufacturing countries/jurisdictions, including Japanese, European and US standards. Effectively the rule means that, with some exceptions for speciality vehicles, vehicles over a certain age (year of manufacture) cannot be imported to New Zealand.
- The Fuel Consumption Information 2008 sets out requirements for the provision of fuel consumption information for light vehicles. This helps to achieve environmental objectives through ensuring vehicle buyers better understand the relative fuel efficiency of vehicles and the cost implications. This is relevant given that emissions, particularly of CO_2, are proportional to fuel consumption.

Other environmental issues are dealt with under the Resource Management Act 1991 (RMA), particularly the environmental effects of roads that include noise and surface run-off.

2.5 Conclusions

Transport regulation examined in this report has focused on safety and environment.

Safety regulation has focused on driver behaviour, the safety of vehicles and the safety of roads and road conditions. Regulations have targeted:

- the major causes of crashes, including speed and alcohol consumption
- the competence of drivers via driver licensing
- driver behaviour via a number of road user regulations
- the crashworthiness of vehicles that reduces impacts where there is a crash
- vehicle condition which reduces the likelihood of a crash
- traffic control devices, including road markings and signs.

Environmental regulations have targeted exhaust emissions and fuel consumption and associated CO_2 emissions. Other environmental effects are targeted largely via road design and the RMA consent process.

3 Regulatory analysis

3.1 Types of regulatory analysis

There are different types of regulatory analysis including:

- monitoring progress of regulation in achieving targeted outcomes over time
- operational evaluation which examines how effective regulation is in achieving outcomes, ie whether the outcomes are the same as expectations
- regulatory impact evaluation which examines whether changes in costs and benefits (wellbeing) are the result of regulatory intervention or of other factors
- regulatory review which examines in more detail whether existing regulation is justified, should be replaced or modified.

The concern in this study has not been so much to do with monitoring of regulation as with the more analytical tasks of the second to fourth bullets above: whether outcomes are as expected, if outcomes are the result of regulation or other factors and if existing regulation is still fit for purpose.

3.2 Ex-post analysis in the OECD

In this section we review approaches used in New Zealand and elsewhere to analyse policy and legislation and a number of recent exercises to improve regulatory approaches. This includes ex-ante and ex-post evaluation of regulation.

An OECD analysis of the use of ex-post analysis of regulations in member countries found that 17 countries and the EU had a mandatory requirement for ex-post evaluation of at least some existing primary laws. New Zealand was among 17 countries that had no requirement for ex-post evaluation.

In total, 17 countries, including New Zealand, require sunset clauses in at least some primary legislation, whereas 17 did not. And a further 17 (including New Zealand) include automatic evaluation requirements in at least some primary legislation. Ex-post evaluations include different components as shown in table 3.1.

Table 3.1 Components of ex- post evaluation (number of countries using different approaches)

Components	All	Major primary laws	Some	Never
Contain an assessment of the achievement of goals	9	2	9	14
Make comparisons of the actual vs predicted impacts	5	3	10	16
Identify unintended consequences	9	1	11	13
Require a consideration of consistency of regulations	7	2	8	17
Assesses consistency with comparable international standards/ rules	2	2	10	20

Source: OECD (2015)

3.3 New Zealand

3.3.1 Improving New Zealand's regulatory performance

The New Zealand Government agreed to a set of expectations for regulatory stewardship in 2013, including 'how departments should be designing and implementing regulatory regimes and their stewardship responsibilities in administering those regimes, such as undertaking monitoring and review' (NZ Treasury 2013b). Of relevance to this work, we note the initial regulatory expectations (box 3.1) include those to:

- regularly check if regulations are fit for purpose
- clearly articulate the objectives of regulation
- clearly articulate the factors imposing greatest risk to regulatory performance
- have processes to improve the regulatory regimes
- only propose regulatory change where there has been a robust case built on impact analysis.

The work for this report is consistent with this set of regulatory expectations and may provide some useful insights into how this process might develop more widely.

Box 3.1 Initial regulatory expectations

The initial expectations for departments in exercising their stewardship role over government regulation [CAB Min (13) 6/2B refers] are that departments will:

- monitor, and thoroughly assess at appropriate intervals, the performance and condition of their regulatory regimes to ensure they are, and will remain, fit for purpose
- clearly articulate what those regimes are trying to achieve, what types of costs and other impacts they may impose, and what factors pose the greatest risks to good regulatory performance
- have processes to use this information to identify and evaluate, and where appropriate report or act on, problems, vulnerabilities and opportunities for improvement in the design and operation of those regimes
- for the above purposes, maintain an up-to-date database of the legislative instruments for which they have policy responsibility, with oversight roles clearly assigned within the department
- not propose regulatory change without:
  - clearly identifying the policy or operational problem it needs to address, and undertaking impact analysis to provide assurance that the case for the proposed change is robust
  - careful implementation planning, including ensuring that implementation needs inform policy, and providing for appropriate review arrangements
- maintain a transparent, risk-based compliance and enforcement strategy, including providing accessible, timely information and support to help regulated entities understand and meet their regulatory requirements
- ensure that where regulatory functions are undertaken outside departments, appropriate monitoring and accountability arrangements are maintained, which reflect the above expectations.

Source: NZ Treasury (2013b)

3.3.2 Regulatory impact analysis

Regulatory impact analysis (RIA) is an expected component of the development of new regulation. RIA is an ex-ante analysis of regulation to ensure:

> *…that regulatory proposals are subject to careful and robust analysis. RIA is intended to provide assurance about whether problems might be adequately addressed through private or non-regulatory arrangements—and to ensure that particular regulatory solutions have been demonstrated to enhance the public interest* (NZ Treasury 2013a).

RIA, summarised in a regulatory impact statement (RIS), can serve two benefits (NZ Treasury 2013a):

1 Enhancing the evidence base to inform decisions about regulatory proposals – to ensure that all practical options for addressing the problem have been considered and the benefits of the preferred option not only exceed the costs but will deliver the highest level of net benefit.

2 Transparency – the presentation of agencies' free and frank advice to decision makers at the relevant decision points provides reassurance that the interests of all sectors of the New Zealand public have been considered. RIA also aims to encourage the public to provide information to enhance the quality of regulatory decisions, to further inform the evidence base.

RIA requirements apply to policy initiatives or reviews when it is considered they would involve 'creating, amending or repealing legislation' and when it is expected to result in a paper being submitted to Cabinet for approval. However, RIA does not initiate the analysis of regulations themselves; it is a process used when there has been a prior decision to analyse some existing regulation(s).

Thus RIA might be a necessary step once a monitoring or review system has identified a need for regulatory change.

3.3.3 NZ Productivity Commission: measuring the performance of regulation

The NZ Productivity Commission in its recent review of regulation, made the following introductory remarks:

> *There is no annual review of regulation, as there is with government spending (the Budget). We do not know how much of our income is taken up by complying with regulations, as we do with our tax bills. And unlike spending, tax or monetary policy, there is no one minister or agency in charge of regulation. This lack of attention has real consequences. Although the 'price' of regulation in general may often be invisible, the costs of poor regulation are all too clear … Rapid changes in technology and markets make the need for good regulation ever more pressing. Better regulation may be the best opportunity to reduce the pressure for more regulation* (NZ Productivity Commission 2014, piii).

The report examined regulatory practice in New Zealand and elsewhere to provide guidance, and to serve as a resource for designing new regulatory regimes and making existing institutions and practices work better.

In its critique of existing regulatory practices in New Zealand, the NZ Productivity Commission noted:

1 Frequent changes to the underlying regulatory frameworks have contributed to New Zealand (network) utilities being assessed as having a higher risk profile than equivalent sectors overseas.

2 The balance of pressures from industry and the community, and New Zealand's very centralised constitutional system, create a bias in favour of more regulation.

3 New Zealand appears to make more use of primary legislation in its regulatory regimes than other jurisdictions, and statutes often address matters in considerable detail.

4 It can be difficult to find time on the Parliamentary calendar for 'repairs and maintenance' of existing legislation. As a result, regulatory agencies often have to work with legislation that is out of date or not fit for purpose. This creates unnecessary costs for regulators and regulated parties, and means that regimes may not keep up with public or political expectations.

5 The ability of the courts to review the behaviour of regulators and, in many cases, the merits of their decisions, is one of the most significant constraints on the exercise of regulatory power in the system.

6 New Zealand does not have strong processes for reviewing regulatory regimes, leading frequently to a 'set and forget' mindset to regulation.

This report directly addresses some of these concerns in a transport context.

3.3.3.1 Risks and externalities

The NZ Productivity Commission (2014, p33) noted that a key source of pressure to regulate is a growing public expectation that the government will intervene to reduce risk and manage externalities. The authors suggest that 'these rising expectations partly reflect a more prosperous society; as incomes rise and technologies to identify and prevent injury, death or loss become more accessible, tolerance of potential harms drops'. There was some suggestion of public expectations of 'no-risk'.

This raises an important issue. The intervention rationale logic adopted in this report (section 4.2) is based on the presence of a market failure and of regulation having positive net benefits to justify intervention. In contrast, the NZ Productivity Commission suggested the public takes a different stance, ie in favour of the government removing a greater level of risk. Individuals may be seeking levels of risk-reduction that go beyond the level of risk they would accept as individuals (weighing up their individual costs and benefits). This may be simply an attempt to obtain benefits (lower risks) while passing costs on to the wider community. Alternatively it might suggest a societal shift towards a different (and higher) valuation of risk events, eg higher estimates of the costs of a crash or injury. These individual valuations are beyond the scope of this study.

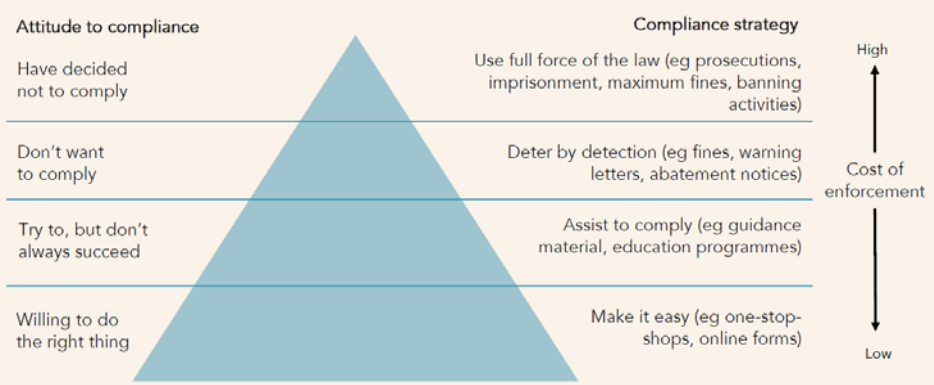
Some of these issues are raised in this report in discussing the *Safer journeys* strategy that underlies the Government's response to crash risk and for which the objectives have been set in terms of a safe transport system, with the implications that safer is always better, regardless of cost.

3.3.3.2 Regulatory approaches

The NZ Productivity Commission identified two approaches to regulation that are of particular relevance:

- **Responsive regulation**, in which regulators select their compliance tool based on the attitude and motivation of regulated entities towards compliance (figure 3.1). For entities that are willing to do the right thing, the regulator may select a low-cost tool (such as education); for entities that are unwilling to comply, the regulator may select high-powered tools (such as prosecutions).
- **Risk- based regulation**, in which regulators focus on identifying and assessing the risk of harm from non-compliance and target their resources towards reducing the greatest harms. Risk-based regulation has become increasingly influential and is endorsed in Cabinet's initial expectations for regulatory stewardship (Office of the Minister of Finance and Office of the Minister for Regulatory Reform 2013).

Figure 3.1 Enforcement pyramid



Source: NZ Productivity Commission (2014)

The NZ Productivity Commission also noted there is no single, superior regulatory strategy but the best approach is situation specific. With respect to these two regulatory approaches, the Commission notes that:

- Responsive regulation has been an important influence in the thinking about effective regulatory compliance worldwide over the last two decades and is widely used as a compliance strategy by New Zealand regulators. The literature points to a number of impediments to successfully implementing responsive regulation. There may be instances where implementing a graduated compliance approach is not in the interest of the overall objectives of the regulatory regime and there can be significant constraints on the regulator in being able to use the enforcement pyramid (figure 3.1) as intended.
- Risk-based regulation has become increasingly influential and Cabinet expects that 'departments, in exercising their stewardship role over government regulation, will maintain a transparent, risk-based compliance and enforcement strategy' (Office of the Minister of Finance and Office of the Minister for Regulatory Reform 2013). There has been widespread endorsement of risk-based approaches to regulation because risk-based approaches directly relate the activities of the regulator (targeting risk) to the objectives of the regulatory regime (reducing the risk of harm). But risk-based approaches pose a number of challenges in implementation. There can be a lot of uncertainty about the nature of the risk and at what point the regulator should intervene.

The NZ Productivity Commission noted some of the barriers to better regulation were related to institutional cultures and suggested that the State Services Commission develop guidelines to assist in cultural change.

In terms of regulatory practice, the NZ Productivity Commission recommended a number of improvements including guidance on regulatory practice should be updated to provide additional information on, inter alia, how to define and target risks.

We note particularly the suggestions that regulation should focus on the most serious areas of risk, that New Zealand regulators may over-estimate risks (or at least do so in comparison with other countries) and that there is a bias towards more regulation.

However, the emphasis on risks, and concentrating regulations on the greatest risk areas, needs to be balanced by the concern with market failure also. The areas of greatest risk may not justify regulation if those bearing risk can manage it. In the context of this exercise in which we are addressing existing regulation, focusing on areas of greatest risk may not identify current regulations for which there is greatest cost.

Risk-based regulation can be defined differently to embrace the approach recommended here. Hutter (2005) notes that risk-based regulation embraces a very broad range of approaches, but that, at a minimum they entail the use of risk-based tools emerging out of economics (cost benefit approaches) and science (risk assessment techniques). This raises an important question which we will return to: whether the pursuit of risk-based regulation leads inevitably to regulation that seeks to minimise physical risk (eg no fatalities) or if risks on the cost side are included so that risk-based regulation is effectively economically efficient regulation?

3.4 Australia

3.4.1 Productivity Commission

The Australian Productivity Commission periodically reviews the stock of existing regulation (Australian Productivity Commission 2011). Australia has a RIS requirement for new regulations, but the Commission

argues it is also important that the stock of regulation be kept under review to verify that it remains 'fit for purpose', with any costly or otherwise poorly performing regulations removed or amended. The costs of regulation were identified as having many causes (box 3.2).

Box 3.2 Causes of regulatory costs

The Regulation Taskforce (2006) identified five features of regulations that contribute to compliance burdens on business that are not justified by the intent of the regulation.

1 Excessive coverage, including 'regulatory creep' – regulations that appear to influence more activity than originally intended or warranted, overly prescriptive, or where the reach of regulation impacting on business, including smaller businesses, has become more extensive over time.

2 Regulation that is redundant – some regulations could have become ineffective or unnecessary as circumstances have changed over time.

3 Excessive reporting or recording requirements – companies face multiple demands from different arms of government for similar information, as well as information demands that are excessive or unnecessary. These are rarely coordinated and often duplicative.

4 Variation in definitions and reporting requirements – regulatory variation of this nature can generate confusion and extra work for businesses than would otherwise be the case.

5 Inconsistent and overlapping regulatory requirements – regulatory requirements that are inconsistently applied, or overlap with other requirements, either within governments, or across jurisdictions. These sources of burden particularly affect businesses that operate on a national basis, or across local government areas in some states.

There may also be economic costs arising from 'distortions' – the effects of regulation on competition and on incentives for investment and innovation. Such distortions (often unintended) can be due to:

- substitution effects resulting from changes in relative prices, including distorting investment decisions which have long-term consequences
- overly prescriptive regulation which prevents innovative or lower cost approaches from meeting the intended outcomes of the regulation
- interactions of regulations that can compound costs, create inconsistencies and otherwise pose dilemmas for business compliance.

In addition, there may be other non-economic costs arising from adverse environmental and social impacts. Finally, if regulation is not effective, there may be 'opportunity costs' in terms of the foregone benefits that regulation intended to deliver.

3.4.2 Programmed review mechanisms

The Australian Productivity Commission (2011) has described programme review mechanisms used in Australia. We outline these in turn below.

3.4.2.1 Sunsetting

'Sunsetting' requires a regulation to be re-made after a certain period (typically 5 to 10 years), if it is not to lapse. The logic supporting sunsetting is that much regulation inevitably has a 'use-by date', when it is no longer needed or will require significant modification. But without a trigger to reassess its utility, at least some of this regulation will inevitably remain in place.

Sunsetting can apply to specific regulations or to all regulations that are not specifically exempted. The Australian Government has been a latecomer to sunsetting relative to state jurisdictions. The Legislative Instruments Act (2003) requires all non-exempt subordinate legislation to lapse after 10 years, including the pre-existing stock of legislation. Commonwealth instruments started sunsetting from early 2015.

3.4.2.2 'Embedded' statutory reviews

Some legislation includes a requirement for a review to be conducted and in some instances it also sets out the specifics of the review, such as timing, the scope of the review and the governance arrangements.[5] Such 'embedded' reviews have generally been used for significant areas of regulation where there are uncertainties about the efficacy or impacts of the legislation (including potential for collateral effects or other unintended consequences), or where the regulatory regime is transitional. Embedded statutory reviews have sometimes also been used to give comfort to stakeholders concerned that they might be adversely affected by new legislation.

3.4.2.3 'Process failure' post implementation reviews

The Australian Government's 'best practice requirements' for making regulation require a 'post implementation review' (PIR) for any regulation that would have required a RIS. A PIR needs to start within one to two years of implementation. The PIR was introduced with the intention of providing a 'fail-safe' mechanism to ensure that regulations made in haste or without sufficient assessment – and therefore having greater potential for adverse effects or unintended consequences – can be re-assessed before they have been in place too long.

Suggested good design features for PIRs include:

- 'arms-length' reviews be undertaken for any regulation assessed as being of major significance
- provision to be made for data generation to monitor the costs of implementation and the outputs and outcomes
- impact assessment be forward- (as in the case of a RIS) as well as backward-looking
- alternatives to achieving the objectives be evaluated
- consultation with stakeholders impacted or potentially impacted by the regulation.

There are several examples of PIRs on the website of the Office of Best Practice Regulation (Department of Prime Minister and Cabinet).[6] One example is a PIR of the national renewable energy target (RET) (Department of the Environment 2014). The Expert Panel for the PIR recommended the RET should be amended in light of the changing circumstances in Australia's main electricity markets (declining electricity demand) and the availability of lower cost emission abatement alternatives. The panel recommended the large-scale renewable energy target (LRET) be either closed to new entrants (and targets reduced accordingly) or that growth in future LRET targets be limited to 50% of overall electricity demand growth. For the small-scale renewable energy scheme, the panel recommended it be terminated immediately or phased out by 2020.

3.4.3 Ad hoc reviews

A variety of other types of reviews are commissioned by governments on a more or less ad hoc basis, including (table 3.2):

- general reviews covering a wide range of regulation, including public stocktakes and principles-based reviews
- reviews that focus on a particular area of regulation, including benchmarking and in-depth reviews.

[5] For example, the Fuel Quality Standards Act 2000, which legislates for national fuel quality standards. A statutory independent review was required two years after the first set of standards came into effect and thereafter every five years.

[6] http://ris.dpmc.gov.au/category/post-implementation-reviews/

Table 3.2 Types of ad hoc review

Review type	Description
Public stocktakes	Consultative reviews that invite businesses to provide information on the burdens imposed by regulation. Public stocktakes are typically 'complaints-based' exercises, with submissions, roundtables and other approaches used to gather information from industry and other interested parties. The problems raised by business are then subject to scrutiny to see if they are significant, and to assess whether there are alternative approaches that can reduce the burden without detracting from the policy objective.
Principles-based reviews	A way of identifying the need for reform for a specific (often broad), set of legislation with certain features in common that potentially give rise to excessive regulatory burdens. The principle(s) provides an initial filter or screen to identify which regulations may warrant reform. The most extensive example of a principles-based review is the National Competition Policy Legislative Review Program, which required all Australian, state and territory government legislation to be screened for anti-competitive effects.
Regulatory benchmarking	Regulatory benchmarking is a process for comparing aspects of regulation across jurisdictions to highlight which jurisdictions are leading or lagging, or to identify leading regulatory practice. The aspects of regulation which can be benchmarked include: requirements and their cost to business; outcomes; and features of the administration and enforcement of regulations. Some types of benchmarking are regular and broadly based, whereas others are selective or targeted exercises.
In-depth reviews	Reviews that examine a particular area of regulation in detail, including the impact of existing regulation or the need for regulation in a specific area, on particular industries or a sector. In-depth reviews usually arise in response to a perceived problem or an emerging issue. A need for these may also be identified through other reviews – including public stocktakes.

Source: Australian Productivity Commission (2011)

The Australian Productivity Commission also developed an effort-impact matrix to help in regulatory review (table 3.3).

Table 3.3 Approaches to managing and reviewing the stock of regulation: an effort- impact matrix (for individual areas of regulation)

	Potentially low return	Potentially high return
High effort	Broad redtape cost estimation Regulatory budgets and one-in one-out[(a)] Frequent stocktakes	In-depth reviews Embedded statutory reviews Benchmarking Packaged sunset reviews
Low effort	Sunsetting Regulator stock management Red tape targets[(b)] RIS stock-flow link	Known high-cost areas and known solutions from past reviews Regulator management strategies where weak in the past Periodic stocktakes

[(a)] High effort to do well and potential for perverse impacts.

[(b)] Where the awareness of compliance burdens is still lacking can be high return

Source: Australian Productivity Commission (2011)

3.5 USA

Despite the OECD analysis suggesting there is no US requirement for ex-post evaluation, there is a long history of such requirements. This includes the President's Executive Order No. 12866 (1993) which, amongst other things, aimed to determine whether regulations have 'become unjustified or unnecessary

as a result of changed circumstances; to confirm that regulations are both compatible with each other and not duplicative or inappropriately burdensome in the aggregate; to ensure that all regulations are consistent with the President's priorities and the principles set forth in this Executive Order, within applicable law; and to otherwise improve the effectiveness of existing regulations'. Periodic reviews are also required under section 610 of the Regulatory Flexibility Act (1980)[7] which requires agencies to conduct reviews of rules published within the last 10 years that have a 'significant economic impact on a substantial number of small entities'.

The latest requirement is set out in Executive Order No. 13563 (EO13563) (2011) which aims to improve regulation and regulatory review. It includes:

- general principles of regulation, including the requirement for benefits to exceed costs and the preference for economic incentives and other regulatory approaches that do not specify the manner of compliance
- requirements for public participation in regulatory development
- integration of regulations across sectors and encouragement of innovation
- flexibility and freedom of choice so that the regulatory burden is reduced
- objectivity of the scientific and technical information used to support regulations
- retrospective analyses of existing rules.

Retrospective analyses are to identify rules that may be 'outmoded, ineffective, insufficient, or excessively burdensome, and to modify, streamline, expand, or repeal them in accordance with what has been learned'. To this end, each agency must develop a plan for how it will 'periodically review its existing significant regulations to determine whether any such regulations should be modified, streamlined, expanded, or repealed so as to make the agency's regulatory program more effective or less burdensome in achieving the regulatory objectives'.

Agencies have developed their own methodologies consistent with the requirements of EO13563. The Department of Transportation (DOT) notes that its philosophy in deciding the need for regulatory change is that its rules should be 'clear, simple, timely, fair, reasonable, and necessary. They should not be issued without appropriate involvement of the public'. To this end, 'once issued, they should be periodically reviewed and revised, as needed, to assure they continue to meet the needs for which they originally were designed'. The factors listed in box 3.3 are considered by DOT officials in determining the need for retrospective reviews. DOT regularly publishes lists of regulations being reviewed and the reasons for those reviews.[8]

Other agencies differ in the extent to which they have established formal processes. The US Environmental Protection Agency (EPA) has a more detailed description of its approach. It identifies regulations on the basis of:

- comments gathered from the public, other federal agencies, and EPA experts
- the expertise of the EPA offices writing the regulations
- agency and administration priorities, such as judicial rulings, emergencies

[7] As amended by the Small Business Regulatory Enforcement Fairness Act (SBREFA) of 1996 and the Small Business and Work Opportunity Act of 2007

[8] www.transportation.gov/regulations/retrospective-review-and-analysis-existing-rules

- the principles and directives of Executive Order 13563
- agency resources.

Box 3.3 US Department of Transportation considerations in regulatory review

1 The nature and extent of public complaints or suggestions (eg petitions for rulemaking).
2 The need to simplify or clarify regulatory language (eg based on requests for interpretation).
3 The need to eliminate overlapping or duplicative regulations.
4 The need to eliminate conflicts or inconsistencies with other rules.
5 The length of time since the last review.
6 The importance or relevance of the problem originally addressed.
7 The burdens imposed on, and the benefits achieved for, those affected and whether they are greater or less than originally estimated.
8 The degree to which technology, economic conditions, or other involved factors have changed.
9 The number of requests for exemption and the number granted.

Source: Department of Transportation (2011)

The criteria and questions used for regulatory review are shown in box 3.4.

Box 3.4 US EPA criteria for regulatory reviews

Benefits justify costs

- Now that the regulation has been in effect for some time, do the benefits of the regulation still justify its costs?

Least burden

- Does the regulation impose requirements on entities that are also subject to requirements under another EPA regulation? If so, what is the cumulative burden and cost of the requirements imposed on the regulated entities?
- Does the regulation impose paperwork activities (reporting, recordkeeping, or third party notifications) that could benefit from online reporting or electronic recordkeeping?
- If this regulation has a large impact on small businesses, could it feasibly be changed to reduce the impact while maintaining environmental protection?
- Do feasible alternatives to this regulation exist that could reduce this regulation's burden on state, local, and/or tribal governments without compromising environmental protection?

Net benefits

- Is it feasible to alter the regulation in such a way as to achieve greater cost effectiveness while still achieving the intended environmental results?

Performance objectives

- Does the regulation have complicated or time-consuming requirements, and are there feasible alternative compliance tools that could relieve burden while maintaining environmental protection?
- Could this regulation be feasibly modified to better partner with other federal agencies, state, local, and/or tribal governments?

Alternatives to direct regulation

- Could this regulation feasibly be modified so as to invite public/private partnerships while ensuring that environmental objectives are still met?
- Does a feasible non-regulatory alternative exist to replace some or all of this regulation's requirements while ensuring that environmental objectives are still met?

Quantified benefits and costs/qualitative values

- Since being finalized, has this regulation lessened or exacerbated existing impacts or created new impacts on vulnerable populations such as low-income or minority populations, children, or the elderly?
- Are there feasible changes that could be made to this regulation to better protect vulnerable populations?

Open exchange of information

- Could this regulation feasibly be modified to make data that is collected more accessible?
- Did the regulatory review consider the perspectives of all stakeholders?

Coordination, simplification, and harmonization across agencies

- If this regulation requires coordination with other EPA regulations, could it be better harmonized than it is now?
- If this regulation requires coordination with the regulations of other federal or state agencies, could it be better harmonized with those regulations than it is now?

Innovation

- Are there feasible changes that could be made to the regulation to promote economic or job growth without compromising environmental protection?
- Could a feasible alteration be made to the regulation to spur new markets, technologies, or jobs?
- Have new or less costly methods, technologies, and/or innovative techniques emerged since this regulation was finalized that would allow regulated entities to achieve the intended environmental results more effectively and/or efficiently?

Flexibility

- Could this regulation include greater flexibilities for the regulated community to encourage innovative thinking and identify the least costly methods for compliance?
- Scientific and technological objectivity
- Has the science of risk assessment advanced such that updated assessments of the regulation's impacts on affected populations such as environmental justice communities, children or the elderly could be improved?
- Has the underlying scientific data changed since this regulation was finalized such that the change supports revision to the regulation?
- Has the regulation or a portion(s) of the regulation achieved its original objective and become obsolete?
- Does the regulation require the use of or otherwise impose a scientific or technical standard? If so, is that standard obsolete or does it otherwise limit the use of updated or improved standards?

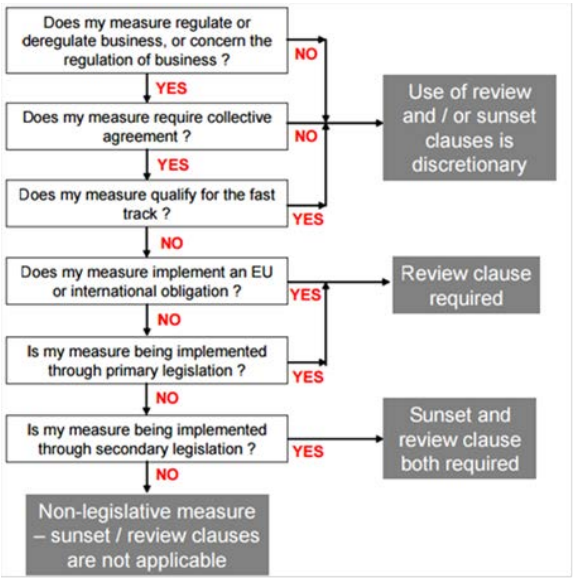
Source: US Environmental Protection Agency (2011)

As an example the EPA reviewed the vehicle fuel vapour recovery systems regulation because of its basis on redundant technology. On-board refuelling vapour recovery technology on current petrol-powered vehicles effectively controls harmful air emissions as cars and trucks refuel. This eliminates the need for controls at the gas pump that were regulated under the previous regulations. The EPA issued a proposed rule in 2011 to fix this, estimating the long-term cost savings associated with this rule to be approximately $87 million per year (2010$).

3.6 UK

In the UK, a number of circumstances result in a requirement for post-implementation review of legislation/regulation or the use of sunset clauses (policy-makers have to review regulation after five years and determine if it is still relevant, rather than leaving regulation permanently on the statute book when it is no longer required).

Figure 3.2 Sunset and review clause requirements



Source: Department for Business, Innovation and Skills (BIS) (2013a)

The sunset and review requirements are put in place to better understand how regulatory measures work in practice. For domestic measures (ie those not introduced as a result of an EU requirement),[9] the review must address three related questions (BIS 2013a).

1 Are the policy objectives that led to the introduction of the measure still valid and relevant?

2 If the objectives are still valid and relevant, is regulation still the best way of achieving those objectives, compared to the possible alternatives?

3 If regulation is still justified, can the existing measure be improved?

A number of things are considered:

- If the original policy objectives have changed or are no longer relevant, the measure should be allowed to expire (or be repealed).
- If the measure has not had a significant beneficial impact in line with the original policy objectives, the presumption should be that it is allowed to expire (or is repealed).
- If the review reveals unintended consequences of regulation, higher than expected costs, or low levels of compliance this should prompt significant redesign of the measure, or a move to address the policy objectives through alternative approaches.
- If a measure is shown to be successful and is retained, the review should still consider how the measure can be improved, for example by reducing the costs to business, or improving enforcement.

The requirements for a PIR are set out in *The magenta book* which provides the recommended central government guidance on evaluation and best practice for departments to follow (HM Treasury 2011). The overall framework involves a cycle of rationale, objectives, appraisal, monitoring, evaluation, and feedback (ROAMEF).

[9] For EU-derived measures, reviews focus on how implementation and enforcement could be improved to reduce burdens on UK businesses and ensure that they are not put at a competitive disadvantage.

Evaluation (after implementation) addresses the following questions:

- How was the policy delivered?
- What difference did the policy make?
- Did the benefits of the policy justify the costs?

The different planning and evaluation steps are set out in table 3.5 and evaluation techniques in table 3.4.

HM Treasury (2011) provides various examples of the different approaches. It appears to be a useful starting point for options for New Zealand.

Also of note, the UK introduced a 'one-in, one-out' system from Autumn 2010. It requires each department that introduces new regulation (an 'IN') to find a 'deregulatory' measure (an 'OUT'), which relieves business of the same net cost as any 'IN' (BIS 2013b). A 'one-in, two-out' rule was introduced in 2013 under which departments have to remove or modify existing regulation(s) to the value of £2 of savings for every pound of cost imposed (BIS 2013b).

Table 3.4 Evaluation approaches

Approach	Explanation
Process evaluation	Process evaluations can use a variety of qualitative and quantitative techniques to explore how a policy was implemented describing the actual processes employed, often with assessments of the effectiveness from individuals involved or affected by the policy implementation.
Empirical impact evaluation	Empirical impact evaluations use quantitative data to test whether a policy was associated with any significant changes in outcomes of interest. Various approaches are available which differ in their ability to control for other factors which might also affect those outcomes (the counterfactual, either directly measured or imputed) and hence in the confidence it is possible to place in the results.
Economic evaluation	Economic evaluation involves calculating the economic costs associated with a policy, and translating its estimated impacts into economic terms to provide a cost-benefit analysis. Economic evaluations will often make use of existing evidence and assumptions to facilitate the translation of inputs and actual measured outcomes into economic measures, making them akin to theory-based evaluations (see below).
Theory-based evaluation	Theory-based evaluation approaches involve understanding, systematically testing and refining the assumed connection (ie the theory) between an intervention and the anticipated impacts. These connections can be explored using a wide range of research methods (both qualitative and quantitative), including those used in empirical impact evaluation.
Meta-evaluation and meta-analysis	Meta-evaluations can use quantitative or qualitative techniques to bring together a number of related evaluations to derive an overview or summary conclusion from their results.
Simulation modelling	Simulation modelling is one way in which the results of different evaluations of separate parts of the impact pathway or logic of an intervention can be combined and requires that the evidence relating to the different links in the logic model are expressed in quantitative terms (eg effect sizes).

Source: HM Treasury (2011)

Table 3.5 Steps involved in planning an evaluation

Defining the policy objectives and intended outcomes	What is the programme logic or theory about how inputs lead to outputs, outcomes and impacts, in the particular policy context?
Defining the audience for the evaluation	Who will be the main users of the findings and how will they be engaged?
Identifying the evaluation objectives and research questions	What do policy makers need to know about what difference the programme made, and/or how it was delivered? How broad is the scope of the evaluation?
Selecting the evaluation approach	Is an impact, process or combined evaluation required? Is an economic evaluation required? How extensive is the evaluation likely to be? What level of robustness is required? Can proportionate steps be taken to increase the potential for good evaluation? What adjustments to policy implementation might improve evaluation feasibility and still be consistent with overall policy objectives?
Identifying the data requirements	What data are required? What is already being collected/available? What additional data need to be collected? If the evaluation is assessing impact, at what point in time should the impact be measured? Who will be responsible for data collection and what processes need to be set up? What data transfer and data security considerations are there?
Identifying the necessary resources and governance arrangements	How large scale/high profile is the policy, and what is a proportionate level of resource for the evaluation? What is the best governance structure to have in place? What budget is to be used for the evaluation and is this compatible with the evaluation requirements? Has sufficient allowance been built in? Who will be the project owner, provide analytical support, be on the steering group? What will the quality assurance processes be?
Conducting the evaluation	Will the evaluation be externally commissioned or conducted in-house? Who will be responsible for specification development, tendering, project management and quality assurance? When does any primary data collection need to take place? Is piloting or cognitive testing of research instruments required? When will the evaluation start and end?
Using and disseminating the evaluation findings	What will the findings be used for, and what decisions will they feed into? How will the findings be shared and disseminated? How will findings feed back into the ROAMEF cycle?

Source: HM Treasury (2011)

3.7 Germany

The Committee of State Secretaries' 2013 Resolution for the Reduction of Bureaucracy resolved that all laws meeting certain cost thresholds should be subject to systematic ex-post evaluation. The thresholds related to annual compliance costs and applied if these costs (estimated ex-ante) exceeded):

- €1 million citizens' material costs or 100,000 hours' time expenditure, or
- €1 million in the business sector, or
- €1 million for public authorities (Sharma et al 2013).

Evaluations should take place three to five years after the regulations become effective. The core criterion is target attainment, but other elements to be included in analysis are side effects (incidental consequences), (public) acceptance of the regulation, practicability and cost-benefit ratio (Sharma et al 2013).

3.8 Canada

In Canada, departments and agencies are responsible for ensuring regulation continually meets its initial policy objectives and for reviewing regulatory frameworks on an ongoing basis (Government of Canada 2012). The evaluation includes:

- inputs (eg resources, mandate, and enabling authorities), activities, effectiveness, ultimate outcomes of the regulatory programme, and the extent to which the programme contributed to the achievement of reported results
- value for money (eg relevance, efficiency, and cost effectiveness)
- governance, decision-making and accountability processes, service standards and service delivery mechanisms.

There is also a requirement for departments and agencies to identify regulatory frameworks in need of review. Once identified, departments and agencies are to examine the regulation with a focus on:

- the effectiveness of the current regulation in meeting the policy objective
- the current instrument selection, level of intervention, and degree of prescriptiveness
- the clarity and accessibility of the regulation to users
- the overall impact on competitiveness, including trade, investment, and innovation.

Canada also has a 'one-for-one' rule, similar to the UK rule from 2010, under which departments and agencies are responsible for:

- controlling the number of regulations by repealing at least one existing regulation every time a new one that imposes an administrative burden (ie red tape) on business is introduced
- restricting the growth of administrative burden by ensuring that new administrative burden on business caused by a regulatory change ('IN') is offset by an equal decrease in administrative burden on business from the existing stock of regulations ('OUT').

3.9 Project analysis

In addition to ex-post analysis of regulations, a number of countries undertake ex-post analysis of projects. While not of direct interest to this project, there are some lessons that might be learned. In

particular the approaches used have examined if ex-ante cost-benefit analyses (CBAs) have been accurate, if objectives have been met and if forecasts have been accurate. The approaches include assessments of individual projects and analyses across multiple projects that allow systematic differences between ex-ante predictions and ex-post outcomes to be identified.

3.9.1 UK Department of Transport

Highways England undertakes post opening project evaluations. They involve three stages (Finch 2015):

1 Collection of pre-scheme baseline data

2 '1 year after' evaluation

3 '5 years after' evaluation.

The analysis compares ex-ante forecast with ex-post result for objectives, eg journey times, congestion, journey time reliability, environmental impacts (air quality, noise) and safety. Additional to these evaluations are independent 'meta reports' which are published biannually to identify common themes in evaluation data and examine the relationship between predicted and observed impacts and to compare the performance of different types of schemes across different regions (Highways England 2013).

The elements include a revisit of the CBA that underpins the decision to go ahead with the project. A meta-analysis of multiple projects examines how they perform in aggregate (table 3.6). The meta-analysis also includes an evaluation of forecasting accuracy.

Table 3.6 Ex- post analysis of achieving major schemes' objectives

Question	Answer
How well are scheme objectives being achieved?	Major schemes are generally successful in delivering against their scheme specific objectives with 94% of scheme specific objectives being achieved. The remainder are either partially achieved (1%) or have insufficient evidence (4%) at this stage.
What are the main benefits of major schemes?	Journey time benefits are the key monetary benefits derived from major schemes, accounting for 75% of all monetary benefits. Safety benefits (measured by reductions in crash numbers) form the second biggest contribution. The mean monetary benefit for schemes appraised over 30 years is £171m and £246m for schemes appraised over 60 years. Widening schemes have the highest average benefits per scheme and the highest total benefits. Total benefits for 68 schemes are £14.2 billion based on varyingly 30 and 60 years of benefits.
Are major schemes offering value for money?	The average benefit-cost ratio is 4.1 which means that for every £1 spent on the scheme, the return will be more than £4 in long-term economic benefits. 72% of schemes achieved high value for money and 85% achieved medium or high value for money. A scheme is high value for money if the benefits are over two times the cost. Highway widening schemes achieved the highest average returns for the money spent and are providing over £5 of economic benefits for every £1 spent. Over time, benefit-cost ratios have been rising. Of the schemes that opened in the years 2008 – 2010, 85% have high out-turn value for money.
Do major schemes improve journey time reliability?	New bypasses, widening schemes and schemes upgrading A-roads to motorways significantly improve journey time reliability, with bypass schemes showing the greatest improvements.

Question	Answer
Are major schemes stimulating economic development?	There is anecdotal evidence to suggest a number of major schemes have served to assist local and regional economic development by reducing congestion, improving journey time reliability and more directly providing new or improved access to potential development sites.
What impacts do major schemes have on the number of crashes?	Major schemes provide a safer driving environment, saving an average of 10 personal injury crashes a year per scheme. The saving is statistically significant in two-thirds of scheme evaluations undertaken. Bypass schemes produce higher average benefits than either widening or junction schemes and have had the greatest overall impact on reducing the number of fatal and serious crashes. The four schemes which were upgrades of A roads to motorway standard have had large safety impacts. This is to be expected as they are larger than average schemes and involve a step change improvement to the road standard.

Source: Highways England (2013)

3.9.2 The French way: LOTI audits

France has a similar system for ex-post analysis of projects. The *Loi d'orientation des transports intérieurs* (LOTI) was introduced in 1982 requiring all major transport projects to undergo ex-post analyses 5 to 10 years after the infrastructure came into operation (Worsley 2015). The timeline of the evaluation period is as follows:

- ex-ante evaluation carried out for future project with consideration given to factors including economic, social, environmental, safety and health outcomes (Chapulut et al 2005)
- evaluation submitted for public scrutiny
- official decision to build taken after public enquiry, often ex-ante estimates are re-evaluated after the public enquiry
- ex-post results are made available to the public and reviewed by an internal unit of the French transport administration (Chapulut et al 2005).

Meunier (2010) found the average cost difference between the initial ex-ante analysis and the ex-post analyses is 24%. However, this difference is only 10% for ex-ante analyses re-evaluated after the public enquiry. Other benefits of this systematic process include:

- comparison between predicted and actual economic internal rate of return for all of France's major transport investments
- identification of the causes for observed differences between ex-ante and ex-post values to improve future appraisal methods
- transparency of ex-ante and ex-post evaluations.

3.9.3 Australia's Bureau of Transport and Regional Economics

Australia's Bureau of Transport and Regional Economics (BTRE) began systematically reviewing major road investments in response to the Australian Transport Council's *National guidelines for transport system management* (NGTSM) (BTRE 2007). The NGTSM outlines best practice for transport planning and evaluation in Australia and was last updated in 2006. The impacts considered by BTRE's studies are purely economic. The central purposes of these case studies are to:

- check the accuracy of the ex-ante CBA
- reveal sources of differences in results between the ex-ante and ex-post CBAs
- draw lessons from the case study in order to improve CBAs (both ex-ante and ex-post) for future projects.

A key learning from BTRE's ex-post projects is that ex-ante evaluations tend to underestimate road user benefits. For example, the current length of evaluation period in Australia is 30 years from the project start date; however, this could lead to underestimation of road user benefits for projects that take a long time to complete. Another cause of underestimation is simple extrapolation of past travel data in the ex-ante analysis. BTRE (2007) concluded that future traffic ex-ante evaluations would benefit from data which allowed for greater sophistication in traffic modelling.

3.9.4 Norwegian Public Roads Administration

The Norwegian Public Roads Administration (NPRA) has developed an evaluation methodology for road projects whereby five projects per year are chosen to undergo an ex-post evaluation. Only impacts that can be monetised are considered at the ex-post stage, including travel time savings, vehicle operating costs, crash costs, induced traffic, inconvenience cost (ferry projects), noise nuisance, local air pollution, road maintenance costs, residual value of capital, cost of public funds and road investment cost (Kjerkreit 2008).

Both the ex-ante and the post-opening impacts are calculated through specific computer software to keep the methodologies consistent. NPRA's primary objective of the ex-post assessment is to measure the accuracy of the information given to the evaluators at the time of the initial planning stage and to find out whether the benefits are acceptably larger, smaller or the same as what was forecasted (Kjerkreit 2008).

Kjerkreit's (2008) study of the NPRA's evaluations concluded that the economic performance of road projects, in net present value terms, was greater than forecasted for seven of the eight projects studied. This can be explained by underestimated traffic growth in the forecasting stage. As mentioned above, this measurement error was also experienced by Australia's BTRE.

3.10 Conclusions – lessons from international examples

The New Zealand Government has an expectation that regulations are regularly checked to see if they are fit for purpose and there are processes to improve regulations, taking account of historical performance against objectives and emerging circumstances that might affect that performance. New Zealand has systems in place for ex-ante analysis of regulations but there is no systematic approach to the review of regulations.

This contrasts with systems in place in other countries. The recent OECD survey suggests that 17 countries and the EU have a mandatory requirement for ex-post evaluation of regulations.

The absence of systems for regular regulatory review is significant, given the NZ Productivity Commission's comments that New Zealand appears to be biased in favour of more regulation and that many regulations have been introduced and not revisited: 'set and forget'. The Commission has also noted there appears to be a greater public demand for regulation, particularly to reduce risks that may reflect shifts in preferences but also might be individuals seeking to obtain the benefits of lower risks while passing costs on to the wider community.

In this report we examine the potential for ex-post analysis of regulation, and approaches that might be used, building on the international experience. The experience is informative with respect to: 1) choosing which regulations to review; and 2) the components of the review.

3.10.1 Which regulations

The international practice includes:

- sunset clauses that require a re-regulation to be made after a specified period, ie the default is for regulations to end and continuation requires a deliberate decision
- scheduled reviews in which a review is to be conducted after a specified period, but without the default position of discontinuation. This might apply to significant regulations only
- unscheduled reviews that might occur in response to monitoring of regulatory outcomes or public comment.

This report has focused on the components of regulatory review rather than its scheduling. Nevertheless, there is increasing use internationally of regulatory approaches which require review or removal to a scheduled timetable; these appear to be useful components of regulation where there is concern over regulatory accumulation.

3.10.2 Components of the review

Building on the experience described from other countries, particularly the UK, USA and Canada, table 3.7 lists the typical components of a regulatory review. These seem to be a useful starting point for reviews as they cover the individual components of a typical policy (or regulation) development process.

The international examples have included the analysis of problems justifying regulations in terms of the changes in trends of the risks that are regulated. Separately, the analysis examines whether alternatives to regulation exist in a way that might be more cost-effective or efficient. In this report we start from the position that the underlying justification for regulation is market failure. We address whether market failure analysis can lead more clearly to the identification of appropriate intervention, ie regulations that address the market failure identified. The analysis of problems from a physical risk perspective is still important, because it defines the size of the problem and thus the scope for benefits to exceed costs. Analysis of the impact of existing regulations on those risks provides information on the effectiveness (and net benefits) of the regulations.

Table 3.7 Main components of regulatory review in international examples

Component	Question(s)
Problem definition	Has the underlying justification for the regulation changed? This includes new scientific developments, changed trends, new technologies etc? Are the objectives that led to the introduction of the regulation still valid and relevant? Have the objectives been achieved, making them redundant?
Regulatory options	Is regulation still the best way to achieve objectives? Are there alternative non-regulatory options, including public-private partnerships?
Effectiveness	How effective is the regulation in meeting objectives?
Benefits and costs	Do the benefits still exceed the costs? Do alternatives exist with lower costs for the same objective? Can greater cost effectiveness be achieved? Are there particular impacts on vulnerable populations such as low-income, minority populations, children, or the elderly?

Component	Question(s)
Transaction/compliance costs	Does it have time-consuming requirements, eg paperwork, that can be reduced?
Regulatory improvement	Better coordination: Can it be modified to better partner with other regulatory areas or levels of government? Innovation and growth: Could the regulation be altered to have more impacts on innovation, economic growth or employment? What are overall impact on competitiveness, including trade, investment, and innovation? Flexibility: Is it highly prescriptive? Could it be made more flexible?

In this report we analyse these different components of regulatory review addressing the most significant components included in table 3.7.

4 Regulatory rationale

Section 3.10.2 set out the different components of regulatory review, building on international approaches but expanded to include the examination of the rationale for regulation on the basis of market failure. In this chapter we examine the question of regulatory rationale as a first component of a regulatory analysis. Effectively this is examining whether the rationale for regulation still applies (if it ever did). In chapter 5 we apply this to transport crashes and environmental problems.

4.1 Why regulate

Before examining the market failure rationale, we first note the difference between positive and normative reasons for regulation.

In examining the spectrum of regulatory responses as an input to the government's *Regulation 2025* project, Meade and Evans (2015) divide their discussion of regulation into:

1 Why do we regulate? – regulation as introduced in practice (the positive question)

2 Why should we regulate? – regulation that is consistent with theory (the normative question).

There is some overlap between the two when regulation is introduced for reasons that are consistent with theory, but other reasons include political or vote-seeking motives, and regulatory capture by major companies. In this study our interest is in normative reasons for regulation, ie the theory of why regulation should be introduced.

The NZ Productivity Commission (2014) noted that pressures on the government to regulate include:

- public expectations around risk and externalities – growing public expectations that the government will intervene to reduce risk and manage externalities
- rent seeking – regulation may be sought to protect an industry or group against competition
- incentives within the political system, that include constant media scrutiny, which encourages rapid responses to risks, failures or incidents, a short Parliamentary term, which puts pressure on politicians to deliver results quickly, and party disciplines, which prevent MPs from challenging or critically scrutinising regulatory proposals that emanate from their side of the House.

In reviewing regulation, the concern is to identify regulations that are consistent with an agreed rationale for intervention.

4.2 Market failure – the rationale for intervention

4.2.1 The market failure concept

As the wording implies, the concept of market failure starts from the assumption that markets fail to achieve some underlying objective. This implies that markets have a purpose, rather than just existing as private arrangements for exchange. Behind the concept of market failure is the assumption that markets exist to serve the community in achieving its objectives. These objectives are assumed to be those defined by utilitarian or welfare economics theory: that the best choice in any decision is that which maximises utility or wellbeing. From this perspective, when markets do not help to maximise community wellbeing, they are regarded as failures.

Market failure as a rationale for government intervention builds on the assumption that the overall goal of government is to maximise the total wellbeing of society over time, rather than, for example, simply to enforce private property rights. From this perspective, a legitimate question for a government to ask is whether the current allocation and use of resources is optimal for society as a whole? Where resource use is not optimal, the government has a role in correcting this.

As a general rule, private interactions (or markets) are assumed to be best able to achieve the optimal allocation of resources because they enable firms and individuals to express what provides them with wellbeing through their various decisions. However, where they do not, a utilitarian philosophy would suggest this is a failure of the market and a justification for government intervention.

Market failures are thus defined as the circumstances in which markets, or the numerous decisions of individuals and companies, do not achieve the best outcome for society as a whole.

4.2.2 The government and utilitarianism

The analysis in this report starts from the assumption that the objective of government regulation is to improve community wellbeing, taking account of the costs and benefits of intervention. Consistent with this, the New Zealand Government's 2009 *Statement on regulation: better regulation, less regulation* (now superseded by the *Regulatory system report 2013, guidance for departments,* NZ Treasury 2013b) states that, to justify regulation, the government needs to be fully satisfied that (English and Hide 2009):

- The problem cannot be adequately addressed through private arrangements and a regulatory solution is required in the public interest.
- All practical options for addressing the problem have been considered.
- The benefits of the preferred option not only exceed the costs (taking account of all relevant considerations) but will deliver the highest level of net benefit of the practical regulatory options available.
- The proposed obligations or entitlements are clear, easily understood and conform as far as possible to established legislative principles and best practice formulations.
- Implementation issues, costs and risks have been fully assessed and addressed.

More simply, from this perspective, the rationale for regulation is two pronged if:

- there is a market failure (private interactions alone will not result in the best outcome for society)
- the identified regulatory intervention is that which maximises net benefits (benefits minus costs).

4.2.3 How do markets fail?

To understand how and why markets 'fail', the starting place is the nature of the theoretical competitive market model from which actual markets might differ. The theoretical market might be specified as follows (adapted from Sorrell et al 2000):

- A complete set of markets with well-defined property rights exists so buyers and sellers can exchange assets freely, ie everyone can express what provides them with wellbeing because they can buy or sell all wellbeing-enhancing goods and services.
- There are numerous consumers and producers that behave competitively, seeking to maximise profits and/or minimise costs – numerous buyers and sellers ensure the market is liquid, so everyone is always able to purchase the wellbeing-enhancing goods and services.

- Market prices and product performances are known by all consumers and firms – everyone fully understands the attributes of all products and services and how they affect wellbeing.
- Transaction costs are zero – participating in the market has no costs so resources will always transfer to those to whom they provide the greatest wellbeing.

Violations of these market conditions lead to four broad types of market failure (Sorrell et al 2000):

1 Incomplete markets – not all resources, or components of resources, or the rights to their use, and that affect wellbeing, can be identified and exchanged with others, eg the existence of externalities such as noise or air pollution

2 Imperfect competition – there are few market participants or barriers to entry

3 Imperfect information – not all market participants have perfect information, eg vehicle purchasers imperfectly understand the full costs of vehicle ownership

4 Asymmetric information – sellers know more about vehicles than buyers.

In the next section we explore the different broad categories of market failure and isolate the chief issues that could be of concern for the land transport sector.

4.3 Types of market failure

4.3.1 Incomplete markets

Markets are incomplete where not all resources, or components of resources, or the rights to their use, and that affect wellbeing, can be identified and exchanged with others. Thus the existence of rights to use a resource, ie a property right, is an important component of a market.

For a (property) right over a resource to be effective it has to be identifiable, recognised by others[10] and be enforceable.[11] In that sense, it is only when property rights are defined in law or recognised by the courts as applying under common law, that the right can be exercised and found to have real value.

There is relatively widespread agreement on the characteristics of efficient property rights (see table 4.1). Markets are incomplete where property rights are not well defined in this terms of flexibility.

In the context of land transport, a major reason for market incompleteness is the existence of externalities (see more detailed discussion below). Property rights do not exist for some resources that affect wellbeing, eg clean air, and decisions on the use of other resources, eg fuel use/travel, take no account of the effects on wellbeing as a result.

Table 4.1 Characteristics of efficient property rights

Characteristic	Description
Flexibility	The extent to which the owner can change the mode or purpose of resource use without losing the right
Exclusivity	Whether others can interfere or reduce an owner's rights. The owner's benefits are greatest when they accrue to the owner and only the owner

[10] If one individual has a right, someone else has a commensurate duty to observe that right; if they do not, the right does not exist.

[11] They define a set of actions that can be undertaken and others that cannot, who can undertake them and who cannot.

Characteristic	Description
Quality of title	The certainty, security and enforceability of the property right. If rights holders are confident of limited change over time, their rights are more certain, and if rights are enforceable, owners are secure from involuntary seizure or from trespass
Transferability	Property rights can be transferred from one owner to another so that an owner can benefit from transferring the property right to the person that values the resource the most
Divisibility	Rights with respect to a property can be divided such that they apply to portions of the property that can be sold (or bought) separately
Duration	Valued because it enables the right holder to obtain value from investments

Source: Guerin (2003); Tietenberg (1984); OECD (2006)

4.3.1.1 Externalities

Externalities exist where decision makers do not take full account of all costs (or benefits) of a decision option because some of these costs (or benefits) fall on others and not (fully) on the decision maker.

Externalities occur where property rights have not been assigned to a resource, or when those who are affected by the use of a resource are not deemed to have property rights in it. Examples of externalities are widespread in environmental policy, eg when road users do not take account of the noise impacts on people living close to the road. In some instances optimal resource allocation can be achieved, despite the presence of externalities. For example, those affected may be able to pay the damage causer not to undertake the activity (Coase 1960); however, usually there are barriers to this making it impractical, particularly the difficulty of identifying the person expected to cause the damage prior to it occurring.

The theoretically ideal approach to correcting externalities is to ensure they are taken into account through decision makers facing a charge equal to marginal external costs (Baumol and Oates 1988).

Some activities may result in externalities which straddle different policy spheres rather than being limited to transport. For example, harmful local air pollution results from fossil fuel combustion. Such issues may fall more naturally under some other policy, eg environment or health policy/regulation, rather than transport. However, there is a risk that the externalities in any one policy sphere are insufficient to make addressing them a policy priority; this could mean that they are never addressed.

Part of the analysis in this study examines whether an externality is best addressed through transport regulation or through more generic regulation covering multiple spheres.

4.3.1.2 Public goods and common pool resources

Complete markets in which there is no market failure are defined with respect to theoretical and idealised private property markets that, under competitive conditions, will yield an efficient allocation of resources (allocation to those that value them most highly, ie for whom they provide the greatest wellbeing benefits). However, there are other property regimes that limit the extent to which prices can be set, largely because of the difficulties of excluding people from resource use. This includes:

- Public goods for which it is not possible to exclude people from their benefits, and they are not depleted by an additional user, eg information has public good properties, in the sense that it is difficult to prevent it from being shared widely. This means it tends to be under-supplied by the private sector (we address this in section 4.3.3)
- Common pool resources that share with public goods the difficulty of excluding people, but for which one person's consumption reduces that available to others (Ostrom and Hess 2007). Public transport

is sometimes defined as a common pool resource (Glover 2011) and public roads have common pool attributes (unless they are toll roads) that lead to congestion.

4.3.1.3 Innovation

Technological change can be subject to market failure. Two externalities are identified (Jaffe et al 2004):

- **Knowledge externalities** Technological innovations tend to have positive spill-overs for others. The owners of the technology (those bearing the costs) may not earn all the benefits when others observe and copy these innovations. This means that technological developments can be under-supplied.
- **Adoption externalities.** The cost or value of a new technology to one user may depend on how many other users have adopted the technology. The benefit associated with the overall scale of technology adoption can be generated by:
  - learning-by-using – observation of the technology adopted by others, so a user creates an externality for others
  - learning-by-doing – production costs tend to fall as manufacturers gain experience
  - network externalities – a product becomes technologically more valuable to an individual user as other users adopt a compatible product (as with telephone and computer networks, for example).

In addition to these externality issues, innovation and diffusion of new technology can be characterised by additional market failures related to incomplete information (Jaffe et al 2004).

4.3.1.4 Split Incentives

Split incentives or principal-agent (PA) problems may arise when a *principal* pays an *agent* to act on its behalf or for some good or service. The International Energy Agency (2007) has identified four different possible arrangements (cases) between principals and agents to identify possible problems relating to energy efficiency; they are pictured in figure 4.1 and explained below, including some examples relating to vehicle use.

1 The principal and agent are the same. The same person selects products, chooses its (energy)[12] efficiency and pays the resulting bills. There is no PA problem.

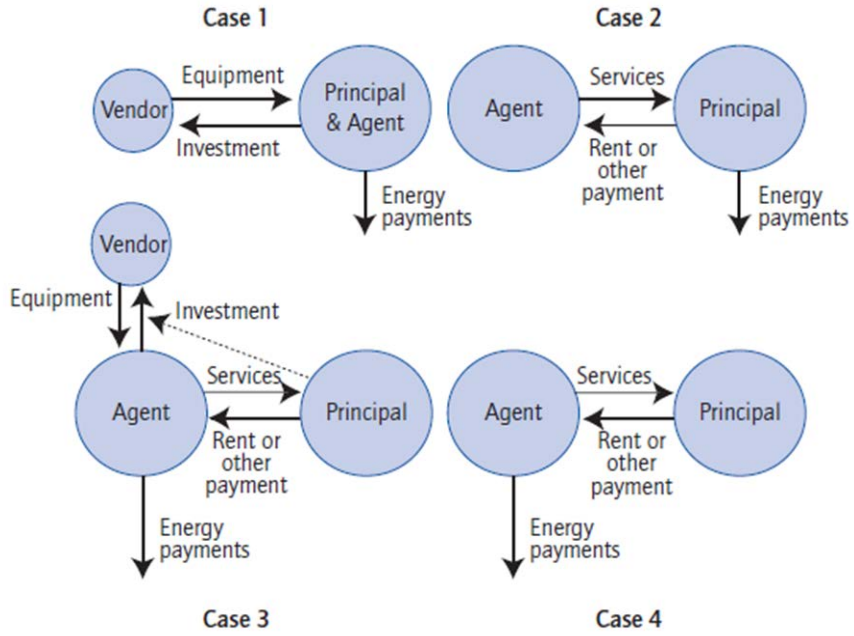
2 The principal and agent are separate, eg the agent (eg employer) offers a product (eg a work vehicle) for the principal's (employee's) benefit. The principal pays a rent or fee to the agent and must pay for the fuel (energy). There is a potential PA problem because the agent lacks incentives to consider energy efficiency performance when purchasing the asset for the principal's use.

3 Here the principal makes a decision that affects the fuel efficiency of the product (the dotted line). It uses the product but does not pay for either the product or the fuel. An example is a company car where the employee (the principal) chooses the company car that they will drive and the agent (the employer) pays for the vehicle and the fuel. The employee has no incentive to choose a fuel-efficient vehicle, nor to limit their fuel use – there is an efficiency and a use problem.

4 The agent (employer) pays for energy consumption and the principal (tenant) pays indirectly as part of the use payment, eg a shared vehicle in which the users pay a fee for average fuel use. The principal has little incentive to limit fuel use as its costs are spread across all users. Note this is also an example of the absence of marginal cost pricing, as discussed below (*imperfect competition*).

[12] The examples are developed for energy efficiency, but the issues would apply to other inputs that caused emissions.

Figure 4.1 The four cases of principal- agent problems



Source: International Energy Agency (2007)

The cases can be summarised in terms of a two by two matrix (table 4.2) in which the PA problem cases are shaded.

Table 4.2 The four cases of principal- agent problems

	End user can choose technology	**End user cannot choose technology**
End user pays fuel bill	Case 1: No PA problems	Case 2: Efficiency problem
End user does not pay the fuel bill	Case 3: Usage and efficiency problem	Case 4: Usage problem

Source: International Energy Agency (2007)

4.3.2 Imperfect competition

Markets allocate resources most efficiently when they are competitive. In addition to the other principles discussed here (well-specified property rights, perfect information), requirements for a fully competitive market include:

- many buyers and sellers so the market is not dominated by any participants (no market power) and all are price takers
- low or zero costs of transactions, entry and exit
- no barriers to access to capital and other resources
- homogenous products so that there are no differences between sellers.

Under these circumstances the prices of outputs would be expected to reflect the marginal costs of supply[13] of the marginal producer[14] and the market participants would be those firms able to supply at least cost. Our main focus here is thus on the existence or not of marginal cost-based pricing, eg in fuel prices.

4.3.2.1 Market power

Where there are few market participants, those with market power can raise prices above the costs of supply. In the transport sector, this may affect the costs of roads or of transport itself, eg charges of transport companies.

To a great extent, the price issues that result from lack of competition are dealt with under alternative policy and the Commerce Act specifically. It is unlikely that transport policy is the appropriate avenue to address issues of market power.

4.3.2.2 Price structure

The other price-related issue is whether market prices are efficiently specified. This applies particularly to the pricing of fuel that affects transport activity and to any pricing of access, eg toll roads. Prices are efficient if the price for an additional unit of activity, eg consuming one more litre of fuel or driving one more kilometre, reflects the marginal cost of supply. Where prices do not reflect marginal costs there will be under- or over-supply of transport activity.

4.3.3 Imperfect information

If decision makers do not have access to full information or do not know how best to process this information, they may not make all decisions that are beneficial (to buyer or seller). The amount of information required for efficiency cannot be precisely established (Sorrell et al 2000).

4.3.3.1 Information as public good

The market (private sector) may under-supply information because it is often difficult to limit access and thus to exclude people from its benefits, eg it has public good characteristics so private firms would be unable to capture all the benefits.

Golove and Eto (1996) point out the public good aspect of information is also relevant to technology adoption:

> *...the information created by the adoption of a new technology by a given firm also has the characteristics of a public good. To the extent that this information is known by competitors, the risk associated with the subsequent adoption of this technology may be reduced, yet the value inherent in this reduced risk cannot be captured by its creator.*

Information gaps will include those relating to the fuel efficiency and emissions intensity of vehicles, and the relative performance of vehicles with different levels of fuel efficiency. One particular and generic information gap would be that relating to future fuel (and emissions) prices, but this will affect all people, including the government.

[13] The costs of producing one more unit of output

[14] This is the highest cost producer that is producing

4.3.3.2 Economies of scale

Information may be under-provided or under-obtained by individuals compared to what is socially optimal when there are economies of scale in information provision. Here there may be benefits from government collecting and providing information in a way that lowers average costs for all decision makers.

4.3.3.3 Information asymmetry and adverse selection

Information asymmetry is a specific form of imperfect information in which one party (generally the supplier) holds much more information than the other (the purchaser), eg regarding energy efficiency in use and the cost implications. The issue of information asymmetry was explored with respect to the second-hand car market, as 'lemons economics' in a paper by Nobel Prize winning economist George Akerlof (1970). Akerlof argued that buyers have little information about the quality of the car they are purchasing. They do not know if it is a good used car or a poor one (a 'lemon') so buyers assume it is of average quality. The price they are willing to pay for an average car is less than the seller of the good used car is willing to accept. Hence owners of good used cars do not place their cars on the market and the quality of the cars on the market is reduced. This tends towards a market which is dominated by 'lemons'.

4.4 Barriers versus market failure

Market failures are defined on the basis of the difference between a theoretically ideal market and an actual market, and on the premise that the operation of a particular market is failing to deliver the social objective of efficient allocation of resources. Market barriers are more loosely defined as outcomes in which a market is not delivering outcomes which a simple net present value analysis would suggest was worthwhile (Jaffe and Stavins 1994). Examples of barriers include factors such as low priorities afforded to fuel efficiency in vehicle purchase decisions, difficulties in obtaining access to capital and high personal discount rates (Brown 2001).

Generally there are reasons why we would treat these issues differently from market failures. In contrast to barriers, the market failure concept provides a discipline to the assessment of the basis for intervention that might be missing from the barrier concept, especially where the economic analysis used to identify a barrier is simplistic. We have retained the stricter market failure criterion in this framework.

4.4.1 Behavioural economics and behavioural failures

Behavioural economics starts from the assumption that people do not behave as predicted by the rational choice model. Rather than all people acting consistently with what will maximise their wellbeing, people show evidence of (Mullainathan and Thaler 2000):

- bounded rationality (the limited cognitive abilities that constrain human problem solving)
- bounded willpower (people sometimes make choices that are not in their long-run interest)[15]
- bounded self-interest (people are often willing to sacrifice their own interests to help others).[16]

Some of these issues, particularly the bounded rationality issues, are very similar to problems of *imperfect information*. The UK Cabinet Office Behavioural Insights Team (2011) (the 'Nudge Unit') analysed behavioural issues as they apply to energy efficiency. In addition to high personal discount rates (as discussed above), these include:

[15] Examples are consuming too much, saving too little, rash decisions etc – see Shogren and Taylor (2008)

[16] Examples include reciprocity, altruism, paternalism and aversion to inequality – Shogren and Taylor (2008)

- The influence of social norms on behaviour and the benefits of providing comparative information to people. In a transport setting, perceived social norms around speeding or drink-driving influence behaviour but information might be used to change these perceptions.
- The importance of default settings because people often do not change them, eg providing pre-set options (eg times for heating systems to go on and off) for people that represent an estimated optimal setting. In a transport setting, the timing of vehicle servicing based on simple rules used by vehicle manufacturers, for example, may not be optimal from a private (or social) perspective.

Generally these behavioural issues are simply examples of bounded rationality and limited information: people are making simplifying assumptions when they are unable to evaluate all decision options (too costly or too complicated). The more complex examples of seemingly irrational behaviour are those relating to addictive behaviour, including drug or alcohol use that affects driving safety.

4.5 Regulatory failure

Just as markets fail, so do governments and regulations. Regulatory failures occur where regulations do not result in the optimal allocation of resources (that which maximises wellbeing), relative to some alternative allocation: a counterfactual. The interest of this report includes the existence of regulatory failure, ie if and where the current regulatory system fails to produce outcomes that maximise wellbeing, especially when it fails to correct market failures or even make matters worse. The analysis is similar to that for market failure, in that it needs to examine whether regulations are limiting the efficient performance of markets.

Treasury identifies a number of reasons for regulatory failure (NZ Treasury 2013a):

- Unintended consequences – by inducing behaviour or providing incentives that do not improve welfare.
- Inefficient regulatory enforcement – in the absence of market pressures, there may be a risk of institutional failure. For example, regulatory activity might not reflect the current preferences or risk-tolerances of the public.
- Moral hazard – making the market less responsive to competitive pressure by giving an implicit guarantee of government support or protecting incumbents from competition.
- Crowding out – a reduction in private economic activity due to complying with regulation.
- Rent seeking behaviour – government involvement can open the door to political lobbying to be given a share of wealth that has already been created. As with crowding out, this activity distracts from creating new wealth.

4.6 Conclusions

Market failure analysis provides a rationale for government intervention via regulation because it provides a reason why, in the absence of intervention, community wellbeing might not be maximised. We turn to specific examples on failures when we examine the issues in more detail in chapter 5.

5 Market failure analysis of road transport

As noted in chapter 4, the rationale for government regulation is the existence of market failures. In this chapter we identify the nature of market failures in road transport. This is used as the basis for assessing where regulation is justified and how this compares with the current use of regulation.

5.1 Crashes and safety

In section 4.2 we categorised market failures in terms of incomplete markets, imperfect competition, imperfect information and asymmetric information. Transport crash and safety issues are characterised by the following:

- Imperfect information – people are not knowledgeable about the risks they face
- Externalities – crashes result in impacts on others, eg pedestrians
- Incomplete markets – people are unable to choose to drive on roads with different levels of safety.

Savage, in his analysis of market failures in transport safety specifically identifies six types of market failure that include (Savage 2001):

- Cognitive failure – fully informed people make poor choices. We include this under imperfect information.
- Carrier myopia – costs of preventing crashes occur up front but benefits are in the future, so there is under-investment in safety. This is an example of higher private discount rates and does not represent a market failure.[17] If the argument is that safety investments are systematically treated differently from other investments, this is likely to reflect some other kind of market failure, ie an information failure or an externality.
- Bilateral crashes – the actions of two parties influence the probability of a crash occurring (one vehicle hits another). This is a sub-category of externalities.
- Imperfect competition – parties have different preferences for safety and all use the same road. We have addressed this under incomplete markets.

We explore these in turn below.

5.1.1 Imperfect information

People may be unaware of the risks faced when they drive or use other forms of travel. Crashes are rare events; based on 2014 data, people are likely to have a crash once every 192,000km[18] or to have an injury crash every 2.5 million km; fatal crashes are even rarer. With average driving distance of approximately

[17] Companies will differ in the extent to which they discount future costs and revenues relative to those in the near term. Generally this reflects their opportunity cost of capital, ie the cost of allocating money to current expenditures is that it is not available for investment purposes for which they might obtain a return. This applies to investments in safety in the same way as it applies to other aspects of their business. The firm's cost of capital may be different from society's social rate of time preference that might be used for policy decision making, but a difference in discount rates does not justify government intervention. If it did, it is likely that it would suggest that the government undertake all investments rather than the private sector.

[18] This is based on total crashes in 2014 (using the adjusted number to take account of unreported crashes) divided by total VKT.

10,286km per annum (MoT 2015c) this would mean a crash approximately every 18 years on average. Thus people have limited personal information to inform them on the risks of crashes and the factors that influence risk. Drivers (and passengers) may have experience of near crashes that might add to the level of experience, and they will also be informed by public information campaigns and other information in the public domain.

Regulators have addressed the lack of information with a number of responses including information provision and direct regulation. For example, the Transport Agency website suggests the key factors involved in safer driving are:

Table 5.1 Information and other responses to information gaps

Factor	Explanation	NZ Transport Agency response
Speed	The faster you drive, the less time you have to respond to hazards and the more likely you are to suffer serious injury in a crash	Advertising: • Numbers campaign (your speed affects others) • Mistakes campaign (other people make mistakes)
Alcohol or drug-affected driving	Consuming alcohol or other substances can impair your judgement and slow your reaction times behind the wheel	Advertising: • Limits campaign (drink) • Local legends campaign (drink) • Thoughts (drugs)
Driver fatigue	Driving when you're tired, weary or exhausted slows your reflexes and affects your ability to concentrate and make good decisions	Advertising: Dead on their feet campaign Fatigue calculator (online)
Driver distraction	Anything that diverts your attention for more than two seconds can significantly increase your likelihood of having a crash	Advertising: Mobile phone campaign
Giving way at intersections	Failing to give way at intersections is one of the main causes of death and injury on New Zealand roads	The Road Code Drive Safe website (www.drivesafe.org.nz/) Other information for visitors: www.nzta.govt.nz/safety/driving-safely/visiting-drivers/
Safety belts	Wearing a correctly fitted safety belt or child restraint reduces the risk of being killed or seriously injured in a road crash by 40%.	The Road Code Drive Safe website (www.drivesafe.org.nz/)

Source: www.nzta.govt.nz/safety/driving-safely/

In addition to these responses, road signs are put in place by local authorities, including in response to the government's *Safer journeys* strategy which aims to guide improvements in road safety over the period 2010 to 2020.

5.1.1.1 Cognitive failure

Even where people have information about risks, they may make poor choices. Savage (2001) provides the example that 'most drivers believe that they are more skilful and safer than the average driver!' This failure is an information processing problem, eg people do not think the information applies to them.

People have a tendency to overestimate the possibility of low probability events and events that kill multiple people at any one time (Lichtenstein et al 1978). They are also particularly fearful of life-

threatening events where they have no control over the outcome. Therefore aviation risks cause a disproportionate amount of fear compared with car driving where many drivers feel they have the skill to mitigate or avoid hazardous situations.

There have been some responses to this type of market failure, eg the senior drivers' self-rating assessment tool.[19] It is an on-line tool that asks a series of questions including those relating to driving behaviour, responses to stressful situations, vision and crashes in the past. This is used to produce feedback and guidance. However, these kinds of tools will not reach the majority of drivers, particularly those who are not in vulnerable categories.

In their analysis of market failures, Sorrell et al (2000) define cognitive failure as a subset of imperfect information.

5.1.2 Externalities

Externalities apply particularly to environmental issues, but there are also significant externalities relating to crashes.

Driver behaviour affects crashes when drivers travel too fast for conditions, make mistakes or do not understand the consequences of their actions. The rational market model would assume that drivers acted in response to an assessment of the risks of a crash and the costs that they faced if a crash was to occur. Acting consistent with this would result in optimal decisions if drivers possessed full information about the level of risk at any time and place (and any conflicting benefits, eg the benefits of arriving earlier at a destination that explains their speed) and if the costs they bore as a result of a crash were equal to the costs imposed on the community as a whole. Where crashes are caused by drivers, they may take account of risks that affect them directly, eg the potential costs of vehicle damage, injury or even death, but they may not fully account for the effects on:

- passengers
- others affected directly, eg vehicles, pedestrians and property owners
- other affected parties, including family, friends and employers/employees.

To some extent the existence of externalities is exacerbated through insurance, including the ACC in New Zealand. We explore these issues separately below.

5.1.2.1 Bilateral crashes

Bilateral crashes are an example of imperfect information and potentially of an externality problem also. Drivers do not fully take account of all the risks associated with their driving behaviour (or their vehicle or conditions) because the risks of a crash are affected by the actions of other drivers also. A driver will not know when another driver is acting differently from how they would expect other drivers to act, and the risks that a driver poses will differ with the behaviour of others. For example, a speeding driver may be more likely to have a crash if another driver is also speeding: the time to stop safely is reduced for both vehicles.

5.1.3 Incomplete markets

Savage defines imperfect competition as a situation which might alternatively be defined as an incomplete market. Drivers may prefer a lower risk driving environment, ie one in which all other drivers drove safely, but such an environment may not be available. They cannot choose to participate in such a driving

[19] www.nzta.govt.nz/safety/driving-safely/senior-drivers/self-rating-assessment/

environment when one does not exist. People have to share roads with people with different risk preferences.

5.2 Insurance

Insurance markets allow people to spread their risks. All road users face a risk of crashes; each time they use the road there is generally a very small probability of a crash but, if the crash occurs, the consequences may be high. Road users can take measures to reduce that risk, eg by driving at a lower speed, travelling in a safer vehicle and so on. Insurance provides a means for allocating and spreading the risk of loss. To the degree that a person owns insurance, they will not have to pay damages if found liable for a crash. This changes incentives.

Ideally, and to achieve optimal social outcomes, people take decisions consistent with their expected utility, ie to maximise their wellbeing. When this comes to crashes, the impact is estimated as the probability of a crash occurring times the cost of that crash if it were to occur; people would make decisions to reduce those risks where the costs are less than the benefits (reduced probability or reduced outcome, or both). In this equation, the expected utility effect of a crash with a large potential impact but a low probability is the same as a higher probability event with a lesser outcome, eg a 0.01% chance of a crash that would cause damage equal to $1 million has the same expected (dis)utility as a 10% risk of a crash that would cause $1,000 of damage. However, people are generally risk-averse in relation to serious crashes because the losses would be significant in relation to their assets, but where losses are more likely to be modest compared with assets, a person is more likely to be risk neutral (Shavell 2002).

Insurance spreads risk in a way that is (broadly) consistent with people facing the expected disutility of crashes. It stops risk-averse individuals from taking excessive care to avoid crashes, eg by not driving. Insurance raises the utility of injurers (they choose to purchase insurance) and does not affect the utility of the injured (they receive compensation) (Shavell 2002).

However, insurance is a blunt instrument and insurance costs do not change with driver behaviour that also affects the risk of a crash. Insurance takes account of risk that is associated with the type of vehicle that a person drives and the risks that are broadly associated with a person by age (reflecting driver maturity and driving experience). However, insurance does not take account of the specific behaviour of an individual, except to the extent that a person has had crashes in the past that have affected insurance premiums. Thus some of the costs of crashes become an externality in decisions that a driver might make to reduce crash risks.

In theory, and in a competitive insurance market, it would be expected that insurance premiums paid would be equal to the annual probability of a crash times the consequences of that crash. Under such a competitive model, and assuming no transaction costs for the insurance company, the expected utility of each individual would be the same regardless of whether or not they took insurance. The incentive to take insurance (if it was not compulsory) is that, although a probability of a crash might be low, the level of cost if a crash were to occur can be very high. Despite not being compulsory, a 2009 survey found that over 92% of vehicles were insured, the majority (86% of those insured) with comprehensive insurance (MoT 2009b, p5). This compares favourably with some other countries with compulsory insurance, eg the UK has compulsory third party insurance but reports that only approximately 94% are insured (ibid, p5).

The situation is somewhat complicated in New Zealand through the existence of the ACC no-fault personal injury cover. This is compulsory insurance that covers the cost of any injuries sustained in a crash.

ACC levies are paid partly through vehicle registrations and partly through fuel taxation (excise duty on petrol). ACC levies are higher for diesel vehicles because there is no charge per litre (or per kilometre

using the RUC). The levy on diesel vehicle registration is set so that a diesel vehicle travelling the average distance per year is subject to the same ACC levies per year as a petrol vehicle which pays a registration fee and an ACC levy of 6.9 cents per litre. ACC levies also vary depending on vehicle type:

- Goods service vehicles pay more because they have a higher risk rating and drive greater distances than standard cars.
- Motorcycles pay more because of the high crash rate and cost of motorcycle crashes.

ACC is a form of compulsory insurance for one element of risk: injury and death as opposed to property damage. However, it uses a different risk model to one which would mimic what a private insurer would do in a theoretical efficient insurance market. Because it is a no-fault insurance scheme, it estimates the risks of different vehicle types being involved in a crash in estimating levies. However, it does not act completely consistently with this. For example, ACC estimates that motorcyclists are far more likely to be involved in a crash than a car driver. Taking account of the probability of a crash, and the costs of that accident, it estimates that a levy per motorcycle (net of ACC payments made per litre of fuel consumed), that cover the expected costs of all injuries to motorcyclists, should be $1,025–$1,881 per annum (table 5.2) (or $587-$1,067 for only those crashes that do not involve other vehicles); current levies for motorcycles are $327 or $427 per annum. The fees are reduced because, otherwise, 'owning a motorcycle may become prohibitively expensive'.

Table 5.2 Comparison of ACC levies with risks

Motorcycle subclass	Current licence fee	Licence fee if based on past claims experience	Licence fee if only considering motorcycle claims (no other vehicles)
600cc or less	$327 pa	$1,025	$587
Over 600cc	$427 pa	$1,881	$1,067

Source: Accident Compensation Corporation (ACC) (2014)

Insurance has social value in that it reduces the risks faced by risk-averse individuals, resulting in them driving more than they would without insurance (and assuming liability rules applied). However, it also reduces the risks faced by risk-seeking individuals. In broad terms it provides the right incentives for people to drive, rather than not drive. However, it reduces incentives for risk-reducing behaviour and introduces externalities where they might not exist with a pure liability regime.

5.3 Path dependency

The New Zealand vehicle fleet is made up of vehicles of different ages; the average age is approximately 13 years old and vehicles imported now will remain in the fleet for many years. The vehicles that are purchased now will affect the safety of the fleet and its emission rates for many years. Our future choices are limited by the choices made in the past, ie we have a 'path dependency'.

This is not a market failure, but it may be the source of considerable regret. For example, if the price of carbon rises to high levels in the future but New Zealand has a stock of carbon-intensive vehicles, it would result in emission reductions being achieved only at high cost by early stock turnover or by limiting use of these vehicles. For policy makers, the question is whether there are future changes in circumstances that are likely to result in regrets and that can be anticipated now.

As an example, two authors from the California Energy Commission noted that 'the United States chose not to regulate passenger truck and SUV size much, and not to penalize size with significant gas taxes. The result has been an arms race in SUV size, as people buy bigger and bigger to feel safe as they face

potential collisions with other big SUVs. Now, even if gas prices rise, many will choose high gas bills and buy big vehicles, just for perceived protection. In Europe, gas taxes are high, cars have stayed small, and people don't need size to feel safe. All the Europeans' safety money can go into smart car design' (Woods and Kandel 2002). They concluded that vehicle and other markets have more than one equilibrium point at which consumers find their optimum vehicle choice and that the markets can develop differently to provide similar levels of net welfare to consumers but be structured quite differently. In the US, because people started buying SUVs, others have followed suit in order to feel safe; however, equal levels of safety and wellbeing could be achieved through a different mix of vehicles with few SUVs.

New Zealand research does not suggest the same problem here (Thomas and Walton 2008). However, the potential for path dependency regrets still exist. The path dependency effect is simply, as a result of numerous decisions made in the past, we have the vehicle fleet that we now have, and because the fleet takes many years to change over, correctly anticipating future values of different vehicle types is useful. However, whether this has any policy implications is not clear. Individuals making vehicle purchase decisions have an incentive to anticipate future value (price depreciation) of their vehicle, and whether the government is better able to anticipate trends is not clear. Where the government might have better information, eg regarding anticipated future international regulatory changes that might affect markets, it can address these through providing information to the market.

5.4 Environment

5.4.1 Externalities

Environmental problems are largely examples of externalities. These are costs (or benefits) the community faces as a result of transport decisions that are not borne by the decision makers. Examples include the emissions from vehicles and road run-off to waterways. We examine a number of the issues separately below.

5.4.1.1 Greenhouse gases

Greenhouse gases (GHGs) from transport are included in the Emissions Trading Scheme (ETS) and are internalised to the extent that the price paid under the ETS reflects the social cost of GHGs and that the market is efficient, ie if the market responds to prices. In this section we address whether the potential external costs are internalised and whether the market responds to this under the discussion of information failures below.

Theory suggests that the optimal approach to addressing an externality problem is to introduce a charge equal to the marginal external (damage) cost (Baumol and Oates 1988). This is the cost of one more tonne of emissions.

There are two possible ways to estimate a cost of carbon: the social cost of carbon, ie an estimate of the damage costs attributable to CO_2–e emissions, or the cost of emission units used by New Zealand to bring itself into compliance with international commitments to limit emissions. We discuss these different options below.

For CO_2 and other GHGs, the complicating factor is that they have global effects; because they are very long-lived,[20] GHGs mix thoroughly in the atmosphere and the emissions from New Zealand will be widely distributed adding to global concentrations. The damage costs associated with one more tonne of CO_2–e emitted from New Zealand will be experienced by all countries. This is relevant to CBA because a national

[20] CO_2 is in the atmosphere until it is absorbed by the ocean or through photosynthesis.

perspective is taken. Effects outside New Zealand are not taken into account; we do not count as a benefit the profits made by foreign-owned companies and we do not count the costs that New Zealand imposes on others. From this perspective, the costs to New Zealand of emissions from New Zealand are very small – a small fraction of any estimates of the global social costs of carbon.[21]

This does not mean that New Zealand's climate change policy is developed with no account taken of the effects on other countries; quite the opposite. Precisely because GHG emissions from all countries have largely global rather than local effects, climate change policy has developed via international agreements under the United Nations Framework Convention on Climate Change (UNFCCC), including the recent Paris Agreement (FCCC/CP/2015/L.9/Rev.1). Under these agreements New Zealand has agreed to limit its emissions (its nationally determined contribution under the Paris Agreement) to some absolute level. The cost of each additional (marginal) tonne of emissions is the cost of coming in to compliance with the agreed limit, ie the cost of New Zealand reducing emissions by one tonne or of purchasing emission units from the international market in a way that would be consistent with the international obligations. Given full information, rational decision making and an economically efficient international regime to limit emissions that included full international trading of emission units allowing global emissions to be limited at least cost, we might expect the price of emission units to reflect the marginal damage cost. However, in the absence of such an ideal market, it is still the price of emission units that reflects the social cost to New Zealand of every additional tonne of emissions. To use a social cost of carbon is to take a global perspective for analysis and, to be consistent, this would also include all impacts on foreign companies and individuals.

New Zealand is in an interim position until 2020. It has a voluntary emission limit that it has taken under the UNFCCC but not under the Kyoto Protocol, and during this period it has more self-defined emission units available than expected demand. However, because New Zealand units (NZUs) are eligible for use currently and in the post-2020 period when New Zealand will have a more binding international target under the Paris Agreement and there is likely to be a shortfall of supply relative to demand, the current prices of NZUs are likely to reflect anticipated future prices, discounted back to the present time. The prices in the ETS, post-2020, are expected to reflect the costs to New Zealand of coming in to compliance with its obligations.

Currently emissions from the transport sector are included in the ETS. However, as at April 2016 the liability for emitters is one NZU for every two tonnes of emissions, ie the liability is only 50% of the total cost. However, this is expected to change in the future (Ministry for the Environment 2015). Thus we can assume that transport fuels will include a price of emitting GHGs and that the price will reflect the social costs to New Zealand as a whole, ie the marginal cost of coming in to compliance with its internationally agreed emissions limit.

The costs of NZUs are passed on in the price of liquid fuels for transport users (Covec 2011). The issue is then whether the market responds efficiently to price and we address this under 'information failures' below.

5.4.2 Imperfect information

People take account of the price of fuel when they decide to make an individual trip and when they invest in vehicles. We assume that companies make these decisions efficiently because of their focus on costs and revenues. In this section we examine whether households do so when making vehicle use and purchase decisions.

[21] Estimated as US$12-$123/tonne of CO_2 in 2020 in Interagency Working Group on Social Cost of Carbon (IAWG) (2010)

Once a vehicle has been purchased, the fuel consumption is determined to a significant degree; short run price elasticities of demand to fuel price are low and people will drive the vehicles they have. The stock of vehicles in New Zealand determines most of the vehicle choice available to future purchasers. The rational choice model assumes that when making a purchase decision, people estimate the benefits they will receive from different types of vehicle and weigh these against the full costs of that vehicle. This includes:

- the initial outlay (capital costs)
- running costs over the time they will own the vehicle, including fuel costs plus repair and maintenance costs, all discounted back to the present
- the expected future revenue from the sale of the vehicle at some later date, discounted back to the present
- the benefits that they will enjoy from use of the vehicle.

However, it is unlikely people will undertake such an analysis or that data is readily available to allow them to do so.

5.4.2.1 Vehicle fuel economy label

Fuel economy information has been available in New Zealand at the point of sale of vehicles since April 2008. Under the Energy Efficiency (Vehicle Fuel Economy Labelling) Regulations, all new cars, and all cars manufactured since 2000 and imported since 2005 for sale, must display information about the vehicle's fuel economy, if that information is available. It applies to any vehicle sold by a motor vehicle trader and any person selling a vehicle on an internet trading website.

The fuel economy information is expressed as:

- fuel economy cost per year
- fuel economy rating out of 6 stars
- fuel economy in litres per 100km.

Fuel costs are estimated on the basis of recent annual average fuel prices (which include emission costs), the manufacturer's estimate of fuel consumption and an assumed 14,000km per year of travel. This provides a basis for comparison of different vehicles.

A September 2008 survey of people who had made vehicle purchase decisions in the prior four months sought to identify the awareness of the vehicle fuel economy label (VFEL) amongst buyers and the influence that it had on purchase decisions (Nielsen 2009). The research based on 500 surveys found that:

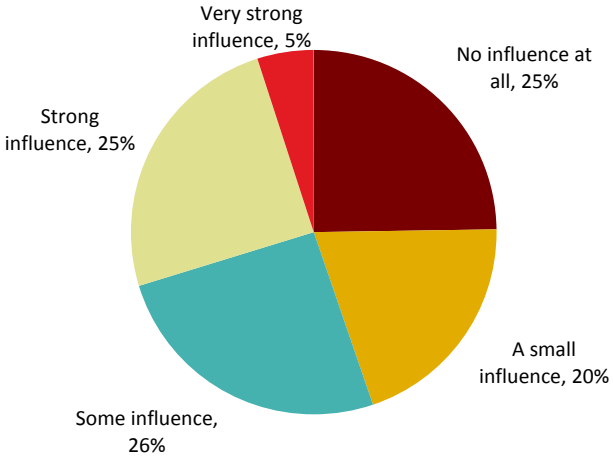
- 64% of car buyers had heard of or seen the VFEL
- 56% of those aware of the VFEL said the label and the information on it had some influence, a strong influence or a very strong influence on their final decision (see figure 5.1)
- car buyers rated fuel consumption the third most important reason, behind price and reliability, for deciding on a particular vehicle (figure 5.2).

Of the information provided on the label, the most helpful information was stated to be the fuel consumption figure (litres per 100km); 55% of people found this most helpful. This was followed by the fuel economy stars (27%) and the cost per year (26%).

Fuel prices have shifted relatively significantly over time. For example, average prices over the 2010–2014 period are approximately 15% higher than current prices, and the peak (in 2013) was 27% higher (Ministry of Business, Innovation and Employment (MBIE) weekly oil price monitoring).

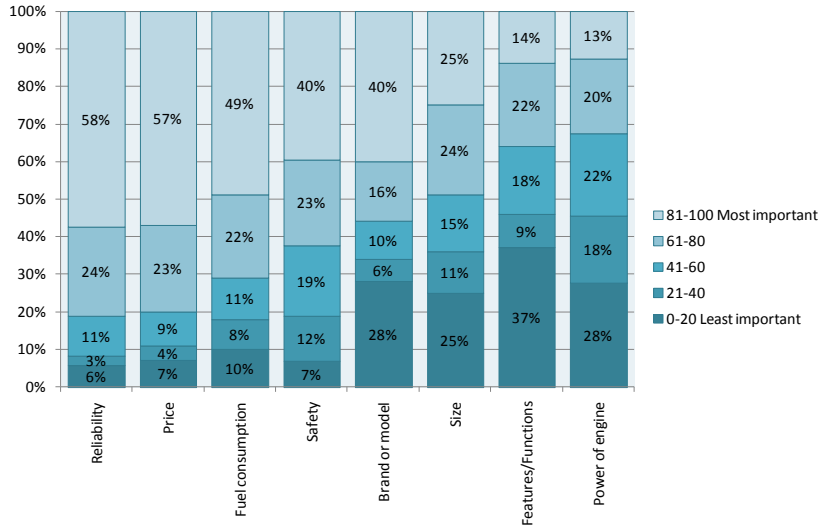
In addition to uncertainties over the fuel price, there are also uncertainties over VKT. Figure 5.3 shows the distribution of light passenger vehicles in categories of annual VKT; the data is shown relative to the assumed 14,000km per annum which is the average distance travelled. The figure suggests the average may not be the best measure to use and it will vary significantly by vehicle, including in relation to the age of the vehicle purchased (new vehicles are driven more than old vehicles). The median VKT is approximately 9,000km rather than the 14,000km assumed. If this is representative of vehicles purchased, more than 50% of people would be presented with information on fuel costs assuming VKT of more than 5,000km than they will actually travel, and over 40% of people will be presented with information on the basis of VKT that is at least double of what they will actually travel.

Figure 5.1 Influence of VFEL on purchasing decisions



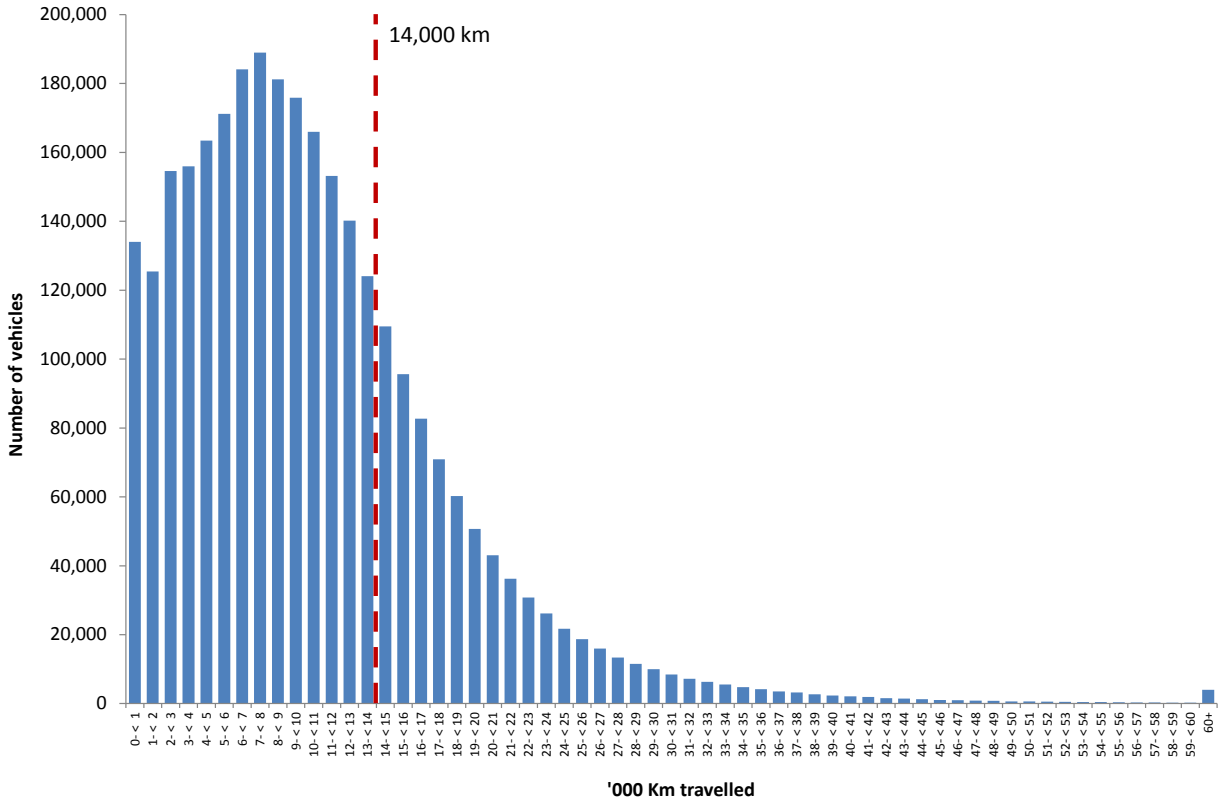
Source: Modified from Nielsen (2009)

Figure 5.2 Factors influencing car buyers



Source: Nielsen (2009)

Figure 5.3 Distribution of distance travelled per vehicle (in 2014) by post- 1999 light passenger vehicles



Source: Data provided by MoT (Stuart Badger, personal communication)

The extent to which the cost information is misleading depends on whether it is used:

- only to compare vehicles (is one vehicle more fuel efficient than another?) for which it might be useful, although it may over-emphasise the importance of the difference, or
- if it is used to estimate total costs of ownership (purchase cost plus fuel cost) for which it could be misleading.

However, we do not know how this information is interpreted by vehicle purchasers, eg whether they make an estimate of lifetime costs on the basis of annual costs, use annual costs as an estimate of lifetime costs or something else.

Because the label is simple and makes broad assumptions about vehicle use, for any individual vehicle purchaser, it may under- or over-estimate actual fuel costs. And whereas relative fuel costs are important, absolute costs are important also because fuel costs are being compared with purchase costs. From an economic efficiency perspective, the label may make decisions better or worse.

The other issue to take into account in defining a market failure is the current behaviour of vehicle purchasers. Interviews conducted by Covec in 2009 with fleet buyers and fleet managers suggested that people wishing to have a more fuel efficient vehicle would often make simplifying assumptions, eg to purchase a small car or a hybrid. These may not be entirely consistent with actual fuel efficiency differences which, for example, are affected more by weight than engine size, but the factors are not unrelated, and the VFEL would be expected to improve these choices.

5.4.2.2 Published studies

A number of studies have addressed the extent to which consumers take account of fuel economy in making purchase decisions. Many of these are US studies. We summarise the results of some of these below.

5.4.2.3 Taking any account of fuel costs

A number of studies suggest that consumers take little account of fuel economy at all. A US national random survey of 1,000 households found that (Opinion Research 2007, cited in Greene & Leiby 2007):

- 39% did not consider fuel economy at all in their last vehicle purchase, and
- of those that did, only 14% mentioned they took economic factors (fuel costs, gasoline prices) into account.

This compares with the results of the VFEL study in New Zealand that suggested 75% of people who were aware of the label took fuel economy into account, at least to some extent (see figure 5.1).[22] Turrentine and Kurani (2007) comment on the expectation that people will behave consistent with the rational choice model in making vehicle purchase decisions.

> *While many analysts admit that something is wrong with rational choice, they still create models and debate fuel economy policy as if drivers keep records on vehicle and gasoline costs, estimate their purchase costs and future ownership and operating costs, and discount future cost and benefit streams, as from higher fuel economy. Consumers are assumed to consider the cost of gasoline and fuel economy both in their travel and vehicle choices, and to consider such costs over time.... past interviews we have conducted with automobile buyers lead us to think that the rational actor model is not an accurate or useful view of how consumers think about fuel economy and automotive fuel costs. A multi-year project on markets for alternative fuelled vehicles in the 1990s left us with the impression that automobile owners did not have any idea how much they spend on fuel and often did not know the fuel economy of their vehicles.*

5.4.2.4 Ability to process information that they have

Those who do have information may not process it accurately. Semi-structured interviews with 57 California households found no households that analysed their fuel costs in a systematic way in their vehicle or fuel purchases, and almost none of them tracked fuel costs over time or considered them explicitly in household budgets (Turrentine and Kurani 2007). The researchers noted that:

> *households may know the cost of their last tank of gasoline and the unit price of gasoline on that day, but this accurate information is rapidly forgotten and replaced by typical information. One effect of this lack of knowledge and information is that when consumers buy a vehicle, they do not have the basic building blocks of knowledge assumed by the model of economically rational decision-making, and they make large errors estimating gasoline costs and savings over time* (p1213).

Consumers do little calculated decision making, relying mostly on information immediately available (Turrentine and Kurani 2007). The researchers noted, 'Even the accountants, bankers, and financial analysts we interviewed do not keep track of their gasoline costs other than to note the price of a gallon or tank of gasoline the last time they went to the gas station—the same as any of our households' (p1216).

[22] Greater concern about fuel efficiency in New Zealand compared with the US may reflect more expensive fuel prices.

Turrentine and Kurani asked how much households would be willing to pay for a 1.5 times increase in fuel economy expressed as miles per gallon. From the 57 households, 'only two individuals offered plausible willingness-to-pay answers arrived at through a process that could be described as economically rational (rather than through simple guessing)'. Also in the US, a study by the National Research Council considered the undervaluing of fuel economy (Greene 2007). In its analysis, a fuel economy increase was considered cost efficient if the marginal cost of the increase was less than or equal to the marginal benefit in fuel savings to the consumer. If car buyers compare the discounted present value of fuel savings over the full life of a vehicle with the increased cost of fuel economy technologies needed to achieve it, fuel economy improvements of 12% to 27% were cost efficient for passenger cars, and from 25% to 42% for light trucks. However, willingness-to-pay studies suggest that, even with full information presented to them, consumers were willing to pay only for technologies with a simple payback period of three years or less;[23] under those assumptions the cost-efficient fuel economy changes ranged from -3% to +3% for cars and 2% to 15% for light trucks.

5.4.2.5 Conclusions from the international literature

The literature seems clear that consumers either do not consider fuel economy in making purchase decisions, or do so, but not in any detailed way. One of the reasons for not considering fuel economy in detail appears to be the inability to process the information, even if they have it. Or possibly, this is a reflection of the (time) costs of processing the information.

It is also clear that vehicle purchases involve consideration of a large number of vehicle attributes, including safety, reliability, size and features. Fuel economy is one attribute in the mix.

Where fuel economy is taken into account it appears to be mostly by those with low income (and thus wishing to limit total costs) or with potentially high fuel costs (eg those with a long commute). This is expected; those for whom fuel costs would have the most significant impacts take more account of it than those for whom it has less impact.

5.5 Potential versus actual market failures

The discussion in this section has identified a number of potential market failures that could affect decisions whether to drive, driver behaviour and vehicle purchase decisions. However, there is a difference between a potential market failure and an actual market failure. An actual market failure would mean that 'market outcomes' are different from what would be expected in the absence of market failures, ie if resources are allocated efficiently. In most cases we do not know what this outcome would look like. For example, there is a potential market failure in vehicle purchase decisions relating to fuel economy but because of the very wide number of factors that go into a vehicle purchase decision, it is not clear if optimal information provision and the capacity to process it, would lead to different purchase decisions.

In these circumstances the best response is to correct market failures through means that will unambiguously improve outcomes, ie through:

- correcting prices to include externalities
- providing information that would allow decision makers to be fully informed.

[23] Half of a random sample of households was asked how much they were willing to pay for a fuel economy improvement that would save them $400 per year in fuel costs. The other half was asked how much money they would have to save each year in fuel costs to justify a $1,200 increase in the price of a vehicle. The average payback periods implied by consumers' answers to these questions were roughly 2–2.5 years, regardless of which way the question was posed (Greene 2007).

5.6 Conclusions

The majority of crash/safety risks involve a combination of:

- imperfect information (or information gaps) – people do not know the risks
- externalities – the impacts/costs fall on people other than the driver responsible (or in part responsible) for the crash (table 5.3).

Table 5.3 Main market failures associated with crashes and environmental effects of road transport

Issue	Imperfect Information	Externalities
Crashes	The risks not well understood are associated with: • driving behaviour (own and others) • the risk profile of other drivers on the road	Crashes have costs for others that are not borne fully by the causer of the crash. Insurance and ACC partly insulates causers from costs.
Environmental impacts	People operate with partial information on the environmental effects of their vehicles, even when the impacts are internalised (GHG emissions via the ETS)	With the exception of GHG (internalised via the ETS), environmental effects are largely external costs

Source: Covec

There is also a problem of incomplete markets in which people cannot chose to share roads only with people with similar risk profiles. This might be described as a variant of an externality problem; others impose risks on you that you have limited control over.

Crashes and safety issues relating to vehicles are significantly affected by insurance, including ACC. It means that market signals may never provide efficient incentives to increase safety. Drivers are insulated from the full costs of their actions through no-fault compensation for crashes (so the burden does not fall on the causers of the crash) and insurance that spreads risk amongst all drivers.

Environmental problems similarly include a mix of imperfect information and externalities. Externalities include:

- the partial internalisation of GHG costs (although we expect that these will be fully internalised in the future
- local air emissions that are currently addressed through emission standards but are still emitted by all petrol and diesel vehicles.

Information problems exist because, although GHG costs are (or will be) internalised in fuel costs, fuel costs are not necessarily taken into account efficiently. However, mechanisms exist to address this, specifically through the VFEL, and the impacts of the information failure are (very largely) borne by the individual themselves via higher fuel costs.[24]

In theory, market failure analysis provides a rationale for intervention across all regulatory spheres. For transport crashes the existence of market failures is almost taken as read and there is no systematic attempt to analyse these. Rather the focus of regulation and government strategy has been on risk reduction, making the transport system safer. This may not be inappropriate as potential market failures

[24] There is some potential wider impact as purchase decisions relating to vehicles when they first enter the New Zealand market have implications for the future stock of vehicles available for purchase.

are widespread. However, it suggests that market failure analysis may not be useful in problem identification. Environmental problems are similarly persistent and difficult to internalise.

Market failure analysis may still be useful in evaluating regulations. Specifically it might be used to identify the nature of the regulation to address a specific risk or problem. We discuss this in more detail in chapter 7.

In chapter 6 we analyse risks from a physical perspective, ie the direct impacts on wellbeing via the costs of crashes and environmental damage and the way in which analysis of these issues might be used to identify problems and assess the effectiveness of regulatory interventions.

6 Risks and risk analysis

The purpose of this research was to examine methodologies for evaluating the performance of regulations in addressing the major risks of the land transport system. In previous sections we have noted that risks include those on the costs side as well as the benefits (reduced crashes, emissions etc). However, in this section we examine the way in which analysis can be used to estimate the benefits of regulation, and the relative contribution of regulation and other exogenous factors to changes in crash rates and to environmental effects.

We start by setting out methodologies that can be used for such analysis. We then go on to use these techniques, or report on their use, in evaluating transport sector problems.

6.1 Evaluation methodologies

This section discusses methodologies to evaluate how factors influence some measure of risk within the road sector. Exogenous factors influencing these risks include:

- social or market trends (eg alcohol consumption, travel preferences, and road investment)
- regulation (eg road safety rules or vehicle emission standards).

Levels of road sector risks can vary across spatial entities (regions or road type), categorical entities (driver age groups or vehicle type) and over time. An example would be crash rates, which can differ across regions, by vehicle type and over time. Therefore, to understand what determines road sector risk, we are most interested in exogenous variables that also vary across entities, over time, or both. For instance, travel volume, a factor contributing to risks within the road sector, can differ by region, by vehicle type and over time.

6.1.1 Regression modelling

Impact evaluation methodologies generally use regression techniques to estimate the statistical relationship between exogenous factors and road sector risks. The basic premise of regression is to understand how changes to exogenous factors (ie explanatory variables) change an outcome variable (known as the dependent variable), which in this case is some measure of road sector risk.

A simple linear regression model can be represented in the following equation:

$$Y = \beta_0 + \beta_1 X_1 + u \qquad \text{(Equation 6.1)}$$

Where: Y = actual value of the outcome/ dependent variable, eg vehicle crashes

X = actual value of an independent/explanatory variable, eg road investment

β_0 = a constant estimated by the model

β_1 = an estimated coefficient which is multiplied by the independent variable to estimate Y

u = error term.

In practice, it is preferred (where possible) that all relevant explanatory variables are included in the model. For example, including a second explanatory variable would require a $\beta_2 X_2$ be added to the equation, a third would require a $\beta_3 X_3$ and so on.

6.1.2 Types of data

Regression models employed for impact evaluation depend on how the data is observed or recorded. Data observed across entities but with no time dimension is known as cross-sectional data (ie provide a snapshot observation). An example would be total road travel by vehicle type in the year 2015. Data of just one variable collected over equally spaced time periods (or observed at equal intervals) is named time series data, eg total annual emissions released from the light petrol fleet between 2000 and 2010. Data that contains both cross-sectional and time dimensions is named panel or longitudinal data, eg fatal crash rates by road user category over years 2005 to 2015.

6.1.3 The counterfactual

Regression modelling can be applied to all these types of data. However, impact evaluation literature strongly recommends the use of data where explanatory and dependent variables have been observed before and after a regulation was introduced. This is because pre-impact data allows the evaluator to estimate the counterfactual: an estimate of the outcome if a specific regulation was not introduced or if a factor had not changed. Because measuring outcomes relative to the counterfactual is best practice, estimating a counterfactual is critical to the overall result of an impact evaluation. Therefore, in light of this counterfactual problem, panel and time series data (ie data that contains information pertaining to pre- and post-regulation) is generally preferred when conducting impact evaluations.[25]

6.1.4 Choosing an impact evaluation methodology

Broadly speaking, there are two key questions which an evaluator must ask in choosing the optimal ex-post methodology:

- Is pre- and post-intervention data available relating to both outcome and explanatory variables available?
- Can a comparison group of adequate size be formed?

An evaluator's answers to these questions determine how the counterfactual outcome is constructed through the available evaluation techniques.

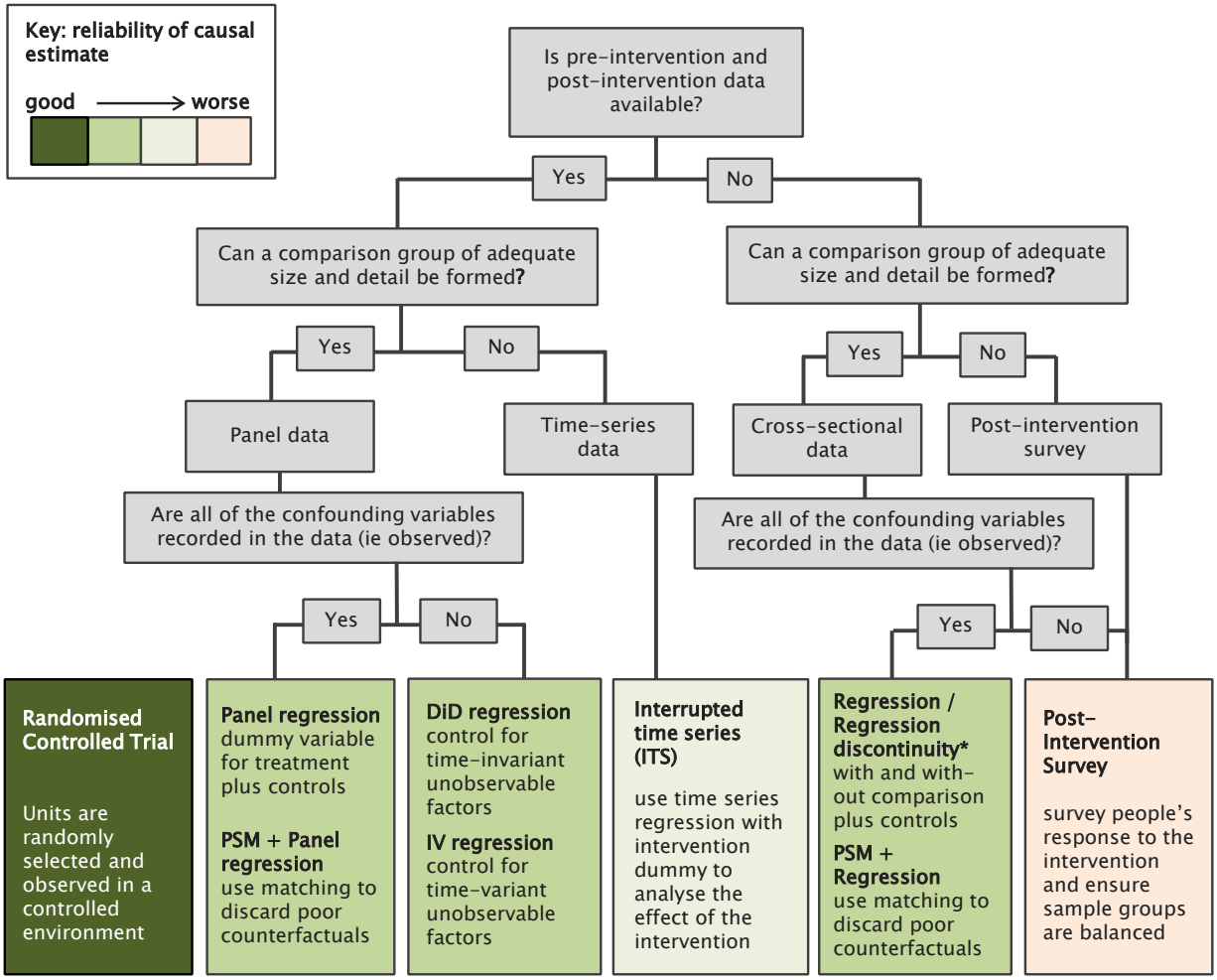
Figure 6.1 displays a flow diagram which can be used to help select the optimal ex-post evaluation methodology (given the data at disposal to the evaluator).

The bottom left box in figure 6.1 depicts the benchmark for all ex-post evaluations: experimental design, in which people/roads/areas are randomly selected to undergo a specific 'treatment' or intervention. Experimental designs are the gold standard approach as they create a counterfactual group/comparison group that is not plagued by selection-bias, in which the comparison group (used to derive the counterfactual outcome) has different characteristics from the group (or roads/areas) subject to regulation. When using a comparison group as the counterfactual, these fundamental differences can cause models to under- or over-estimate the effect of an intervention.

In reality, randomised, controlled experiments are almost impossible to conduct within the road transportation sector because regulations are likely to apply to all. Still, an experimental methodology stands as a useful benchmark which all other impact evaluation methods can be compared against.

[25] Cross-sectional techniques may be just as useful if 'treatment' can be randomly assigned or when factors that have caused units to be 'treated' or not can be controlled. For example, if new traffic light technology were introduced, you could randomise the intersections where it was installed.

Figure 6.1 Flow diagram of ex- post methodology selection process



*** Regression Discontinuity (RD) is a special type of cross section regression used when there is no overlap between treatment and control groups.**

Source: Covec

Data that is readily available for ex-post analysis of road sector risks typically is not in panel form, ie it does not record outcomes and attributes of people (or roads/areas) influenced (or not) by a regulation. This means panel data techniques such as the difference-in-differences estimator cannot be used for ex-post evaluation. Therefore, the following sections will mainly focus on the next best alternative, time series analysis, with special attention given to how these respective methods deal with the counterfactual.

6.1.5 Impact evaluation with time series modelling

Good sources of time series data regarding road sector risks can be found on MoT's website[26] (eg road crash and fleet statistics data) with possible explanatory variables also found here or in the New Zealand household travel survey.[27] Through a combination of these and other sources, we can control for the majority of important factors influencing trends in the road sector. This method was adopted by Stroombergen (2013), an econometric investigation which provides instrumental findings to our following analysis of factors determining road safety in New Zealand.

[26] www.transport.govt.nz/research/roadcrashstatistics/

[27] http://nzdotstat.stats.govt.nz/wbos/Index.aspx

6.1.5.1 Interrupted time series analysis

Interrupted time series analysis (ITSA) provide a means of estimating the effects of a change in law or social policy (Reis and Judd 2000), and is a method found to be useful in evaluation of past transport sector regulations (Andreuccetti et al 2011; West et al 1989). ITSA uses time series data to explain why an outcome variable's level changed at a specific point in time. ITSA predicts the impact of a regulation/intervention through a 'dummy' variable, whereby regulation time periods are coded with 1s, and 0s otherwise. The regulation dummy variable could also be interacted with other dependent variables, such as the time trend (regulation x year). The coefficient of this interaction would represent the difference between pre- and post-intervention slopes of the outcome (Linden 2015). However, one would need more observations in the regulation period than what is used here.

To demonstrate this method, we analyse the impact of a 2011 policy change which brought the under 20-year-old drivers' blood alcohol concentration (BAC) limit to zero.[28] We constructed a small data set which contains information about alcohol/drug-affected drivers involved in fatal crashes for 15–19 year olds from 2000 to 2013 (table 6.1). Other variables included in this data are: VKT for 15–19 year olds, 20–24-year-old alcohol/drug drivers involved in fatal crashes and non-alcohol/drug fatal crashes from drivers aged 1–19 years

Table 6.1 Alcohol/drug fatalities data for 15–19 year olds

Year	15–19 a/d fatal	Regulation	15–19 VKT (b)	20–24 a/d fatal	15–19 non- a/d fatal
2000	18	0	10.1	24	38
2001	22	0	10.5	20	38
2002	14	0	10.9	23	30
2003	25	0	11.3	24	46
2004	20	0	10.3	21	56
2005	18	0	9.7	22	55
2006	19	0	9.7	20	40
2007	19	0	9.4	29	42
2008	17	0	9.7	30	38
2009	23	0	9.8	25	30
2010	22	0	9.2	32	34
2011	12	1	8.4	21	20
2012	9	1	7.8	24	12
2013	14	1	7.3	19	13

Source: Alcohol crash data – MoT (2015a). VKT data – MoT (2015c). Crash data – MoT (2014).

Annual fatal crash numbers are very volatile with only three observations after the intervention. Road fatalities (strictly fatal crashes) follow a Poisson distribution, where the distribution mean is equal to its variance. This type of distribution tends to apply when a relatively small number of uncommon independent events occur over a set period.[29] Figure 6.2 shows the trend in 15–19-year-old drivers involved in alcohol/drug fatal crashes from 2000 to 2013.

[28] Enabled through the Land Transport (Road Safety and other Matters) Amendment Act 2011.

[29] We are aware that the NZ Transport Agency uses Poisson distribution techniques in some of its PIRs, but for simplicity we have excluded such methods from this discussion.

Figure 6.2 15–19- year- old drivers involved in alcohol/drug fatal crashes, 2000 to 2013

Source: MoT (2015a)

The simplest way to estimate the effect of the zero tolerance rule is to regress only the regulation dummy on 15–19 year olds' alcohol/drug fatalities (dependent variable). However, we could improve our estimate by including other possible explanatory variables, such as, time (including 'year' as another independent variable) and annual kilometres driven (VKT) by 15–19 year olds.

Table 6.2 shows diagnostic information for three different interrupted time series models corresponding to four different combinations of explanatory variables used to predict 15–19 year olds' alcohol/drug related fatalities: regulation dummy only, regulation dummy and time, regulation dummy and VKT, and regulation dummy, time and VKT.

Table 6.2 Regression results –dependent variable: 15–19 alcohol/drug- related fatalities

Parameter	Model 1	Model 2	Model 3	Model 4
Intercept (β_0)	19.7*** *(0.91)*	-374 *(584)*	17.7 (14.6)	-972 *(875)*
Regulation (β_1)	-8.06*** *(1.96)*	-9.44*** *(2.86)*	-7.61* (3.81)	-7.18* *(3.78)*
Year (β_2)		0.20 *(0.29)*		0.49 *(0.43)*
15–19 yrs VKT (β_3)			0.20 (1.45)	1.92 *(2.10)*
Adjusted R^2	0.55	0.53	0.51	0.52

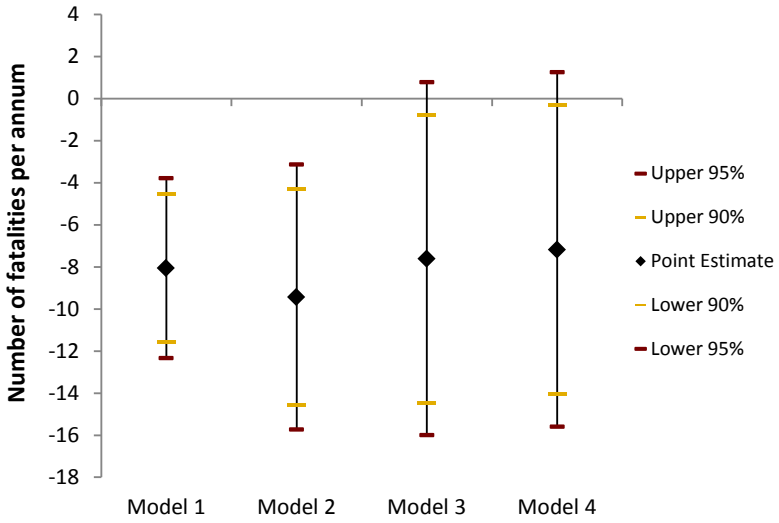
Note: *** p-value < 0.01 , ** p-value < 0.05, * p-value < 0.10: standard errors in brackets.[30]

When only the regulation dummy is used to explain 15–19 year olds' alcohol/drug related fatalities, the estimated impact of the regulation is a statistically significant 8.06 fewer deaths (on average) over the years following the introduction of the regulation. When the time trend is included, the estimated effect increases in absolute terms to -9.44 (statistically significant at the 1% level, although the standard error has increased). However, when VKT is controlled for in models 3 and 4, the estimated effect reduces to 7.61 and 7.18 fewer fatalities per year, respectively (with both estimators only significant at the 10%

[30] Broadly speaking the p-value represents the probability that the estimated relationship could occur by chance, given an underlying assumption about the distribution of the data.

level).[31] Figure 6.3 illustrates each model's estimated impact of the regulation (point estimate) and their 90% and 95% confidence intervals.

Figure 6.3 Regulation dummy coefficients (β_1) and their respective 90% and 95% confidence intervals



Source: Covec

Figure 6.3 shows that the 95% confidence intervals of all three β_1 point estimates overlap, meaning the magnitude of the estimated treatment effect is fairly consistent between the models. Model 4 may be seen as the preferred specification given that its coefficient, β_1 reflects a more defendable counterfactual assumption, ie controls for the effect of time and VKT on the outcome variable.

Noteworthy, however, is the lack of explanatory power of the 'year' and 'VKT' variables (ie high p-values and the adjusted R^2 do not increase). One could run an F-test[32] to see whether both 'year' and 'VKT' add joint explanatory power to the model. This would test whether the unrestricted regression, model 4, provides more explanatory power than the restricted regression, model 1. Applying this test shows that these variables are not jointly significant at 5% level (p-value > 0.05), suggesting that the treatment effect estimates of model 2, 3 and 4 are no more robust than that of model 1.

The ITSA models above infer that the zero tolerance rule caused around seven to nine fewer alcohol/drug-related fatalities for 15–19-year-old drivers, over the first three of the regulation. However, these estimates are subject to internal validity problems due to the omission of potential explanatory factors. Although the incorporation of a time trend is intended to capture this omission, the extent to which this omission is manifested in the estimated coefficient on regulation depends on the correlation of missing variables with the regulation effect. Therefore, these models may be capturing the influence of other independent variables (causes) implemented at the same time as the introduction of the zero alcohol tolerance regulation. Other plausible causes to the change in the observed outcomes include the Alcohol Interlock

[31] VKT could also be controlled for by having fatalities/VKT as the dependent variable as did Stroombergen (2013) in his analysis.

[32] An F-test is any statistical test in which the test statistic has an F-distribution under the null hypothesis. It can be helpful in determining whether certain independent variables are making a significant contribution to the regression model.

Programme (AIP)[33] which increased penalties for repeated drink/drug driving offenders and the increase in age for obtaining a driver licence from 15 to 16 years (MoT 2016a). Both these regulations were also implemented in 2011, thus our regulation dummy may be measuring the joint effect of all these regulations. We discuss below a method that can be used to confirm that we have not omitted variables (from the models) causing the observed change in outcomes.

6.1.5.2 Non- equivalent dependent variable

A non-equivalent dependent variable (NEDV) is defined as 'dependent variable that is predicted not to change because of treatment, but is expected to respond to some or all of the contextually important internal validity threats in the same way as the target outcome' (Mathison 2011, p33). Thus, a useful NEDV is one that would respond to explanatory variables in a similar fashion to the dependent variable of interest under the counterfactual. The idea here is to replace the actual dependent variable in the ITSA regression models with a NEDV, then run a time series regression using the regulation dummy (and other important factors) as explanatory variables. If the NEDV is found to be associated with the regulation variable, we have evidence that an omitted factor(s) could have contributed to the observed outcome. If we find no statistical association, we can be further convinced that our original ITSA estimates are robust. In this case, both alcohol/drug affected fatalities for 20–24 year olds and non-alcohol/drug fatalities for 15–19 year olds are possible NEDVs. These variables are recorded in table 6.3 and illustrated in figure 6.4 alongside the original dependent variable (15–19 a/d fatal).

Figure 6.4 NEDVs and 15–19 driver alcohol/drug fatalities, 2000–2013

Source: Alcohol crash data – MoT (2015a). Other crash data – MoT (2014)

It is important to consider what missing explanatory variables are likely to have influenced the chosen NEDV(s). For example, reductions in non-alcohol/drug related fatalities for 15–19-year-old drivers is more likely to be the result of increasing the legal driving age and not the introduction of the AIP. The exact opposite could be assumed for reductions in alcohol/drug related fatalities for 20–24-year-old drivers. Table 6.3 shows the regression results when the different NEDVs are used.

[33] Data regarding the age of drivers penalised by the AIP would be helpful to understand the relevance of this variable; however, such data is not made public.

Table 6.3 Regression results – non- equivalent dependent variable

	Model 5	Model 6	Model 7	Model 8
NEDV	**15–19 non- a/d fatalities**		**20–24 a/d fatalities**	
Intercept (β_0)	40.64*** *(2.47)*	1,356 (2,476)	24.5*** *(1.17)*	-1,551** *(605)*
Regulation (β_1)	-25.64*** *(5.32)*	-22.9* (10.7)	-3.21 *(2.53)*	-8.71*** *(2.97)*
Year (β_2)		-0.65 (1.21)		0.79** *(0.30)*
15–19 yrs (β_3)		-0.81 (5,92)		
Adjusted R^2	0.63	0.57	0.05	0.36

Note: *** p-value < 0.01 ** p-value < 0.05, * p-value < 0.10: standard errors in brackets.[34]

Regression results show that both NEDVs are statistically associated with the regulation dummy (with the exception of model 7). Because the NEDVs were not expected to be associated with the (zero alcohol tolerance) regulation effect, we can thus conclude that these other interventions (omitted from our previous ITSA models) are probably contributing to the regulation effect, ie the effects of regulation on fatalities are probably over estimated.

6.1.5.3 Projecting the counterfactual

Another time series technique available to evaluators is to project a counterfactual, and then compare the real outcomes against the estimated outcomes. For consistency, we demonstrate this technique using the same data above.

This method first requires using the pre-regulation data to estimate the relationship between the past outcomes variable and the explanatory variables. For example, we use 15–19-year-old drivers' VKT and a time trend to estimate their pre-intervention relationships with 15–19-year-old drivers' alcohol/drug related fatalities (table 6.4).

Table 6.4 Regression results – dependent variable: 15–19 alcohol/drug- related fatalities (2000–2010)

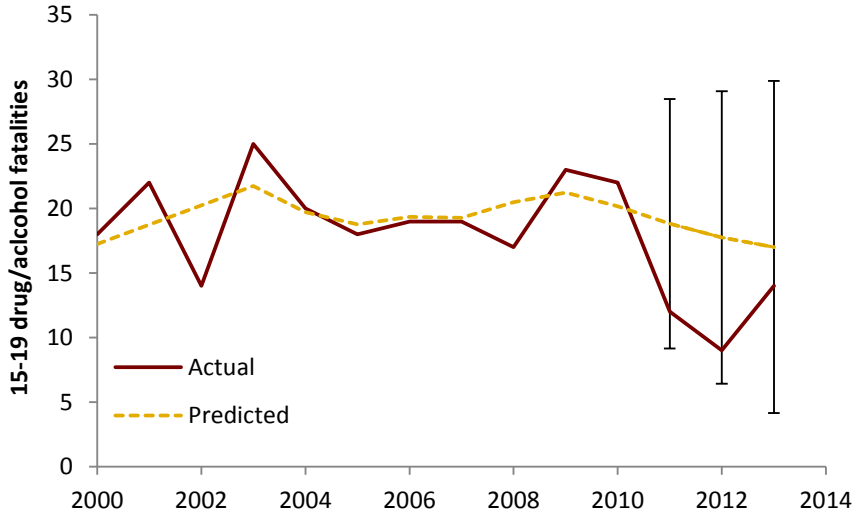
Parameter	Model 6
Intercept (β_0)	-1,102 *(917)*
VKT (β_2)	2.55 *(2.57)*
Year (β_3)	0.55 *(0.45)*
Adjusted R^2	0.16

Note: *** p-value < 0.01, ** p-value < 0.05, * p-value < 0.10: standard errors in brackets.

None of the variables are good predictors of the outcome variable. However, the purpose of this example is to demonstrate techniques, not to give policy advice using robust models. Using these estimates produced by this regression, we can estimate the counterfactual fatality rate for the years of regulation. This is done by multiplying the past estimated relationship by the actual values of the explanatory variables over the intervention period. Figure 6.5 illustrates these counterfactual estimates, projected from 2011 to 2013, and the actual trend in 15–19 year olds' alcohol/drug fatalities.

[34] Broadly speaking the p-value represents the probability that the estimated relationship could occur by chance, given an underlying assumption about the distribution of the data.

Figure 6.5 Actual and projected counterfactual for15–19 year olds' alcohol/drug fatalities



Source: Actual values from MoT (2015a)

The error bars in figure 6.5 represent the 95% confidence intervals for each forecast estimate. Although the counterfactual projections appear relatively greater than the actual values, each year's actual outcomes are within the 95% confidence intervals. Therefore we cannot accept that the counterfactual is statistically different from the actual values in any year, ie this method estimates the zero BAC regulation to be ineffective in reducing 15–19-year-old drivers' drug/alcohol related fatalities.

6.1.5.4 Methodology triangulation and conclusions

This section has presented three impact evaluation methods which can be applied when the data is limited to time series form. In-text examples have shown how these methods do not necessarily provide the same impact estimates, which is largely due to different counterfactual assumptions inherent to each model specification. Specifically, the ITSA predictions were fairly consistent, with the treatment effect estimated to be on average, seven to nine fewer fatalities per year than the counterfactual case. However, both the non-equivalent independent variable and the counterfactual projection methods found the estimated reduction in fatalities to suffer from omitted variable bias and to be of weak statistical significance. This highlights the importance of fully considering the possible threats to validity and the use of different tools to enable an evaluator to pinpoint the factors confounding the treatment effect estimation. Unfortunately, in comparison with panel data techniques, time series methods are limited in their ability to control for confounders.

In practice, the validity and reliability of impact estimates depend a great deal on the data at hand and the methodological skills and training of the evaluator (Ezemenari et al 1999). Triangulation can be used to provide greater confidence to impact assessments. This is where evaluators use different data collection techniques (ie both qualitative and quantitative) to support impact estimates. Qualitative assessments are not easily carried out for impact assessments of road sector risks however. Still, the same theory can be applied to data analysis methodologies. For example, triangulation could be used to identify biases that certain models are susceptible to, and thus improve the overall reliability of impact estimates.

6.1.6 Impact evaluation with panel data

Panel data sets are best suited for evaluation of regulatory impacts. However, generating panel data is difficult in practice and often expensive. The attraction of panel data is that it allows evaluators to control

for selection-bias from unobserved characteristics (ie unobserved confounders) that is not possible with time series and cross-sectional data.

6.1.6.1 Panel data: difference- in- difference

If the regulation only applies to a sub-set of the population and panel data is available, the difference-in-differences (DiD) estimator can be a useful impact evaluation method. This model requires pre- and post-regulation data from that influenced, as well as not influenced, by the regulation (control group). This data has to pertain to the same observations in both time periods.

In practice, regulations that only apply to a subset of the population are generally targeted towards a specific group or category (ie young drivers or diesel cars). This means characteristics of those in the control group will not match those who are subject to regulation. Significant differences between control and treatment groups cause selection-bias. Selection-bias is of particular concern when it is caused by unobservable factors (unobserved heterogeneity) since these cannot be used as control variables in a regression model (Khandker et al 2010). The DiD methodology can attempt to control selection-bias caused by unobserved characteristics that are constant over time. This can be done through a simple regression model in which the researcher must compute the difference between pre- and post-outcomes for all units[35] ($Y_1 - Y_0$) and then regress this on a dummy variable (D_R) representing whether-or-not the unit was regulated or not. The corresponding regression can be represented by the following equation:

$$Y_1 - Y_0 = a + \beta_R D_R + e \qquad \text{(Equation 6.2)}$$

Where

$Y_1 - Y_0$ = post-regulation outcome minus the pre-regulation outcome for each observation

a = a constant produced by the model, representing the effect of time on all observations

β_R = effect of the regulation on the regulated units

D_R = regulation & time dummy variable, 1 if observation is regulated, 0 otherwise

e = error term.

The DiD regression equation above is the condensed version of the post-regulation equation minus the pre-regulation equation. It would normally include other observed explanatory variables to control for differences between the control and treatment groups that can be observed. The intuition here is the effects of any unobserved characteristics (that are constant over the time) are differenced out, ie the effects of such factors will no longer bias model estimates.

6.1.6.2 Difference- in- differences limitations

It is important to note the DiD estimator can only control for unobserved characteristics that are constant over time. It is also assumed the composition of the control and treatment groups are the same (on average) aside from differences in observed characteristics. In reality, these assumptions may not necessarily be true. DiD used in conjunction with other techniques can attempt to control for unobserved characteristics that change over time. However, data available for analysis of road sector risks in New Zealand generally do not permit the use of the DiD estimator.

In conclusion, panel data techniques are difficult to apply at the individual level when evaluating road crash risk. This is because we would require data regarding a person's frequency of involvement in a crash. As crashes are relatively infrequent at the individual level, it would be very difficult (and costly) to examine a sample of sufficient size.

[35] Units being people, roads or areas

6.2 Potential sources of risks

To review the existing set of regulations or their absence, the analysis in this report focuses on environmental and safety issues, as noted in section 1.2. This defines the broad scope of the risks or problems that are of concern here.

A risk is the possibility of an adverse impact, ie of something that would reduce the wellbeing of people. As noted above, it is a separate and necessary question to address whether these problems are also market failures. However, first we identify them in physical terms.

Transport is an activity that is not usually pursued for its own benefits, ie the transport system does not directly provide wellbeing. Rather, it enables people to do other things that provide wellbeing. It facilitates economic activity and enables people to participate in society and the activities they wish to undertake. Transport is equivalent to a transaction cost with respect to those other activities and problems occur where those costs are higher than they could be. Risks associated with the road transport system include those that result in:

- crashes, including those that:
  - produce fatalities
  - produce non-fatal injuries
  - result in physical damage to the vehicle or property
- environmental and health effects, including:
  - GHG emissions
  - local air pollutants
  - noise
  - road run-off/water pollution
  - vibration.

The range of effects were considered in a review by MoT of the total costs of different transport modes (road, rail, maritime). The identified effects associated with road transport are shown in table 6.5. They include ‘upstream and downstream effects’, ie indirect costs of transport including energy production, vehicle production and maintenance, and infrastructure construction and maintenance. That analysis included an estimate of the size of the impact and the size of the external effects. The latter takes account of whether the impacts are borne by those external to the transport system.

The impacts are defined by:

- scale of effects, whether local or global – the latter applies to GHGs only
- the potential intensity based on the chance of occurrence and potential size of impact. Those which are high-high include crashes, a number of environmental effects (GHGs, harmful emissions, noise) and end-of-life disposal
- duration, whether temporary or permanent, or where an issue can lead to both types of problem
- frequency, which is different from duration
- scope for mitigation
- size of external effects.

Using these factors, issues that appear particularly important are:

- GHG and local emissions – they can have high chances of occurrence and have high impacts, be permanent and on-going, with high external effects but also with a high scope for mitigation
- crashes are similarly important although the frequency is regarded as intermittent; however, this may be at an individual level, whereas crashes of some sort are regular and on-going
- noise has high potential intensity, duration and frequency, but is less amenable to mitigation.

Table 6.5 Potential size and scale of social and environmental impacts

Social and environmental impacts		Scale of effects	Potential intensity		Duration	Frequency	Scope for mitigation	Size of external effects
			Chance of occur-rence	Size of impact				
Congestion		Local	H	M	temporary	intermittent	H	M
Crashes		Local	H	H	both	intermittent	H	H
GHG emissions		Global	H	H	permanent	on-going	H	H
Harmful emissions		Local	H	H	both	on-going	H	H
Noise		Local	H	H	both	on-going	M	H
Vibration		Local	M	L – M	temporary	intermittent	L – M	H
Run-off and water quality	Spills	Local	L – M	M	temporary	intermittent	L	M
	Operational discharges	Local	L	L – M	temporary	on-going	M	L
	Run-off	Local	M	M	temporary	on-going	M	M
Biosecurity and biodiversity		Local	M	M	both	intermittent	M	H
Upstream and downstream effects	Energy production/ infrastructure construction	Global	H	M	both	on-going	M	H
	End of life disposal	Local	H	H	permanent	on-going	M	H

Source: Adapted from MoT (2009a)

6.2.1 Risk analysis

The Transport Agency has a manual for addressing its risk (Transit NZ 2004). This is used as a means for identifying and managing significant risks to its business with the aim of 'better decisions, processes, plans, and programmes'. The potential consequences of risk events are categorised, including risks that are seen as 'threats' and 'opportunities'. More recently this risk classification approach has been included in the Risk Management Standard (NZ Transport Agency 2015); the risk classifications for health and safety and environmental threats are shown in table 6.6. There are similar classifications developed for opportunities but our concern in this work is with the threats as these are the ones that might be regulated.

The Transport Agency uses these classifications to develop a quantified score of the risks.

These are risks from the Transport Agency's perspective rather than the nation's and do not provide guidance on how significant risks are likely to be, only how to categorise those that are identified.

Table 6.6 Rating the consequence of risks (semi- quantitative threat criteria)

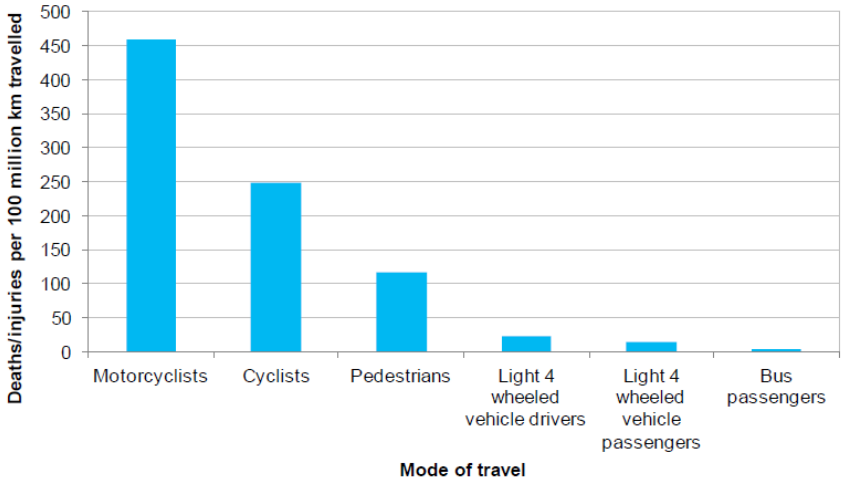
Rating scale	Health and safety	Environmental
Very high	Potential for fatality or multiple injuries leading to permanent disability or permanent negative impact on public health.	Potential incident causing an environmental impact that takes more than 1 year to restore or is permanent or is of international concern.
High	Potential for recoverable injuries requiring hospitalisation or resulting in non-permanent negative impact on public health.	Potential incident causing an environmental impact that may take up to 1 year to restore or is of national importance.
Medium	Potential for recoverable injuries requiring professional medical treatment and resulting in employment absenteeism.	Potential incident causing an environmental impact that may take 6–12 months to restore or is reportable to relevant authorities or is of regional importance.
Low	Potential for recoverable injuries requiring professional medical treatment but with negligible lost time.	Potential incident causing an environmental impact that may take 1–6 months to restore.
Very low	Potential for recoverable injuries manageable with in-situ first aid care.	Potential incident causing an environmental impact that should take less than 1 month to restore.

Source: NZ Transport Agency (2015)

MoT periodically assesses the risk from transport, particularly the differences between modes (MoT 2015d). It concludes from an analysis of data that:

- the riskiest travel mode is motorcycling (see figure 6.6).
- the least risky travel mode is being a bus passenger, followed by walking
- males generally have a higher risk of dying in motor vehicle crashes than females, especially in the 15–29-year-old age groups.[36]

Figure 6.6 Deaths or injuries in motor vehicle crashes per 100 million km travelled per year



Source: MoT (2015d)

In this report we explore the risks associated with crashes and the environment in more detail.

[36] MoT (2015d) also notes 'When looking at risk by age patterns you have to take into account that children and those over 70 years old are more fragile. They are more likely to die or be injured in a crash, but this does not necessarily mean they are more likely to get into a situation where they are involved in a crash'.

6.3 Crash and safety risk

6.3.1 Social costs of crashes

Road crashes are one element of risk associated with transport that results in increased total costs to society. The greatest costs of road crashes are those associated with fatalities, loss of life quality from non-fatal injuries and vehicle damage (MoT 2016c).

MoT regularly estimates the social costs of crashes by type. The latest data is for 2014. Combining road crash data with MoT's cost estimates by crash type, table 6.7 summarises the total social cost of crashes per annum ($4.06 billion) and the percentage that each cost contributes to the total per crash type. Social costs are dominated by the impacts of loss of life and life quality (table 6.7).

Tay (2001) highlights that New Zealand traffic safety initiatives are primarily focused on reducing road fatalities. For example, in 2003 the government launched a *Road safety to 2010* strategy which aimed to reduce road fatalities to no more than 300 per year by 2010 (MoT 2015e).

Table 6.7 Social costs of road crashes (2014) in 2015 prices

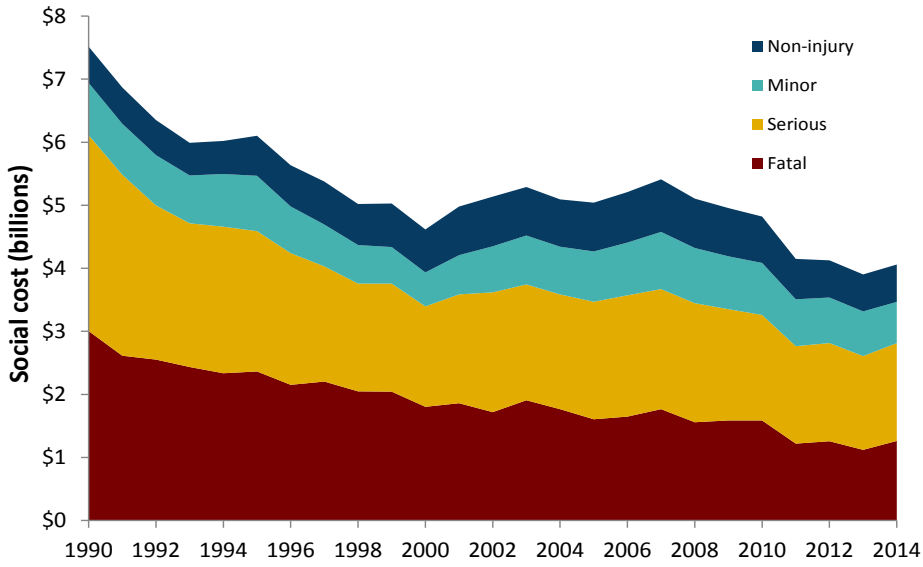
	Fatal	Serious	Minor	Non- injury	Total
Incidents	294	3,667	29,968	197,640	
Cost per incident	$4,094,500	$430,400	$22,900	$3,000	
Total social cost ($billions)	$1.20	$1.58	$0.69	$0.59	$4.06
Percentage of total cost	30%	39%	17%	14%	100%
Cost percentage of each crash type					
Loss of life and life quality	99%	94%	71%	0%	78%
Loss of output	<1%	<1%	1%	0%	0%
Medical cost	<1%	3%	3%	0%	2%
Legal and court cost	<1%	1%	4%	0%	1%
Vehicle damage cost	<1%	1%	20%	100%	19%

Source: MoT (2016c); MoT (2014)

Although the social cost of road deaths is substantial – around $4m per fatality in 2015 prices (MoT 2016c) – the costs of road deaths sum to less than a third of the total social cost of road casualties (table 6.7). Tay suggests that, because the factors contributing to fatal crashes are not necessarily the same (by magnitude or type) as those for severe and minor crashes, overemphasis on fatal crashes in the development of policy may not lead to optimal allocation of limited road safety resources. A recent analysis of the causes of New Zealand's road crashes (Stroombergen, 2013) focused on fatalities per unit of travel. However, this reflected constraints in his brief rather than a deliberate decision that fatalities were a good proxy for social costs.

The total social cost of road crashes per annum has fallen from around $7.5 billion in 1990 to around $4 billion in 2014 (figure 6.7), and road fatalities' percentage of the social costs of crashes has also fallen from 40% to 30% over this same period.

Figure 6.7 Social cost by crash type (2015 prices)



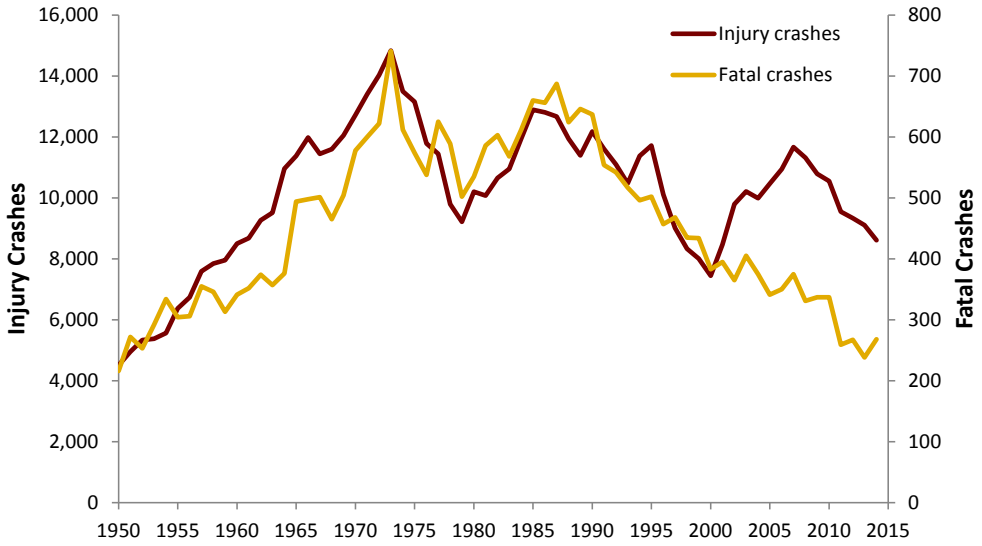
Source: MoT (2016c)

We briefly examine this changing social cost composition through trends in fatal and injury crashes in the following section.

6.3.2 Crash rates

Figure 6.8 illustrates the number of injury and fatal crashes from 1950 to 2014.

Figure 6.8 Number of annual road crashes 1950–2014



Source: MoT (2014)

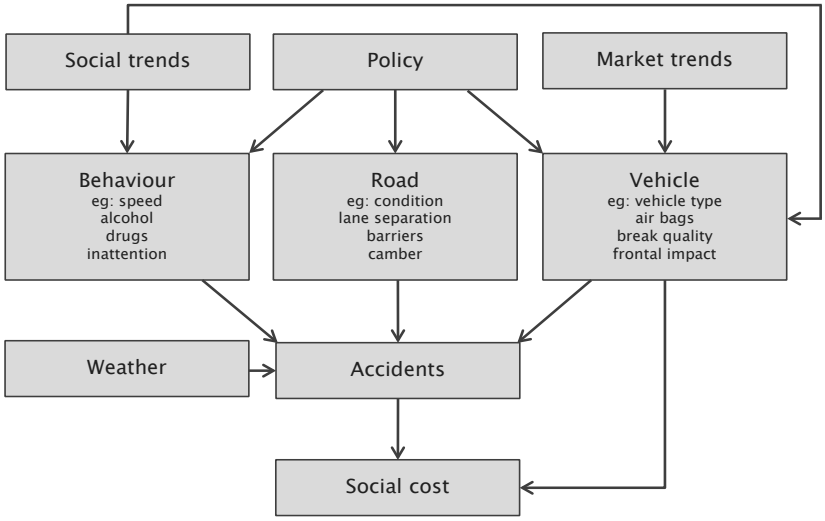
Fatal crashes are those which result in at least one death, whereas injury crashes are those which result in only a minor or serious injury (ie they are mutually exclusive categories). Fatal and non-fatal crashes have tracked closely until the early 2000s when a divergence of trend occurs over several years. The trends illustrated in figure 6.8 are total crashes. They neither account for total travel (ie how the number of

crashes has changed with changes in travel volume) nor other important factors affecting crash rates. The trends show that fatalities have been reducing since the 1980s and that both injury and fatal crashes have fluctuated widely over time.

6.3.3 Factors affecting crash rates

Factors influencing road crashes include driver behaviour, road characteristics, vehicle characteristics and weather (figure 6.9). These factors are affected in turn by social trends, policy and market trends.

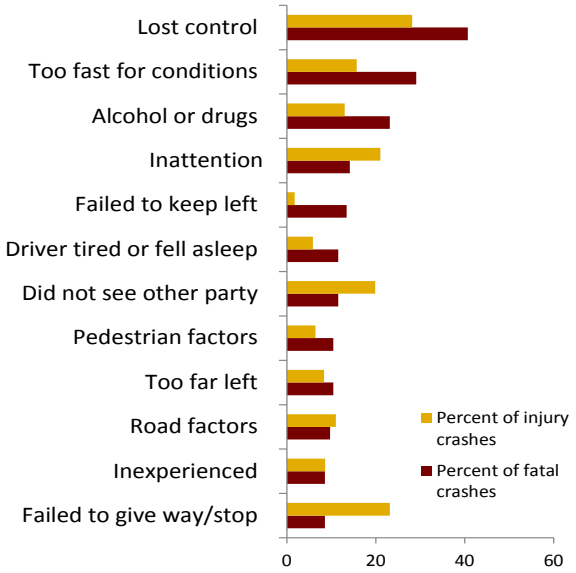
Figure 6.9 Factors affecting road crashes



Source: Covec

The most common causes of road crashes are presented in figure 6.10. Essentially, these are the factors which lead to the occurrence and severity of a crash (ie the behaviour, road and vehicle factors in figure 6.9). 'Lost control,' 'too fast for conditions' and 'alcohol or drugs' contributed to 41%, 29% and 23% of all fatal crashes in 2014, respectively.

Figure 6.10 Factors contributing to crashes year ended 2014

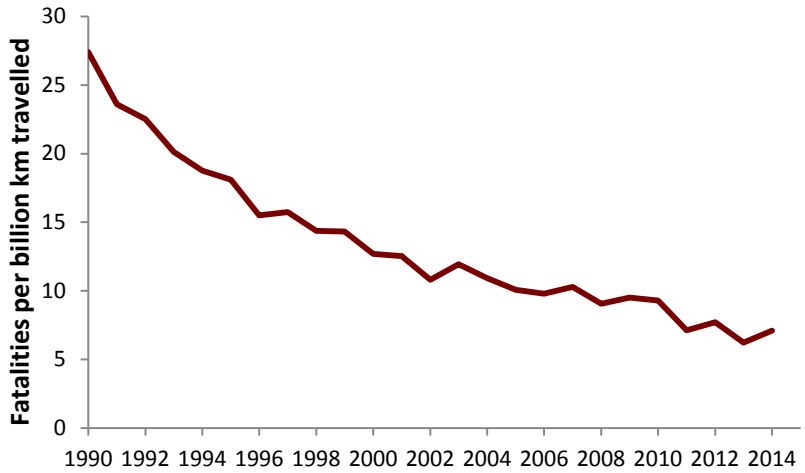


Source: MoT (2014)

Stroombergen (2013) examined the impacts of three variables (the driver, the road and the vehicle) to understand factors influencing a 74% reduction in deaths per unit of travel from 1990 to 2012 (figure 6.11). Using econometric modelling, he could explain 10,000 out of the 12,300 additional fatalities that he estimates would have occurred under the counterfactual in which fatalities per unit of travel had remained unchanged since 1990. The models estimated that, of the explainable 10,000 fewer deaths:

- 45% are attributed to vehicle improvements (ie vehicle crash worthiness) and fewer motorcycles per unit of travel (motorcycles are essentially less-safe vehicles)
- 19% are attributed to real net investment in road infrastructure per unit of travel
- 36% are attributed to the driver, ie the effects of advertising, breath testing, and average speed.

Figure 6.11 New Zealand road fatalities per unit of travel 1990–2014



Source: MoT (2014)

In this section we examine the above variables as well as a wider set of factors that might affect crash rates, including the impacts of:

- travel volume
- demographic changes
- vehicle improvements
- road improvements
- vehicle speed
- driving under the influence
- enforcement and advertising.

6.3.3.1 Travel volume

The aggregated distance travelled by New Zealand vehicles is expected to be a strong determinant of total road casualty levels. To control for this factor, trends in road crashes are analysed per VKT. As total VKT data prior to 2000 is not available, we develop a prediction model to produce a longer time series for total VKT. We regress the log transformation of total VKT on the log transformation of fuel consumption to

estimate the elasticity of VKT with respect to fuel consumption (table 6.8). This regression can be represented in equation 6.3:[37]

$$ln(VKT) = \beta \cdot ln(Fuel) \quad OR \quad VKT = Fuel^{\beta} \qquad \text{(Equation 6.3)}$$

Where: *VKT* = total vehicle kilometres travelled

β = VKT elasticity with respect to fuel consumption, defined in table 6.8

Fuel = combined petrol and diesel consumption (in PJ).

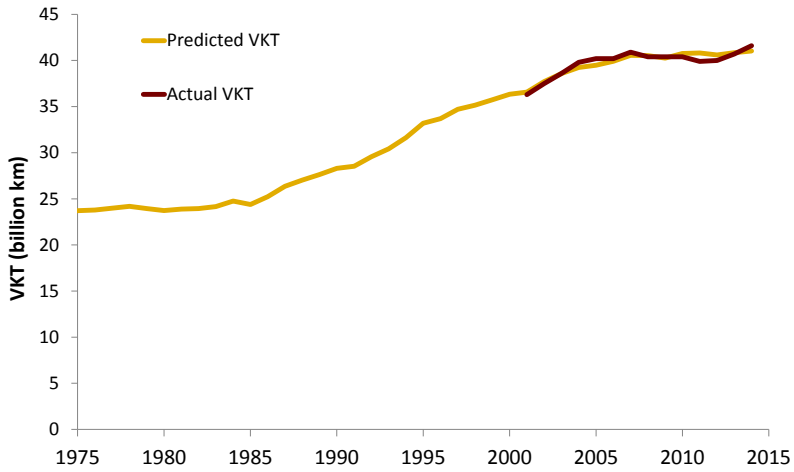
Regression coefficients in table 6.8 show a 10% increase in fuel consumption would result in a 7.1% increase in total VKT.[38] Using this predicted relationship, we use actual fuel consumption and registration data to 'backcast' total VKT from 2000 to 1975 (figure 6.12).

Table 6.8 Regression results

Parameter	Coefficient
Fuel (β)	0.71*** *(<0.001)*

Note: *** = p < 0.01 (standard errors)

Figure 6.12 Total VKT on New Zealand roads 1975–2014



Source: Actual VKT retrieved from www.transport.govt.nz/ourwork/tmif/transport-volume/tv001/. Non-commercial VKT retrieved from the New Zealand Household Travel Survey data.

The model does not take account of any change in average fuel efficiency of vehicles over time. However, to the extent that this has occurred, there have also been changes in the mix of vehicles in the fleet, including a shift towards larger engines and heavier vehicles over time. Thus a model that predicts VKT on the basis of no real change in average fuel efficiency of the fleet may not be inaccurate.

The 'actual' series above shows that VKT may have begun to plateau around 2007/2008. Although some researchers believe slowing VKT is a result of a fundamental decrease in demand for car travel (Litman 2015), others believe this trend is more a result of changing economic conditions, ie the recent economic recession (Blumenberg et al 2012).

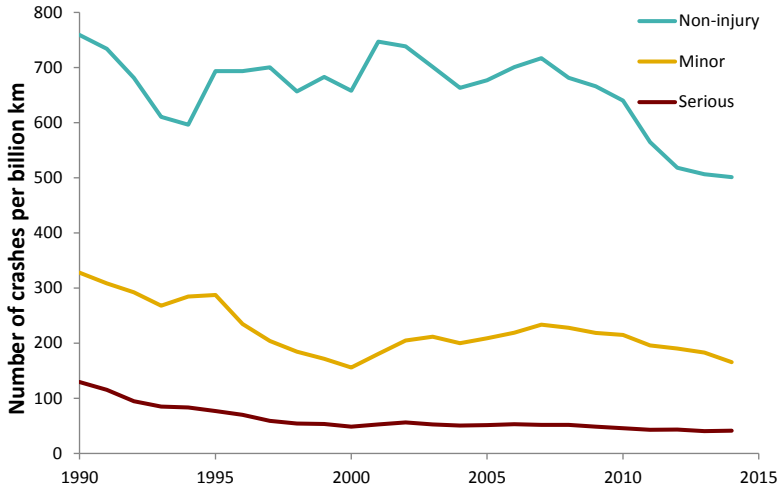
[37] Constant set to equal zero.

[38] The corresponding p-value is less than 0.01 meaning there is less than a 1% probability that no relationship exists between the dependent and independent variables as defined by the model.

6.3.3.2 Crashes per VKT

The early 2000s saw an increase in both serious and minor crash rates (figure 6.13), although non-injury crash rates eventually declined past 2000 levels in 2010 (659 to 635 crashes per billion km), minor crashes are still yet to drop below 2000 levels of 156 crashes per billion km.

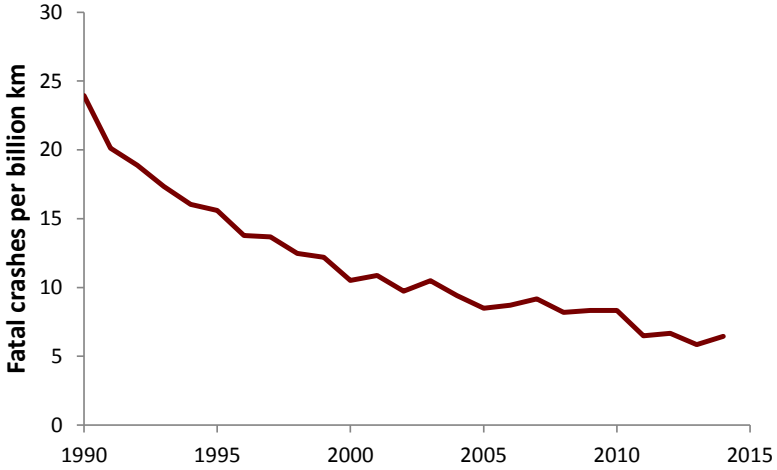
Figure 6.13 Injury crashes per VKT 1990–2014



Source: MoT (2014)

Figure 6.14 illustrates that fatal crashes per unit of travel, just like total fatal crash rates, have been falling consistently since 1990. There is a 71% reduction in fatal crashes/VKT from 1990 to 2014 compared with a 58% reduction in fatal crashes in total over this same period.

Figure 6.14 Fatal crashes per VKT 1990–2014

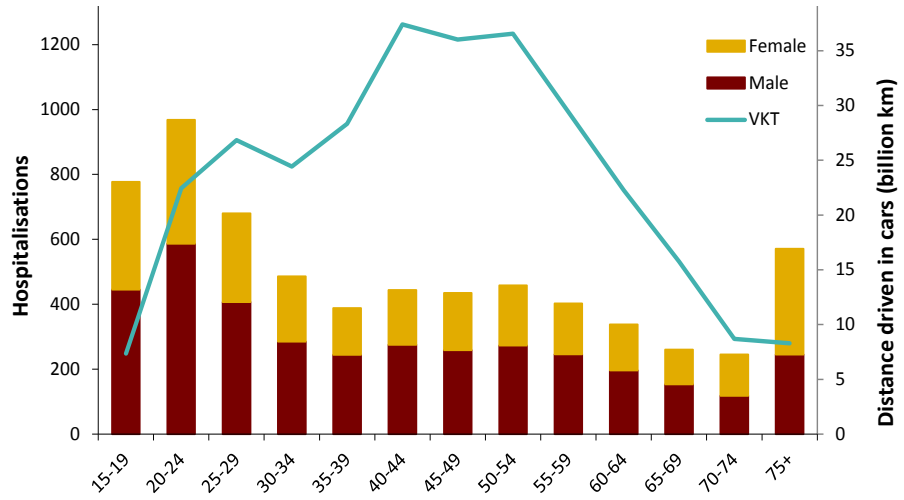


Source: MoT (2014)

6.3.3.3 Demographic changes

New Zealand road crash statistics reveal an over-representation of certain demographic categories: young males (15–24 years) make up a significant proportion of injury road crashes relative to their respective distance driven in cars (figure 6.15).

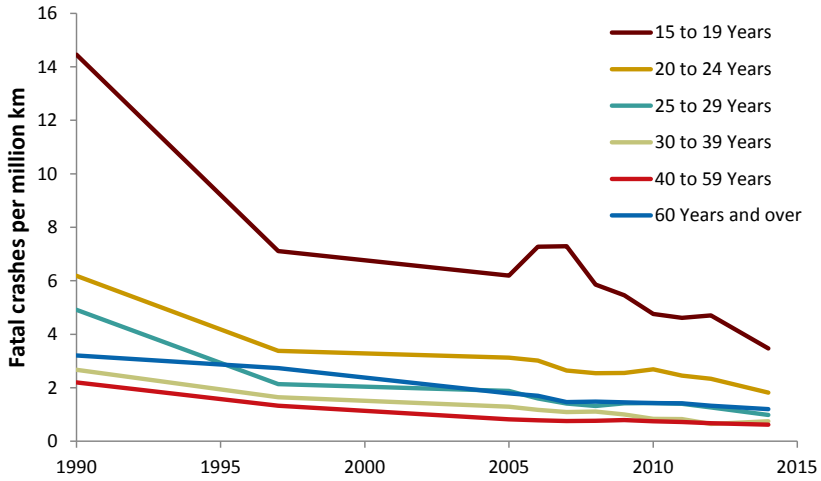
Figure 6.15 Hospitalisations from road crashes by age and sex, and VKT by age (2011–2014)



Source: Hospitalisation data from MoT (2014). VKT by age (2011–2014) data retrieved from P Phipps, Transport Agency.

Although figure 6.15 shows a disproportionate number of young people are involved in road crashes, a New Zealand study found total travel time and recreational travel time has reduced for people aged between 15 and 30 years from 1989 to 2012 (Rive et al 2015). More stringent youth driver licensing requirements and growing use of online shopping and social networking (which has the potential to replace journeys that would otherwise have been made) were factors that could have caused this trend. In contrast to this finding, Covec (2016) could not find any discernible difference in kilometres driven by current and past generations. Although young people's travel trends are debatable, their involvement in road crashes per unit of travel appears to be more certain. Figure 6.16 shows crashes per unit of travel for drivers aged between 15 and 19 years has declined significantly since 1990.

Figure 6.16 Drivers involved in fatal crashes per VKT by age 1990–2014



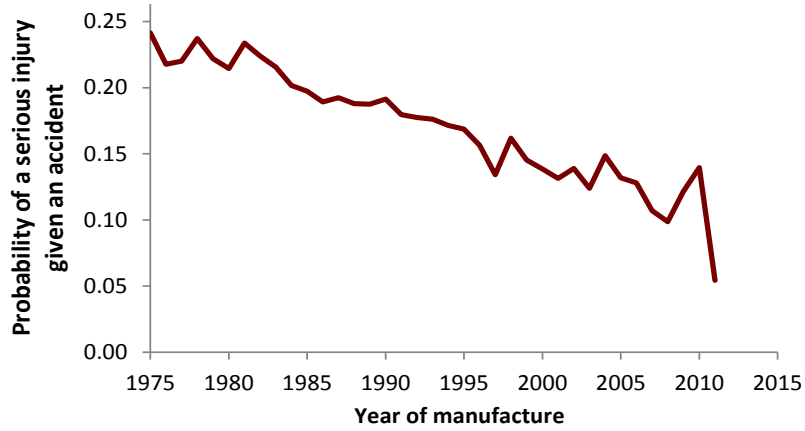
Source: Fatality data from MoT (2014). VKT by age data retrieved from P Phipps, Transport Agency.

6.3.3.4 Vehicle improvements

As noted above, Stroombergen's (2013) analysis suggests vehicle improvements are the leading cause of the downward trend in fatalities per unit of travel, contributing 45% of the total. Vehicle safety data was taken from Newstead et al (2011), who estimated the average 'crashworthiness' of New Zealand's light

vehicle fleet by year of manufacture. Figure 6.17 shows the updated crashworthiness values from Newstead et al (2013). Crashworthiness is defined as the estimated risk of the driver being killed or admitted to hospital when involved in a crash.

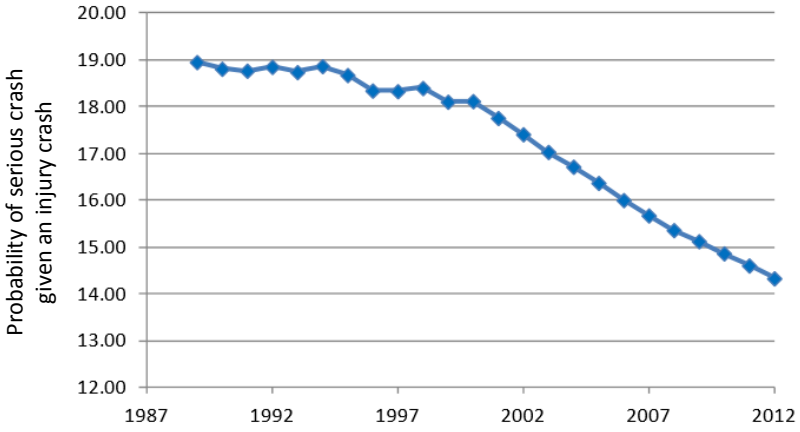
Figure 6.17 Light vehicle crashworthiness by year of manufacture



Source: Newstead et al (2013)

Evidently, the probability of a severe or fatal injury has been declining (ie crashworthiness has been improving) by year of vehicle manufacture. Combining fleet composition data with the crashworthiness data, Stroombergen estimated the average vehicle crashworthiness from 1987 to 2012 (figure 6.18).

Figure 6.18 Average fleet crashworthiness 1998–2015



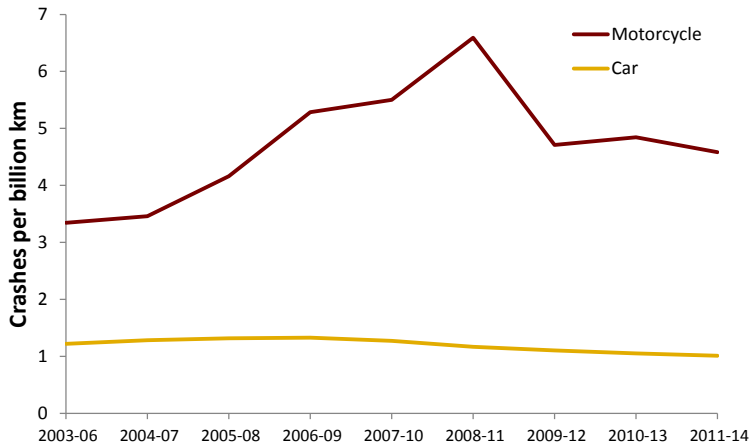
Source: Stroombergen (2013)

Figure 6.18 shows the average fleet crashworthiness (defined as the probability of a serious injury crash, given an injury crash) has been steadily improving since the early 2000s. We explore possible explanations for this trend in section 6.3.7.

6.3.3.5 Motorcycles

Relative to other road vehicles, motorcyclists are more vulnerable to injury or fatality in the event of a crash. Figure 6.19 shows the number of crashes per km driven by cars and motorcycles; per unit of travel, motorcyclists are significantly more likely to crash than cars.

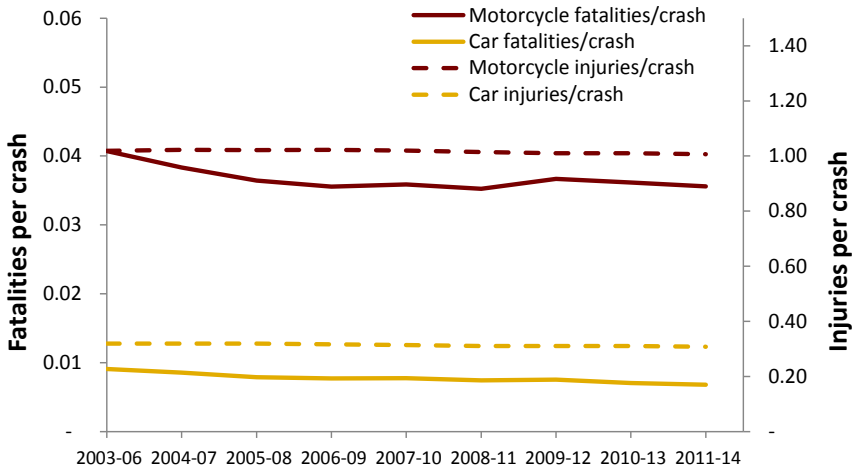
Figure 6.19 Crashes per VKT by transport mode 2003–2013



Source: Crash data – MoT (2014). VKT data – New Zealand Household Travel Survey data.

Not only are motorcyclists more likely to crash per unit of travel, they are also more likely to suffer from a fatal or serious injury in the event of a crash, as shown in the fatalities per crash and injuries per crash data (figure 6.20).

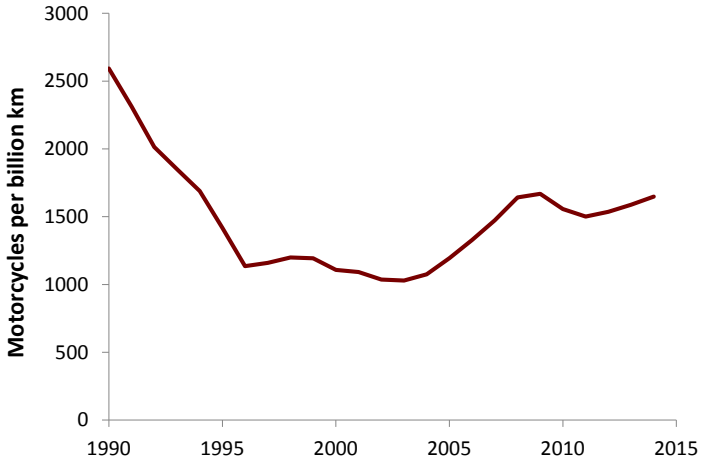
Figure 6.20 Fatalities and injuries per crash for motorcyclists and cars



Source: MoT (2014)

Given the lower amount of protection that a motorcycle provides its rider in the event of a crash, all other things equal, Stroombergen suggests that having fewer motorcycles within the vehicle fleet would improve the fleet's overall safety quality. Accordingly, in addition to the average fleet crashworthiness data, he used licensed motorcycles per unit of total travel to describe vehicle safety (figure 6.21).

Figure 6.21 Licensed motorcycle per total VKT 1990–2014



Source: Motorcycle registrations from MIA vehicle registration data (www.mia.org.nz/Sales-Data/Vehicle-Sales#oss).

Licensed motorcycles per total VKT fell significantly over the early 1990s, coinciding with the steepest decline in fatalities per VKT. Consequently, Stroombergen (2013) found this variable accounted for 33% of the decline in fatalities per unit of travel from 1990 to 2012.

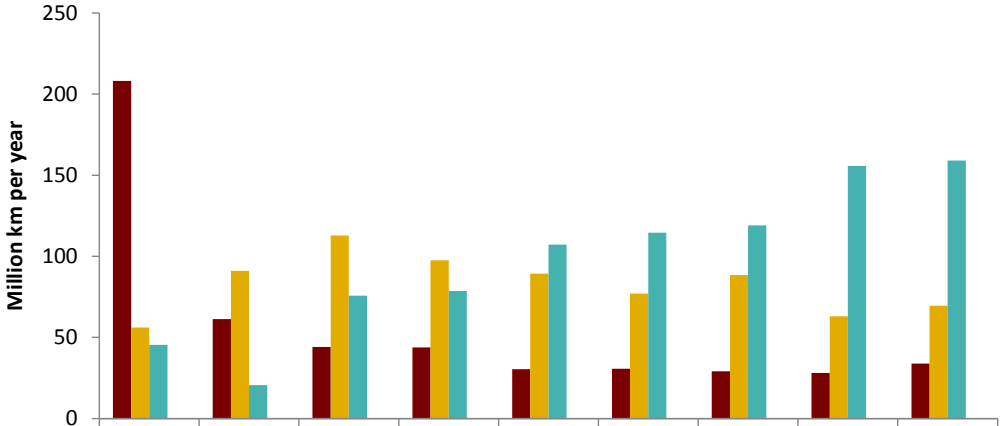
However, assuming the number of motorcycles in the fleet is a useful measure of fleet safety is somewhat simplistic; for example, it does not take account of the age and gender characteristics of motorcycle drivers. Stroombergen acknowledges this limitation, noting that, 'In the past young males were the main motorcycle users, so an already high-risk group used the highest risk vehicle. However, the proportion of motorcycle users accounted for by this age group has declined, so the strength of the estimated relationship between registrations and F/V [fatalities per vehicle] may be less in future'. He suggests that understanding the changes in explanatory variables is another research topic.

The proportion of total motorcycle users who are 'high-risk' young males has declined significantly: 15–29 year olds made up 67% of total motorcycle VKT (208 million kilometres) in 1989, but only 13% of total motorcycle VKT (34 million kilometres per annum) over the 2009 to 2014 period (figure 6.22). This significant change has had a direct effect on young people's involvement in motorcycle crashes. In 1985, 89 motorcyclists aged 15–24 years died from fatal road crashes (or 67% of total motorcycle deaths). This number has fallen to five in 2012 (or 14% of total motorcycle deaths) (MoT 2013).

Distance travelled by young motorcyclists is likely to have a significant relationship to overall fatalities per VKT. Thus Stroombergen's omission of this variable would mean at least some of the relationship between VKT by motorcycles and the number of crashes causing injury or fatality may reflect the age of the driver rather than only the vehicle type.

An investigation into the current factors influencing motorcycle crashes found very different ownership and crash characteristics between users of small motorcycles/mopeds and large motorcycles (Keall et al 2013). Smaller motorcycles are more likely to be owned by younger people living in urban areas. Crashes involving small motorcycles tend to be the fault of other drivers, with a relatively small proportion of these crashes resulting in a fatality (25%). Larger motorcycles are predominantly owned by older males, with 48% of their crashes resulting in fatal or serious injury outcomes. This is likely to be caused by the higher speeds when crashing. Understanding these evident links between size, ownership and crash characteristics is crucial to future motorcycle safety regulatory analysis.

Figure 6.22 Motorcycle VKT by age group of rider



	1989/90	1997/98	2003–08	2004–09	2005–10	2006–11	2007–12	2008–13	2009–14
15–29	208	61	44	44	30	31	29	28	34
30–44	56	91	113	98	89	77	88	63	70
45+	45	21	76	79	107	115	119	156	159
Total	310	173	233	220	227	222	237	247	263

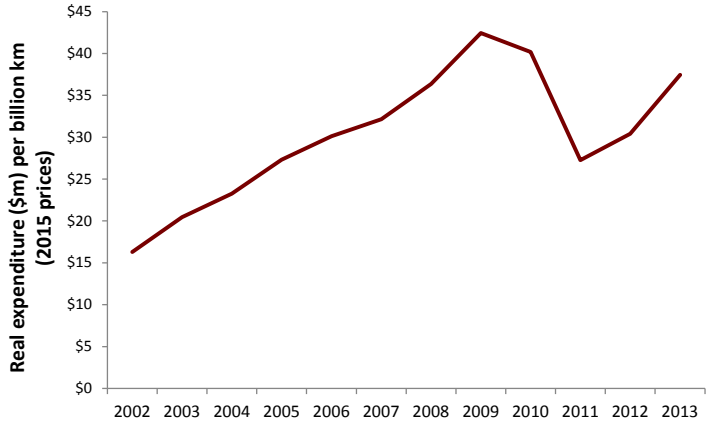
Source: MoT (2015) Motorcycling New Zealand Household Travel Survey 2009–2014

6.3.3.6 Road improvements

The likelihood and severity of road crashes are influenced by road condition, including: pavement condition, lane separation and width, road camber, lighting and roadside hazards such as power poles and loose gravel. Because it is difficult to determine the collective safety quality of road infrastructure at any one time, trends belonging to general road quality are difficult to analyse.

In absence of this data, Stroombergen used real roading capital stock as an indicator for road quality. Assuming expenditure on road maintenance and renewals is equivalent to roading depreciations costs, he used real investment in new roads and improvement of infrastructure as a proxy for the roading capital stock. We replicate this variable in figure 6.23 which shows (in absolute terms) real investment in new roads and improved infrastructure per unit of travel has increased over the last decade.

Figure 6.23 Real expenditure on new roads and improved infrastructure per VKT (2015 prices)



Source: Road investment from Transport Agency funding data (www.nzta.govt.nz/assets/userfiles/transport-data/FundRoadImprovement.html), converted to real prices using Statistics New Zealand Infoshare PPI-output series of heavy and civil engineering construction.

The trend above is similar to Stroombergen's roading capital stock. He also found that road improvements contributed 19% of the reduction in road fatalities since 1990.

6.3.3.7 Driver improvements

Stroombergen estimates that 36% of the reduction in fatal crashes since 1990 are attributable to driver improvements which are sourced to the effects of advertising campaigns, breath testing, and average speed.

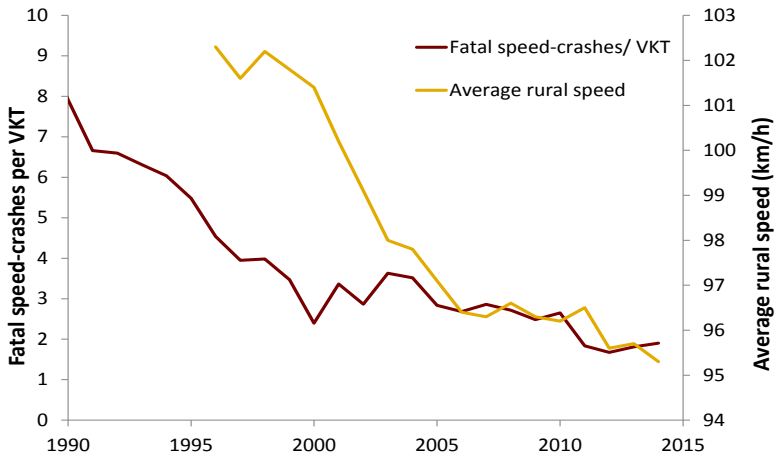
NZ Transport Agency (2016a) highlights speed as the single biggest road safety issue in New Zealand today. High vehicle speeds increase the likelihood of crash involvement and risk of serious injury or death. Crash statistics reveal that, as the severity of a crash increases, so does the probability of speed being a contributing factor. For example, in 2014 'driving too fast for the conditions' contributed to 14% of minor injury crashes, 19% of serious injury crashes and 29% of fatal crashes (MoT 2015f). 'Driving too fast for the conditions' is not the same as speeding (exceeding speed limits), but the concepts are clearly related; it may be a proxy for speeding associated with crashes, given that vehicle speed on impact is generally unknown.

MoT carries out annual speed surveys that measure the free speeds of vehicles (ie when the vehicle is unimpeded by the presence of other vehicles) in 100km/h and 50km/h areas.

Figure 6.24 presents MoT's open road speed data and fatal speed crashes per VKT. In general, speed-related crashes per unit of travel are declining; however, this downward trend has slowed since 2000.

A simple regression to explain the downward trend in the number of fatal speed-crashes per VKT on the basis of changes in average rural speed finds this relationship to be statistically significant ($p < 0.01$).[39] This regression model can explain only about half of the variation in speed crashes per VKT (adjusted R^2 = 0.54). However, a differenced model which regresses the annual change in fatal speed crashes/VKT on the annual change in average speed, shows no statistical significance between the two variables, suggesting that further resources aimed at reducing mean rural speed may not reduce fatalities. Other explanatory factors not taken into account could include levels of drug and/or alcohol use. For example, alcohol/drug use was also a contributing factor in 45% of all speed-related crashes in 2014 (MoT 2015f).

Figure 6.24 Speed- related crashes per VKT by crash type 1990–2014



Source: Crash data from MoT (2014). Speed data from MoT website, road safety surveys, speed survey results – car speeds

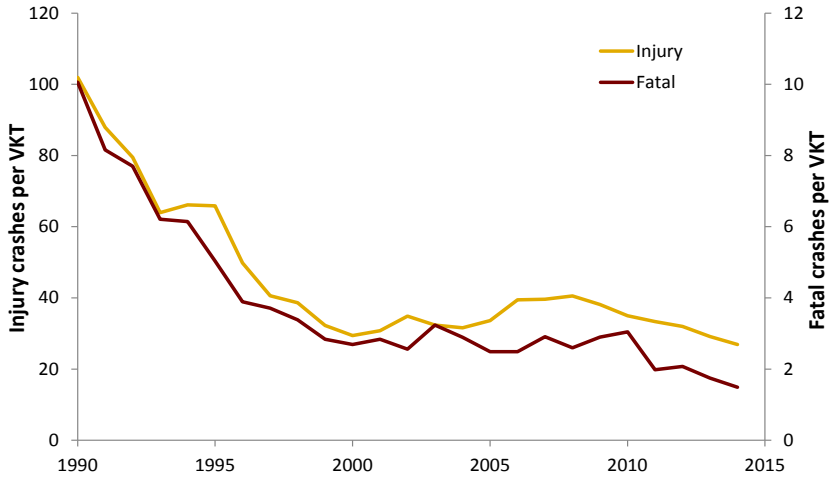
[39] Broadly speaking the p-value represents the probability that the estimated relationship could occur by chance, given an underlying assumption about the distribution of the data.

6.3.3.8 Driving under the influence

Drivers' consumption of alcohol and/or drugs is one of the leading causes of road crashes, contributing to 23% of fatal crashes and 13% of injury crashes in 2014 (MoT 2015a).

Figure 6.25 shows the trend in crashes per VKT for those crashes where alcohol or drugs was a contributing factor. Alcohol/drug-related crashes per unit of travel are declining; this trend has slowed since 2000. The role of regulation is further discussed in section 6.3.5.

Figure 6.25 Alcohol/drug- related crashes per VKT by crash type 1990–2014



Source: MoT (2014)

In the previous section we examined the factors contributing to risks of crashes. In this section we examine whether existing regulations have had an impact on these factors.

Since New Zealand's peak in annual road deaths of 843 in 1973, the vehicle fleet has more than doubled yet road fatalities have dropped by almost two thirds to 295 in 2014. Evidently, changes in contributing factors since 1973 have significantly improved the safety quality of New Zealand vehicles, drivers and/or roads. Some reductions in crash rates will be explained by exogenous factors, such as improvements in vehicle technology of which New Zealand consumers are 'takers'. However, regulation will have affected crash rates also and in this section we examine the effectiveness of road safety regulations.

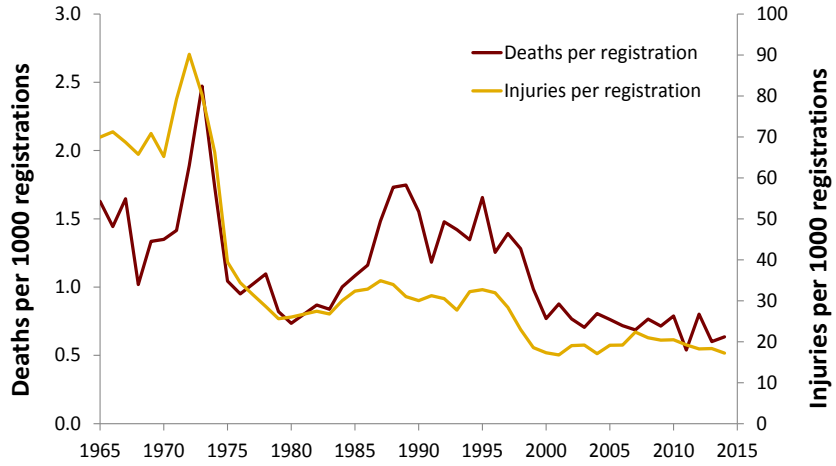
6.3.4 Motorcycle regulation

A few important motorcycle safety regulations have been introduced since 1965. As motorcycle VKT is a key driver of motorcyclist crash and death rates, motorcycle casualties per unit of travel would be an appropriate variable to illustrate changes in motorcycle safety. However, given that motorcycle VKT data is not available for years prior to 1990, we use motorcycle casualties per registered motorcycle as an indicator for motorcycle risk. Figure 6.26 shows a steep decline in deaths and injuries per registration over the 1970s. The beginning of this decline coincides with the introduction of road safety legislation which legally required all motorcyclists and their passengers to wear helmets at all speeds (prior to 1973 helmets were only compulsory when travelling above 50km/h). However, the change in the open road speed limit from 55 to 50mph in 1973 may have also contributed to reduced motorcycle deaths.

The next period of sustained decline in motorcycle casualties per registration began around the mid to late 1980s. Unsurprisingly, this corresponds with the decline of high-risk young people's use of motorcycles as discussed in section 6.3.3.4. Reeder et al (1999) found this trend had a statistically significant association with the introduction of the Graduated Driver Licensing System (GDLS) in 1987. This

system required novice drivers and riders to progress from a learner to a full licence by gradually gaining the skills and experience necessary to drive safely. Although some aspects of this scheme had applied to novice motorcyclists, a number of other new restrictions (and incentives to take supplementary training) were placed in the GDLS. The GDLS is also likely to be responsible for the significant reduction in 15–19-year-old car drivers' involvement in fatal crashes per VKT as seen in figure 6.14. Begg and Stephenson (2003) found fatal and serious injury crash rates among young people have remained well below the pre-GDLS level, suggesting the impact of the GDLS has been long lasting. Other motorcycle safety regulations of significance were not introduced until 2009 when motorcycle and moped riders were required to switch on their headlamps during daylight hours, and in 2012 when novice riders were required to have motorcycle power-to-weight restrictions and competency-based training and assessments.

Figure 6.26 Motorcycle casualties per 1,000 registrations



Source: Motorcycle deaths from MoT (2014). Motorcycle registrations retrieved from MIA (www.mia.org.nz/Sales-Data/Vehicle-Sales#oss).

6.3.5 Drink-driving regulation

Drink-driving is one of the most heavily targeted road safety risks in New Zealand. The introduction of the 'breathalyser' in 1969 was a key milestone as it facilitated regulation of alcohol-impaired driving in New Zealand. The original legal limit was set at 100mg of alcohol per 100ml of blood; this was lowered to 80mg in 1978, and then to 50mg in 2014. A zero alcohol limit was introduced for drivers under 20 years old and repeat drink drivers in 2011. Data concerning alcohol-related crashes is not available for the early changes (in 1969 and 1978) or for the latest change in 2014. However, we can analyse the impact of the recently introduced zero alcohol limit policy for young drivers.

Since the zero alcohol limit for drivers under the age of 20 years was introduced, there has been a 46% fall in the number of under 20s caught with 50mg–80mg of alcohol per 100ml of blood and a 43% reduction in offences by under 20s who are over 80mg/100 ml (MoT 2016a). Over the three years preceding the introduction of the zero tolerance policy (2008–10), the number of 15–19-year-old drivers affected by alcohol/drug and involved in fatal crashes averaged 20 per annum. This average dropped to 10 per annum during the three-year period (2012–2014) following the policy introduction (MoT 2015a).

6.3.6 Advertising and enforcement

Advertising campaigns and enforcement were the other 'driver' variables included in Stroombergen's analysis. Quantifying the effectiveness of these measures can be difficult as they:

- are often implemented in conjunction with each other, making it difficult to determine their respective effect on road crashes
- both have short-term effects (ie increase a driver's perceived probability of being caught for speeding) and long-term effects (ie changed social norms) which are difficult to measure.

However, Stroombergen and other researchers have found each to have an independent effect (Tay 2005). Specifically, police breath-testing and road safety advertising (measured in target audience rating points) from 1990–2012 accounted for 11% and 16% of the reduction in road deaths, respectively (Stroombergen (2013).

Speed limit enforcement is another intervention that may influence vehicle crash rates. Povey et al (2003) found that over the period of 1996–2002, an increase of 10,000 speed camera infringements was associated with a 0.7% and 1.1% reduction in average and 85th percentile rural speeds, respectively. Section 6.3.3.7 analysed the relationship between rural speed and road crashes but did not find it to be statistically significant. Stroombergen did not include any type of infringement as an explanatory variable in his analysis, as more infringements could reflect:

- more enforcement, and so could persuade people to drive more safely, implying fatalities decrease as infringements increase
- a given enforcement input could be capturing more unsafe behaviour, implying fatalities increase as infringements increase.

6.3.7 Vehicle standards regulation

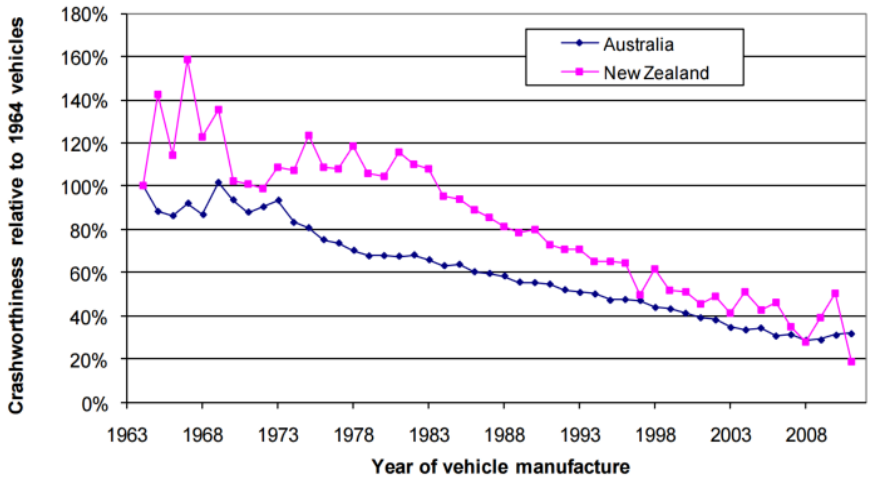
New Zealand's original vehicle standards regulations were established in the 1936 Traffic Regulations (TR36, and later updated in TR54 and TR76) which focused on requirements for vehicles built in New Zealand. It was not until the 1990 Transport Vehicle Standards Regulations (VSRs) when New Zealand vehicle standards were aligned with that of vehicle safety-conscious countries from which the majority of the country's vehicles were now sourced (Newstead et al 2013). The VSRs require safety items such as safety belts, glazing and lighting equipment to comply (and be maintained in accordance) with a specified standard in order for the vehicle to be registered in New Zealand.

This legislation has since been revoked and replaced by a number of Land Transport Rules. These rules are a form of delegated legislation signed into law by the Minister of Transport under the Land Transport Act 1998. The objectives of the Land Transport Rules include (NZ Transport Agency 2016c):

- mandating safe and appropriate behaviour by road users
- controlling people and vehicles' entry to/exit from the land transport system
- ensuring road vehicles are built and maintained to safe standards and are operated safely
- ensuring uniform and effective traffic control measures are in place
- providing for road controlling authorities to set safe and appropriate speeds.

New Zealand's current regulations, particularly regarding vehicle compliance, largely reflect that of safety-conscious vehicle export countries. Thus, one might expect such legislation to have a minimal impact on overall vehicle safety quality. Figure 6.27 shows the estimated average crashworthiness of vehicles in the fleet, by year of manufacture, relative to the average crashworthiness in 1964. Crashworthiness is estimated by predicting the probability of a serious injury crash, given the event of an injury crash and data is presented for New Zealand and Australia.

Figure 6.27 Crashworthiness relative to 1964 vehicles



Source: Newstead et al (2013)

The data suggests that improvements to the average vehicle safety performance in New Zealand and Australia occurred over different time periods. Newstead et al (2003) suggest that, in both countries, the improvements can be linked to periods of relatively intense vehicle safety reforms. For New Zealand, such improvements occurred for vehicles manufactured from the mid-1980s to 2008, and can be credited to the VSRs (1990) and the Land Transport Rules.

The rate at which regulation influences overall fleet safety is determined by the relative stringency of the regulation and the rate at which vehicles turn over in the fleet. The average age of the New Zealand fleet is somewhat higher than that in Australia suggesting a slower turnover.

6.3.8 Conclusions

The immediate factors contributing to crashes are identified in figure 6.10 above. The most influential factors to changes in the number of crashes include:

- general safety improvements to the vehicle fleet
- fewer motorcycles per total VKT
- change in motorcyclists' demographic composition
- increased road capital stock.

Stroombergen quantified the impact of all but one of these variables: change in motorcyclists' demographic composition. The factors above are not forms of regulation in themselves; however, there is a possibility that changes to these variables were a consequence of road safety regulation. This will be the focus of the following section.

Of the road safety legislation introduced during recent years, a handful stand out as being particularly beneficial to road safety progress in New Zealand. Such regulations tend to be those which have targeted 'high-risk' drivers such as the GDLS (1987) and the three regulatory interventions introduced in 2011 that were analysed in section 6.1: the zero alcohol tolerance for under-20s, the increase in the legal driving age from 15 to 16 and the AIP. Vehicle safety legislation such as the Transport Vehicle Standards (1990) and subsequent Land Transport Rules (eg revised frontal impact standards in 2002) have also been effective in reducing road casualties.

6.4 Environment and health

The road transport sector can impose substantial risks to the environment and to human health. In New Zealand, vehicle emissions and road run-off are the predominant sources of these risks, which include:

- reduced life expectancy
- reduced life quality (ie restricted activity and increased hospital admissions)
- positive climate forcing (ie global warming)
- degradation of water quality from road run-off.

The following sections examine these external health and environmental impacts and their respective costs to society.

6.4.1 Global emissions

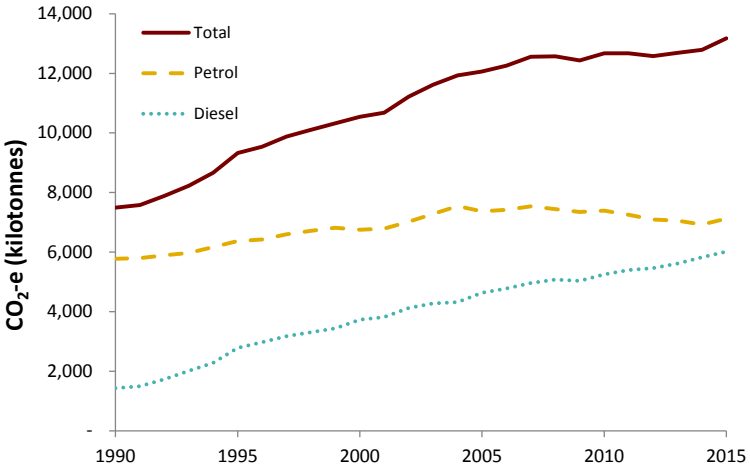
Vehicle emissions include those with local effects on health, visibility etc (see below) and those with global effects (GHG emissions).

Carbon dioxide (CO_2) and other GHGs have global effects as they are very long lived in the atmosphere, spread widely and have effects across the globe. GHGs from transport fuels include CO_2, methane (CH_4) and nitrous oxide (N_2O); they are measured together in CO_2-equivalents (CO_2-e) that sum the total global warming potentials of these different gases.

CO_2-e emissions from road transport are directly proportional to fuel consumption. They have increased steadily over time, although they have stabilised since about 2007 (figure 6.28). This trend has been driven by increasing CO_2 emissions from diesel vehicles. Growth in CO_2 emissions from petrol vehicles has been moderate.

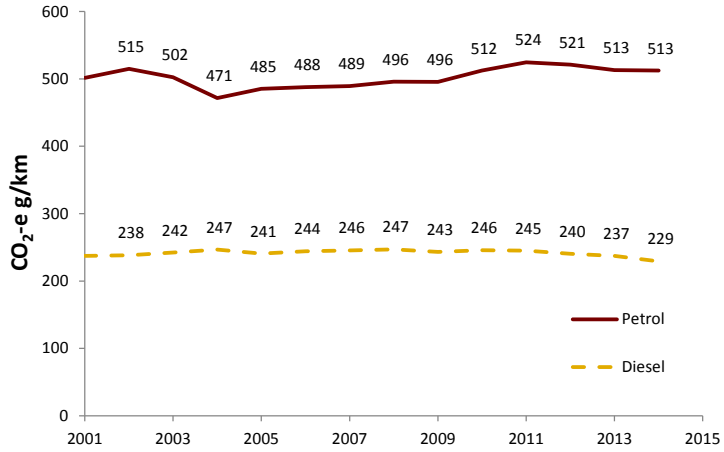
Figure 6.29 suggests that petrol and diesel CO_2-e emission factors (and thus average fuel economy) have not improved since 2001. Growth in travel, particularly diesel travel, is the primary cause of increasing CO_2-e emissions. Indeed, over this period, diesel travel grew 49% from 7.6 to 11.3 billion kilometres, while petrol travel increased by a mere 5% from 28.6 to 30.2 billion kilometres (MoT 2015b).

Figure 6.28 Total CO_2- e emissions per annum, 1990–2015



Source: MBIE (2016) Energy Greenhouse Gas Emissions web tables (www.mbie.govt.nz/info-services/sectors-industries/energy/energy-data-modelling/publications/energy-greenhouse-gas-emissions). 2014 and 2015 values were estimated using MBIE emissions factors and fuel consumption data.

Figure 6.29 Petrol and diesel CO_2- e emissions factors, 2001–2014



Source: CO_2 emissions from MBIE (2016) Energy Greenhouse Gas Emissions web tables (www.mbie.govt.nz/info-services/sectors-industries/energy/energy-data-modelling/publications/energy-greenhouse-gas-emissions). VKT data from MoT (2015b)

Currently road transport global emissions are included in the ETS and this broadly internalises the costs to New Zealand of these emissions (we discuss any ongoing market failures in section 5.4).

6.4.2 Local emissions

Local air pollution is a complex mixture of contaminants and particles. The most harmful of these substances include (Denne et al 2013):

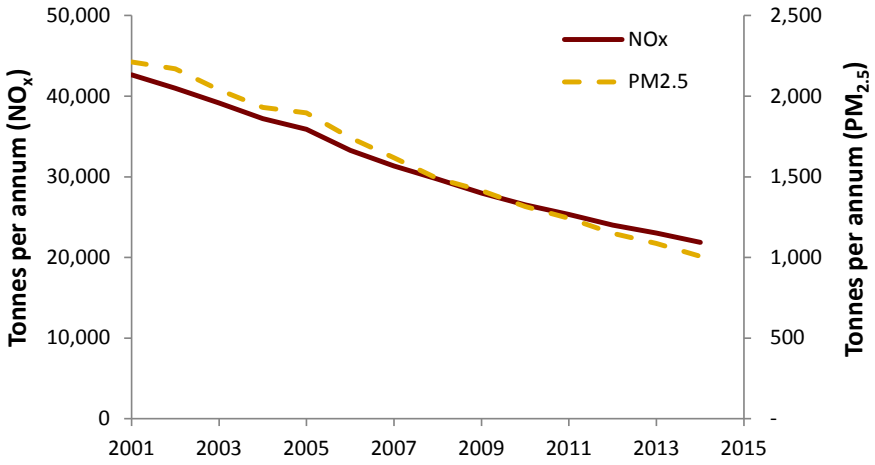
- particulates $PM_{2.5}$ or PM_{10} – very fine particles that can reduce life expectancy and intensify a number of respiratory and cardiac problems.
- carbon monoxide (CO) – worsens heart disease and causes drowsiness and learning difficulties. CO concentrations are often correlated with PM_{10} levels in cities; and
- nitrogen dioxide (NO_2) – aggravates asthma and other respiratory problems and also tends to be correlated with PM_{10} levels.

Contrary to the global emissions trend, local emissions from the road transport sector (represented by $PM_{2.5}$ and NO_2) have been steadily falling since 2001 (figure 6.30). These values were calculated through combining respective fleet weighted emission factors estimated by the Vehicle Emissions Prediction Model (VEPM)[40] with MoT VKT data.

We explore the factors contributing to local emission trends from the road transport sector in the following section.

[40] The VEPM was developed by the Transport Agency and Auckland Council to predict emissions from vehicles in the New Zealand fleet under typical traffic, road and operating conditions.

Figure 6.30 Total $PM_{2.5}$ and NO_2 vehicle emissions, 2001–2014



Source: Emissions factors estimated using VEPM Model 5.1 (default settings). VKT from MoT (2015b)

6.4.2.1 Factors affecting local emissions

Motor vehicle pollution is a function of:

- vehicle emission intensities (which vary across fleet categories)
- distance travelled (total and by fleet category)
- driver behaviour.

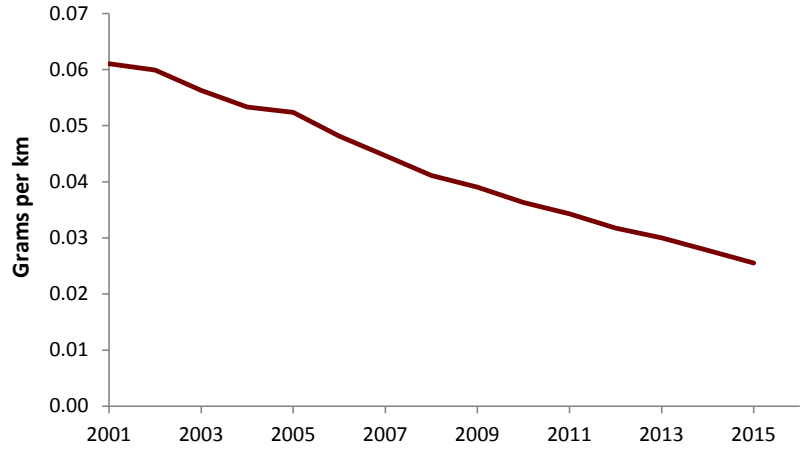
As driver behaviour is not easily measured, however, we focus on other key factors that determine intensity of local emissions released by motor vehicles.

6.4.2.2 Vehicle emission intensities: particulates

Particulate matter is known to have the most severe health and environmental impact. PM_{10} concentrations are monitored over a wide range of New Zealand locations yet measuring PM_{10} directly produced from vehicles is problematic as natural sources also contribute to total PM_{10} levels. Very small particles, $PM_{2.5}$ (particulates with a diameter of less than 2.5µm), are more definitely the result of human activity; however these particulates are not recorded over a wide range of locations.

Kuschel et al (2012) estimate that road transport contributed to 22% of total social costs of anthropogenic air pollution (measured as costs of PM_{10} emissions) in New Zealand in 2006. The relative contribution of vehicles varies by location. For example, in Auckland the 2006 estimates of anthropogenic PM_{10} emissions across the region are 38% from transport (Xie et al 2014). Figure 6.31 presents the fleet weighted $PM_{2.5}$ emissions estimated by the VEPM. The estimated fleet weighted $PM_{2.5}$ emissions have fallen significantly from 0.061g/km in 2001 to 0.026g/km in 2015.

Figure 6.31 Weighted average $PM_{2.5}$ emissions from the New Zealand fleet 2001–2015

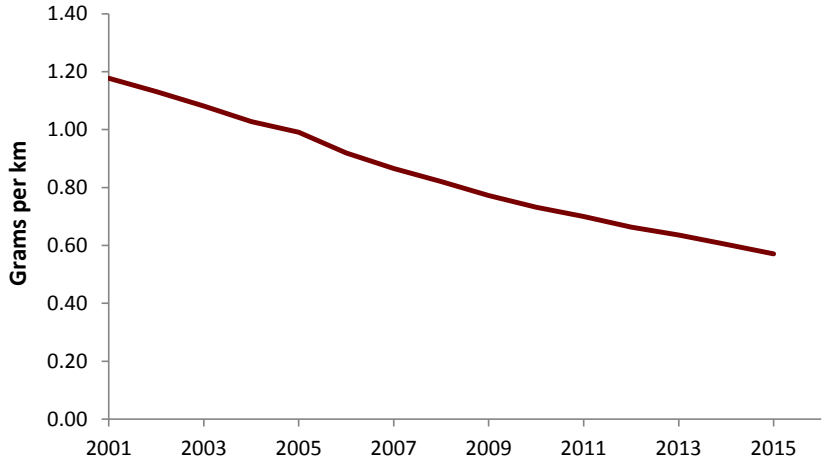


Source: Estimated using VEPM model 5.1 (default settings)

6.4.2.3 Vehicle emission intensities: nitrogen dioxide

VEPM estimates of fleet weighted average NO_2 emissions are presented in figure 6.32. The NO_2 trend is comparable to that of $PM_{2.5}$ in figure 6.31.

Figure 6.32 Weighted average NO_2 emissions from the New Zealand fleet 2001–2015



Source: Estimated using VEPM model 5.1 (default settings)

To check the validity of VEPM estimates, researchers have tested VEPM predictions against remote sensing samples. Remote sensing samples measure actual exhaust emissions of a large number of in-use vehicles. A 2012 analysis found accord between fleet average trends estimated by the VEPM and measured trends in average vehicle emissions for the light fleet (Metcalfe et al 2013). Some discrepancies were found between predicted and actual emissions values. The results suggest the actual rate of reduction in NO_x and PM_{10} emission factors from diesel vehicles is likely to be less than the VEPM estimated rate (NZ Transport Agency 2013). However, a 2014 study did not find great differences between VEPM estimates of emissions from diesel vehicles and actual values (Golder Associates 2014).

The inconsistency concerning diesel vehicles found in the 2012 study is supported by results from a recent European investigation which revealed that nearly all new diesel cars exceeded the official European limit for NOx (NZ Transport Agency 2013). All vehicles tested had passed the standard when tested in a laboratory

under fixed conditions but, when taken out onto real roads, almost all emitted far more pollution. The European study found 'just one of 201 Euro 5 diesels, the EU standard from 2009, did not exceed the limit, while only seven of 62 Euro 6 diesels, the stricter standard since 2014, did so' (Carrington et al 2016).

6.4.2.4 Emissions factors by fleet category

Motor vehicle emission factors are measured by the quantity of a pollutant released to the atmosphere for every kilometre travelled (ie emission intensity). Figures 6.33 and 6.34 illustrate the weighted average NO_x and PM_{10} emission factors from the entire vehicle fleet.

Emission factors are known to vary by fleet category. For example, diesel vehicles tend to have higher emissions of particulate and nitrogen oxides per kilometre travelled (NZ Transport Agency 2013). Table 6.9 presents PM_{10} and NO_2 emission factors from the VEPM (theoretical data) and the most recent remote sensing data (actual data) (Golder Associates 2014). As expected, both theoretical and actual data shows significantly higher PM_{10} emission factors for diesel vehicles compared with petrol vehicles. However, there does not appear to be a discernible difference in NO_2 emission factors between diesel and petrol vehicles. Heavy vehicles were not included in the analysis, although the literature suggests heavy vehicle emission intensities (for PM_{10} & NO_2) are substantially higher than those of light vehicles (Ban-Weiss et al 2008).

Table 6.9 Comparison of remote sensing and VEPM data for light duty vehicles

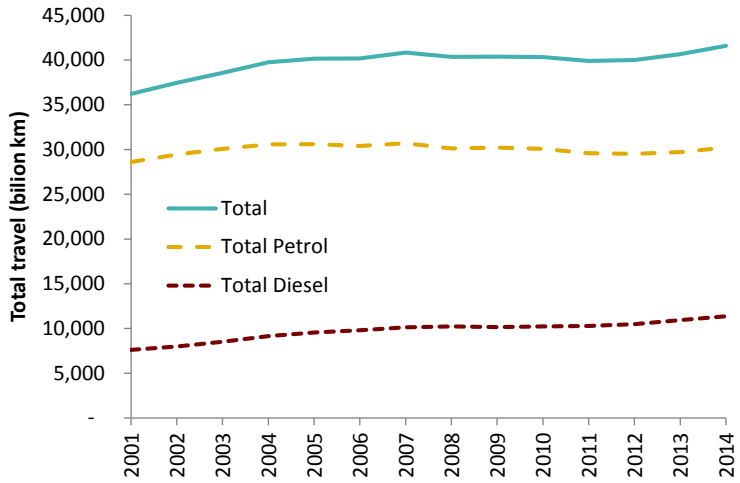
Emission	Source	Petrol car	Petrol LCV	Diesel car	Diesel LCV
PM_{10}	RSD mean (g/km)	0.041	0.084	0.138	0.115
	VEPM mean (g/km)	0.005	0.004	0.264	0.174
NO_2	RSD mean (g/km)	0.68	1.37	0.52	0.67
	VEPM mean (g/km)	0.69	0.96	0.85	1.35

Source: Golder Associates (2014)

6.4.2.5 VKT

Total distance driven by motor vehicles is directly related to fuel consumption, which in turn, broadly determines the total amount of local emissions released by motor vehicles. Annual VKT growth ranged between -1% and 2% over the previous decade. The recent slowing of VKT growth would have contributed to a slowing of emissions growth also.

Figure 6.33 Total travel on New Zealand roads, 2001–2014



Source: MoT (2015b)

As emission factors differ according to vehicle type, distance travelled by the respective fleet categories is what determines total vehicle emissions. Travel on New Zealand roads is dominated by light passenger vehicles. In 2014 light passenger vehicles made up 76% of annual VKT, followed by light commercial (16%), heavy trucks (6%), buses (1%) and motorcycles (1%) (MoT 2015b).

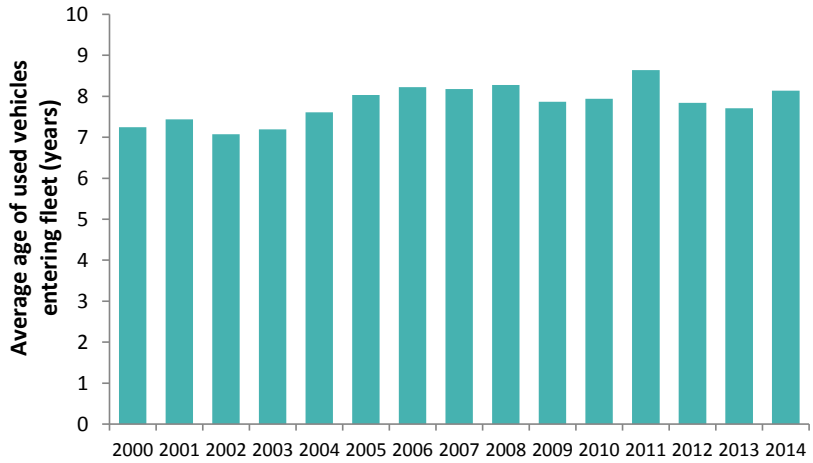
6.4.2.6 Light vehicles

Given that the majority of travel is done by the light fleet, trends within this vehicle category are of great importance to overall emission intensities.

6.4.2.7 Vehicles entering the light fleet

The average age of used imported vehicles entering the light fleet increased gradually until 2008 when the Vehicle Emissions Standards Rule (2007) came into effect. However, figure 6.34 shows this trend resumed its pre-2008 growth rate as the age range of the vehicles compliant with the rule broadened. Further tightening on emission standards in 2012 saw another drop in the average age of used light vehicles entering the fleet (MoT 2015b). Again, as the age range of the vehicles compliant with the updated rule broadened, the average age of used light vehicles has begun to increase.

Figure 6.34 Average age of used light vehicles entering the fleet, 2000–2014



Source: MoT (2015b)

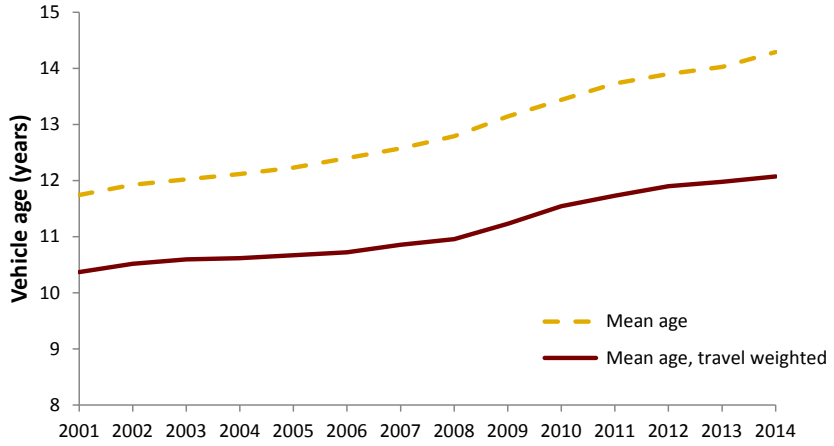
6.4.2.8 The aging light fleet

Figure 6.35 shows mean age and travel-weighted mean age trends for the light vehicle fleet. Two key trends can be seen in this figure. First, the travel-weighted mean age of the light fleet is lower than its mean age, ie newer cars tend to travel more than older cars. Second, the travel-weighted mean age of New Zealand's light fleet is increasing.

An aging fleet could be due to gradual improvements in vehicle manufacturing quality, which in turn extends the road life of a vehicle. The continuation of this trend could be explained by the 2007 Vehicle Exhaust Emissions Rule (section 2.4). This rule included more stringent requirements for used vehicles, for example:

- imported used vehicles manufactured before 1 January 2004 now had to comply with a minimum emissions standard
- a testing regime was introduced to ensure that emissions from used vehicle imports remained within stated limits (NZ Transport Agency 2016c).

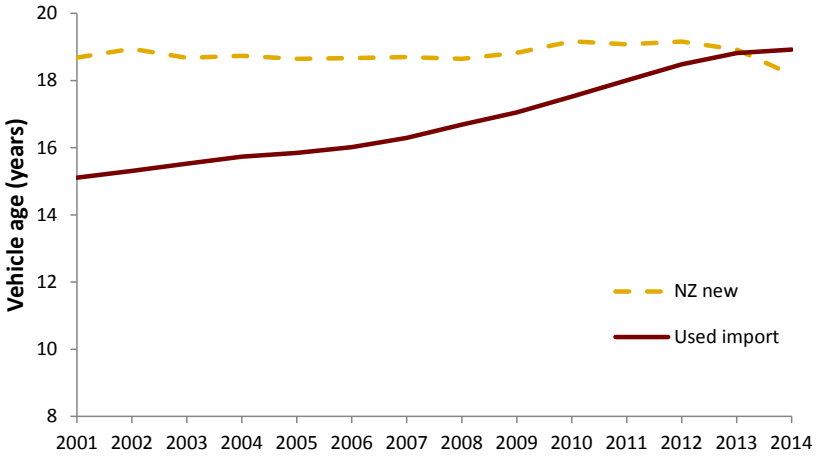
Figure 6.35 Light fleet mean age and travel- weighted mean age, 2001–2014



Source: MoT (2015b)

Consequently, the average age of light used imports entering the fleet lowered; however, the number of used imports entering the fleet significantly reduced. This is because tighter import standards are likely to incentivise used import car owners to hold on to their vehicles for longer. The combined impact is reflected in the increasing average scrappage age for imported used vehicles (figure 6.36).

Figure 6.36 Average light vehicle scrappage age, 2001–2014



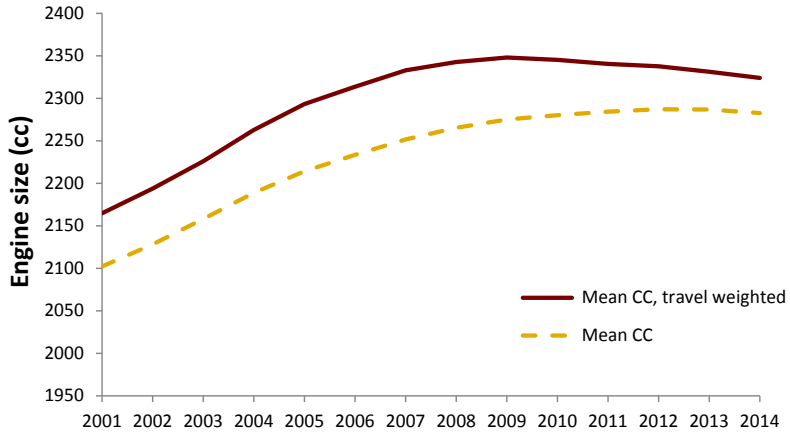
Source: MoT (2015b)

Ultimately, an aging vehicle fleet prevents New Zealand benefiting from technology gains and stricter emissions standards that predominantly apply to newer vehicles.

6.4.2.9 Heavier light vehicles

Another important light vehicle trend is the growing engine size. Figure 6.37 shows the average engine size and travel-weighted average engine size (for the light vehicle fleet) grew over the early 2000s, but has begun to plateau since 2007. The combination of trends from figure 6.36 and figure 6.37 suggests newer vehicles tend to both travel further and have larger engines.

Figure 6.37 Light fleet travel- weighted average engine size, 2001–2014

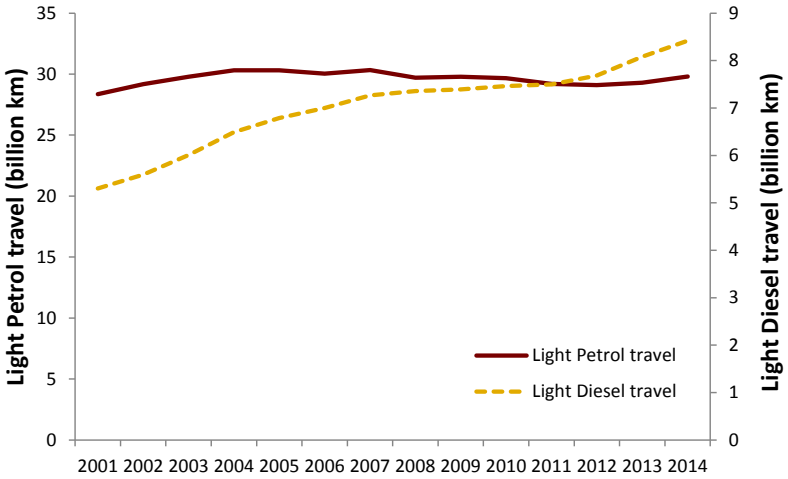


Source: MoT (2015b)

6.4.2.10 Light diesel travel growth

The most significant growth in light travel has come from diesel vehicles. Figure 6.38 shows light petrol travel has grown only 5% in absolute terms since 2001, whereas light diesel travel has increased by 59%.

Figure 6.38 Light petrol and diesel VKT, 2001–2014



Source: MoT (2015b)

Substantial growth in diesel travel could be somewhat explained by an increasing demand for bigger vehicles (figure 6.37), as larger engines tend to be diesel powered. Growing travel of diesel cars means such vehicles are becoming of increasing importance to total PM_{10} (and probably NO_2) emission levels.

Vehicle emission standards are generally lower for diesel vehicles relative to petrol vehicles. For example, the Euro 5 regulations (the current standard for all European vehicles in the New Zealand fleet) permit a NOx emission factor for diesel cars of 180mg/km, compared with 60mg/km for petrol cars. Given the less stringent local emission requirements for diesel vehicles, increasing diesel travel may undermine efforts to reduce overall local vehicle emissions.

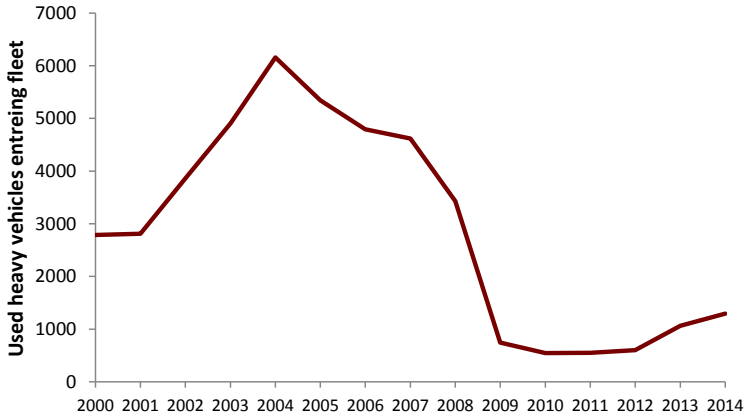
6.4.2.11 Heavy vehicles

Heavy commercial vehicles (ie buses and trucks) make up around 7% of total VKT (MoT 2015b). This percentage has remained relatively unchanged over the past decade. However, heavy vehicles are likely to contribute disproportionately to total local emissions released from the road sector.

6.4.2.12 Vehicles entering the heavy fleet

Figure 6.39 shows a significant drop in used heavy vehicles entering the fleet until 2008. This coincides with both the implementation of the 2007 Vehicle Exhaust Emissions Rule and the global financial crisis. Since then, used heavy vehicle registrations have increased as more compliant vehicles have become available.

Figure 6.39 Used heavy vehicles entering the fleet, 2000–2014

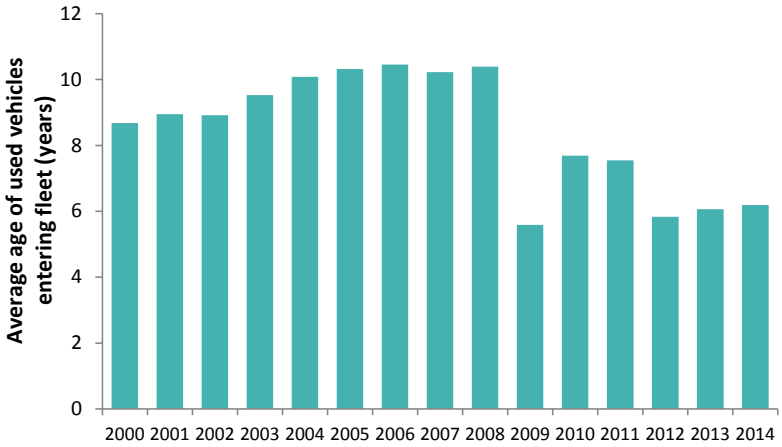


Source: MoT (2015b)

The Vehicle Exhaust Emissions Rule (2007) has also effectively reduced the average age of used heavy vehicles entering the fleet (MoT 2015b, p13).

Figure 6.40 shows the average age of used heavy vehicles entering the fleet dropped from around 10 years to around six years over the years following the introduction of this rule.

Figure 6.40 Average age of used heavy vehicles entering the fleet, 2000–2014



Source: MoT (2015b)

More stringent requirements on exhaust emissions for heavy vehicles have significantly lowered the ratio of used to new vehicles entering the fleet. Before the implementation of this rule, around 1.2 used heavy

vehicles were entering the fleet for every new heavy vehicle. This ratio has since fallen to 0.3 used heavy vehicles for every new heavy vehicle (figure 6.4.1).

Figure 6.41 Used/new heavy vehicles entering the fleet

Source: MoT (2015b)

6.4.3 Road run-off

Vehicles can affect aquatic receiving environments through adding to contaminant concentrations in run-off from roads. Contaminants include fuels, additives, oil and brake and tyre residues containing a variety of toxic and ecotoxic components, such as heavy metals and organic compounds (Gardiner et al 2016). Road run-off and other environmental effects of roads are regulated under the RMA. This includes the National Policy Statement for Freshwater Management 2014. Our interest in this report is primarily on transport-specific regulation.

6.5 Summary and conclusions

In this chapter we have reviewed a number of analytical techniques that can be used to analyse safety and environmental problems associated with road transport. These have focused on econometric or regression analysis methods that enable comparison of current safety and environmental outcomes with estimates of what they would be in the absence of regulation. This includes assessing the influence of a range of (exogenous) factors on the outcomes, including the effects of regulation.

7 Regulatory options and improvement

In this chapter we examine:

- regulatory options – how to identify the set of interventions that governments can make to address identified market failures or risks and whether there is a hierarchy of options or if a particular market failure identification would suggest a particular type of intervention
- regulatory improvement – the components of analysis of existing regulations and the scope for improvement rather than replacement.

7.1 Regulatory approaches

In chapter 2 we discussed the types of regulation used in the New Zealand transport sector in terms of Acts of Parliament, Orders in Council and so on. Our concern in this section is with the way regulation functions, particularly the extent to which the regulatory options make use of markets to achieve objectives.

Regulatory or policy approaches differ according to how they influence behaviour towards outcomes. We classify them broadly into information, market-based, and command and control instruments in table 7.1.

Table 7.1 Types of regulatory intervention

Level of market intervention	Instrument type	Description	Examples
Low	Information	Information provision: market participants are provided with information to make decisions that are otherwise not influenced by the government	Vehicle fuel economy labelling Road signs
		Nudges: decisions are influenced by the way information and choices are presented	Default responses Advertising messages
	Market-based	Revenue-raising instruments: charges that aim to recover revenue with least distortion	Vehicle excise duty, road user charges
		Price-based instruments: changing market prices to influence behaviour	Congestion charging
		Quantity-based instruments: market creation, eg tradable permits	Emissions Trading Scheme
High	Command and control	Performance-based: required outcomes	Speed limits, emission limits
		Process-based: required inputs	Equipment requirements, eg safety belts, helmets

Source: Covec

Information instruments address information gaps and are used to increase the information available to decision makers. Examples include the VFEL, which provides purchasers of vehicles with data on relative fuel economy (using a star system) and expected running costs. Road signs can also be informational, eg guidelines on speeds for corners.

Nudges are types of information instruments that have been popularised through the publication of *Nudge: improving decisions about health, wealth and happiness* (Thaler and Sunstein 2009) which suggests the way

people are presented with information can influence their decisions. For example, Wales has adopted a soft opt-out system for organ and tissue donation; since 2015, all people over the age of 18 who die in Wales are presumed to be organ or tissue donors unless they explicitly ask not to be.[41] This does not change the freedom of individuals to be donors or not, but means people must make a deliberate effort not to be a donor; the policy 'nudges' people towards being donors. Another UK example is that payments rose when letters to non-payers of car tax included a picture of the offending vehicle (Behavioural Insights Team 2014). This suggested the individual had been identified and was being targeted.

Market-based instruments (MBIs) affect behaviour through changing prices of existing goods or through creating markets that did not previously exist. Currently in New Zealand, with the exception of the ETS, market-based instruments have been introduced largely for revenue raising purposes rather than to have an incentive effect. Vehicle excise duty and RUCs apply charges to vehicle use on the basis of fuel consumption or kilometres travelled. The system is used to internalise the costs of road use, particularly damage to roads and the requirement for new road investment. However, these charges increase the costs of travel and influence transport behaviour towards less travel.

MBIs which more explicitly target behaviour include congestion charges that have been applied in other countries, and have been canvassed for New Zealand (MoT 2006; MoT 2008). The reasons for introducing the ETS to New Zealand included reducing GHG emissions below business-as-usual levels.[42]

Command and control instruments are more prescriptive in their requirements. This might include required outcomes (such as road speeds) or required technologies or equipment, such as helmets and safety belts.

7.2 Regulatory choice

7.2.1 Matching regulatory choice to market failure category

Where regulatory intervention is justified on the basis of market failure (and level of risk), the choice of optimal regulatory approach is determined to a significant extent by the analysis of costs and benefits. However, it is best informed by the market failure analysis also. For example, a CBA might suggest wellbeing would be improved if people purchased vehicles that were smaller or more fuel-efficient than those they currently bought, and this might be used, in turn, to suggest regulation be used to restrict choice. However, although this might be a wellbeing-maximising outcome, the estimated net benefits might also be the result of failing to fully account for people's preferences in vehicle purchase. Market failure analysis would suggest the potential source of the problem is that people lack information on the full lifetime costs of vehicle ownership. Addressing an information gap through a regulatory response of providing information, viz fuel economy labelling, preserves individuals' freedom of choice in decision making while enabling them to make better decisions based on a greater amount of relevant information.

One response to this issue might be for the nature of the market failure to determine the regulatory intervention, with information failures addressed through information provision and so on. However, we do not always regulate in this way. Energy efficiency regulation has been used to limit choice in energy using products in the form of minimum energy performance standards set under the Energy Efficiency (Energy Using Products) Regulations 2002.[43] The argument for using restrictive standards rather than

[41] http://organdonationwales.org/Organ-Donation-is-changing-in-Wales/Donation-is-changing-in-Wales/?lang=en

[42] Section 3 (Purpose) Climate Change Response Act 2002

[43] www.eeca.govt.nz/standards-ratings-and-labels/equipment-energy-efficiency-programme/product-standards-regulations-and-registration/

simply information programmes might be the certainty of outcome is greater and the potential costs of restricting choice are small, so it is less likely the CBA has missed significant costs (or benefits); because of the types of products regulated,[44] people place less value on the features (or brands) that might be restricted as they do with restricting vehicle choice.

We address the issues further below relating to the individual market failures.

7.2.2 Incomplete information

Where there is incomplete information, a regulatory (or policy) response of information provision is a first step consideration. Whether information is actually provided will depend on the assessment of the costs of providing it, whether it can be provided effectively and its expected response (and benefits), ie a CBA. A useful example is the VFEL where information has been provided on fuel use per vehicle to vehicle purchasers but there are compromises made in balancing simplicity and accuracy, ie the approach taken has been to include an estimated cost per year using an average VKT which might be quite different from that actually travelled.

People will not always act consistently with a rational choice model, ie to maximise their (or society's) best interests, even where full information is provided. For example, people show evidence of bounded rationality (the limited cognitive abilities that constrain human problem solving) (Mullainathan and Thaler 2000; Shogren and Taylor 2008). Where this is common and/or the outcomes are significant, regulators may move beyond simple information provision, either towards nudges or regulatory interventions that limit choices (command and control options).

Information instruments can be efficient because they do not restrict individual choice and do not attempt to define what is in an individual's best interests. This can be suitable where there are no external costs, and/or where there are potentially significant costs of regulation that cannot be readily quantified (eg costs of restricting vehicle choice). In the absence of these conditions alternative or additional interventions might be required.

7.2.3 Externalities

The theoretical ideal response to an externality problem is a Pigouvian tax, named after economist Arthur Pigou; it is a charge equal to the marginal external (damage) cost (Baumol and Oates 1988). If such a charge could be designed and applied (at the right price) to the activities that resulted in marginal damage (wellbeing reduction), we would be indifferent if people chose to undertake the activity (and pay the charge) or to not undertake the activity to avoid the charge. If someone chose to pay the charge it would be because they valued that activity at least as much as the damage cost.

To adopt a Pigouvian tax the impacts should be quantifiable at the margin, eg as a result of one more kilometre of travel. However, there is a significant difference between the nature and predictability of the environmental and crash effects.

7.2.3.1 Environmental impacts

In general, the environmental effects of road transport are more predictable than for crashes; however, there are significant uncertainties.

GHG emissions are predictable and already internalised, or there is a mechanism to do so – the ETS (see section 5.4.1.1). For air emissions, emission charges would be suitable if emissions could be predicted on

[44] These include commercial and industrial equipment (fans, commercial refrigerators, motors), heating, cooling and hot water devices, home entertainment, lighting equipment and whiteware.

the basis of some easily measurable level of activity or input, eg if the external cost was directly proportional to the quantity of emissions and if the quantity of emissions was directly proportional to, say fuel consumption. However, the relationship is not that simple:

- Costs will vary with exposure, particularly between emitting in high versus low density areas. The external costs of driving in Auckland are greater than in some other part of the country in which there is significantly lower population density and few people will be exposed to any pollutants.
- Emissions vary with the vehicle (and driver behaviour) in addition to the fuel consumption. The vehicle affects the emission level through the completeness and temperature of combustion, for example.
- There are differences between the emissions (and fuel consumption) performance of vehicles in a test and on-road.

Thus an emissions charge might be calculated to represent the average cost per litre of fuel from the average vehicle, but this will under-price the effects in some places and over-charge in others. This has not stopped other jurisdictions introducing economic instruments for pollutants, including a number of examples of tradable allowance systems for NOx and SO_2 in the USA. These result in prices for emissions that do not vary by location. Although not completely efficient, they have been regarded as successful, partly because they have resulted in reduced emissions at lower cost than more direct (command and control) regulatory approaches. Studies that have compared the costs of environmental policy before (ex-ante) and after (ex-post) implementation, ie as predicted in policy analysis and as measured following their introduction, have shown that ex-ante cost estimates tend to be higher than actual costs in ex-post evaluations, and that this is particularly and consistently so for economic incentives (Harrington et al 1999).

The efficiency benefits of environmental taxes include a marginal incentive to reduce pollution, ie every unit (eg kilogramme) of emissions reduced is rewarded. In contrast, regulations that limit emission through controlling vehicle types provide no ongoing incentive to reduce emissions further, eg by reducing vehicle use or more conservative driving (noting the points made above that we can only reward effective emission reductions imperfectly).

In contrast to air emissions which are more predictable (emissions are a certainty, although the impacts are not), other environmental effects are less predictable or are more site specific. This includes road run-off, noise and visual impacts.

There may be a potential for wider use of MBIs in regulation of the environmental effects of road transport.

7.2.3.2 Crashes

In contrast, to environmental effects, crashes are less predictable. As discussed in section 5.1.1, crashes are rare events; people are likely to crash every 192,000km or once every 18 years. We know there is a relationship between vehicle speed and crashes, but not everyone who speeds has a crash and some who do not speed have a crash. Whereas for environmental externalities the more certain effects can be used to develop a marginal relationship between driving a kilometre and the emission impacts, no such relationships can be developed for crashes. Crashes are not random but they are not easily predicted either.

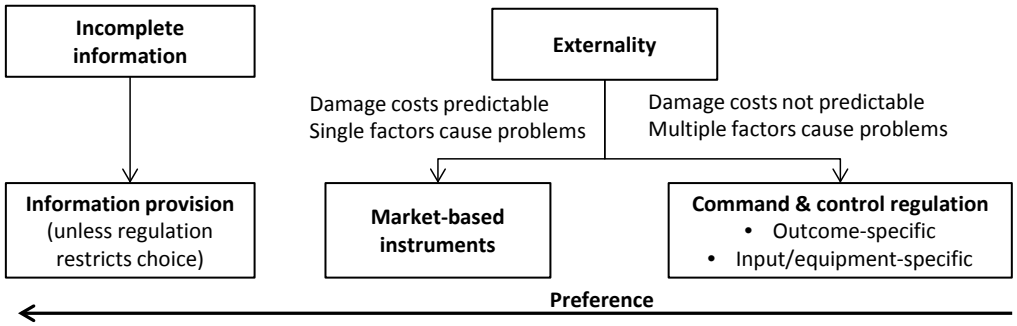
For crashes there is thus no means for developing a Pigouvian tax. Crashes, and their social costs, are the result of a complex combination of factors that include driver behaviour, vehicle quality, road condition and external factors such as weather. The externality properties of crashes are also influenced by insurance which is widely regarded as socially desirable. In these circumstances the analysis of market

failure provides little guidance for regulation. We know there is a set of potential market failures behind crashes but we cannot solve them directly.

7.2.4 Possible decision approach

Building on the discussion above, we might use the identified market failures as a way to identify the types of regulation that are justified. Figure 7.1 provides a possible decision guide to the analysis of existing regulations and their suitability. We explain the components below.

Figure 7.1 Regulatory choice based on market failure



Source: Covec

7.2.4.1 Incomplete Information

Information gaps are best addressed through information provision. This applies whether externalities exist or not. Information provision will always improve decision making where people have behavioural choice that affects outcomes. The exception is where regulation restricts choice, eg where, to reduce risks, vehicles must include specific equipment or be built to specified standards. In these cases information provision may help to explain regulations, but may not affect behaviour.

7.2.4.2 Externalities

Identifying externalities

Externalities exist where others, who have no influence on the decision, are affected by the decision(s) of an individual. However, the decision on whether the existence of an externality justifies interventions that go beyond information provision may depend on the relative size of the external costs compared to those borne by the decision maker.

Impacts might be classified in terms of whether the effects are limited to the driver alone or if they extend to others, including passengers, other road users and/or the wider community (table 7.2). Effects on the wider community can include direct effects, eg pollution impacts on people in the same airshed, or indirect effects, eg the impacts of fatalities on family, friends and colleagues.

Table 7.2 Risk matrix for crashes and environmental effects

Extent of impact	Level of social costs from fatalities, injuries, health effects				
	Very high	High	Medium	Low	Very low
Driver only					
Driver + passengers					
Other drivers, road users, pedestrians					
Wider community					

Source: Covec

Where it could influence whether a regulation should consist of more than information provision, the identification of externalities should take account of the extent to which the impacts are borne by those other than the driver, eg using a rating scale from very high to very low (table 6.6). If there are external costs, but the effects are mainly borne by the driver, the justification for intervention to tackle the externality is much less than if a more significant proportion of total impacts are borne by others.

For example, helmets worn by cyclists or motorcyclists have injury- or fatality-reducing effects that are very largely confined to the wearer. An externality issue still exists because:

- crashes might not be the fault of the cyclist/motorcyclist
- others (friends, family) are affected when any individual is injured or killed.

However, riders still have some control over the likelihood of a crash through decisions on where, when and how they travel: the helmet wearer (or non-wearer) is able to calculate the risks of wearing a helmet or not. And despite helmet-wearing reducing crashes, some international studies have found compulsory bicycle helmet regulations have greater health costs than benefits, particularly taking account of the impact on bicycle use and its health benefits.[45] Thus using the existence of external costs (which might be much less significant than the direct costs) to justify regulation may pass on significant costs to the rider (including those who choose not to ride because of the regulation).

Thus such considerations appear to be a useful input to the review of existing regulations and decisions on the rationale for new regulation. Because helmet-wearing (or not) is more internalised than other transport decisions that carry risks, regulation should give greater pause for thought (and analysis).

7.2.4.3 Regulating for externalities

Theory suggests the best approach to addressing an externality is for a charge to be introduced so that the impact is internalised. However, this works efficiently where the impact is:

- predictable – every kilometre travelled or litre of fuel consumed results in a quantifiable impact. GHG emissions are the best example
- attributable to a single factor rather than a combination.

Where MBIs are not suitable, regulatory interventions may be justified.

[45] A recent CBA of compulsory cycle helmet wearing in Germany found costs exceeded the benefits taking account of the benefit of increased safety when cyclists wear a helmet or use a transport mode that is less risky than cycling, the cost of purchasing helmets, reduced fitness when cycling is replaced by a motorised transport, the discomfort of wearing helmets and environmental externalities (Sieg 2014).

However, this classification is not absolute. Environmental impacts other than GHGs are not entirely predictable, eg emission impacts vary by location and driving behaviour, amongst other factors, but a price on emissions[46] would be expected to result in emission reductions. Similarly, vehicles entering dense urban areas may not always cause congestion, but congestion charges lead to reduced total congestion. MBIs may still be applicable, although the outcomes may be less certain than with regulation: MBIs should be considered alongside command and control regulation in CBAs.

Crash damage is not predictable with any certainty. Although analysis can find predictive relationships between behaviour and outcome, eg crashes increase with speed, speeding does not inevitably result in a crash. Also, there are generally multiple factors involved: inexperience plus speed plus road conditions and so on. Combined, these factors suggest MBIs are likely to be less suitable for tackling risks of crashes.

Command-and-control regulations will include those that are outcome specific, eg speed limits, and those that are input or equipment specific, such as frontal impact regulations. In all cases, the benefits of regulation should exceed the costs.

7.3 Implementation and operational improvement

Rather than regulations being justified or not, they may be justified but not implemented well. This might be identified through analysis that showed existing regulations to be ineffective while still being justified through an analysis of the problems. In this sub-section we examine how scope for regulatory improvement might be identified.

Box 3.4 in section 3.5 examined approaches used by the US EPA. This included a number of questions in regulatory reviews that were targeted at identifying implementation or operational issues, such as reducing transaction costs:

- Does the regulation impose paperwork activities (reporting, recordkeeping, or third party notifications) that could benefit from online reporting or electronic recordkeeping?
- Does the regulation have complicated or time-consuming requirements, and are there feasible alternative compliance tools that could be more cost-effective?

Others that address the development of technologies that might make current compliance approaches redundant or offering scope for cost reductions:

- Have new or less costly methods, technologies, and/or innovative techniques emerged since this regulation was finalised that would allow regulated entities to achieve the intended results more effectively and/or efficiently?

These appear to be useful questions for analysis of road transport regulations.

The nature of analysis to identify scope for improvement in implementation or operation of the regulation is likely to remain a series of questions. A suggested set of questions is included in table 7.3. This builds on the questions used by the US EPA (transaction costs and technology improvements) and adds questions relating to better targeting of regulation and the specific settings or levels of regulation.

[46] Options might include a charge that varied with vehicle type or an additional charge on fuel consumption

Table 7.3 Regulatory improvement options

Improvement potential	Issues and questions
Process improvements	Can process requirements be changed so that transaction costs can be reduced?
Implementation improvements	Have new or less costly methods, technologies, and/or innovative techniques emerged since this regulation was finalised that would enable objectives to be achieved more effectively and/or efficiently?
Target improvements	Can the regulation be better targeted at causes (or causers) of crashes or environmental effects? Can this reduce costs or improve benefit-cost ratio?
Setting improvements	Can the settings within the regulation be changed to improve efficiency, eg speed limits, technical standards?

7.4 Conclusions

Market failure analysis is unlikely to provide useful advice on whether to intervene to regulate the causes of road transport crashes and environmental effects. This is because market failures are widespread. However, market failure analysis may be useful in pointing towards the kinds of regulations or policy responses that are most suitable.

Figure 7.1 provides a guide for analysing existing regulations and whether they are consistent with the nature of the market failure that justifies them. The preference within regulations is to the left of the diagram: information provision > MBIs > command and control regulation. The step towards more interventionist and less market-driven regulation is based on: (1) the existence of external impacts that are significant in comparison with private impacts; and (2) impacts not being easily predictable or the result of single determinant factors.

Scope for regulatory improvement in terms of operation or implementation is achieved through addressing a series of questions that examine the scope for change that would have efficiency benefits.

8 Conclusions and methodology implications

8.1 Elements of regulatory evaluation

This report examines 'the best approach for determining and monitoring the contribution that government regulatory interventions in New Zealand make to mitigate the major risks associated with the land transport system'. This has been defined broadly such the major risks of the land transport system include the costs of regulation as well as the impacts on human health and the environment.

The context for the study includes that of the government's agenda to improve New Zealand's regulatory performance under which it has an expectation that regulations are regularly checked to see if they are fit for purpose and that there are processes to improve regulations. Currently New Zealand has no systematic approach to the review of regulations. This contrasts with systems in place in many other countries where ex-post evaluation of regulations is common-place.

The NZ Productivity Commission has commented that New Zealand appears to be biased in favour of more regulation, that many regulations have been introduced and never revisited and there might be individuals seeking to obtain the benefits of lower risks while passing costs on to the wider community.

We have examined the different components that might go into an ex-post evaluation of regulation in land transport. Building on international approaches as summarised in table 3.7, we summarise the elements noted in table 8.1 and describe them in more detail below.

Table 8.1 Elements of ex- post evaluation

Component	Question(s)	Analytical tasks
1 Problem definition	Q1(a) What is the problem, the underlying justification for the regulation? (b) Has it changed? This includes new scientific developments, changed trends, new technologies etc?	A.1(a) Market failure analysis. Is there a market failure and of what form? • Incomplete information • Externality • Incomplete markets (b) Analysis of trends in the: • the physical problem (crash numbers, emissions etc) • the underlying causal factors.
2 Effectiveness of current regulation	Q2 (a) How effective is the regulation in addressing the problem(s)? (b) Were expected benefits (or net benefits) achieved? (c) Have there been unintended consequences?	A.2 (a) Analysis of outcomes compared to some counterfactual with no regulation (or some alternative) to isolate the effects of regulation (b) Comparison of outcomes with expected outcomes
3 Regulatory options	Q3 (a) Is regulation still the best way to achieve objectives? (b) Are there regulatory and non-regulatory options?	A.3 (a) analysis of regulatory response suggested by market failure identification (b) Regulatory review – literature review and international comparative review
4 Regulatory analysis	Q4 (a) Do the benefits still exceed the costs? (b) Do alternatives exist with lower costs for the same objective? Can greater cost-effectiveness be achieved?	A.4 (a) Cost benefit analysis (or review of existing CBA) of current regulation and alternatives (initial high-level analysis)

Component	Question(s)	Analytical tasks
5 Regulatory improvement	Q5 (a) Can the regulation be modified to better partner with other regulatory areas or levels of government? (b) Does it have time-consuming requirements, eg paperwork, that can be reduced? (c) Flexibility: Is it highly prescriptive? Could it be made more flexible?	Transaction cost analysis

Such a periodic and systematic review of regulation would help to achieve some of the government's regulatory concerns and address some of the problems raised by the NZ Productivity Commission. Analytically it includes:

- a re-examination of the problem the regulation is addressing to ensure the problem still exists
- a review of the operation of the existing regulation in terms of its effectiveness in tackling the identified problem
- identification of regulatory options, including non-regulatory responses
- analysis of the costs of the regulation and its benefits – do the costs still exceed the benefits or are there alternatives that would have greater net benefits?
- whether there is scope for regulatory improvement.

Such a re-visitation of the problem can be used to assess whether, starting from a clean slate, regulation would be introduced now. The next step is to ask whether regulation is still the best approach or if some other type of response is more suitable. For example, if the problem is largely being solved through changes in preferences including market preferences, regulation may be achieving little.

Where regulation is still justified, it is useful to analyse whether the particular regulation is both effective and efficient. Effectiveness analysis might use a number of analytical (econometric) techniques to separate out the impacts of regulation versus other factors.

Even where regulation is still justified there may be room for improvement. A necessary final step is to see whether the lessons learned to date have identified any scope for changes to legislation that would improve its effectiveness or efficiency (eg reduce costs).

Such a periodic and systematic approach to ex-post analysis would help to ensure that land transport regulation was fit for purpose.

8.2 Problem definition

The problem definition stage is to address whether there is a rationale for the regulation. The problem is defined in term of the existence of a market failure and in physical terms – the safety or environmental issues that arise and the causal factors.

8.2.1 Market failure analysis

Market failures associated with road transport are widespread and they are relatively straightforward to identify. Nevertheless it is useful to do so as it focuses the analysis on the source of the problem and provides information for the choice of regulatory response, if any.

Market failure analysis requires an assessment of the elements shown in table 8.2.

Table 8.2 Components of market failure analysis for road transport

Market failure	Questions for analysis
Incomplete information	Are problems arising because people are making decisions with limited information or with limited ability to process the information? This might include: • vehicle or equipment purchase decisions • driving behaviour.
Externalities	Are some impacts the regulation aims to address borne by people other than the person(s) directly responsible for the problem (eg the driver)? This would apply to crashes and to emissions.
Other	Are there any other sources of market failure of relevance, eg imperfect market competition?

Ideally market failure analysis is used to identify whether there is a rationale for regulation. And the analysis in chapter 5 suggests there is a potential market failure relating to crashes as a result of information failures and externalities, and an externality problem relating to emissions. However, the failures relating to crashes and safety are not readily fixed, particularly because of the role of insurance in isolating individuals from the marginal effects of behavioural decisions. No matter what regulation is put in place it will always be possible to identify a market failure. In this context, a simple question: *is there a market failure?* may not be that useful. What may be useful is to understand the nature and degree of market failure.

In section 5.6 we noted an examination of the extent of the externality problem would be a useful way to identify more pernicious failures. This would, for example, categorise externalities in terms of whether the party affected was:

- the driver only
- driver and passengers only
- other road users
- the wider community.

If the effects are driver only, or mostly driver-only, then the market failure is more dominated by imperfect information than externality. Under these circumstances, regulatory interventions that go beyond information provision are more difficult to justify and would require a solid CBA.

The question is thus not 'is there a market failure?', but 'what is the extent of market failure?'

The nature of market failures in the environment sphere is more straightforward. The effects are more inevitable or predictable and the potential for directly addressing the externalities is more achievable.

8.2.2 Physical problem definition

Although market failures provide the rationale for (potential) intervention, we are not concerned with market failures that do not have wellbeing-reducing effects. This is consistent with risk-based regulation in which resources are focused on reducing the greatest harms.

8.2.2.1 What is the physical effect that the regulation is addressing?

The physical problem is the effect that results in a reduction in wellbeing, including crashes and environmental effects. The physical problem is expected to be one of the following:

- crash-related problems:
  - fatalities
  - injuries
  - damage to property
- environmental effects:
  - global emissions (GHG)
  - local emissions
  - other, eg road run-off.

Problem analysis would include bringing together data on the problem targeted by regulation. For example, analysis might address the relationship between speed and crashes, or between vehicle technology, emissions and pollutant concentrations (or exposure). The expectation would be for the analysis to identify the series of steps that link inputs to outputs, outcomes and impacts. This is ideally a quantitative (regression) analysis.

The problem definition needs to include an assessment of how significant this problem is. For example, if there is a relationship between alcohol and crashes (as there is), then the analysis needs to also identify how common such crashes are, ie whether this is a minor issue or a significant cause of crashes.

Chapter 6 included a discussion of the analytical work undertaken by Infometrics (Stroombergen 2013). This included econometric analysis of the causes of changes in crash rates over time. This analysis identified the causes of crashes related to driver behaviour, road condition and vehicle quality, all of which are potentially addressed by policy but are also influenced by social and market trends. Exogenous factors such as weather also affected crashes. This is summarised in figure 6.9.

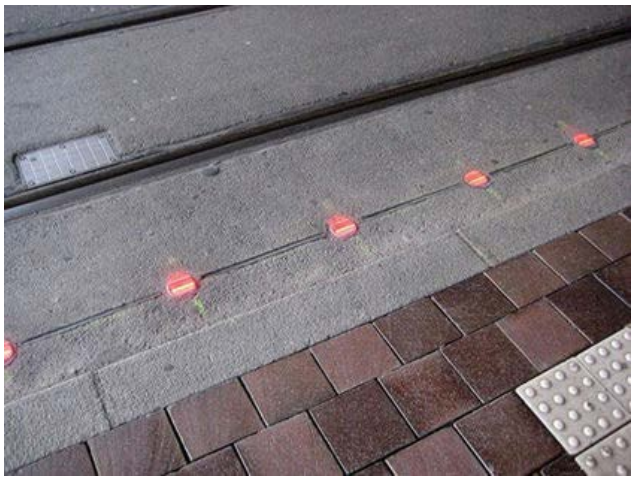
This is consistent with the factors identified in the *Safer journeys* strategy that include safe roads, vehicles and road use, while identifying speed as a specific factor.

8.2.2.2 Are there any underlying (or exogenous) trends?

One of the important issues in regulatory or policy development is examining the trends in the factors that result in crashes or environmental problems. This might include trends in technology and in preferences. For example, rules have needed to be changed over time to take account of changes in mobile device technologies and their use for navigation. Similarly, technology developments and the way people use them changes some of the hazards relating to roads; we note, for example, recent reports in which the German city of Augsburg has installed traffic lights in the pavement (figure 8.1) so pedestrians looking down at a smartphone will not miss the indication that it is unsafe to cross.[47] Changes in human behaviour may change the ways in which crashes occur.

[47] www.telegraph.co.uk/technology/2016/04/26/german-city-installs-traffic-lights-in-pavements-to-protect-text/

Figure 8.1 Pavement traffic lights in Augsburg, Germany



Source: www.augsburger-allgemeine.de/community/img/82110/origs37541677/7390208574-w512-h960/.jpg

Other significant trends relate to preferences of different age groups for motorcycles, regarded as a vehicle type with particular safety risks. There has been a very significant shift in motorcycle VKT from those aged 15–29 to those aged 45 and over (figure 6.22).

8.2.2.3 Problem analysis components

The analysis should include:

- Elaboration of the specific causal steps between the regulated activity or thing and the wellbeing-reducing effects, eg how speed leads to crashes and the causal link, eg the relationship between speed and crashes (by type, severity etc).
- Identification and analysis of trends in exogenous factors that affect the outcome, eg whether speeds are falling anyway, or if vehicles are getting less emissions intensive over time.
- Identification of the major causes of the problem being addressed, ie the factors that are most significant in causing the wellbeing-reducing effects, eg where alcohol/drug use sits alongside other causes of crashes. How significant is it compared to other causes (note this will need to isolate the effects of existing regulation in estimating whether there is a problem).

This analysis will provide an understanding of the causes and significance of the problem that is regulated and whether it is likely to be affected by trends unlinked to regulation.

8.3 Effectiveness analysis

The next proposed step is an analysis of the effectiveness of existing regulation in addressing the identified problem. This requires the existing level of outcomes (crashes, emissions) to be compared against some alternative scenario of what the outcomes would be in the absence of the regulation. In addition the analysis should consider:

- whether the benefits (or net benefits) were achieved as measured in a CBA at the time of the regulation
- if there were any unintended consequences that might have reduced (or increased) the effectiveness of the regulation.

The analysis of effectiveness in delivering outcomes is likely to require regression analysis, as discussed in chapter 6 and in figure 6.1. This would be used to identify the influence of regulation versus other factors determining outcomes.

The estimate of monetary benefits resulting from the regulation stems directly from the assessment of the physical effects of regulation.

An examination of unintended consequences may be in quantified terms and may be a factor that feeds into the assessment of effectiveness. It might also be used as an input to the analysis of potential for regulatory improvement.

8.4 Options analysis

Options analysis addresses whether regulation is still the best approach to addressing the problem and if there are regulatory alternatives.

The analysis might start with the analysis of market failures and then address whether any identified market failures suggest a particular form of intervention, as described in figure 7.1. The analysis takes a starting point that, where possible, less interventionist regulations that make more use of market decisions are likely to produce results with overall greater net benefits because they maximise freedom of choice for individuals. The step towards more interventionist and less market-driven regulation is based on: (1) the existence of external impacts that are significant in comparison with private impacts; and (2) impacts not being easily predictable or the result of single determinant factors.

Identification of regulatory options is thus firstly theoretical. The second element is an analysis of what other jurisdictions do to address the same or similar problems. Is the New Zealand regulatory approach typical or is it more interventionist than that adopted by other countries?

The output of this assessment will be an identification of regulatory options that might be considered alongside the existing regulation in a reappraisal of costs and benefits. Alternatively, if there are no identified options the analysis would concentrate next on identifying scope for regulatory improvement.

8.5 Regulatory analysis

The regulatory analysis is an ex-post analysis of costs and benefits. The extent of such an analysis would depend on the importance or size of the regulation, ie how much effect does it have on the market?

CBA is a systematic approach to comparing the advantages and disadvantages of decision options. The approaches used are widely discussed elsewhere[48] and are not repeated here.

The re-analysis might comprise:

- a review of the existing CBA undertaken when the regulation was first introduced, including any assessment of alternatives. This would analyse whether the assumptions still hold and whether important cost or benefit items have changed. Analysis could identify whether changing these inputs would change the estimated outcome
- addition of new regulatory options to the existing analysis
- a new analysis including the existing regulation and alternatives.

[48] For example: NZ Transport Agency (2016b); NZ Treasury (2015)

The analysis would be undertaken to examine if the benefits still exceed the costs and if regulatory options are likely to have greater net benefits.

8.6 Regulatory improvement

If the regulation is still deemed to be worthwhile and the benefits exceed the costs, this step would examine if there is scope for improvement, and if the benefits of such improvement exceed the costs. This might include the elements shown in table 8.1 with questions relating to improvements in process, implementation, targets of regulation and the specific regulatory settings or levels of regulation.

Regulatory improvement analysis is particularly applicable where analysis has otherwise suggested no changes to the regulations. The approach suggested is to address this issue by working through a series of questions that prompt for improvement potential.

8.7 Conclusions

The components of a regulatory analysis as set out in this chapter provide the basis for a systematic ex-post analysis of transport regulation. It would enable the Transport Agency and the government to have greater confidence that existing regulations were fit for purpose or if there was scope for regulatory change or regulatory improvement to increase the net benefits of regulation.

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Appendix A: Land Transport Rules for road safety

Rule	What	Application/purpose
Vehicle Repair 1998	Sets a standard for repair of vehicles and requires repairers to use suitable methods in attaining that standard. The standard for repair is that the vehicle, its structure, systems, components and equipment must be restored to a safe tolerance of their manufactured state. The methods of repair depend on factors such as the class and make of the vehicle, the vehicle standards which apply, and the manufacturer's specifications.	The rule applies to all repairs and to all vehicles and includes structural, mechanical and electrical repair. The only applicable compliance mechanism (at present) is provided in Vehicle Standards Compliance 1998 rule. This requires repair certifiers to inspect and certify repairs following corrosion or structural damage which would adversely affect a motor vehicle's safety performance before a vehicle can be registered in New Zealand.
Driver Licensing 1999	This rule specifies the requirements for obtaining and renewing a driver licence or licence endorsement in New Zealand. It also specifies the requirements for driver licensing service providers.	This rule brings together requirements relating to driver licensing and makes some major changes to the driver licensing system. Such changes are predominantly aimed at reducing the exposure of young drivers (between the ages of 15 and 24 years) to road crashes, reducing the crash risk of other novice drivers, reducing the number of drivers who drive while unlicensed or disqualified, having better-prepared and better-skilled drivers, improving enforcement and deterrence, improving driver attitudes, and developing a more positive road safety culture.
Glazing, Windscreen Wipe and Wash, and Mirrors 1999	Establishes minimum safety levels for vehicle glazing, and the safety requirements for windscreen wipe systems, windscreen wash systems, and rear-view mirrors. Revokes and replaces Land Transport Rule: Glazing 1996.	Safety requirements differ according to vehicle class and year of manufacture. These standards must be maintained throughout the on-road life of the vehicle. Relevant components and systems must be kept within a safe tolerance of their manufactured state. A choice of overseas standards is provided to give flexibility within agreed safety parameters.
Passenger Service Vehicles 1999	Specifies the legal requirements for the design and construction of all passenger service vehicles in New Zealand. This rule ensures that any vehicles offering a passenger service in New Zealand are safely designed and constructed.	Covers all vehicles used in passenger service, with some additional requirements according to whether the vehicle is 'light' or 'heavy'. Includes privately owned and operated vehicles that have more than 12 seats or that are heavy motor vehicles with more than nine seats. Updated the Passenger Service Vehicle Construction Regulations 1978 in order to cover new types of passenger service vehicles (ie minivans and minibuses), new technologies, and new safety standards and practices being introduced overseas.
Door Retention Systems 2001	This rule covers the design, construction and maintenance of door retention systems used by passengers and drivers for entrance and exit.	Requirements differ according to vehicle class and year of manufacture. The purpose of this rule is to ensure doors remain secure during operation of a motor vehicle and perform satisfactorily in a crash. Updates Land Transport Rule: Door Retention Systems 1997, and consolidates and continues relevant provisions of the TR76 and the VSRs 1990.
Frontal	Requires specified vehicles to comply with	Applies to vehicles first certified for entry into service in

Rule	What	Application/purpose
Impact 2001	approved frontal impact standards of Europe, US, Australia or Japan. Frontal impact protection must remain similar to that of its manufactured quality. Updates previous frontal impact rule (1997) which only applied to vehicles manufactured on or after March 1999.	New Zealand. This rule speeds up the introduction of safer frontal impact protection systems by requiring compliance from all passenger cars imported into New Zealand regardless of the date on which they were manufactured.
External Projections 2001	The rule requires that external projections on vehicles are designed and maintained to ensure the safety of other road users.	Updates and replaces Land Transport Rule: External Projections 1997 with only minor changes made to ensure consistency among the land transport rules relating to vehicle standards. Safety requirements differ according to vehicle class and year of manufacture. These standards must be maintained throughout the on-road life of the vehicle.
Interior Impact 2001	Requires vehicles to comply with approved interior impact standards of Europe, US, Australia or Japan. Vehicles that comply with the frontal impact rule 2001 are not required to comply with standards specified in this rule, although other provisions still apply.	Safety requirements differ according to vehicle class and year of manufacture. These standards must be maintained throughout the on-road life of the vehicle.
Head Restraints 2001	Requires that, if head restraints are fitted to motor vehicles, they must be designed and maintained to protect the head and neck of occupants from whiplash injury in a crash. Approved head restraint standards are those of Europe, US, Australia or Japan.	Safety requirements differ according to vehicle class and year of manufacture. These standards must be maintained throughout the on-road life of the vehicle. Updates Land Transport Rule: Head Restraints 1997.
Steering Systems 2001	Covers the design, construction and maintenance of steering systems in motor vehicles. The rule's aim is to ensure that steering systems provide safe and sensitive control of a motor vehicle, and to minimise injury to the driver, who might come into contact with steering systems or components in a crash. Steering system requirements depend on vehicle class and year of manufacture. Vehicles that comply with the frontal impact rule 2001 are not required to comply with standards specified in this rule, although other provisions still apply.	Updates and replaces Land Transport Rule: Steering Systems 1997. The rule structure and scope remain much the same apart from amendments to the general safety requirements to ensure that the rule covers any system or component that affects the directional control of the motor vehicle and the scope of the rule now encompasses a wider range of vehicle classes. The general safety requirements set out in this rule consolidate and roll over relevant provisions of the Traffic Regulations 1976 and the Transport (Vehicle Standards) Regulations 1990.
Tyres and Wheels 2001	This rule sets requirements relating to tyres and wheels and their assembly with hubs and axles, on all motor vehicles and also on pedal cycles.	Tyres manufactured before the rule comes into force can continue to be used if they comply with the general safety requirements and vehicle standards applicable at the time of their manufacture. Tyres manufactured after the rule comes into force must comply with any new approved vehicle standards.
Light Vehicle Brakes 2002	Specifies the types of brakes that must be fitted in most types of light vehicle, and the safety requirements for those brakes.	Different brake types and their requirements apply according to vehicle class and year of manufacture. These standards must be maintained throughout the on-road life of the vehicle. Updates the relevant provisions of the TR76 and the 1990 VSRs.

Rule	What	Application/purpose
Seatbelts and Seatbelt Anchorages 2002	This rule states in which seating positions seatbelts must be fitted in vehicles, as well as the type of seatbelt that must be used. Seatbelt and anchorage standards must comply with those approved in Europe, US, Australia, Japan or South Africa.	Seatbelt and anchorage type required depends on vehicle class and first year of registration/ year of manufacture. These standards must be maintained throughout the on-road life of the vehicle. Updates the relevant provisions of the TR76 and the VSRs 1990.
Seats and Seat Anchorages 2002	Covers the design, construction and maintenance of seats and seat anchorages to ensure that seats meet at least the minimum strength standards and are securely anchored to the structure of the vehicle.	Requirements depend on vehicle class and year of manufacture. This rule provides a choice of overseas standards to give flexibility within agreed safety parameters, and enable New Zealand to align with world best practice. Links with, and provides a means of assessment for Vehicle Standards Compliance 2002, which sets procedures for vehicle inspection and certification.
Vehicle Standards Compliance 2002	Authorised by the Land Transport Act 1998 and implemented to control entry of vehicles into, and operation of vehicles in, the land transport system. Revokes and replaces Land Transport Rule: Vehicle Standards Compliance 1998.	Applies to all persons operating a motor vehicle on a road in New Zealand, all persons and organisations appointed as certifiers to carry out inspection and certification activities for motor vehicles, and all motor vehicles operated on a road in New Zealand. The main change introduced by this rule (with respect to Vehicle Standards Compliance 1998) is the removal of the distinction between requirements for vehicles with a warrant of fitness that were new when entering service in New Zealand, and vehicles that were used imports. All these vehicles now require an annual warrant of fitness inspection until they are six years old, and a six-monthly inspection thereafter.
Vehicle Dimensions and Mass 2002	Covers requirements for dimension and mass limits to enable vehicles, in particular, heavy truck and trailer combinations, to be operated safely on New Zealand's roads. The rule requires compliance with two approved standards. One of these relates to testing for Static Roll Threshold (which is used to determine the stability of a vehicle). The other is an approved standard with which retroreflective materials used for 'oversize' signs and hazard warning panels must comply if the over-sized vehicle is driven at night.	This rule clarifies, consolidates and rationalises the existing requirements for vehicle dimension and mass limits. It also takes into consideration the recommendations of the 1996 Parliamentary Inquiry into Truck Crashes with new requirements regarding (1) vehicle stability: in order to reduce the incidence of rollover and loss-of-control crashes among heavy vehicles and (2) trailer to truck mass ratio: to address the tendency of heavy vehicles with trailers to jack-knife while undertaking emergency manoeuvres.
Setting of Speed Limits 2003	The Land Transport Rule: Setting of Speed Limits 2003 establishes procedures for road controlling authorities to set enforceable speed limits on roads within their jurisdictions. This rule promotes national uniformity in speed limits by requiring road controlling authorities to apply a consistent method so that national speed limits policy is translated into a safe and appropriate speed limit for any given road. It is important to note that this rule changes the procedure under which a speed limit is	The government first proposed a land transport rule for setting of speed limits in 1995 in order to address the complexities and deficiencies of existing systems. These led to the situation where the responsibility for, and ownership of, speed limits was divided between organisations at both central and local government level. This rule now restricts the power to set a speed limit to the road controlling authorities who can create bylaws concerning the use of roads under the Local Government Act 2002 (principally, territorial local authorities and Transit New Zealand) or power to make

Rule	What	Application/purpose
	created, but it does not change the policy and method that dictate the choice of speed limit itself.	bylaws under specific legislation (such as some airport authorities).
Vehicle Lighting 2004	Regulates what and how lighting equipment must be fitted and how it is to be maintained. A choice of standards from a range of vehicle safety-conscious jurisdiction provides flexibility within agreed safety parameters.	Lighting requirements depend on vehicle class and year of manufacture. These standards must be maintained throughout the on-road life of the vehicle. This rule has been amended several times over the 2004–2015 period.
Vehicle Equipment 2004	Covers the safety and maintenance requirements for the following equipment fitted to motor vehicles: warning devices, speedometers, sun visors, mudguards, footrests on motorcycles and mopeds, child restraints, televisions, fuel tanks and fuel lines.	Applies throughout the on-road life of a motor vehicle by specifying requirements for certification as a prerequisite to first registration in New Zealand, repair, modification, and in-service inspection. This rule has become of increasing importance with respect to the growing popularity of vehicle navigational devices, eg this rule requires that television screens must not be visible to the driver unless it is for navigational purposes (or other specified purposes).
Road User 2004	Establishes the rules under which traffic operates on roads. These rules broadly encompass driving behaviour with respect to: traffic signs and signals, stopping and giving way, speed limits, parking, driver responsibility and occupant protection.	Applies to all road users, whether they are drivers, riders, passengers or pedestrians. Most of the existing legal requirements are contained in regulations in parts 2, 3, 4, and 6 of the TR76. Included in this rule was the ban on use of mobile phones while driving unless it is for emergency purposes or used via a hands-free system. The Road User Amendment Rule 2009 means drivers will not be able to look at a navigation aid on a mobile phone when driving, even if it is mounted on the dashboard. Mobile phones can be used in a cradle while driving but only to make, receive or terminate a phone call.
Heavy Vehicles 2004	This rule underpins the overall level of safety of heavy vehicles in New Zealand. Includes requirements pertaining to vehicle standards, general safety, towing connection, load security equipment, modification and repair.	Applies to vehicles with a gross vehicle mass of more than 3500 kilograms. Consolidates and improves upon measures introduced in the late 1980s in response to the rising numbers of crashes resulting from heavy-vehicle defects.
Traffic Control Devices 2004	Specifies the requirements for the design, construction, installation, operation and maintenance of traffic control devices, and sets out the functions and responsibilities of road controlling authorities in providing traffic control devices.	The Traffic Control Devices Rule contains standards and guidelines to provide safe, appropriate and consistent use of traffic control devices and roads nationwide. The most significant regulations introduced include: (1) requirement for all multi-laned roundabouts to have markings to direct the flow of traffic, and (2) pedestrian crossings can be no more than 15 metres wide (exceptions are made if it's interrupted by a raised traffic island or if it is controlled by traffic lights). Such changes have been implemented to reduce avoidable road crashes at these respective sites.
Dangerous Goods 2005	Sets requirements for the safe transport of dangerous goods on land in New Zealand. This rule covers the packaging, identification and documentation of dangerous goods, segregation of incompatible goods, transport procedures, and the training and	Updates Land Transport Rule: Dangerous Goods 1999. Changes made are mostly minor from a technical perspective, but intended to ensure that uniformity is maintained with international maritime and aviation practice for the transport of dangerous goods.

Rule	What	Application/purpose
	responsibilities of those involved in the transport of dangerous goods. Requirements are applied according to the nature, quantity and use of the goods.	
Heavy Vehicle Brakes 2006	Addresses one of the most important vehicle safety issues for New Zealand road users: heavy-vehicle braking. This rule sets out requirements to ensure that heavy vehicles can brake safely at any road-legal load condition.	Implemented in response to a Parliamentary report which found heavy vehicles were over-represented in New Zealand road crash statistics. Subsequent analysis of police reported crashes involving heavy vehicles (from 1997 to 2002) showed that brakes were the single most important vehicle factor in these crashes. Brake types and their requirements apply according to vehicle class.
Operator Licensing 2007	Establishes a fair and consistent framework for the licensing of transport operators. The large majority of requirements in this rule have been carried over from the Transport Services Licensing Act and regulations.	Key changes made include more stringent requirements for previously disqualified drivers, required 'certificate of responsibility' for persons using a vehicle under, and greater clarification regarding who might be liable (operator or driver) in the event of an offence relating to the use of a vehicle.
Work Time and Logbooks 2007	This rule sets out how the limits to the work time hours are to be administered, as prescribed by the Land Transport Act 1998. This rule applies to anyone who is legally required to manage driving hours.	The rule consolidates and clarifies existing legal requirements and includes changes aimed at increasing safety, including: variations to work time limits, when a minimum 30-minute rest period must be taken, responsibilities for managing driver fatigue, and how records of hours worked should be kept and maintained.
Operator Safety Rating 2008	Sets out the key aspects of the transport industry Operator Rating System (ORS), a system that aims to improve the safety of heavy vehicles on New Zealand roads. ORS scores range from 1–5 stars, based on how operators have been assessed in safety-related events over a given 24-month time frame.	The overall objective of this rule is to reduce transport industry crashes by enabling enforcement efforts to focus on those operators with poorer records of compliance.

Source: NZ Transport Agency (2016c)

Appendix B: Glossary

ACC	Accident Compensation Corporation
AIP	Alcohol Interlock Programme
BAC	blood alcohol concentration
BIS	Department for Business Innovation and Skills, UK (since 2015 Department for Business, Energy and Industrial Strategy)
BTRE	Bureau of Transport and Regional Economics (Australia)
CBA	cost-benefit analysis
CBT	compulsory breath test
CH_4	methane
CO	carbon monoxide
CO_2	carbon dioxide
DiD	difference-in-difference
DOT	Department of Transportation (US)
EEM	Economic Evaluation Manual
EO	Executive Order (US)
EPA	Environmental Protection Agency (US)
ETS	emissions trading scheme
EU	European Union
FCCC	Framework Convention on Climate Change
GDLS	Graduated Driver Licensing System
GHG	greenhouse gas
HM	Her Majesty's
ITSA	interrupted time series analysis
LRET	large-scale renewable energy target
LTA	Land Transport Authority
LTMA	Land Transport Management Act (2003)
LTSA	Land Transport Safety Authority
MBI	market-based instrument
MBIE	Ministry of Business, Innovation and Employment
MoT	Ministry of Transport (New Zealand
NEDV	non-equivalent dependent variable
NGTSM	National Guidelines for Transport System Management (Australia)

NO_2	nitrogen dioxide
NO_x	nitrogen oxides
NPRA	Norwegian Public Roads Administration
NRSC	National Road Safety Committee
NZS	New Zealand standard
NZU	New Zealand unit
OECD	Organisation for Economic Co-operation and Development
ORS	operator rating system
PA	principal-agent
PIR	post-implementation review
PM	particulate matter
POPE	post-opening project evaluations
RET	renewable energy target (UK)
RIA	regulatory impact analysis
RIS	regulatory impact statement
ROAMEF	rationale, objectives, appraisal, monitoring, evaluation and feedback
RSL	road speed limit
RMA	Resource Management Act 1991
RUC	road user charge
SCC	social cost of carbon
SEIOSNOSE	significant economic impact on a substantial number of small entities (US)
SO_2	sulphur dioxide
Transport Agency	New Zealand Transport Agency
UNFCCC	United Nations Framework Convention on Climate Change
VEPM	Vehicle Emissions Prediction Model
VFEL	vehicle fuel economy label
VKT	vehicle kilometres travelled
VSRs	vehicle standards regulations