

The Economic Impact of New Zealand Professional Firefighters

Report to the New Zealand Professional Firefighters' Union

> March 2012

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Executive Summary

The collective employment agreement between the New Zealand Professional Firefighters' Union (NZPFU) and the New Zealand Fire Service (NZFS) lapsed in December 2010. Negotiations over a new collective employment agreement have stalled, and Union members began industrial action in August 2011.

To help ascertain a fair and right salary that professional firefighters should be paid, the NZPFU asked Castalia to conduct an Economic Impact Assessment (EIA) of the value created by professional firefighters. The NZPFU also asked for "an economic assessment of the current funding model and comparisons to alternative models" to understand whether the NZFS is constrained in its wage negotiating position by an inefficient funding model—this addressed in a separate report summarising previous reviews of the funding model.

The purpose of this report is to shed light on why wage negotiations have so far failed to produce a "fair and right" wage for firefighters, and to contribute to the evaluation of value created by firefighters.

Wage negotiations are unlikely to deliver the right outcomes for firefighters:

- An absence of alternative employment options and employers for firefighters forces outcomes towards one end of the usual wage negotiation range. As background to our valuation exercise, we explore why the current approach to determining wages has proven uncertain for the NZFS and disadvantageous to NZPFU members seeking a "fair and right" wage. Wage negotiations currently produce a wage that is pushed as low as firefighters' other employment alternatives dictate—i.e. to firefighters' next best alternative income source.
- The usual metrics will not identify a problem. Due to the nature of modern firefighting, particularly operating specialised equipment and managing fire and emergency incidents in challenging environments, firefighting has and will always attract applicants.
- In most jobs, the value that the employee creates is known, because the good or services they produce are bought by customers and clients. The value created by the employee serves as an upper bound for wages. However because New Zealanders do not pay directly for firefighting services, the value of a firefighter is not known. Estimating economic value helps to understand the extent of the usual negotiation range. Instead of being immediately forced towards the lower bound of feasible wages, negotiations should also take into account the upper bound what value do firefighters create? This serves as an alternative point from which to assess wage demands.

Estimates of economic value suggest a different benchmark for wages:

- We look at the benefits to citizens who receive services from professional firefighters, by observing how individual firefighters reduce average response times to fires and other emergencies like road accidents.
- We then estimate the value of life and property saved by the marginal firefighter—as a result of the likely impact of a firefighter on incident response times.

• We estimate that each professional firefighter creates approximately \$177,000 worth of value to New Zealand each year, not including various benefits that we were unable to quantify.

By calculating the economic impact of firefighters in New Zealand, we estimate a potential upper bound of wage negotiations. This better identifies the spectrum of potential wage settlements, assisting NZPFU negotiations with the NZFS.

We also outline the numerous benefits that we were unable to quantify, due to the unavailability of data, the dispersed nature of the value captured by society, and the difficulty in clearly isolating firefighters' role in promoting community well-being.

A brief survey of the qualitative impacts from effective fire prevention and education, security, and community peace of mind suggests that these benefits are likely to be substantial. Because the bulk of firefighters activities are unquantifiable, the estimate that firefighters create \$177,000 of value annually is likely to be well below the full value of a firefighter to New Zealand.

1 Introduction

NZPFU asked Castalia to consider what economic value professional firefighters create, and what relevance this value has in determining a "fair and right" wage for professional firefighters in New Zealand.

Outline of report

This report aims to answer two questions:

- How do you determine a "fair and right" wage? Section Two looks at how wages are typically determined in labour markets, and why the market for professional firefighters' labour is failing to deliver the right outcomes.
- What is the economic impact (EI) of a firefighter in New Zealand? Section Three estimates the value created by one firefighter, by putting a conservative dollar figure on the benefits delivered by professional firefighters in New Zealand.

We have taken a conservative approach to calculating the value of a firefighter to New Zealand, and recognised that there is no robust method for quantifying the value that firefighters create in some activities. We have described these unquantifiable benefits provided by firefighters in Section Four.

Due to limitations in New Zealand data, we have relied on international studies and made assumptions about how to apply these studies to New Zealand firefighters. To improve the robustness of our approach, we have also tested the sensitivity of our EI result to changes in these assumptions.

The appendices give more detail on certain more technical elements of our analysis:

- Appendix A provides more detail on the calculations used to determine the economic value created by firefighters
- Appendix B explains how to put a value on saving a life
- Appendix C explains the difficulty in determining how many lives are saved by firefighters

2 Background: How are "Fair and Right" Wages Determined?

This section examines how wages are determined for most jobs, and explains why this same approach does not work to determine a "fair and right" wage for firefighters. We start by examining key indicators in the market for firefighters' labour. We then discuss why negotiations might be expected to fail even though key indicators do not suggest a problem in attracting and retaining professional firefighters in New Zealand.

How Wages are Determined in Most Jobs

Wages result from negotiations between employers and employees, where each party can have different levels of bargaining power and ability to influence final wage outcomes.

In wage negotiations each party will try to push the wage towards the limit of what the other party will accept. An employee will use her bargaining power to increase the wage towards the employer's next best option—either to employ someone else to do the job, or leave the role unfilled. In contrast, the employer will use her bargaining power to ensure that the wage only reflects alternatives that are open to the employee—such as getting another job. This is illustrated in Figure 2.1.

Figure 2.1: The Spectrum of Wage Negotiations



The employer and employee can therefore be expected to negotiate a wage that is somewhere along a spectrum from:

- The minimum wage that the employee is willing to accept, which will depend on what the employee could earn in other jobs.
 - When there are many employers competing for a particular individual or skill set, the employee has the power to say to the employer, 'you must pay me at least \$x, or I will move to another firm'

- This is countered by the employer's power to say 'if you do not accept a wage of \$y, I have other applicants who will fill this role'
- The maximum wage that the employer is willing to pay depends on the value that the employee creates (relative to other employees that could fill the role). The employer will not pay the employee more than the value the employee produces for the company.
 - Determining the value that an employee creates is relatively easy in occupations where customers and clients pay directly for goods or services. For example, a dairy farm worker creates value by milking cows. The most a farm owner is willing to pay the worker is the amount that customers pay for the milk produced, minus the costs of other inputs—cows, grazing land, milking sheds. The most a law firm is willing to pay a lawyer is the amount clients pay for services minus the cost of supporting the lawyer to provide those services—office rental, running a computer.
- A "fair and right" wage occurs when there are no fundamental distortions to employee and employer bargaining power, meaning that wage outcomes will result somewhere between the lowest wage that the employee will accept and the highest wage the employer is willing to pay. Outcomes at either extremes of the negotiation range may indicate failures in the labour market that call for a different approach to wage negotiations.

2.1 Why Fire Service negotiations are unlikely to reflect what firefighters consider is a "fair and right" wage

There are two main reasons why wage negotiations are not likely to produce a "fair and right" wage for firefighters—there are few alternative employers and the value of the services provided by firefighters is not well-known.

There are few alternative employers

The NZFS is the dominant employer of firefighters in New Zealand. Alternative employers of firefighters include handful of private forestry and airport fire and emergency response crews. Not all firefighting skills are easily transferable to other jobs—even within firefighting, New Zealanders often need to re-train to qualify for work in other countries, including Australia.

Having few viable alternative jobs means that two parts of the traditional wage negotiation do not function well for firefighters:

- The lower bound of the wage spectrum is very low for firefighters, because there is little competition between alternative employers for firefighting skills. Firefighters cannot easily take their skills to alternative jobs, so end up accepting low wages in roles that fully use their skills.
 - This is in contrast to many other professions where employers have to pay high wages to stop the skilled professionals going to a competing firm. Even other traditionally unionised jobs tend to have more choice of employers—Police officers can opt for private security work, and teachers and nurses can chose between the public sector and a range of private hospitals and schools.
- Firefighters have little bargaining power to negotiate a higher wage. The NZFS could offer low wages to the many applicants—subject to applicant quality. Industrial action is limited by firefighters' legislative and civil

obligations in society as first responders to a range of fire and emergency situations.

The value of the services provided by firefighters is not well-known

The maximum value that the NZFS will pay should be based on the value that firefighters create.

- However, because those who benefit from firefighters' work do not directly pay for those benefits, that value is not revealed to wage negotiators and not reflected in funds collected for future provision.
- Without clear price signals indicating what society would be willing to pay for firefighters' services in different situations, these benefits require specific calculation.



Figure 2.2: Problems with Wage Negotiations for Firefighters

These two problems mean that wage negotiations do not produce a "fair and right" wage. Because the NZFS has significant bargaining power, firefighters' wages end up lower than would be delivered by a more balanced negotiation.

The NZFS does not currently negotiate from what would otherwise form the upper bound of wage negotiations in other jobs—the monetary value of firefighters' efforts does not appear to feature in current bargaining. In calculating the likely economic impact of firefighters, we provide an indication of the value they create for NZFS. This is an attempt to gauge the benefits that accrue to New Zealand society from NZPFU labour.

The wage spectrum is likely to be very wide for firefighters, and given the fact that there is only one employer of firefighters, wage negotiations are likely to have been confined to the lower end of this spectrum. Our analysis in the next section suggests that previous wage negotiations have been concentrated at the extreme lower end of this spectrum.

Wage negotiations may be more balanced if the upper bound of the wage spectrum was better understood. Understanding how wages are negotiated in other sectors, and quantifying the upper bound of the wage spectrum, could help the employer and the employee negotiate in a way that is more likely to produce a "fair and right" wagesomewhere between the minimum the employee is willing to accept and maximum the employer (purchasing labour on behalf of society at large) is willing to pay.

Low turnover does not signal that firefighters are paid a "fair and right" wage

Firefighters have one of the lowest staff turnover rates of all professions (see Figure 2.3), with just 2.3 percent leaving and being replaced each year. With few firefighters leaving, there is strong competition for each of the approximately 30 places on the firefighters training intake each year.



Figure 2.3: Firefighters Have A Low Staff Turnover Rate

Source: The 2.3 percent staff turnover figure for firefighters in 2007 in New Zealand comes from the 2011 NZFS Annual Report. Data for other professions is for the United States in 2006. (http://www.nobscot.com/survey/us_voluntary_turnover_0806.cfm).

A report from the New Zealand Treasury (<u>http://www.treasury.govt.nz/publications/research-policy/wp/2004/04-11/12.htm</u>) shows that New Zealand has a slightly higher staff turnover rate on average than the US, meaning that turnover rates for other industries in New Zealand are likely to be higher than those presented here.

Several non-wage factors—the challenge of the job, the broad range of skills required and the public service nature of firefighting—are likely to drive the high number of applications. A low turnover rate may also be a symptom of firefighters not having alternative jobs to take their firefighting skills to.

A low turnover rate and a large number of applications¹ (600 a year for approximately 40 positions²) could indicate that firefighters are happy with their wages, but the fact that only major one employer of firefighters operates in the market for their labour is likely to better explain low wages and coinciding low turnover rate. The NZFS is the major employer of firefighters in New Zealand, meaning anyone wanting to enter firefighting must accept the NZFS's terms and salary.

¹ The number of applications is trending down. Fewer people being interested in becoming a professional firefighter as a primary occupation could result in poorer quality applicants over time.

² See information online at: <u>http://www.fire.org.nz/recruit/the-recruitment-process/initial-application.html</u> (last accessed 29 March 2012).

3 What is the Value of a Firefighter to New Zealand?

Firefighters create value in many ways, from stopping property damage in structural fires, to rescuing people from car wrecks, to neutralising hazardous chemical spills.

In this section, we calculate a conservative estimate of the value of firefighters to New Zealand by estimating a monetary figure for the value that firefighters create in some of their core activities.

This section is divided into three subsections:

- Firefighters create value in many ways—We identify the main services that firefighters provide. Fires make up only one quarter of the events that firefighters attend, so it is important to acknowledge the value firefighters create in their other activities such attending road accidents, hazardous emergencies and medical emergencies.
- Conceptual Framework for Estimating Value of Firefighters—We develop a framework for quantifying three of the core ways that fire fighters create value. We find that each firefighter creates an average of \$177,000 worth of value each year by reducing property damage in fires, saving lives in emergency rescues and avoiding costs in hazardous emergencies.
- Sensitivity Analysis—We test the sensitivity of the average annual value created by a firefighter to changes in our assumptions. We find that by altering the main assumptions by plus or minus 20 percent, the annual average value of a firefighter varies by at most \$39,000.

3.1 How Firefighters Create Value

Firefighters conduct two main activities: proactive fire prevention and attending incidents reactively. Figure 3.1 looks at each of the main reactive activities where firefighters create value.

When estimating the value of firefighters, we want to have confidence that the method and the numbers we use are robust. So we only calculate the value of activities where there is sufficient international research and sufficient NZFS data to have confidence in our estimates.

Ideally we would measure precisely the monetary value generated by each of the activities firefighters undertake. However it is hard to isolate the value that firefighters create in some of their activities (see Section 4). There is only sufficient data to estimate a numerical value for the following three activities:

- Saving property in fires
- Saving lives in emergency rescues (like road accidents) and
- Avoiding costs in hazardous emergencies.



Figure 3.1: Quantifiable Benefits from Firefighters

Key: The number in brackets is the number of incidents attended by professional firefighters in New Zealand in 2008/09 (New Zealand Fire Service Data)

We therefore only estimate the value of these benefits that can be quantified. Section 4 provides more detail on the unquantifiable ways that firefighters create value. This includes a qualitative description of the value created by saving lives in fires, avoiding environmental damage in hazardous emergencies, responding to false alarms and good intent calls. Section 4 also explains the methodological and data problems that mean that the value of these activities cannot be quantified.

3.2 Conceptual Framework for Estimating Value of Firefighters

Figure 3.1 shows the four-step process we use to estimate the value of a firefighter to New Zealand. For numerical workings of each step, see Appendix B.

For fires and emergency rescue situations, the quicker that firefighters respond, the more effective their services and therefore the more valuable is their work. We can estimate the value of a firefighter's labour by calculating how much faster the service can respond with more fire crews and what the effect of responding quicker might be to lives and property saved. The approach of using response times to calculate the value of firefighters has been used both in New Zealand and internationally.³

³ In February 2009, the Department of Communities and Local Government produced a report called "Review of Fire and Rescue Service Response Times". This report found that response times to emergencies in Britain had increased over the past five years, mainly due to increased traffic congestion preventing fire appliances reaching the emergency as fast as they used to. The Report went on to calculate the impact of this increased response time: "Using response time fatality rate relationships, it was predicted that the increased response times may contribute to about 13 additional fatalities in dwelling and Other Buildings fires each year, possibly 65 additional deaths in Road Traffic Collisions (RTCs) and an £85m increase in Other Buildings fire damage."

In September 2009, Neil Challands of the New Zealand Fire Service published an article on "The relationships between fire service response time and fire outcomes" in the Academic Journal *Fire Technology*.

In January 2012, the Tasmanian Branch of the United Firefighters Union in Australia Commissioned a study called "the adverse social and economic consequences of reducing Tasmanian Fire Service capacity to manage fire risk and respond safely to fire". This study referenced the Department of Communities and Local Government Study,



Figure 3.2: Estimating the Value Contributions to Society of a Firefighter

Our final estimate of the economic impact of a firefighter will not strictly be the average value of all firefighters in New Zealand, but the value of one more firefighter to the current stock of NZPFU effort. This is a more useful calculation for the determination of firefighters' wages, as the price of labour in most markets is dependent on the value created by one more employee (the marginal firefighter for a required level of service), not the value created by the average employee.

However, as discussed in Step One below, one firefighter alone is unlikely to make a significant difference to response times. We have therefore averaged the impact of the marginal increment of firefighting effort (a one-appliance crew) to an individual firefighter.

3.2.1 Step One: How do firefighters affect response times?

The more firefighters and fire stations, the quicker the response time to a fire event or an emergency like a car accident. This is because the most important determinant of response times is the distance from the fire station to the fire. Having more firefighters can reduce the distance from the fire station to the fire by enabling more fire stations to be staffed (see Figure 3.3).

as well as the Challands study to show that reductions in funding would increase response times, causing more property damage and more fire deaths.

Figure 3.3: Recruiting More Firefighters would Reduce Response Times



Factors other than the distance from the fire station to the fire also affect response times. Quicker response times are likely to be achieved when:

- There is less traffic congestion
- Emergency call centres and dispatch systems are more efficient
- The location of the fire is able to be determined more quickly, and
- The firefighters are at the station, rather than on call at home.

Figure 3.5 shows a non-linear relationship between the number of firefighters and average response times: each extra firefighter creates a smaller reduction in response time than the firefighters before them:

- When there are very few firefighters, adding one more firefighter has a large impact. If there was only one fire crew in New Zealand (for instance, based in Wellington), the average response time to a fire in New Zealand would be many hours. The impact of adding another fire crew based in Auckland would result in a significant reduction in average response times, as all fires in Auckland would be reached in one hour, rather than in nine hours for the crew from Wellington to drive to Auckland.
- When there are many firefighters, adding one more firefighter has a small impact. Imagine there are already 2,000 fire stations in New Zealand. Adding one more fire crew to say a new sub-development in Tauranga might reduce response times to the 30 fires a year in that sub development by 6 minutes. However this only reduces average response times across the whole of New Zealand by a split second.

Similarly, one firefighter alone is unlikely to make a difference to response times—the useful increment is more likely to be a fire appliance with a four or five member crew. For the purposes of our calculation of the economic impact, we have averaged this impact to each individual firefighter in that crew—the resulting value is therefore the average firefighter in the marginal increment of firefighting effort.

Figure 3.4: Relationship between the Number of Firefighters and Response Times



New Zealand data is insufficient to establish a clear relationship between the number of firefighters and response times. The number of firefighters in New Zealand has been relatively constant over the last decade, meaning there is not enough variation to estimate a relationship with response times.

The United Kingdom has a comparable fire service in terms of society's expectations, and has been subject to focussed investigation and data collection in recent years. The UK fire sector is likely to have the following similarities with the New Zealand fire sector:

- Community expectations of the fire service, due to similar levels of economic development
- Common use of particular items of specialised emergency and extraction equipment, response systems
- Number of professional firefighters per capita (4.2 per capita in New Zealand, compared to 5.8 per capita in United Kingdom)

A study conducted by the UK Department of Communities and Local Government (DCLG) calculated the effect of adding more fire stations on fire service response times. Based on their research of the UK fire service, the DCLG posited that adding another fire station (with one fire appliance) "would reduce the time spent responding to fires within 2km to one minute."

Under this assumption, the DCLG estimated that adding 50 more fire stations to the UK's current 3,200 fire stations (a 1.5 percent increase, assuming that new fire stations would have the same average number of firefighters as old stations) would reduce average response times to all incidents across the UK by 5 percent.

Although fire services in New Zealand and the UK share some key features, the relationship between firefighters and response times might differ between the two countries for several reasons.

- New Zealand has lower population density than Britain, which explains New Zealand's longer average response times (7.5 minutes in New Zealand compared to 6.5 minutes in the UK)⁴
- New Zealand also has a much larger proportion of volunteer firefighters than the UK.

These differences may mean that having one percent more firefighters in New Zealand may have a smaller percentage impact on response times than having one percent more firefighters in the UK.

We believe that these differences are unlikely to reduce the relationship between the number of firefighters and response times by more than 50 percent. We therefore conservatively estimate that a one percent increase in the number of firefighters in New Zealand only has only half the impact of a one percent increase in the number of firefighters in the UK.

Applying this relationship to the New Zealand context implies that having one more firefighter in New Zealand would reduce average response times by 0.15 seconds (see Figure 3.5)

Figure 3.5: One Extra Firefighter Reduces Average Response Time by 0.15 Seconds



Because one more firefighter has a different impact on response times depending on how many firefighters there are already, the conclusion that one more firefighter reduces response times by 0.15 seconds only applies to adding one more firefighter to the 1,700 existing professional firefighters in New Zealand. The 1699th firefighter had a slightly bigger impact on response times, and the 1698th firefighter had a bigger impact again.

⁴ Average response time to incidents in the Urban fire districts in 2008/09 is based on New Zealand Fire Service data, whereas UK data is from 2006 and based on a report by the Department of Communities and Local Government (2009) Review of Fire and Rescue Service response times, available online at: http://www.communities.gov.uk/documents/fire/pdf/frsresponsetimes.pdf (last accessed 29 March 2012)

3.2.2 Step Two: How much value do firefighters create by attending fires, emergency rescues and hazardous emergencies each year?

The value created by firefighters in fires and emergency rescues is linked to how fast they respond: the quicker a firefighter reaches a burning building, the more property damage can be avoided; the quicker a firefighter reaches a car wreck, the more likely that the firefighter can save a life.

Quicker response times reduce property damage in fires

A 2009 New Zealand study⁵ has examined how much property damage occurs per minute it takes firefighters to reach a fire. Using data on 27,500 structure fires in New Zealand from July 2003—June 2008, the study finds a linear relationship between response times and total value of property burned: \$4,024 of property burns on average for every minute it takes firefighters to respond to a fire.

In other words, firefighters create **\$4,024** worth of value on average (by avoiding property damage) for each minute quicker they can respond, holding other factors constant. From a statistical point of view, the relationship is relatively strong, with 55 percent of the variation in the value of property damage is explained by variation in firefighters' response times.⁶

In Step One, we found that having one more firefighter in New Zealand reduces response times by 0.15 seconds. Figure 3.6 shows how this means that each firefighter creates \$194,000 of value a year by stopping property damage in fires.

Figure 3.6: Each Firefighter Creates \$194,000 of Value per Year Reducing Property Damage in Fires



Quicker response times save lives in emergency rescues

Firefighters perform four kinds of "emergency rescue" activities where quicker response times save lives: road accidents, medical emergencies, natural disasters, and urban search and rescue. We use the relationship between response times and deaths in the most common emergency rescue (road accidents) to model the general relationship between response times and the number of deaths in emergency rescues.

⁵ Challands, N. (2009) The relationships between fire service response time and fire outcomes, *Fire Technology*, p665 as described in note 2 above.

⁶ Goodness of fit (\mathbb{R}^2) of 0.55.

Determining the impact of firefighters' response times on fatality rates in road accidents requires controlling for other factors that might affect the risk of fatalities. For example, the likelihood of serious consequences in any given car accident increases:

- The longer it takes emergency crews (including firefighters and ambulance staff) to arrive
- As the speed at which the crash occurred increases
- As the age of the cars involved increases (older cars are less likely to crumple in a way that protects the occupants and less likely to have airbags), and
- If the occupants of the car are not wearing seatbelts.

Information on these features of road accidents is not recorded by the New Zealand Fire Service—the only information collected following a road accident attended by NZFS staff is the response time and the equipment used. Without data on the number of deaths in road accidents and data on the critical factors determining mortality that are listed above, we cannot isolate the effect of response time on the number of deaths in road accidents.

The UK Department of Communities and Local Government (DCLG) has developed a risk modelling program called the "Fire Service Emergency Cover Toolkit" (FSEC) that uses a highly detailed road accident dataset to isolate the impacts of various factors. DCLG used the toolkit to analyse the relationship between response time and fatality rate, accounting for other factors that affect the fatality rate, finding that the FSEC formula indicates a 10 percent increase in road traffic collision response times translates into a 7 percent increase in predicted fatalities. For example, an average response of 8 minutes has a predicted fatality rate of 0.097 per life risk incident (controlling for other factors), compared to a 0.104 fatality rate for an 8.8 minute response time.

The relationship between firefighter response time and the fatality rate in road accidents in New Zealand is likely to be similar to the relationship in the UK, as the role of firefighters in road accidents in relatively similar in the two countries. However, there are some important differences in the characteristics affecting road accidents in New Zealand and in the UK. In particular:

- There are likely to be fewer accidents per capita in the UK because there are 50 percent more cars per capita in New Zealand (0.75⁷) than in the UK (0.42⁸)
- Fatality rates from road accidents in New Zealand are likely to be higher than in the UK because the average car in New Zealand is five years older than the average car in the UK⁹, and
- Roads in New Zealand tend to be more isolated and on more geographically challenging than roads in the UK, meaning more accidents per capita, and slower response times to road accidents

⁷ Ministry of Transport, Transport Volume Fleet Information, available online at: <u>http://www.transport.govt.nz/ourwork/TMIF/Pages/TV004.aspx</u> (last accessed 29 March 2012).

⁸ Dargay J, Hanly M, Madre JL, and Hivert L (2003) Demotorisation seen through Panel Surveys: A Comparison of France, Britain and Germany, Paper from the 10th International Conference on Travel Behaviour Research, available online at: <u>http://www2.cege.ucl.ac.uk/cts/tsu/papers/iatbrfinalversion.pdf</u> (last accessed 29 March 2012).

⁹ Average age of cars in Britain is 7.1 years according to Motor Trade Insider (2010) Average age of cars on UK roads increases (available online at: <u>http://www.motor-trade-insider.com/index.php/2010/07/average-age-of-cars-on-uk-roads-increases/</u>), while the average age of cars in New Zealand is 12.04 years, according to the Ministry for the Environment (data available online at: <u>http://www.mfe.govt.nz/environmental-reporting/transport/vehicle-km-travelled/vehicle-age/</u>). Web sources last accessed 29 March 2012.

We believe that these differences are unlikely to reduce the relationship between firefighters' response times and the number of fatalities in road accidents by more than 50 percent. So we use the conservative assumption that a one minute increase in response time to road accidents in New Zealand has only half the impact on fatality rates as a one minute increase in response times in the UK. This means that, for each minute longer it takes a firefighter to respond to a given car accident in New Zealand, an additional **0.001875** people die.

To determine the value created by saving lives, we need to put a value on a life. We have used the \$3.58 million value of statistical life (VoSL) that the New Zealand Transport Agency uses to value of a life saved on New Zealand roads.¹⁰ For more information on how to calculate the value of a life, see Appendix A.

Figure 3.7 shows how the value of a life can be used to determine that each firefighter creates \$12,000 worth of value a year by saving lives in emergency rescues.

Figure 3.7: Each Firefighter Creates \$12,000 of Value per Year by Saving Lives in Emergency Rescues



In addition to saving lives, firefighters create value at car accidents by controlling traffic (preventing further accidents), and clearing hazards for traffic to flow again. The NZFS does not have data on time taken to clear accidents or on the disruption crashes cause, so this additional value has not been quantified.

Value created in Hazardous Incidents

Firefighters create two sorts of value by attending hazardous incidents (see Figure 3.1):

• **Protecting the public and the environment**—This source of value is *unquantifiable* because there is no New Zealand data on the environmental damage from hazardous substances, or injuries to the public from hazards (see Section 4).

¹⁰ This figure is contained in a Ministerial Directive from the NZ Gazette, No 72, page 1,602, 16 May 1991 and calculated by the Ministry of Transport, and most recently updated in 2010. Obtained from Ministry of Transport (2010) The Social Cost of Road Crashes and Injuries, page 9, available online here: http://www.transport.govt.nz/ourwork/Land/landsafety/Documents/Social-cost-of-road-crashes-and-injuries-2010-update.pdf (last accessed 29 March 2012).

• Avoiding costs—Firefighters attending hazardous incidents avoid the cost of hiring and training other people to neutralise hazards. We conservatively estimate the value of these avoided costs based on the current charge out rate for attending hazardous incidents.

Section 47C of the Fire Service Act 1975 (the Act) allows the Fire Service Commission to charge for attendance at hazardous incidents¹¹. Currently the NZFS charges \$660 per hour that a four crew appliance attends a hazardous incident.¹²

The Act also states that "the amount of the charge made shall include all costs incurred...in stabilising or rendering safe the hazardous substance emergency" (47C(3)). This implies that the rate of \$660 an hour was set to cover the average cost of responding to the average hazardous incident.

For the purposes of this estimate, firefighters create \$660 of value for every hour that a four crew appliance attends a hazardous emergency—but this assumes (again, unrealistically conservatively) that the costs recovered by the fire service for attending these events perfectly compensates the efficient costs of service provision.

The New Zealand Fire Service records the number of four crew appliances that attend each hazardous emergency (7,920 in 2009). Although the NZFS records data on the start and end time of each incident, it cautions that the data is inaccurate (for example a number of hazardous incidents are recorded to last for several weeks due to inaccurate data collection).

By eliminating outliers in the raw data, we have assumed that the average length of time spent at each hazardous emergency is approximately two hours. Figure 3.8 shows how this was used to calculate that each of New Zealand's 1,700 firefighters creates an average of \$3,000 of value each year by neutralising hazardous incidents.

Figure 3.8: Each Firefighter Creates \$6,000 worth of value each year by avoiding costs to New Zealanders in hazardous incidents



¹¹ Fire Service Act available online at: <u>http://www.legislation.govt.nz/act/public/1975/0042/latest/DLM433733.html</u> (last accessed 29 March 2012).

¹² Latest NZFS Charging Schedule, available online at: <u>http://www.fire.org.nz/Business-Fire-Safety/Hazardous-Substances/Documents/POLFA72A%20Schedule%20of%20Charges%20updated%2018%20May%202011.pdf</u> (last accessed 29 March 2012).

3.2.3 Step Three: How much does it cost to support firefighters?

Firefighters cannot create value without support staff and equipment. They cannot attend events without communications support, and cannot rescue people without expensive extractive equipment such as the "jaws of life". Certain hazards also cannot be neutralised without specialist appliances. To determine the value that firefighters create (as distinct from the value created by supporting infrastructure), the cost of supporting firefighters—purchasing and maintaining capital equipment and paying support staff must be subtracted from the total value we estimate that firefighters create.

According to the 2009 annual report, gross expenditure by the New Zealand Fire Service in the 2008/09 financial year was \$299 million. Of that:

- \$13 million was spent on the wages of managers, trainers and communications centre staff that allow firefighters to do their job.
 - Because the NZPFU estimates that professional firefighters respond to 80 percent of all 111 calls, we assume that 80 percent of these support staff costs should accrue to *professional* firefighters.
- \$98 million was spent on non-labour costs such as buying fire appliances, renting buildings, and maintaining safety gear.
 - Although the NZPFU estimates that professional fire stations account for 20 percent of all New Zealand fire stations, professional fire stations are likely to be more on valuable land in urban areas, have more appliances, and have newer appliances than rural fire stations.
 - We further assume that the average professional fire station costs four times as much to build, stock and maintain than the average rural fire station.
 - These assumptions imply that 50 percent of the total non-labour costs go to supporting *professional* firefighters and 50 percent goes to volunteer firefighters.

Table 3.1 shows that the NZFS spent approximately \$35,000 to support each professional firefighter in 2009.

Type of Cost	Description of Cost	Cost (NZ\$)
Labour	Key Management personnel benefits	\$3.2m
costs	Communications Centre Staff (77 staff at an average of \$45,000 each)	\$3.4m
	Management and Training staff (63 staff at an average of \$100,000 each)	\$6.3m
	Total labour costs	\$12.9m
	Percentage of labour costs that accrue to <u>Professional</u> firefighters (rather than volunteers)	80 %
	Current labour costs, supporting NZPFU firefighters	\$10.3m
Non-	Fleet	\$11.9m
labour costs	Occupancy	\$11.9m
	Depreciation of equipment	\$26.9m
	Administration	\$14.9m
	Other costs	\$32.8m
	Total non-labour costs	\$98.4m
	Percentage of non-labour costs that accrue to <u>Professional</u> firefighters (rather than volunteers)	50%
	Non-labour costs to support NZPFU firefighters	\$49.2m
Total costs	Total annual cost of supporting all firefighters	\$111.5m
	Total annual cost of supporting NZPFU firefighters	\$59.5m
	Number of NZPFU firefighters	1,700
	Average annual cost of supporting each NZPFU firefighter	\$35,000

Table 3.1: Cost Build Up of Supporting NZPFU Firefighters

3.2.4 Step Four: How much value does a firefighter create each year?

Combining the value that firefighters create in three of their core activities, and subtracting the cost of supporting firefighters, we estimate that each professional firefighter creates an average of \$177,000 worth of value each year (see

Table 3.2).13

This is based on the value created by adding one more firefighter to the current stock of fire service effort, and averaging that value across the entire firefighting membership of the NZPFU.

¹³ More detailed calculations are shown in Appendix A





3.3 Sensitivity Analysis

Recognising that the \$177,000 value is the result of a highly simplified model of fire service benefits, we now turn to the sensitivity of the final value of a firefighter to changes in our assumptions.

In particular, we test the sensitivity of the value of a firefighter by modifying the following assumptions by plus and minus 20 percent:

- The impact of having one more firefighter on response times
- The impact of responding one minute quicker on the number of fatalities in road accidents
- The percentage of emergency rescue incidents in New Zealand where lives are at risk
- The average length of time that firefighters spend at each hazardous substance incident

The impact on the final value of a firefighter from changing these assumptions by plus or minus 20 percent is shown in

Figure 3.3.14

¹⁴ More detailed calculations are shown in Appendix AAppendix B.

Figure 3.3: Sensitivity Analysis

		Additional Firefighter Economic Impact	
Description	Assumption	Reduce by 20%	Increase by 20%
Reduction in response time from having one more firefighter	0.15 seconds	\$138,470	\$215,925
Number of lives lost in rescue emergencies per minute	0.001875 lives	\$172,692	\$184,704
Percentage of emergency events with lives at risk	10%	\$174,694	\$179,7 00
Average time spent at each hazardous emergency	2 hours	\$175,967	\$178,427

Figure 3.3 shows that the value of a firefighter is most sensitive to changes in the assumption about the relationship between the number of firefighters and response times. Decreasing the strength of this relationship by 20 percent results in a value per firefighter \$39,000 lower (a 22 percent drop in the estimated value).

4 Unquantifiable Ways that Firefighters create Value

In the previous section, we estimated that firefighters create \$177,000 of quantifiable value each year on average, based on overseas and NZFS research, and some conservative assumptions.

This figure, as an estimate of total value, omits several important services delivered by firefighters—they also create value in activities where a monetary value is difficult to observe or is non-existent. Some of the ways that firefighters create value are not able to be quantified, either because there is insufficient data or there is no robust methodology. For example, we do not know how many people would die in fires without firefighters, so we cannot quantify the value firefighters create by saving lives in fires.

By describing the qualitative benefits, we aim to provide some perspective for the total value received by New Zealand society as a result of professional firefighters. It is likely that the unquantifiable benefits are in reality very valuable to communities, but without surveying recipients of services with a clear and consistent framework, it would be difficult to estimate how much society is willing to pay for the services.

Figure 4.1 recaps the different ways that firefighters create value, highlighting that the value that firefighters create in many of these activities is difficult to identify with data currently collected by the NZFS.



Figure 4.1: Unquantifiable Benefits of Firefighters

In this section, we explain in more detail the six unquantifiable ways that firefighters create value. We describe how the value is observed in the community, and in each case explain why it is not possible to calculate a monetary estimate of this value.

Fire Safety Education

Fire safety education is proactive in that it limits the incidence of fire and can reduce potential losses. It is arguably the most important way that fire fighters create value. For example, it is more effective to visit homes and ensure smoke alarms are correctly installed and functioning, than to save people and property because smoke alarms have not been correctly installed or checked. It is also more efficient to avoid fires through safety awareness campaigns such as "get fire wise" than it is to put out fires.

While valuable, it is difficult to trace particular prevention and community awareness efforts to the outcomes of fires. For example, we do not know how many fires may have been started in the absence of the NZFS "fire-wise" campaign. In attempting to calculate a monetary valuation of firefighters' work, we therefore exclude the (likely substantial) value created by firefighters in preventing fires through fire safety education.

Saving Lives in Fires

Saving lives is one of the more high-profile outcomes of firefighting effort, but NZFS data does not accurately record how citizens are assisted by firefighters, or whether a life was clearly at risk. It is also difficult to identify how many lives are saved in fires due to unavailability of data on how many deaths would result from there being no firefighters.

The difficulties encountered in various methods are explained in more detail in Appendix C. Due to these difficulties, we have been unable to confidently quantify that value of lives saved in fires.

Avoiding Negative Flow-on Effects of Fires

Fires can have negative effects beyond direct life and property losses—fires in commercial buildings can disrupt businesses. At the lower end of the impact scale, a fire could mean a few days working from home, while at the higher end, whole businesses can shut down permanently. Firefighters attending incidents that have the potential to result in large job losses and a wider negative impact on the community therefore assist in preventing significant losses to communities, external to the individuals directly affected.

Avoiding Injuries

Firefighters avoid injuries to members of the public through fighting fires, attending road accidents and cleaning up hazardous substances. The Ministry of Transport¹⁵ calculates that avoiding a serious injury is worth \$380,000 in terms of medical expenses and lost income, while avoiding a minor injury is worth \$20,000.

However it is difficult to determine how many injuries are avoided each year due to the presence of firefighters. First, the NZFS does not accurately record the number of current injuries—it only records injuries at fires, and there is no clear delineation between serious and minor injuries. Second even if there were data on the number of current injuries, we cannot answer how many more injuries would there have been if there were no firefighters (similarly to lives saved, discussed above).

False Alarms

False alarms occur when emergency calls require no specific fire service attention—either through faulty alarms, or because the situation is under control before a fire crew arrives. Firefighters are not able to determine which emergency calls will result in "false alarms" at the time of the call.

¹⁵ This figure is contained in a Ministerial Directive from the NZ Gazette, No 72, page 1,602, 16 May 1991 and calculated by the Ministry of Transport, and most recently updated in 2010. Obtained from Ministry of Transport (2010) The Social Cost of Road Crashes and Injuries, page 9, available online here: http://www.transport.govt.nz/ourwork/Land/landsafety/Documents/Social-cost-of-road-crashes-and-injuries-2010-update.pdf (last accessed 14 March 2012)

Asking a building occupant to search premises for signs of a fire following an alarm can be dangerous and time consuming. It is generally more effective for firefighters (who are trained to locate fires) to check a building than building occupants and relatively untrained volunteer fire wardens. How firefighters respond to false alarms dictates how quickly workers can return to productive activities. The fact the NZFS attends these calls also provides "peace of mind" that houses or buildings are safe.

While these benefits are important, we do not have data on how much quicker workers can return to their building if the NZFS attends a false alarm, compared with a fire warden checking a building. There are also no surveys asking the public to put a value on "peace of mind". We have therefore not included the value that firefighters create by attending false alarms in our quantitative analysis.

Attending "good intent" calls

Firefighters classify certain incidents as "good intent" calls. This appears to be a catch-all term, including (for example) calls to rescue cats from trees and helping secure building materials in storms.

Firefighters create value in attending these events by generally helping out the community. However there is insufficient detail on the nature of each of these events, or on how much value the public receive from these events to estimate a monetary value.

Avoiding harm to the environment and to the public in hazardous emergencies

Attending and managing hazardous emergencies provides benefits beyond avoided costs (calculated in Section 3.2.2). In particular, firefighters avoid harm to the general public and to the environment by attending to hazardous incidents effectively. However, we cannot quantify these benefits because the NZFS does not collect data on the results of these events, such as the consequences of contaminated land or water and risk to human health. Even if this data were available, we do not know how much soil and water would be contaminated and how many people would be injured in these hazardous incidents *without* assistance from firefighters.

Because the bulk of firefighters activities are unquantifiable, the estimate that firefighters create \$177,000 of value annually is likely to be well below the full value of a firefighter to New Zealand.

5 Relevance for Wage Negotiations

We have conservatively quantified three ways firefighters create value at \$177,000, and described the additional benefits that we cannot quantify.

This gives better idea of the potential wage spectrum—the least that firefighters can hope to earn—based on their alternative employment opportunities—and the most society should be willing to pay for the labour component of fire services. We have essentially attempted to estimate the upper bound of the spectrum, excluding some significant value that we have been unable to quantify (described in detail in Section 4, and represented in Figure 5.1).

This estimate is therefore not necessarily the value of a "fair and right" wage for firefighters. It also does not overcome the fundamental problem of market failure—the fact that there is no competition for firefighters' labour.

However, the estimate does provide clarity about how much the NZFS could justifiably try to recover from society in return for the quantifiable benefits of NZPFU labour. This deepens our understanding of firefighters' contributions to society through the provision of essential public services.

While understanding what society would <u>actually</u> be willing to pay for fire services might be instructive, it would be either:

- a) Conceptually difficult to determine from individuals' purchasing preferences (insurance-based risk aversion patterns are notoriously difficult to establish), or
- b) Based on survey responses that is unlikely to reveal the true benefits that society as a whole enjoys.

We consider that our approach has used publicly available information to estimate the economic value of NZPFU labour to the extent possible—subject to certain clear and conservative assumptions.

Figure 5.1: Wage Spectrum for Firefighters Wage Negotiations



In calculating the likely economic impact of firefighters, we provide an indication of the value they create for the NZFS. This is an attempt to gauge the benefits that accrue to New Zealand society from NZPFU labour. Our analysis (at least in terms of the value created by firefighters that is quantifiable) suggests that previous wage negotiations have been concentrated at the extreme lower end of the wage negotiating spectrum.

Wage negotiations may then be more likely to produce what both the employer and NZPFU members consider to be a "fair and right" wage—somewhere between the maximum the employer in willing to pay and the minimum the employee is willing to accept.

Appendix A: Numbers Used To Calculate Value of A Firefighter

Figure 5.2: Calculation Steps

Type of Incident	Type of IncidentDescription of Step	
	Reduction in response time from one more firefighter (minutes)	0.002545
	Average value of property damage per minute of response time	\$4,024
Fires	Average value of property saved at each incident by having one more firefighter	\$10.24
	Number of fires attended in 2009	18,908
	Annual value created by one firefighter in saving property	\$193,638
	Average number of lives lost in rescue emergencies per minute of response time	0.001875
	Value of a statistical life (Ministry of Transport)	\$3.58m
	Average value of lives saved per minute of response time	\$6,713
Emergency rescues	Average value of lives saved by quicker response time per incident	\$17
	Number of emergency rescues attended in 2009	7326
	Percentage of emergency events with lives at risk	0.1
	Annual value created by one firefighter in saving lives in rescue emergencies	\$12,515
	Value created per four man crew attending a hazardous incident per hour	\$660
	Number of hours spent at hazardous incidents in 2009 by four man crews	15,840
Hazardous emergencies	Total value (in terms of avoided costs) of firefighters attending hazardous incidents in 2009	\$10.45m
	Number of firefighters in New Zealand in 2009	1,700
	Annual value created by one firefighter in attending hazardous incidents	\$6,150
Capital and support costs	Cost of paying support staff (managers, trainers, communications centre staff)	\$12.9m

Percentage of support staff time that goes to supporting <i>professional</i> firefighters	80%
Non-labour costs of firefighting (fire appliances, property rental, administration)	\$98.4m
Percentage of non-labour costs of firefighting to support <i>professional</i> firefighters	50%
Annual cost of supporting one professional firefighter	\$35,012
Annual net value created by one firefighter	\$177,291

Appendix B: Value of a Life

There is a broad literature on how to calculate the value of a human life. The two main methods involve calculating the lost earning potential when someone dies, and looking at how much people are willing to pay to take measures that reduce their chance of dying.

We investigate the latter approach to gauge expectations in fire situations: people can reduce risks of harm in a fire by installing a fire alarm. Table 5.1 shows this calculation.

Description	Value or Ratio
Chance of dying in house fire in New Zealand if at least one functioning smoke alarm*	1 : 285,000
Chance of dying in a house fire in New Zealand if no functioning smoke alarm	1:117,000
Reduced chance of dying in a fire in New Zealand from having a functioning smoke alarm	1 : 190,476
Annual cost of a smoke alarm: \$35 to buy (\$3.50 per year if lasts 10 years), plus \$10 per year for batteries	\$13.50
Implicit value individuals put on life by spending \$13.50 per year maintaining a working smoke alarm	\$2.57m

Table 5.1: Calculating the Value of A Life

Source: "New Zealand Fire Risk Data (1986-1993)", by P Narayanan and P Whiting, BRANZ.

\$2.57 million per life is lower than the \$3.58 million that the New Zealand Transport Agency uses to value a life saved on New Zealand roads—using the value of statistical life (VoSL), calculated by the Ministry of Transport¹⁶.

This comparison suggests that using the revealed willingness of New Zealanders to spend money on reducing the risks to their lives would not statistically overstate the live-saving benefits of firefighters to New Zealand.

¹⁶ Contained in a Ministerial Directive from NZ Gazette No 72, page 1,602, 16 May 1991.

Appendix C: Difficulties in Determining Number of Lives Saved By Firefighters

We considered three possible ways to measure the number of lives saved in fires.

Comparing deaths in other countries or with other time periods

We could conceivably compare the number of deaths in fires if New Zealand had no firefighters, with the number of current deaths. This could be done by looking at another country with similar features to New Zealand, or looking at different periods of time

However, there are no modern economies that do not have a fire service, and each service provides slightly different services, making fair comparisons difficult. Many homes also now have smoke alarms, and many commercial and public buildings now have sprinkler systems. Buildings generally have been made substantially safer in the last two decade, and the use of fire retardant building materials is now very common. While fires in these situations still destroy substantial amounts of property, their effect on human health hazards would be difficult to isolate.

Direct measurement

This method would require firefighters accurately counting the number of people they rescue from a burning building *who would not have made it out of the fire alive without firefighters*.

If a firefighter carries an unconscious person from a fire, then we could accurately conclude a "saved life", because they know the person could not have made it out without them. However, if a firefighter enters a building burning an encounters someone crawling around in the smoke, you do not know whether that person would have made it out of the fire alive if the firefighter had not arrived to show them the way out.

NZFS data has categories such as "rescued" "extricated" and "assisted". If "extricated" was clearly defined and accurately recorded as number of people that "would not have made it out of the fire alive without firefighters", and "rescued" was clearly defined and accurately measured as "only had a 50-50 chance of making it out of the building alive without a firefighter", then we would be able to estimate the number of lives saved without firefighters.

Unfortunately the definitions of "extricated" and "rescued" are not clear. Even if they were clear, it is impossible to accurately record the likelihood that someone would make it out of a fire alive without firefighters.

Using response times

If we had data showing how many lives are saved on average by responding to a fire quicker, then we could attribute those lives saved to having more firefighters. It is evident that the longer a structure fire burns, the less likely it is that anyone inside that structure will survive. However, unlike in road accidents it is very hard to determine a relationship between firefighters' response times and the number of people who die in fires.

• To date, most studies have graphed response times against the number of people who died. Challands (2009) finds that "there is no discernible relationship between fire service response time and the occurrence of fire fatalities...this would confirm the belief general within fire services that occupants need to self-evacuate long before fire services arrive".

Other studies do find a relationship between response times and the number of fatalities. UK-based consultancy Entec found that "the probability of fire death was linked to attendance time of fire appliances. If appliances could attend in less than five minutes, the probability of death was 3.8 per hundred fires. If appliances took six to 10 minutes to attend a fire, the probability of death was 4.2 per hundred fires."¹⁷

However, the figures prepared by Entec do not reveal how many lives would be saved with <u>faster</u> fire service response times. This would require data showing deaths in each minute a fire burns <u>without</u> firefighters. This would then be compared to how many people die in each minute a fire burns <u>with</u> firefighters.

A hypothetical example is shown in Figure 5.3. To estimate how many lives are saved by firefighters by reducing response times from seven minutes to six minutes, we need data showing how the number of deaths in the seventh minute of a fire without firefighters. Reducing response times to six minutes cannot save deaths that occur before the sixth minute of the fire—it could only save deaths that occurred in the seventh minute of fires that fire assistance arrived too late to prevent.

Figure 5.3: Comparing <u>Hypothetical</u> Number of Deaths per 1,000 Fires with and Without Firefighters



We cannot collect data to replicate the graph in Figure 5.3 with actual evidence:

- The time of death (for the usefulness of different response times) is problematic. For example, a person may have died in the first minute of a fire (for instance in an initial explosion) or just before the fire was put out in the ninth minute (by smoke inhalation).
- We do not know the likely number of deaths if there were no firefighters.

Although many people perceive that one of the most important roles of firefighters' is rescuing people from burning buildings, we cannot find reliable data to determine the scale and therefore the value of this activity. This makes our estimate of the value of firefighters more conservative.

¹⁷ Entec (2010) "It's about time: why emergency response times matter to firefighters and the public" Report for the British Fire Brigade Union, available online at: <u>http://www.fbu.org.uk/wp-content/uploads/2010/11/6367-Its-about-time-LOW-RES2.pdf</u> (last accessed 29 March 2012).



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