LIFE SAVERS NOT REVENUE RAISERS-
SAFETY CAMERAS IN IRELAND: A COST BENEFIT
ANALYSIS

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Dissertation submitted to Trinity College Dublin in fulfilment
of the requirements for the degree of Master of Science (M.Sc.)
in Economic Policy Studies

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DECLARATION

I declare that this dissertation, submitted to Trinity College Dublin for the degree of Master of Science (M.Sc.) in Economic Policy Studies has not been submitted as an exercise for a degree at this or any other university. All research contained herewith is entirely my own.

Date: July 4, 2014.

Signature: ___________________________________

Derek Rafferty.
Summary

Despite excellent progress over the last decade or so, road traffic collisions still remain a significant cause of death and injury in Ireland. Each year almost 200 people are killed and close to 6,000 are injured on the Irish road network. Irish and international research indicates that upto 30% of road collisions have speed as a contributory factor. Measures to reduce traffic speed are considered key to reducing casualties on the road. Increasing use of technology is seen as the way forward in the battle against road deaths. In Ireland speed or safety cameras are one technological innovation used to help reduce traffic speeds, traffic collisions, and casualties. A major expansion of the safety camera network has been underway in Ireland since 2011, led at national level by An Garda Síochána and endorsed by all the key stakeholders in the road safety arena. The Government hopes that the safety camera initiative will help it achieve its road safety targets over the next few years.

Studies have been carried out around the world and have consistently shown that considerable road safety benefits are achieved with safety camera programmes. No major piece of analysis of the possible impacts of safety cameras on road safety was carried out in Ireland before or after their widespread introduction.

This study carried out a comprehensive cost-benefit analysis in respect of the national safety camera network in Ireland (operated by the private company GoSafe).

The critical part of the analysis was an assessment of the effectiveness of safety cameras in reducing the numbers of deaths and injuries on Irish roads. In order to isolate the impact of the cameras on road accidents a controlled before and after study was used to compare fatalities and injuries at sites where safety cameras were positioned vis-à-vis sites which did not have any camera present. Time trend, seasonality, traffic levels and regression to mean were controlled for.

The costs of installing and operating safety cameras were contrasted with the monetary value of benefits brought about by their presence on the Irish road network. This included the annual income generated by speeding fines and the value of lives saved and injuries prevented. The results of the study show that safety cameras are an effective means of reducing road traffic collisions and related deaths and injuries in Ireland and because of this they generate a
significant benefit to Irish society of over €70 million each year- see the table below for more
details. Even when modelling with more pessimistic assumptions (e.g. a decline in incident
reductions, reductions in fine income etc.) the analysis still showed that the cameras produced a
substantial net benefit over their costs.

Contrary to popular belief Irish safety cameras are not a ‘cash cow’ for the State. The
operational costs of running safety cameras in Ireland are more than double the fine income
they generate. However, these safety cameras do save lives in a cost effective way. Thus,
continued expansion of the safety camera programme is a worthwhile objective.

Summary of Cost Benefit Assessment of Safety cameras in Ireland

<table>
<thead>
<tr>
<th>Benefits</th>
<th>€</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accident Savings</td>
<td>80,070,3953</td>
</tr>
<tr>
<td>Fine revenue</td>
<td>6,905,600</td>
</tr>
<tr>
<td>(a) Total Benefits</td>
<td>86,975,995</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Costs</th>
<th>€</th>
</tr>
</thead>
<tbody>
<tr>
<td>GoSafe Contract</td>
<td>16,000,000</td>
</tr>
<tr>
<td>Signage etc.</td>
<td>103,667</td>
</tr>
<tr>
<td>Planning</td>
<td>4,522</td>
</tr>
<tr>
<td>Enforcement</td>
<td>149,988</td>
</tr>
<tr>
<td>Publicity</td>
<td>339,728</td>
</tr>
<tr>
<td>(b) Total Costs</td>
<td>16,597,905</td>
</tr>
<tr>
<td><strong>Net Benefits (a)-(b)</strong></td>
<td>70,378,090</td>
</tr>
</tbody>
</table>

| Benefit-Cost Ratio      | 5.24   |
Acknowledgements

I would like to thank the Department of Transport, Tourism and Sport for sponsoring me to undertake the MSc course of which this dissertation is but the culmination of two years hard work. In particular the understanding of my various colleagues over the past two years is something I have very much appreciated.

Sincere gratitude must also go to all those who helped in terms of providing the information that allowed me to complete my research. In particular various members of An Garda Síochána were of great assistance in providing much of the data upon which my analysis is based. Sam Scriven from the Garda Research Unit deserves special praise.

The excellent guidance and words of wisdom of my supervisor Dr. Michéal Collins were of great help throughout my research. His positive approach inspired confidence in me and his good natured and reassuring manner kept me calm and minimised the stress of the process.

Finally, and most importantly of all, to my partner Stéphanie, her support on this and everything else in my life has been quite simply, immeasurable.

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Derek Rafferty.

Dublin, July 2014.
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Chapter 1  Background and Context

1.1  Road Safety in Ireland

Ireland’s road safety performance has been exceptional over the last decade or so. Fatalities for all road user groups have decreased significantly since 2000 with total fatalities falling by 61%. In 2012 there were 162 road collision fatalities, an average of 14 deaths per month, which was the lowest recorded number since safety records began to be kept in 1959. However, provisional figures for 2013 did see an increase in year-on-year fatalities to 190 for the first time since 2005.¹ Table 1 sets out the number of deaths and injuries on Irish roads during the 2005 to 2013 period.

<table>
<thead>
<tr>
<th>Casualties</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Killed</td>
<td>396</td>
<td>365</td>
<td>338</td>
<td>279</td>
<td>238</td>
<td>212</td>
<td>186</td>
<td>162</td>
<td>190</td>
</tr>
<tr>
<td>Seriously injured</td>
<td>1,021</td>
<td>907</td>
<td>860</td>
<td>835</td>
<td>640</td>
<td>561</td>
<td>472</td>
<td>474</td>
<td>474</td>
</tr>
<tr>
<td>Minor injuries</td>
<td>8,297</td>
<td>7,668</td>
<td>6,946</td>
<td>8,923</td>
<td>9,102</td>
<td>7,709</td>
<td>6,763</td>
<td>7,468</td>
<td>6,488</td>
</tr>
<tr>
<td>Total</td>
<td>9,714</td>
<td>8,940</td>
<td>8,144</td>
<td>10,037</td>
<td>9,980</td>
<td>8,482</td>
<td>7,421</td>
<td>8,104</td>
<td>7,152</td>
</tr>
</tbody>
</table>


* Note: Figures for 2013 are provisional.

Figure 1 shows graphically the progress made with respect to road fatalities and serious injuries since 2005. Note that the overall trend was already a significantly downward one when speed or safety cameras were first introduced on a wide-scale in Ireland 2011 (IMPORTANT NOTE: Throughout this Study the cameras will be referred to as “Safety Cameras” as that the name used by

¹ Gay Byrne, outgoing Chairperson of the Road Safety Authority (RSA) stated that the reason for the higher death rates in 2013 was because Ireland "as a society dropped our guard" and that traditional police enforcement levels had dropped (European Transport Safety Council’s (ETSC) 8th Road Safety Performance Index (PIN) Report 2014)
An Garda Síochána - however, the name “Speed camera” is probably more frequently used by the public.

Figure 1


According to the OECD’s International Road Traffic Accident Database (IRTAD) (2014), the main changes in policies and legislation in the past decade that have influenced road safety in Ireland were the

- Introduction of the penalty points system for speeding offences in November 2002;
- Operation of the Safety Camera Network, and the
- Operation of mandatory alcohol testing checkpoints introduced in July 2006.
1.1.1 Ireland’s Road Safety Performance in an international context

To compare road safety in different countries, the so-called mortality rate is typically used i.e. the number of fatalities per inhabitant. Figure 1 presents the mortality rate for EU countries for 2013. By this measure, Ireland is in the top ten in Europe with around 41 fatalities per million inhabitants. The EU average stands at 51 deaths per million inhabitants with only two countries Sweden (27) and the UK (28) achieving a rate of less than 30 per million inhabitants.

Figure 2 Road deaths per million inhabitants (OECD 2013.)
The mortality rate does not take the quantity of traffic or distances travelled in a country into account. To an extent, dissimilarities between countries can therefore be caused by differences in the degree of urbanisation, motorisation and/or mobility. Another measure, defined as the number of fatalities per motor vehicle kilometre, does take this into account. Unfortunately, only a limited number of countries have reliable data on the annual distance travelled (hence the wider use of the fatality measure). Figure 3 shows the position in those European countries where the data is available. Among these Ireland ranks second only to Sweden.

Figure 3  Road deaths per billion vehicle kms travelled 2012
Thus, the level of road safety in Ireland has been amongst Europe’s best for some years now. Less than a handful of countries have comparable or better safety records in the last decade or so-a period in which road deaths have fallen by almost 70% in Ireland. This level of performance has been all the more remarkable given the increases in population, registered drivers and motor vehicles during the period.²

However, as the OECD (2006) point out these positive figures and downward trends should not hide the economic costs and human tragedies behind the data. The socio-economic costs are very high—and not just the pain and suffering endured by crash victims. At a Road Safety Conference in Dublin in 2013 it was stated that if you add up the expense of medical treatment and of losing members of the workforce, and the extra financial burden placed on insurance, legal and social support systems, the EU’s road injuries give rise to a combined annual bill of around 2% of GDP.³ For 2012, that would be about €250 billion. Ireland’s own safety performance is again significantly better than the EU average with Table 2 showing the estimated economic cost of all road accidents to be almost €910 million in 2013 or 0.56% of GDP.⁴ Unfortunately, these details and numbers of serious injuries and their associated costs are only estimates. The real figures are likely to be much higher, because of the substantial problem of misreporting and underreporting.⁵

Recognising this the RSA’s current strategy document covering the period 2013-2020 targets a reduction of road collision fatalities on Irish roads to 25 per million population or less by 2020.⁶

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² Since 2000, the population has increased by 21% and registered motor vehicles (total fleet) by 43% (Road Safety Authority 2012).
³ On 28 March 2013, the Irish Road Safety Authority organised an international road safety conference as one of the Irish EU Presidency events. Some 300 participants – international road safety experts, NGOs, police officers, representatives from Member State transport ministries and other stakeholders – participated in the full day conference in Dublin. Further information available from <http://www.rsa.ie/Utility/News/2013/Varadkar-launches-new-Road-Safety-Strategy/>
⁴ See Appendix A for estimates covering the period 2005-2013 inclusive.
⁶ These targets are reflective of The European Road Safety Action Programme 2011-2020 which sets out plans to reduce the number of road deaths on Europe’s roads by half over a ten-year period.
### Table 2  
**Economic costs of road accidents in Ireland, 2013**

<table>
<thead>
<tr>
<th>Costs (EUR)</th>
<th>Unit Cost</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatalities</td>
<td>2.706 million</td>
<td>512.9 million</td>
</tr>
<tr>
<td>Serious injuries</td>
<td>310,039</td>
<td>150.9 million</td>
</tr>
<tr>
<td>Slight injuries</td>
<td>28,388</td>
<td>177.2 million</td>
</tr>
<tr>
<td>Property damage and other costs</td>
<td>3,190</td>
<td>68.7 million</td>
</tr>
<tr>
<td>Total (EUR)</td>
<td></td>
<td>909.7 million</td>
</tr>
<tr>
<td>Total as % of GDP</td>
<td></td>
<td>0.56%</td>
</tr>
</tbody>
</table>

*Source: Author’s own calculations based on data taken from the ‘Road Safety Authority Provisional Review of Road Crashes 2013’ and using parameter values from Department of Transport ‘Guidelines on a Common Appraisal Framework for Transport Projects and Programmes’ (2009).*

1.2.1  **The Crucial Role of Speed**

There is a consistency in road safety research findings throughout the globe over the past decade when it comes to the relationship between speed and road accidents. In terms of actual fatalities and injuries experienced worldwide, it is suggested that speed contributes to around one-third of all fatal crashes (OECD 2006).

According to the Finnish Transport Safety Agency (2013) one out of four drivers involved in a fatal accident in 2011 in Finland, whether as the guilty party or otherwise, was speeding. In the UK it has been established that excessive or inappropriate speed is a major contributory factor in at least one-third of all road crashes, making it the single most important contributory factor to casualties on UK roads (Butcher 2013). This finding is consistent with data from the US Department of Transportation which estimated that in 2012 30% of all fatalities were speeding related\(^7\).

The Irish experience with regard to speed and road safety appears to be somewhat better. The RSA (2014) reported that of all fatalities and serious injuries recorded between 1997 and 2011, speed was a contributory factor in 22% of fatalities and in 19% of serious injuries.\(^8\)

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\(^7\) Department of Transportation (2012). Interestingly this figure is very consistent over time with the corresponding figure for 2003 being reported as 31%.

\(^8\) Although in single vehicle collisions, the most common collision type, speed was a cause in 26% of cases.
The UK’s Transport Research Laboratory (TRL) (2005) suggested that each one mile per hour reduction in average speed can produce a 5% reduction in road deaths. Elvik (2004) concluded that there is a definite causal relationship between speed and road safety. He found that the statistical relationship between speed and road safety is very consistent. When speed goes down, the number of accidents or injured road users also goes down in 95% of the cases. When speed goes up, the number of accidents or injured road users goes up in 71% of the cases.

Given that the road safety literature strongly supports the relationship between speed and both the frequency and severity of crashes it is understandable therefore that road safety professionals should make speed management a priority in casualty reduction strategies. As Stevenson (2011) points out:

...managing or containing travel speeds so that they reflect the road environment is.... the most fundamental tenet of road safety and one of the most effective ways of managing the burgeoning incidence of road injury.

1.3 Speed- the Response

It is predicted that, if the number of drivers who are speeding is reduced, both the likelihood and severity of a crash will be lowered (Pilkington 2003). Research has also demonstrated that securing greater compliance with road traffic law can play a key part in reducing accidents (Elvik 2004).

A sizeable body of literature exists which convincingly demonstrates the relationship between relative and absolute excess in speed and road traffic crashes, injuries and deaths. Thus, the role for regulating, monitoring, and enforcing speed limitations is not in doubt (Wilson et al 2012).

The generally accepted model for improving all aspects of road safety is based on the integration of initiatives surrounding the three key pillars of education, engineering and enforcement. It is believed that road users will improve their conduct when informed of and educated in the dangers of inappropriate behaviour. Deaths and injuries on the road should also decrease as vehicles and roads become safer.

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9 In a report carried out by Elliott M.A., and Broughton. J.
10 The current Road Safety Strategy (2013-2020) commits to maintaining a high level of enforcement and promises to target enforcement on ‘key high risk behaviours’ such as speeding.
11 Ireland’s National Road Safety Strategies are based on three key areas of intervention with measures relating to: (i) Education – awareness raising, formal education and training (ii) Engineering – the design of roads and vehicles and (iii) Enforcement – the prevention, policing and mitigation of the effect of collisions. These interventions are commonly referred to as the 3Es and they have formed the basic framework for Irish Road Safety strategies since the first such strategy was produced in 1998.
However, if and when road users ignore both educational and engineering initiatives, then reliance must be placed on enforcement (SafetyNet 2009). It is generally accepted that traffic law enforcement influences driving behaviour through two processes: general deterrence and specific deterrence. \(^{12}\) General deterrence can be defined as the impact of the threat of legal punishment on the public at large. Specific deterrence can be seen as the impact of the actual legal punishment on those who are apprehended.

The general assumption underlying police enforcement is that it should primarily aim at general deterrence, which is first and foremost achieved by increasing the subjective risk of apprehension (SafetyNet (2009)). Wegman (2002) also emphasised the importance of general over specific deterrence noting that the overall preventive effects of police surveillance are generally greater if the subjective risk of the offender being caught is higher. In other words, the personal perception on the part of the road user of his or her chances of being caught while infringing a traffic regulation. \(^{13}\)

A key question that needs answering is therefore how can a considerably greater effort for enforcement be achieved? Wegman advocated a simultaneous increase in the quantity and quality of measures and approaches. He called for a combination of extra (financial) resources, greater efficiency, good police management, good training programmes and more application of technology and computerisation. In contrast to Wegman, Zaidel (2000) saw limited scope for increased manpower assisting in the fight against speeding. He criticised conventional manpower-using methods of police enforcement of speed as being (too) selective, sporadic, inconsistent, and in the end, being rather expensive and ineffective.

In Ireland there are two main methods of speed enforcement. The first one is to check drivers alongside the road and stop offenders. In the literature this is often called physical policing. Physical policing makes use of manned (visible or invisible) observation units and manned (visible) apprehension units where the offenders are stopped. The second method is to detect speed offenders by means of a safety camera and to send them a fine or a notification by mail. \(^{14}\) The disadvantage is that physical policing is far more labour-intensive and that it is virtually impossible to reach the same enforcement level as with safety cameras. Hence the objective chance of apprehension is much smaller. The problem with traditional enforcement methods is that the

\(^{12}\) As discussed in both SafetyNet (2009) and Department of Justice (2005).

\(^{13}\) Wegman (2002) noted that the level of punishment, the certainty of being punished and the speed with which the punishment is meted out will do little to prevent traffic infringements if the perceived risk of being caught remains very small.

\(^{14}\) Safety cameras can be used fulltime at fixed locations (fixed cameras) or can be rotated over different locations (mobile cameras). Safety cameras can operate automatically (unmanned) or as part of a manned control (either in a visible or in a hidden car or van).
limited policing resources available, as compared to the relatively high number of speeding motorists, results in a low perceived risk of apprehension (Zaal 1994).

Thus, in respect of speed, traditional traffic law enforcement is insufficient to achieve effective speed compliance by all road users. The number of police officers that are required to intercept sufficient offenders to create real ‘general deterrence’ is greater than any police organisation can allocate to traffic policing.\(^\text{15}\) Decina (2007) observed that the principal problem with traditional enforcement systems is that conventional law enforcement has not been able to keep pace with increased traffic volumes and increased vehicle mileage worldwide.

The accepted solution to the limitations of traditional traffic law enforcement is the increased use of automated technology. Automated methods to enforce traffic legislation have been used internationally over the last 25 years or so. The use of camera technology in particular can result in increased volumes in detections of traffic offenders, thereby achieving greater general deterrence.\(^\text{16}\) Excessive speeding behaviour is widespread and the use of safety cameras and associated automated devices is considered the most efficient way to significantly increase both detection and apprehension rates (Zaal 1994). This is a view formally endorsed in Ireland by the Department of Justice (2005) who recommended that modern camera technology should play a greater role in the context of traffic law enforcement in Ireland.

1.4 **History of Safety Camera Use in Ireland**

Among the priorities of the Government strategy for road safety 1998-2002, Ireland’s first ever national road safety strategy, were actions targeted at speeding. The High Level Group on Road Safety set up under this strategy considered the use of camera technology in a mixed traffic environment, and a consultancy study was commissioned on the topic.\(^\text{17}\) However, it would be over a decade later before the widespread use of safety cameras became a reality on Irish roads as it was

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\(^\text{15}\) Traditional traffic law enforcement is based on an ‘intercept’. A police officer detects a road traffic offence, stops the vehicle and either issue a fixed charge notice (previously known as a fine on the spot) or instigates a criminal proceeding by issuing a summons to the driver.

\(^\text{16}\) Of course, it is important to remember at all times that the aim of enforcement is to reduce the level of speeding so that real benefits can be delivered to society in terms of the number of lives saved and the increased economic production of those who otherwise would have died or suffered life-changing injuries.

\(^\text{17}\) Entitled “The Use of Safety cameras in Ireland”, this study was ultimately delivered in 2002 and was authored by Smith, Bodinaar and Cameron.
noted by commentators that then Fianna Fail led Government missed five deadlines to roll-out safety cameras.  

Nonetheless, although full implementation was some years away it was during the late 90s that cameras made their first tentative appearance on Ireland’s roads (Bacon 1999). Fixed safety cameras were in operation on four of the main national routes out of Dublin and on the M50 by 2001. Speed limit enforcement was also being supported by an increase in mobile speed detection, the use of laser speed detection as well as in-car and motorcycle cameras.  

The Department of Transport (2004) explained that the extension of safety cameras nationwide was not pursued over the lifetime of the first Road Safety Strategy pending the completion of the Smith consultancy study. Once completed the study recommended that the project be rolled out on a phased basis and in addition to speeding offences that it be extended to other appropriate traffic offences. It was noted that other new legislative provisions would be needed to be introduced to support this initiative.  

The 2004-2006 strategy proposed that:

An Garda Síochána will enter into arrangements for the engagement of a private sector concern for the purpose of the provision and operation of a nationwide programme for the detection of speeding offences. (Department of Transport (2004). p.25).

No specific date was given for the implementation of the objective but in the absence of such a date one could assume that it was to be during the lifetime of the Strategy. Another High Level Group was set up in 2005 chaired by the Department of Justice which this time had a very specific remit to look at the use of cameras in Ireland. In July 2005, following the report of this expert working group, the Government approved a tender process for the outsourcing by An Garda Síochána for a network of speed detecting cameras.

The first concrete target date for deployment was set down in writing in the 2007-2012 Road Safety Strategy (Road Safety Authority 2007) which tasked the Gardaí amongst others with implementing a Safety Camera Network in the region of 6,000 hours enforcement per month by the end of quarter 2

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20 The necessary legislation to allow images generated from a safety camera to be used in court proceedings was brought into law in 2010 via section 81 of the Road Traffic Act 2010.
2008. This was a position fully supported by the Garda Inspectorate (2008) who, based primarily on experiences in France, “…enthusiastically endorses the Irish Government’s decision to proceed with the purchase of safety cameras.” They maintained that the cameras, coupled with a strong public information campaign, would deter speeders and serve as an effective collision prevention tool.

A public procurement process was conducted in 2007 by An Garda Síochána for the provision of a service for speed surveying and monitoring of vehicles. Responses to the tender request suggested that the likely cost of the contract would be significantly greater than had been previously projected. Estimates of annual revenue were revised downwards to around €27 million (from an earlier predicted level of €40-70 million). The advice to Government in June 2009 noted the difficulties in accurately estimating this figure but the indications were that the revenues would exceed costs. A formal proposal to proceed with the project was approved by the Government in June 2009.

A contract was agreed with the successful tenderer, the GoSafe Consortium, to provide outsourced safety cameras for a period of five years. GoSafe commenced operations in November 2010 and were required to provide 7,475 hours per month, of which 6,725 hours coverage are assigned for speed enforcement and the remaining hours for speed surveying across the various designated zones. The private contractor operates on the basis of agreed speed thresholds, locations, dates and times determined by An Garda Síochána (Garda Inspectorate 2014).

As of July 2014 there are 727 stretches of road identified as speed enforcement zones. These account for 2,354 km of road network – or 2.5% of the 96,000 km in the country. These same stretches of road accounted for 48% of all fatal collisions in the years 2006 to 2012 with 60% being regional / local roads and 40% being national primary or secondary routes (less than 3% of these are motorways). The number of locations is to be increased when necessary to get the road safety result sought.

1.5 Safety Camera Policy Issues

The objective of the overall safety camera project was set out clearly by the Department of Justice (2005) as being to reduce the number of speed related collisions by:

1. increasing compliance with speed limits across the entire road network;
2. reducing the speed of vehicles at locations that have a speed related collision history; and
3. acting as a deterrent to driving at excessive speeds.

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21 As estimated by the Department of Justice (2005). Perhaps evidence of optimism bias often allegedly prevalent, according to the Department of Public Expenditure and Reform (2009) in transport cost benefit analyses?
It was noted that the use of camera technology would result in increased volumes of detections of traffic offences thereby achieving greater general compliance with road traffic laws.

It was originally intended that the privately operated services would augment the ongoing enforcement activities of An Garda Síochána. However, with the outsourcing contract for speed detections and traffic surveying due for renewal in 2015, the Garda Inspectorate (2014) has recommended that the Garda’s own mobile speed detection service be wound up and incorporated into the privately outsourced camera contract.

At an early stage it was noted that for any safety camera project to be successful, the public must recognise that its purpose is to save lives and that it not be associated with revenue collection. This presumably was in recognition of the experience in other countries – most notably the UK and the US- where certain interest groups had reacted negatively and aggressively to the roll-out of safety cameras in those jurisdictions.

A key principle of the safety camera system in Ireland is proportionality. The cameras are to be used to increase compliance with speed limits across the entire road network; and to reduce the speed of vehicles at locations that either have a speed related collision history or are of a type where a higher than expected frequency of collisions may be expected to occur.

It was noted that implementing a successful safety camera network required an integrated technology system that links the camera output to the vehicle and licence databases and to the courts administration system. This was one of the reasons that led to the outsourcing of the system to the private sector (Department of Justice 2005). At all times a commitment has been given that the operation of the Safety Camera Network was to be supported by a high profile and continuous...

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22 Note that the AGS still carries out a large amount of speed detection themselves (in overall terms more than 60% of all speed detections are still made by AGS). Much of this is done through the use of their own mobile speed vans known as “Garda Robot Vans”. AGS has eight mobile robot vans for the detection of speeding and other road traffic offences, one of which is assigned to each of the six Garda regions, and the other two vans are shared nationally. These mobile vans are operated by traffic Gardaí.

23 Recommendation 2.11 (Garda Inspectorate (2014)).

public awareness campaign to ensure drivers are aware of the role of safety cameras in enhancing their safety (Road Safety Authority 2007).
CHAPTER 2    Research Aims and Methodological Approach

2.1    Study Objectives

This study is an attempt to assess the overall value of the safety camera system to Ireland and its citizens. The aim of the study is:

“To provide a detailed and rigorous cost benefit analysis in relation to safety cameras, by identifying and quantifying the whole range of relevant factors and producing a comprehensive and clear account of the analysis process”.

2.2    Scope

The automated response to speeding in Ireland is not just down to the private contractor, GoSafe, who are responsible for the management and operation of the large scale mobile camera regime that has been in place since late 2010. An Garda Síochána (AGS) still carry out a large number of detections themselves with their own fleet of mobile camera vans. Furthermore they still use radar guns to assess speed and perform traditional intercept speed enforcement in the normal course of their duties. However, this study is focussed only on the GoSafe cameras primarily because it is only this group of cameras for which there was enough reliable data in a readily accessible form.25 From this point on all references to safety cameras in Ireland should be taken to mean the GoSafe mobile cameras unless otherwise stated.

It should be noted also that to better facilitate the analysis only full year data has been used for the safety cameras. Thus, although the camera system began to be rolled out in late 2010 only data from 1 January 2011 to 31 December 2013 has been used as the ‘after’ period for analysis purposes. It is acknowledged that this means a small portion of 2010 data may be wrongly classified but given the relatively low number of cameras rolled-out towards the last two months of 2010 it is not expected that this will make an appreciable difference to the overall end results.

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25 In total AGS estimate that in 2013 approximately 62% of all speed detections were carried out by Gardaí with the remainder by the GoSafe safety cameras.
2.3 Methodology

The study will follow the classic approach for all cost benefit analyses recommended by Boardman et al. (2010). The following is a list of steps that, according to Boardman comprise a generic cost–benefit analysis;

1. List alternative projects/programs.
2. List stakeholders.
3. Select measurement(s) and measure all cost/benefit elements.
4. Predict outcome of cost and benefits over relevant time period.
5. Convert all costs and benefits into a common currency.
6. Apply discount rate.
7. Calculate net present value of project options.
8. Perform sensitivity analysis.

Given that this study is an ex-post CBA not all of the above steps are as relevant as they would be in the case of a classic ex-ante CBA and the approach taken in this study takes account of this fact. In particular the time period focused on in this study is one year. The standard approach in the CBA literature is to spread the value of costs and benefits over a much longer period- typically 20 years. In the case of road safety this is not deemed to be practical due to the rapid pace of change in respect of car technology, road engineering, traffic patterns and policing strategies. This is also the approach taken in many of the international studies examining the road safety impact of safety cameras (see section 3.1). As a result of the one year timeframe being adopted the issue of discount rates and the net present value are not as relevant as they would normally be in a CBA.

2.4 The Data

During the course of the research, the relevant data on costs and benefits was collated from all agencies directly involved with the introduction and operation of safety cameras in Ireland. These included AGS, GoSafe, the Road Safety Authority (RSA), the National Roads Authority (NRA), the Department of Transport, Tourism and Sport (DTTAS), and the Courts Service. The data was used to

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26 See also the Department of Public Expenditure and Reform (2009) which recommends a broadly similar approach specifically for the Irish public sector.
27 Typically CBAs are carried out before a project is actually implemented i.e. ex-ante. This study is applying the rules of ex-ante to a project that has been in full flow for more than three years and as such can be termed an ex-post CBA.
28 DTTAS was known as the Department of Transport (DoT) until February 2011.
provide separate accounts of the costs and benefits experienced by each agency. An overall assessment of costs and benefits, known as the cost benefit equation or benefit cost ratio (BCR) will then be produced using this material. The research was further informed by interviews with AGS, the DTTAS, the RSA, the NRA, the UK Department for Transport and Transport Scotland.

Table 3 Summary of the Information on the Costs and Benefits of Safety cameras in Ireland and their sources.

<table>
<thead>
<tr>
<th>Costs</th>
<th>Source(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purchasing, installing, operating and maintaining the cameras</td>
<td>GoSafe/ AGS</td>
</tr>
<tr>
<td>Costs to the courts and the Director of Public Prosecutions (DPP) resulting from the use of the cameras</td>
<td>Department of Transport (DoT)/ Courts Service</td>
</tr>
<tr>
<td>Associated road safety publicity campaigns</td>
<td>RSA</td>
</tr>
</tbody>
</table>

**Benefits**

<table>
<thead>
<tr>
<th>Benefits</th>
<th>Source(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Savings in human life and injury, as well as those associated with reduced damage to property</td>
<td>DoT/ RSA</td>
</tr>
<tr>
<td>Savings experienced by An Garda Síochána (AGS) and emergency services as a result of attending fewer road accidents</td>
<td>DoT / AGS</td>
</tr>
<tr>
<td>Savings experienced by the health service as a result of dealing with fewer road accident victims</td>
<td>DoT</td>
</tr>
<tr>
<td>Fine income generated as a result of camera use</td>
<td>AGS</td>
</tr>
<tr>
<td>Improved traffic flow, reduced journey times and an ‘improved environment’.</td>
<td>Author.</td>
</tr>
</tbody>
</table>

In order to make an overall assessment of the net cost or benefit of the safety camera system, a number of data sources have been used. In relation to the ongoing operational costs of the system data has been provided by the private operator GoSafe (through AGS). Savings in human life and injury and public service usage has been estimated using a combination of road accident data published by the RSA and parameter values published by the Department of Transport (2009). To better isolate the impact of the introduction of the camera system, data specific to the camera sites was provided in raw format by the AGS Research Analysis Unit (see section 2.5.1 below for further details).
The most significant benefit of any speed enforcement technique or treatment is the improved safety performance it delivers—namely the reduction in fatalities and injuries (Rosebud 2006). Given its significance in the overall cost-benefit analysis (CBA), the detailed approach taken to arrive at this figure for Ireland since 2011 is described in more detail in the section immediately below.

2.5 Approach to estimating Road Safety Benefits

2.5.1 Data

All data relating to safety camera operations, including enforcement periods, and accident, fatality and injury numbers at sites, have been taken from the AGS Camera Programme database. This is an administrative data source used by AGS to collate and record data related to collisions, casualties and enforcement at all types at safety camera sites. The data in this database is confidential and as such is unpublished. Conditional access to the database was granted to the author and the majority of the data was extracted from the database during the April to May 2014 period. Road safety data for the camera sites was available for the period 2005-2013 inclusive. Corresponding national data was collated from publically available sources. A total of 567 sites had data for the full 8-year period in question. Sites ranged in length from just over 526 m to more than 10.6 km. the average site length was 3.6 km.

2.5.2 Methodology—Before and After Study

A core objective of this study is to isolate the impact of the introduction of safety cameras in Ireland on road safety performance. In effect the question to be answered is what would the safety performance have been like at camera sites had the camera regime not been in operation? Or put another way what precise impact did this one change—the use of safety cameras at known accident black-spots—have on road safety in Ireland?

Properly designed studies extract the treatment effect from the total change in safety performance in order to assess if the safety treatment has resulted in a safety improvement or deterioration. According to Wilson et al (2012) a randomised controlled trial (RCT) offers the highest level of evidence in this area. Hauer (1997) assigns this approach a slightly different nomenclature—a ‘randomised Before-After experiment’. However, it amounts to the same thing i.e. essentially a real-world ‘experiment’ where in the context of trying to estimate the safety impact of cameras on routes that were to have a camera installed would be chosen at random from a hat. The impact of the cameras on road safety would then be directly compared with those routes which were not

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29 In the main, the RSA’s annual Road Safety Collision Facts series but augmented by direct correspondence with both the RSA and An Garda Siochána.
chosen at random. However, in reality such trials are difficult to conduct in road safety enforcement studies due to perceived deficiencies in moral and ethical terms.\footnote{Safety cameras are most often introduced at sites based on their history of high rates of speed related crashes. In these cases it would be considered unethical to randomise intervention to some traffic ‘hot-spots’ and not to others, especially when the hypothesis is that the intervention will be beneficial (Hauer 2002).}

In the absence of a RCT the next best option has been chosen; namely an observational “Before-After” (B-A) study. This method is referred to somewhat unflatteringly by Hauer as an ‘old warhorse’. However, he maintains it is a useful methodological approach if ‘efficient use’ is made of it. To meet this standard this study will compare road safety performance statistics after the introduction of the cameras with the performance prior to the camera regime launch. Crucially though, the comparisons will only be made after controlling for as many of the typical cofounders i.e. other non-camera variables, that might influence speed enforcement outcomes including regression to mean (RTM), trend and traffic effects. Not do so would mean that study would be open to the charge that it was ‘naïve’ in nature and more importantly potentially significantly overestimate the impact of the camera treatment.\footnote{See Hauer (2002) and Allsop (2010).}

A review of a number of studies over the past decade illustrated that the most significant of these factors were RTM, trend and traffic flow effects (see section 3.1.3). The review findings correspond to those identified by the Transportation Safety Council (2009) who noted that the safety performance of a transportation facility changes over time and pointed out that this change from the before period to the after period can be disaggregated into four components. The first of these is referred to as the “Treatment Effect”. In essence this is the change in safety performance caused by the implementation of a specific treatment. In this case the introduction of safety cameras into various national locations is the “treatment”. This is the target of the study and can be found by finding and comparing the answers to the following two questions:

- **What would the safety performance have been in the after period had the treatment not been applied?**
- **What is the safety performance of the treatment facility in the after period?**

To answer the first question, the Transportation Safety Council stated that the following three causal factors or effects must be fully quantified and isolated.
(i) *Exposure Effect* - this is caused by the change in traffic volumes and patterns. Traffic patterns and accident frequencies have direct relationships. Therefore it is conceivable that the accident frequency might increase as traffic volumes increase and vice versa.

(ii) *Trend effect* - this is caused by factors not recognised, measured and understood. For example, traffic composition, weather conditions, levels of driver education, quality and age of the national car fleet, may have changed from the before and after period and thus impacted on the ‘after’ situation.

(iii) *Random Effect*: This occurs because of the phenomenon of RTM.

The overall process followed in this study in relation to isolating the impact of the cameras on road safety, including the specific approach used to take account of these three factors, is described in Box 1 below.

In order to facilitate the calculations and associated analysis made in this study the following assumptions have been made:

- The expected number of accidents at a road site is proportional to the traffic flow.
- The sundry number of factors that exerted a downward influence on road safety casualties at a national level would have had an identical impact at sites where cameras were installed.
- Using data for a period of six-years before the introduction of safety cameras eliminates or severely dilutes any possible RTM effects.
- There have been no major changes in the road layout or other road engineering methods between the periods.
- The level of driver education and associated publicity campaigns, particularly with respect to speeding, did not appreciably change.
Box 1: Road Safety Benefits- Methodological Approach Followed in this Study

**Step 1** Control for the possible effect of RTM or selection bias by using a sufficiently large ‘Before’ period against which to compare the ‘After’ data. This is done through using a six-year “Before” period i.e. all the available data.

**Step 2** Estimate what the safety performance of the camera sites actually was in both the “Before” and “After” periods. Subtract these figures to arrive at the ‘gross’ effect of the cameras (on fatalities and serious and minor injuries) having eliminated or significantly reduced possible selection bias in Step 1.

**Step 3** Adjust the figure found under Step 2 to take account of changes in traffic levels and flows between the two periods.

**Step 4** Strip out the natural trend in the data by adjusting the traffic adjusted figure arrived at under Step 3. This is done by using national road safety data as a control or ‘comparison’ group.

**Step 5** Examine the figure found following Step 4 by considering other factors that may have impacted on results but whose effects could not be modelled or isolated.

**Step 6** Using Department of Transport parameter values calculate a monetary value for the figures arrived at under Step 4.
CHAPTER 3  Literature Review

This Chapter looks primarily at the significant amount of literature generated on the subject of safety cameras since they first appeared on the road safety landscape in the late 1980s. The chapter concludes with a brief exploration of the key issues generated by the literature relevant to a cost benefit analysis and describes how they will be dealt with in this study.

3.1 Safety Cameras

3.1.1 Ireland

Safety cameras were introduced into Ireland on a nationwide basis from November 2010. Prior to their installation there was no formal cost benefit analysis (CBA) carried out. However, Smith et al (2002) did estimate the economic benefits (crash cost savings) and certain costs (offence detection and processing costs) of a mobile camera system and concluded that “…..there is no doubt that an expanded mobile safety camera programme would produce benefits to the Irish community well in excess of the cost of the programme”.32 No CBA has taken place since the cameras were installed although there is a commitment in the latest Road Safety Strategy to assess their effectiveness on or before 2015.33

In the absence of a full CBA or other formal appraisal tool it appears as if the decision to use safety cameras on a wide scale on Irish roads was taken on the basis of their perceived success in other jurisdictions as set out in Smith et al. This led to the inclusion of a specific commitment to install safety cameras in the 2004 edition of the Road Safety Strategy. The precise detailed proposed approach to implementing the camera regime was subsequently set out by the Department of Justice (2005).

3.1.2 International

Safety cameras have been in use in a number of other countries since the late 1980s. They are particularly prevalent in the UK and Australia where their use has been both championed and challenged for more than two decades.34

32 Smith et al (2002) was a confidential report produced for the Irish Government. Their limited CBA estimated a marginal benefit-cost ratio of more than one for increases of upto 300% (from the then current (2001) level) in speeding infringement notices.
33 See Road Safety Strategy 2013-2020 -Priority Number 70.
34 Both the association of British Drivers (www.abdd.org.uk) and the motorist group Safe Speed (www.safespeed.org.uk) have campaigned vigorously against the cameras for many years. See for example: The Telegraph “Scrap Speed Cambers Now” June 2007. Available from <http://www.telegraph.co.uk/motoring/road-safety/2747604/Scrap-speed-cambers-now.html>
An early attempt at a comprehensive CBA was undertaken in the UK in 1996 by Hooke et al. Examining all the likely costs and benefits of a safety camera regime they concluded that an amount of five times the initial investment was returned after one year and a return of more than 25 times is achieved after five years. They found that accidents had fell by 28% at safety camera sites. The Hooke study was comprehensive in that it estimated a monetary value on all the key costs and benefits of a safety camera regime. However, one criticism subsequently levelled at their work was that it had overestimated the key road safety benefit due to a failure to properly take account of potential ‘co-founder’ variables i.e. other variables/factors that may have had an impact on the number of road deaths and injuries during the period of the study.\(^\text{35}\)

Since the 1990s virtually all published studies seeking to measure the effectiveness of safety cameras have focussed on two main outcome indicators, namely speed and road safety i.e. fatalities and injuries. According to Rosebud (2006), this is an acceptable approach as the economic evaluation of road safety impacts for the cost-benefit analysis is based on the costs incurred as a result of road accidents. Again no such research has appeared in Ireland although estimates of the economic cost of lives lost and injuries suffered do appear each year in the Road Safety Authority’s (RSA) Annual Report. There has been limited attention given to the non-safety related benefits of the cameras in the literature\(^\text{36}\).

Research on the road safety related impacts of safety cameras has been widespread. Studies have been carried out based on experiences in many EU countries (most notably the UK), as well as Australia and North America. A summary of some of the more significant studies is presented in table 4.\(^\text{37}\)

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\(^{35}\) In fact the Hooke et al (1996) study was specifically excluded from the 2010 systematic review carried out by Wilson et al. as it was deemed to be of an insufficient quality as it was an uncontrolled before-after study.\(^{36}\) It is accepted that there is a possibility that there may have been studies that focussed on these areas published in “Grey literature” i.e. informally published written material that are difficult to trace via conventional channels such as published journals because it is not published commercially. Much Government material can follow into this category. It has been estimated that in the economic sciences more than 10% of sources cited can fall into this category.\(^{37}\) These are the 12 studies (from 35) which garnered a “High” rating in the systematic review conducted by Wilson et al (2012) which ranked the research literature based on their economic and statistical rigour.
<table>
<thead>
<tr>
<th>Year</th>
<th>Study and Country</th>
<th>Road Type</th>
<th>Camera Type</th>
<th>Effect on Crashes</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1988</td>
<td>Australia- (NSW)- Kearns and Webster</td>
<td>Rural</td>
<td>Aerial surveillance</td>
<td>21-23% reduction in crashes</td>
<td>Used 14 experimental and 14 control sites. ‘After’ period was less than one year. RTM discussed but not fully accounted for.</td>
</tr>
<tr>
<td>2003</td>
<td>Australia- (QLD)- Newstead and Cameron</td>
<td>All</td>
<td>Mobile</td>
<td>45% reduction in fatal crashes within 2 km of the sites.</td>
<td>No adjustment for RTM.</td>
</tr>
<tr>
<td>2002</td>
<td>Australia- Victoria- Diamantopoulou and Corben</td>
<td>Urban</td>
<td>Fixed</td>
<td>13% reduction in fatal crashes. Reductions of 10% and 7% in serious and overall injuries respectively.</td>
<td>Combined study period was only 20 weeks in total.</td>
</tr>
<tr>
<td>1982</td>
<td>Canada- (Toronto)- Hauer and Ahlin</td>
<td>Rural</td>
<td>Fixed</td>
<td>Speed study only. Speeds reduced at enforcement sites and a ‘time-halo’ effect was also found.</td>
<td>Study period was only five weeks</td>
</tr>
<tr>
<td>2005</td>
<td>UK (Nationwide)- Hirst et al.</td>
<td>All</td>
<td>Fixed</td>
<td>Reduction of 13% in serious and fatal injuries.</td>
<td>Empirical Bayes method used to account for RTM. Traffic flow, speed behaviour and crash trends were taken into account. (Note 1)</td>
</tr>
<tr>
<td>2008</td>
<td>UK (Norfolk)- Jones et</td>
<td>All</td>
<td>Mobile</td>
<td>19% reduction for all crashes and injuries</td>
<td>Account taken of RTM, crash</td>
</tr>
<tr>
<td>Year</td>
<td>Location</td>
<td>Region</td>
<td>Device Type</td>
<td>Effects Noticeable</td>
<td>Control Measures</td>
</tr>
<tr>
<td>------</td>
<td>----------</td>
<td>--------</td>
<td>-------------</td>
<td>--------------------</td>
<td>------------------</td>
</tr>
<tr>
<td>2005</td>
<td>Netherlands (Friesland)- Goldenbeld and van Schagen-</td>
<td>Rural</td>
<td>Mobile</td>
<td>44% reduction for fatal and serious crashes.</td>
<td>Migration, crash trends and road engineering events.</td>
</tr>
<tr>
<td>1997</td>
<td>Norway (Nationwide)- Elvik</td>
<td>Rural</td>
<td>Fixed</td>
<td>Reduction of 21% in both injury accidents and serious traffic casualties.</td>
<td>No account taken of RTM.</td>
</tr>
<tr>
<td>1997</td>
<td>Norway (Oslo)-Vaa</td>
<td>Rural</td>
<td>Radar/Laser Gun</td>
<td>Reduction of 20% in injury crashes.</td>
<td>Study controlled for RTM, changes to traffic volumes and general crash trends.</td>
</tr>
<tr>
<td>1997</td>
<td>Norway (Oslo)-Vaa</td>
<td>Rural</td>
<td>Radar/Laser Gun</td>
<td>Speed study only. Proportion of drivers speeding was reduced by 10%.</td>
<td>Total combined study period was 16 weeks.</td>
</tr>
<tr>
<td>2009</td>
<td>Shin et al- USA</td>
<td>Urban</td>
<td>Fixed</td>
<td>Reduction in crashes of between 44-55% and in injuries of 46-56%.</td>
<td>B&amp;A Study with a comparison zone. Controlled for traffic flow, trend and RTM effects.</td>
</tr>
<tr>
<td>1991</td>
<td>Australia (Victoria)- Cameron and Carvallo</td>
<td>Urban and Rural</td>
<td>Radar and Speed guns and safety cameras</td>
<td>Injury crash frequency reduced by 30% in Melbourne city. Reductions of 14-20% in rural zones</td>
<td>Five phase study over a 10-year period</td>
</tr>
<tr>
<td>2007</td>
<td>Spain (Barcelona)- Perez et al</td>
<td>Urban</td>
<td>Fixed</td>
<td>26% reduction in total crashes and a similar 27% reduction in the number of injury crashes.</td>
<td>No account taken of possible RTM effects. Trend, seasonality and traffic flow were controlled for.</td>
</tr>
</tbody>
</table>

Source(s): See References section.
The Empirical Bayes method is one way of adjusting data to reduce or dilute the possible effects of selection bias. Fawcett and Thorpe (2013) describe it as being the ‘gold standard’ approach to removing the RTM effect. However, they go on to argue that it itself has limitations and that a fuller more rigorous statistical approach- a full Bayesian approach- is more effective than Empirical Bayes. To be able to apply an empirical or full Bayesian approach requires an ability to be able to construct predictive accident models for the various camera site locations. Data constraints in Ireland, for the moment, prevent this from being a viable approach and hence it was not considered in this study.

A more detailed descriptive summary of each of these studies is contained in appendix B and the review which examined many of these studies is discussed in more detail in the section below.

3.1.3 Systematic Reviews- Findings

Three systematic reviews have been undertaken in relation to safety cameras in the period between 2005 and 2010.

A Transport Research Laboratory (TRL) study (2005) reviewed the literature on police enforcement and with respect to speed enforcement the review concluded that:

- Safety cameras are more effective than physical policing methods in reducing speeds and crashes
- Safety cameras are more effective in reducing crashes inside urban areas than on rural roads
- Fixed safety cameras are more effective in reducing speeds and crashes than mobile safety cameras.

Two further comprehensive systematic reviews have both concurred that considerable road safety benefits are achieved with safety camera programmes, albeit with varying estimates of effectiveness. For example, the most recent review (Wilson et al 2012) found a reduction in serious injuries and deaths ranging from 11% to 44% associated with safety camera programmes, while an earlier review (Pilkington and Kinra 2005) reported reductions in fatalities in the range 17–71%. Although both reviews reported that much of the selected research is of varying quality, there is an overwhelming consistency in the findings of the evaluations supporting the fact that the use of overt and covert cameras is a worthwhile intervention for reducing the numbers of traffic injuries and deaths.
In between the two systematic reviews SafetyNet (2009) found in their review of the available studies at that time that the best estimate was that automatic camera enforcement results in a crash reduction of 15 to 20%. They observed that the reported effects of speed enforcement are by no means clear cut but rather that they vary considerably. Effectiveness they found depended on many factors, such as the actual enforcement effort, the initial speed and safety level and the type and amount of supporting publicity.

The Cofounder Problem

Pilkington and Kinra (2005) noted that the majority of the studies they looked at had failed to take account of cofounders. In a similar vein Wilson et al. referred to Hauer (1997) when concluding that the key issues in relation to risk of bias and potential cofounders was on three variables known to be particularly important in road safety evaluations i.e. regression to the mean (RTM), long term trends and changes in traffic volumes. Of these RTM effects is seen as being by far the most important (see below for a brief exposition on this issue). For example, Allsop (2010) stated that “No one starting this kind of analysis now would contemplate doing anything other than doing their very best to allow or exclude – I’ve worked on the basis of excluding – regression to the mean”. Furthermore, in his review of the 2011 Key Scottish Safety Camera Programme Statistics Maher (2013) contended that in order to assess the effectiveness of safety cameras, allowance had to be made for RTM as “Otherwise, there is a danger that the reduction claimed to be attributable to the treatment (cameras) will be exaggerated and the methodology will be open to criticism”.

Most of the studies in the Wilson et al. review only controlled for, or described a few if any, of the other possible effects on speed or crashes such as season, time of day, changes in road design, speed limits, and levels of road safety publicity.

The Regression to Mean Phenomenon

Safety cameras are installed at sites where there has been a high level of collisions over a short period of time. The high level of collisions may be due to an increase above typical levels which has occurred as a result of chance. If the increase is down to chance or bad luck then it would be

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38 SafetyNet is a research Group fully funded by the EU Commission.
39 Maher also advised that account should be taken of trend. He estimated that in previous UK studies the RTM effect was significant and ranged from 20% in Mountain et al (1998) to more than 60% in the Department for Transport (2004).
40 This is the approach taken in Ireland as set out in the Department of Justice (2005) and the Road Safety Strategy 2007-2012. A similar approach is taken in all other jurisdictions.
reasonable to expect the number of accidents to fall from this untypically high level upon next measurement. Such a change would be expected irrespective of whether a safety camera had been installed or not. This is what is known as the regression to mean (RTM). This bias must be corrected for to uncover the real benefit of the camera (Hauer 1997 and Allsop 2010).

**Traffic Effects**

Intuitively, the number of accidents on the road network is connected to the level of traffic travelling on that network. All other things being equal the more traffic there is the more accidents that are likely to happen. Therefore if traffic levels decrease during a period of time then we would expect the number of accidents (fatalities and injuries) to decrease also (Elvik 2004). Thus, even if cameras had not been installed some decrease in accident levels would be expected. To isolate the camera effect on accidents the effect of different traffic levels must therefore be acknowledged and accounted for.

**Trend Effects**

Strategies to improve road safety performance worldwide are very conscious of the fact that it is an integrated approach that is the most effective in improving performance. No one measure on its own can achieve the levels of reductions in deaths and injuries that Governments and citizens demand. Typically focus is placed on three broad categories of interventions- engineering, education and enforcement. It is the sum of all these interventions that combine to impact on the levels of road fatalities and injuries. Safety cameras belong to the “Enforcement’ family of measures. They are but one measure in the overall policy mix. Thus, one would expect that even if they did not exist in Ireland then all the other measures that were implemented would have an impact on the overall road safety statistics. The overall impact of all measures can be seen by simply examining the raw figures. Failure to allow for this trend data would lead any researcher susceptible to the charge that they have simply ignored all other possible impacts of road safety performance other than cameras. Thus, a correct study must ensure that account is taken of national trend.

3.1.4 Research since 2010

Since the most recent systematic review (Wilson et al 2012) further research has reiterated the unanimous nature of the worldwide findings. Stevenson (2011) based on research findings in the

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41 The Wilson et al study was formally published in 2012 but was available online in 2010. Thus, the period after the original publication of the Wilson et al study (a seminal systematic review) is deemed to start in 2010.

42 During the course of this research no negative studies were discovered. However as Pilkington (2005) pointed out it is reasonable to expect that if any published negative studies existed, they would have received
UK and Australia concluded that “The evidence of the effectiveness of overt safety cameras is overwhelming”. He highlighted findings in the State of Victoria Australia which showed a 47% reduction in casualty crashes, with a cost saving to the community of over A$8 million per annum.43

Allsop (2010) found that the number of fatal and serious collisions near 551 fixed safety cameras in the UK dropped by 27% after the cameras were put in place. These findings were more robust than many others as he claimed to have successfully allowed for RTM by comparing the years after the cameras were installed with more than three years of data before they were installed. Allsop admitted that he had not provided “scientific proof” that the placement of the cameras caused the decrease in the number of accidents but says

“it would be extraordinary if on average over 551 sites this average change took place substantially for any other reason than that the cameras had been established there”.44

Allsop points out that if the cameras were not responsible, other factors must be – but other factors could increase the number of collisions as well as decrease it, so it would be very unlikely for something else to have caused a downward trend at all these sites. Such was the confidence in the rigour of the work that Professor Stephen Glaister Director of the RAC Foundation, who commissioned the work asserted in the foreword to Allsop’s work that “…the overwhelming evidence is that if safety cameras were decommissioned across Great Britain then about 800 more people per year would be killed or seriously injured”.

Butcher (2013) concluded that safety cameras may save the lives of motorists and other road users. This followed an assessment of a number of UK studies from 1999-2012 which Butcher claimed showed that deaths and serious injuries were reduced by over a third at safety camera sites.

The findings of many of the UK reports were disputed by commentators with the main issue of contention being once again an alleged failing of the studies to account for RTM effects. It was claimed that this deficiency resulted in an “illusion of benefit” being presented for safety cameras.45

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45 The motoring advocacy Group (Safe Speed- see www.safespeed.org.uk) commented on the Allsop report to the effect that “. The recent official report on the benefits of UK safety cameras is totally unjustified in its headline conclusions”. 

28
3.2 Cost Benefit Analysis

Simply put, a cost-benefit analysis (CBA) can be seen as a weighing-scale approach to making decisions: all the pluses (the benefits) are put on one side of the balance and all the minuses (the costs) are put on the other. Whichever weighs the heavier wins. In recent years, cost-benefit analysis has been widely used for analysing public-sector projects. In Ireland the Public Spending Code requires that any project, capital or current, with an estimated cost of €20m or more must have a CBA.  

There are two major types of CBA. Ex-ante CBA, which is just standard CBA as the term is commonly used, is conducted while a project or policy is under consideration, before it is started or implemented. Ex-post CBA is conducted at the end of a project and should be performed exactly as an ex-ante but using historical rather than forecasted data (Florio and Vignetti, 2013). The value of ex-post analysis is, according to Boardman et al (2010), that they contribute to “learning” by Government managers, politicians and academics as to whether particular classes of project are worthwhile.

In public sector terms, a CBA attempts to evaluate proposals from the perspective of society by placing all the costs and benefits on a comparative monetary scale. According to Rosebud (2006) avoiding the costs incurred as a result of road accidents represents the economic benefit of road safety measures.

Although widely used or perhaps because of that, CBA is also widely criticised. The main criticism or the perceived weakness of the technique tends to surround the monetisation of non-marketed costs and benefits and the externalities created by the project. Snell (2011) refers to this as the ‘valuation problem’. Those who question CBA doubt if a cost could ever be put on a human life for example. They object on pure ethical grounds- it is simply, in their view, wrong to do this. The Center for Progressive Reform (CPR) accuses economists in this instance of “pricing the priceless” and of a “shameless application of economics to human life”. In contrast CBA advocates point out that it

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46 In addition under EU Regulations Article 40(e) of Regulation 1083/2006 stipulates that the presentation to the Commission of major projects for financial support under the Structural Funds or the Cohesion Fund must be accompanied by information concerning the cost benefit analysis. A project is defined as a “major project” when its total cost exceeds €25 million in the case of environment or €50 million in other fields.  
47 In rare circumstances a CBA study may be performed during the course of the life of a project, that is, in median res. Like ex-ante these have the potential of directly influencing a decision- whether or not to continue with a project. They also provide information that can be used to predict costs and benefits in future ex ante analyses.  
48 The Center for Progressive Reform (CPER) is a non-profit research and educational organization. The organization’s 50+ Member Scholars -- working academics at institutions of higher learning across the United States -- provide research, analysis and commentary on a range of issues related to the environment, health
promises to make public spending policy choices more rational and help policymakers to make better decisions on how to spend on costly safety measures designed to reduce the loss of life.

Of course, the value of a CBA depends on the accuracy of the individual cost and benefit estimates. But people carry out the analysis, and therefore errors are bound to occur at times. Costs and benefits being intangible give room for subjectivity while performing the analysis. Since some of the costs incurred and benefits reaped are non-monetary, inaccurate results from the analysis are to be expected. As Boardman observes prediction is subject to omission errors and forecasting errors, and monetisation is subject to valuation errors.

Optimism bias describes the effect that project analysts overestimate the benefits and underestimate the costs and timings for a project. The Department of Public Expenditure and Reform (2009) asserts that it is critical that optimism bias is avoided. Florio and Vignetti (2013) noted the vast literature that exists providing evidence of systematic underestimation of investment costs and overestimation of demand in ex-ante CBA of large infrastructure projects. Flyvberg (2007) offers three broad categories of explanations for this:

- technical explanations: errors and pitfalls in forecasting techniques,
- psychological explanations: planning fallacy and optimism bias, and
- political-economic explanations: planners and promoters may deliberately and strategically overestimate benefits and underestimate costs when forecasting the outcomes of projects.

and safety. The CPER’s views on aspects of CBA are available from <http://www.progressivereform.org/perspcostbenefit.cfm>
Chapter 4- Safety Cameras- the Costs

4.1 Total Costs

Safety camera costs can be grouped into two broad categories as follows:

- **Fixed costs** are incurred on a one-off basis and include, planning, procurement (of both cameras and the vehicles to house them), installation and signing costs.

- **Current costs** are incurred every year and include the operation and maintenance of the cameras and vehicles, and related liaison and publicity. Costs associated with enforcement also constitute current costs.

*Table 5 Direct Cost to the State of the GoSafe Camera System*

<table>
<thead>
<tr>
<th>Year</th>
<th>GoSafe Contract Cost (€m)</th>
<th>GoSafe Cost per Camera site (€) (a)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>15.8</td>
<td>22,571</td>
</tr>
<tr>
<td>2012</td>
<td>15.6</td>
<td>22,286</td>
</tr>
<tr>
<td>2013</td>
<td>16.6**</td>
<td>23,714</td>
</tr>
<tr>
<td>Total</td>
<td>48.0</td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>16.0</td>
<td>22,857</td>
</tr>
</tbody>
</table>

*Source: Garda Inspectorate (2014)*

Notes to Table 5

(a) *This is an estimate based on an assumption of 700 active sites each year. There are a total of 727 sites in June 2014 but this figure has changed over the 2011-2013 period as new sites were added and other sites dropped. A figure of 700 has been taken to be the average number of operational sites in each year.*

(b) *The figure for 2013 is provisional.*

As previously stated this study deals only with the mobile safety cameras operated by the GoSafe consortium on behalf of An Garda Síochána (AGS), and not the mobile cameras and hand-held speed checking devices used by the AGS. Thus, the primary group of costs that are relevant are those that the State has to pay GoSafe. An overall annual cost of this programme is available and this is set out
in table 5. However, it has not been possible to source more detailed information that would allow a further breakdown of the GoSafe costs into fixed and current categories.\textsuperscript{49}

The remainder of this chapter examines in more detail all of the fixed and current costs associated with safety cameras. The extent to which these categories of costs are borne by the various agencies involved is also considered. Cost information when available, is given, and is based on material collected from a wide range of agencies during the course of this research.

4.2 Fixed Costs

Planning can be treated as a fixed cost because it takes place prior to camera installation and the investment can be spread across its life cycle. Most police costs in this area relate to staff time and focus on the efforts made, in conjunction with the National Roads Authority (NRA), to identify those locations which merited being designated as a camera site. Both the AGS and NRA were asked to estimate the spent by their staff working on planning activities. The results were converted to monetary amounts using the appropriate published (at 2013 rates) salary levels.\textsuperscript{50}

The mobile cameras that GoSafe operate around the country are typically housed in a white van. The vans are specially adapted and fitted-out to house the camera and its associated technology. Approximately 50 of these vans are used by GoSafe around the country. No actual cost per van was given although it was confirmed that the total cost consists of the van purchase, the van fit-out and the actual technology employed in the van so it will vary based on the choices made.\textsuperscript{51}

Procurement of these vans and the associated equipment also constitutes a significant fixed cost. Again this is borne by GoSafe and an assumption is made that this is covered in the overall contracted cost to the State. Note that camera equipment per se is not the only fixed cost to be met. Other one off expenditure e.g. on viewing equipment, on software to help process paperwork or on other non-camera equipment needed to facilitate prosecutions was also required.

The average estimated cost of signage per zone is €540 approximately. This covers the cost of signage and associated installation for two signs- one each at the entry and exit points per sign. This

\textsuperscript{49} Estimates were made of such costs in the UK by Hooke et al (1996). They found that more than 80% of the fixed costs for safety cameras related to the procurement and installation of the cameras and the vehicles that house them. Signing accounted for just under 5% of total fixed costs and other equipment for just over 10%. The costs associated with planning were relatively very small (under half a percent). Corresponding data for Ireland was requested by the author (via AGS) however, GoSafe expressed a preference to keep this data confidential as they deemed it to be commercially sensitive.

\textsuperscript{50} Department of Justice and Equality- Pay- Available from <http://www.justice.ie/en/JELR/Pages/Pay>

\textsuperscript{51} By way of comparison the AGS equivalent vans known as Garda robot-vans are estimated to cost €100,000 (although these are somewhat larger than the GoSafe vans) (Garda Inspectorate 2014).
cost was incurred by the NRA during the roll-out of the programme from November 2010 onwards at a total cost of €311,000. Although as the signs need to be replaced or as new sites open the cost may be attributed to GoSafe in which case it will be covered by the overall contract price paid to GoSafe by the State.

4.3 Current Costs

Experience in other jurisdictions suggested that that the bulk of the current costs for safety cameras were accounted for by enforcement costs. From discussions with the key stakeholders this also appears to be the case in Ireland.

When a person does not automatically pay the fine incurred for excessive speed they will be summoned to appear in court. The summons process is managed entirely by AGS. The summons application process itself is an automatic process, so as such does not require any physical resources. The summonses are then sorted within the AGS Fixed Charge Processing Office (FCPO) and the court packs created. There is a dedicated summons section within the FCPO to handle this process. The court packs are then sent out to the district where the case is due to be heard. GoSafe cases are prosecuted locally by a Superintendent (or another member on his/her behalf), with the GoSafe operator called as a witness. Using the same salary data as indicted for the ‘Planning’ category an estimate of almost €150,000 was made in respect of this cost category (see appendix C for further details regarding the calculation of this figure).

All publicity/advertising is attributable to the AGS and the RSA. The AGS developed and now maintain a website with information on the various camera sites and also deal with any queries that are raised either by the public or the media (through the Garda Press Office). Publicity through advertising campaigns is managed by and paid for by the RSA as part of their overall education and training budget and amounted to €678,556 for 2012-2013.

4.4 Other non-quantifiable costs

Without doubt the additional offences detected by the safety cameras have led to an additional number of court cases around the country since 2011. Thus, it is fair to assume that this has generated additional court costs and additional expenses for AGS who prosecute these cases on behalf of the State. Unfortunately however, there is no official estimates of such costs available.

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52 See Hooke et al (1996) who found that over 70% was taken up by fixed penalty and summons enforcement.
53 A fine for excessive speeding is €80 plus two penalty points attached to a driver’s licence. A person has 28 days to pay this fine. If they fail to do so they have a further 28 days to pay an increased fine of €120. Failure to meet this deadline will result in a summons to appear in court where, if they are found guilty, the sentencing is at the discretion of the Judge.
Appendix C briefly describes some of the more detailed issues surrounding the estimation of costs.

An effort was made during the course of this research to identify other, less obvious costs which might be associated with the introduction of camera technology. This issue was discussed with all the key agencies involved, but no additional costs of any significance were identified. Particular attention was paid to determining whether there was any “public hostility” to the new technology, as this could have represented a major cost. There was no evidence that this was a factor. In fact both the AGS and GoSafe reported that the communities in the areas where the camera sites were located were quite welcoming to the GoSafe cameras and their employees.\(^{54}\)

Table 6 below summarises the overall cost situation identified as part of this research.

\begin{table}[h]
\centering
\begin{tabular}{|l|l|l|}
\hline
\textbf{Cost} & \textbf{Value} & \textbf{Agency} \\
\hline
Procurement and Operation & €16 million p.a. & GoSafe \\
\hline
Planning & €4,522 p.a. & AGS/NRA \\
\hline
Signage & 103,677 & NRA \\
\hline
Enforcement & 149,988 & AGS \\
\hline
Publicity & 339,728 & RSA/AGS \\
\hline
Court Time & N/A & Courts Service \\
\hline
\end{tabular}
\caption{Summary of the Cost of Ireland’s Safety Camera System}
\end{table}

\textit{Source: Estimated by the author from data sourced from the various relevant agencies included in the third column of the table.}

\(^{54}\) This positive attitude of the general public to safety cameras can also be found in various surveys of public opinion made before and after the launch of the GoSafe camera regime. For example, AA (2010) found that “67.7% of respondents favoured the widespread use of safety cameras” and AA (2011) noted that “…8 out of 10 motorists now believe that the mobile speed vans… are a legitimate and effective means of stamping out speeding at accident black spots”.

34
Chapter 5 Safety Cameras - the Benefits

This chapter is broken down into two distinct parts. The first part deals with the major benefits, in economic and societal terms that safety cameras are believed to deliver - namely a reduction in the number of road accidents and incidents. The second part considers all other possible benefits that can flow from a road safety camera system.

5.1 Road Safety related benefits

Table 7 shows in summary form, the average annual road safety reduction at camera locations, in terms of fatalities, serious and minor injuries between the two periods being analysed i.e. the “Before” and “After” periods of this study (more detailed data is available in appendix D). The results suggest that safety cameras can and do contribute towards reducing the level of accidents on Irish roads with for example, the average number of deaths at all sites falling by almost two thirds (66%) between the two periods. In other words each year during the 2005-2010 period, before the introduction of the cameras, saw an average of 59 people lose their lives at the camera site locations but this number had fallen to just over 20 once the cameras had become operational - a prima facie saving of 39 lives each year. Practically identical percentage changes can be observed for serious injuries with a smaller percentage effect (44.92%) in evidence for minor injuries. 55

Table 7 Number of people killed or injured in Ireland at Mobile Camera Sites 2005-2013

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th>Average</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatal</td>
<td>356</td>
<td>61</td>
<td>59.33</td>
<td>20.33</td>
<td>39</td>
<td>65.73</td>
</tr>
<tr>
<td>Serious Injury</td>
<td>626</td>
<td>108</td>
<td>104.33</td>
<td>36</td>
<td>68.33</td>
<td>65.39</td>
</tr>
<tr>
<td>Minor injury</td>
<td>4920</td>
<td>1355</td>
<td>820</td>
<td>451.67</td>
<td>368.33</td>
<td>44.92</td>
</tr>
</tbody>
</table>

Table 8 shows similar data in respect of the entire country. The results here show that road related accidents and incidents fell significantly across the nation when comparing the two periods of the study. Annual road fatalities went down by more than 41% between the periods with an average of 179.33 deaths in the three-year period 2011-2013 compared to 304.67 deaths each year in the

55 Given that TRL (2005) has indicated that a reduction in average speed of 1 mph can produce a 5% reduction in accidents, a drop in accident levels would be expected at the camera sites would be expected if average speeds fell at the sites. Unfortunately, there was no speed data available for any of the sites either before or indeed after the cameras went ‘live’. This is regrettable and is an area which could be usefully addressed in respect of any future planned expansion of the camera regime.
period before cameras became part of Ireland’s road safety landscape. Again a similar proportional national reduction in respect of serious injuries can be seen in respect of serious injuries. However, in the case of minor injuries the fall of just over 12% was significantly below the reduction experienced at camera sites.

Table 8 Average Annual Number of people killed or injured in Ireland 2005-2013

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatal</td>
<td>1828</td>
<td>538</td>
<td>304.67</td>
<td>179.33</td>
<td>125.34</td>
<td>41.14</td>
</tr>
<tr>
<td>Serious Injury</td>
<td>4824</td>
<td>1437</td>
<td>804.00</td>
<td>479</td>
<td>325</td>
<td>40.42</td>
</tr>
<tr>
<td>Minor injury</td>
<td>46894</td>
<td>20599</td>
<td>7815.67</td>
<td>6866.33</td>
<td>949.34</td>
<td>12.15</td>
</tr>
</tbody>
</table>

The overall national analysis set out in Table 8 also includes by definition, those sites where cameras were located from 2011 onwards. Thus, the reductions experienced at camera sites are included in these figures. To isolate any possible national trend effect it makes sense to remove the camera sites from the overall national dataset. Table 9 presents the results of the national experience with respect to accidents and injuries etc. on Irish roads minus the camera sites.

Table 9 Average Annual Number of people killed or injured in Ireland at non camera locations 2005-2013

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatal</td>
<td>1472</td>
<td>477</td>
<td>245.33</td>
<td>159</td>
<td>86.33</td>
<td>35.19</td>
</tr>
<tr>
<td>Serious Injury</td>
<td>4198</td>
<td>1329</td>
<td>699.67</td>
<td>443</td>
<td>256.67</td>
<td>44.93</td>
</tr>
<tr>
<td>Minor injury</td>
<td>41974</td>
<td>19244</td>
<td>6995.67</td>
<td>6414.67</td>
<td>581</td>
<td>3.76</td>
</tr>
</tbody>
</table>

Figure 4 shows in graphic form the trend at the camera sites and at a national level.
As per the methodology described in section 2.5.2 (Box 1) the overall value of the treatment effect of the safety cameras can now be calculated at this point using a three-step approach as follows:

**Step 1**- Remove the traffic effect by adjusting the camera data to take account of the change in traffic levels between the two periods.

**Step 2**- Remove the effect of trend from the data by adjusting the data to take account of the national fall in road safety accidents that was taking place as a result of a various number of other factors.

**Step 3** – Assign a monetary value to the estimated savings in deaths and injuries attributable to the installation of safety cameras using nationally accepted parameter values.

It is worth re-iterating at this point the approach set out immediately above will take account of two of the three key co-founders identified by the international literature. The most significant co-founder that of selection bias or RTM has been controlled for by the use of a six-year before data period.\(^{56}\)

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\(^{56}\) Note that the methodological approach set out in Box 1 of Chapter 2 is consistent with the 3-step approach set out in this chapter- both simply have different starting points. Most notably steps 1 and 2, as set out in Chapter 2- have already been calculated before we reach this point.
Step 1 Adjusting for Traffic Effect

There is a proven relationship between the level of traffic and the number of road accidents. As traffic goes up so do accident rates and vice versa. Thus, in order to isolate the possible improvement attributable to cameras alone the effect of traffic must be estimated and then subtracted from the overall reduction in deaths and injuries.

Unfortunately there was no traffic counts carried out at camera sites either before or after their installation. Thus, another way of estimating the change in traffic levels had to be arrived at. The approach taken was to analyse traffic levels in sites close to existing camera locations. This was done for a random selection of 15 camera sites throughout the country that had such nearby traffic counters using extensive NRA traffic counter data. This detailed process is described in Appendix E. The results of this exercise led to the conclusion that traffic levels declined by 5.69% between the two study periods. Table 10 below shows the number of road accidents during 2011-13 (the “after” period) following an adjustment for this traffic data.

Table 10 Number of people killed or injured in Ireland at camera locations 2011-2013 adjusted for change in traffic levels

<table>
<thead>
<tr>
<th>Camera Sites</th>
<th>Difference</th>
<th>Traffic Change</th>
<th>Diff from traffic</th>
<th>Remainder</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatal</td>
<td>39.00</td>
<td>-5.69%</td>
<td>-2.22</td>
<td>36.78</td>
</tr>
<tr>
<td>Serious</td>
<td>68.33</td>
<td>-5.69%</td>
<td>-3.89</td>
<td>64.45</td>
</tr>
<tr>
<td>Minor</td>
<td>368.33</td>
<td>-5.69%</td>
<td>-20.96</td>
<td>347.38</td>
</tr>
</tbody>
</table>

It is estimated that even if no cameras had been introduced there would have been an average fall of 2.22 deaths each year at the camera locations due to reduced traffic levels with almost four less serious injuries and a reduction of almost 21 in minor injuries. Stripping out the possible effects of lower traffic levels leads to a conclusion that the traffic adjusted impact of safety cameras was actually 36.78 lives saved each year (64.45 serious injuries and 347.38 minor injuries).
Step 2  Adjusting for Trend Effect

As described in Chapter 1 the Government’s Road Safety Strategies have brought forward an integrated approach to addressing the many causes of road accidents in Ireland. Various measures taken under the broad headings of education, engineering and enforcement have been taken over recent years and each can be expected to have some impact on road safety and consequently the quantum of road accidents. Together these have worked to have an impact on the national level of deaths and injuries on Irish roads. There is no reason to believe that the combination of all these measures would not have had a similar level of impact on safety camera locations as they did on all other locations across the country. In order to isolate the possible improvement attributable to cameras alone the effect of this national trend should be calculated and then subtracted from the overall reduction in deaths and injuries. This calculation will be carried out on the traffic adjusted figures for all national sites excluding camera sites. This is because using the full national figure which includes the camera site data, would in effect lead to a double counting of the benefits of the camera regime.

The impact of the camera following adjustments for traffic and then trend is set out in table 11.

Table 11  Number of people killed or injured in Ireland at camera locations adjusted for traffic and trend effects 2011-2013

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatal</td>
<td>1472</td>
<td>477</td>
<td>245.33</td>
<td>159</td>
<td>86.33</td>
<td>35.19</td>
<td>36.78</td>
</tr>
<tr>
<td>Serious</td>
<td>4198</td>
<td>1329</td>
<td>699.67</td>
<td>443</td>
<td>256.67</td>
<td>36.68</td>
<td>64.45</td>
</tr>
<tr>
<td>Minor</td>
<td>41974</td>
<td>19244</td>
<td>6995.67</td>
<td>6414.67</td>
<td>581</td>
<td>8.31</td>
<td>347.38</td>
</tr>
</tbody>
</table>

The data in table 11 shows that even if cameras had not been introduced at the various locations then deaths at these locations would have fallen by over 35% anyway with serious injuries set to drop by 36.68% Adjusting for this means that the safety cameras can be estimated to have saved 23.84 lives each year, and prevented the annual occurrence 40.80 serious injuries and 318.53 minor injuries. 55% of the fall in fatalities (23.84 from 39) was due to the cameras.
Step 3 The monetary benefit of accident savings

If cameras have the intended effect of reducing accidents, a number of parties can be expected to experience benefits (or cost savings). These include the police and other emergency services (who deal with the accident), the health service (who treat the injured), insurers (who may have to meet costs associated with the accident), as well as the economy as a whole (in terms of lost output if the injured cannot work) and, of course most importantly of all, the victim of the accident. The Department of Transport (2009) produced estimates of the monetary value of accidents of differing levels of severity which take into account all such “benefits”. The latest available estimates produced in 2009 (but at 2002 market prices) are shown within Table 12 together with an adjusted calculation, using the Department’s own suggested methodology, showing the value in 2013 prices.

<table>
<thead>
<tr>
<th>Accident Types</th>
<th>2002 Values (Market Prices)</th>
<th>2013 Values (Market Prices)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Per Casualty €</td>
<td>Per Accident</td>
</tr>
<tr>
<td>Fatal</td>
<td>2,018,126</td>
<td>15,882</td>
</tr>
<tr>
<td>Serious Injury</td>
<td>226,757</td>
<td>6,769</td>
</tr>
<tr>
<td>Minor injury</td>
<td>17,486</td>
<td>3,896</td>
</tr>
<tr>
<td>Damage Only</td>
<td>N/A</td>
<td>2,403</td>
</tr>
</tbody>
</table>

Source: Adapted from Department of Transport (2009).

As per table 12 above, the value of saving one life on Irish roads in 2013 would be approximately €2.7 million. The Department of Transport methodology for producing these estimates was based on work carried out by Goodbody Economic Consultants (2004) and is already used by other agencies, as recommended by the Department of Finance Spending Code, particularly in relation to transport infrastructure projects (For example, in cost benefit analysis of various road projects conducted by the NRA in recent years). As mentioned earlier (see section 3.2), the subject is not without controversy and arguments have been advanced suggesting that the value placed on human life is insufficient or indeed that a human life simply cannot or should not have a value placed on it at all (see section 6.3 where alternative values for lives saved and injuries avoided are used as part of the sensitivity analysis).
5.2 Value of accident reductions

Combining the data from tables 11 and 12 above leads to the estimates presented below in table 13 which shows the annual monetary value of traffic camera linked accident savings. This suggests that safety cameras have generated an annual road safety benefit or dividend of over €86 million during the three-year period of their operation. Savings from reduced fatalities accounted for the vast bulk of this figure- €64.4 million or 84%. Injury related savings amounted to the balance with €12.6 million (14.6%) on serious injuries and slightly over €9 million (10.4%) saved for minor injuries.

Table 13 Estimated annual monetary value of accident reductions attributable to safety cameras for 2013

<table>
<thead>
<tr>
<th></th>
<th>(a) Annual Reduction in Accidents</th>
<th>(b) Imputed Monetary Benefit per Unit (€)(1)</th>
<th>Imputed Monetary Benefit Total (€) (2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatal</td>
<td>23.84</td>
<td>2,700,439</td>
<td>64,378,457</td>
</tr>
<tr>
<td>Serious Injury</td>
<td>40.80</td>
<td>310,039</td>
<td>12,649,608</td>
</tr>
<tr>
<td>Minor injury</td>
<td>318.53</td>
<td>28,388</td>
<td>9,042,329</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>86,070,395</td>
</tr>
</tbody>
</table>

(1) Values taken from the Department of Transport Parameter values. Total equals the value per casualty plus the value per accident.

(2) Simply the product of the relevant annual reduction (column (a)) by the unit imputed monetary benefit (column (b)).

5.3 Value of fines and penalties

Traffic cameras also generate revenue in terms of fixed penalty income and the recovery of fines and costs awarded by the courts against offenders. These payments represent what can be described as a “transfer” between one section of the community and another i.e. the benefit to the Exchequer of additional income is offset by costs to offenders.

Strictly speaking, transfer payments should be excluded from a cost benefit analysis, since they do not represent an additional gain to the community as a whole (Boardman et al 2010). However, it is arguable that fines should be treated as a benefit for the purpose of this cost benefit assessment,
since it would seem perverse to treat the consequence of law enforcement as a ‘cost’ to offenders. Therefore, fine income has been counted as a benefit for the purposes of the main assessment, although the exclusion of fine income has also been modelled in Chapter 6 (sensitivity analysis) to show how this affects the overall cost-benefit equation. A discussion around the merits or otherwise of this approach can be found in Elvik (1999).

Table 14 All fixed charge speeding notices issued 2005-2013 (includes both intercept and non-intercept) (Garda and GoSafe).

<table>
<thead>
<tr>
<th>Year</th>
<th>No. of Notices</th>
<th>Max Possible Income (1)</th>
<th>Annual % Change in issued notices</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>178,171</td>
<td>14,253,680</td>
<td></td>
</tr>
<tr>
<td>2009</td>
<td>180,345</td>
<td>14,427,600</td>
<td>1.22</td>
</tr>
<tr>
<td>2010</td>
<td>158,123</td>
<td>12,649,840</td>
<td>-12.32</td>
</tr>
<tr>
<td><strong>Average 2005-2010</strong></td>
<td><strong>172,213</strong></td>
<td><strong>13,777,040</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Annual Percentage Change 2005-10</strong></td>
<td></td>
<td>-8.97</td>
</tr>
<tr>
<td>2011</td>
<td>262,799</td>
<td>21,023,920</td>
<td>66.20</td>
</tr>
<tr>
<td>2012</td>
<td>225,041</td>
<td>18,003,280</td>
<td>-14.37</td>
</tr>
<tr>
<td>2013</td>
<td>205,719</td>
<td>16,457,520</td>
<td>-8.59</td>
</tr>
<tr>
<td><strong>Average 2011-13</strong></td>
<td><strong>231,186</strong></td>
<td><strong>18,494,880</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Annual Percentage Change 2011-13</strong></td>
<td></td>
<td>-8.91</td>
</tr>
</tbody>
</table>

*Notes: (1) Assumes 100% payment of each fine at the initial penalty rate of €80.*

*Data was not available from AGS in the appropriate format for the period 2005-2007*

*Source: An Garda Síochána*

Table 14 shows the number of notices issued each year since 2008 for speeding offences. Each offence generates a basic fine of €80. The average annual number of speeding notices issued before camera installation was just over 170,000. This has increased to a little over 230,000 in 2013 or by approximately 30%.
The fine income generated by the installation of the cameras is set out in Table 15 below.

### Table 15  Fine Income GoSafe 2011-2013

<table>
<thead>
<tr>
<th></th>
<th>Total Offences</th>
<th>Total Paid</th>
<th>Total Summons</th>
<th>Paid (€)</th>
<th>Paid After Summons (€)</th>
<th>Annual Total (€)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>118,566</td>
<td>90,436</td>
<td>17,723</td>
<td>7,234,880</td>
<td>2,126,760</td>
<td>9,361,640</td>
</tr>
<tr>
<td>2012</td>
<td>70,942</td>
<td>53,422</td>
<td>11,538</td>
<td>4,273,760</td>
<td>1,384,560</td>
<td>5,658,320</td>
</tr>
<tr>
<td>2013</td>
<td>71,117</td>
<td>54,385</td>
<td>11,217</td>
<td>4,350,800</td>
<td>1,346,040</td>
<td>5,696,840</td>
</tr>
<tr>
<td>Total</td>
<td>260,625</td>
<td>198,243</td>
<td>40,478</td>
<td>15,859,440</td>
<td>4,857,360</td>
<td>20,716,800</td>
</tr>
</tbody>
</table>

| % of Total | 100% | 76.1% | 15.5% |

| Average 2011-13 | 101,183 | 75,142 | 14,690 |

|                      | 5,286,480 | 1,619,120 | 6,905,600 |

*Source: An Garda Síochána.*

An assumption that the fine paid upon conviction in court was €120 had to be made.\(^{57}\) This is the amount payable in any event for a late fine. In all likelihood this is probably an underestimation. It should be noted that approximately 8-9% of all speeding notices issued are set aside and not collected. The vast majority of these relate to drivers who are not resident in the State.

Total fine income generated by the cameras is estimated at €20.7 million over the three year period of their operation or an average of just over €6.9 million each year. The actual amounts generated followed the expected pattern of starting off at a high level and then beginning to drop significantly as the deterrence effect took hold.\(^{58}\) €9.6 million was collected in the first full year of the camera regime. This had fallen to €5.6 million in each of the two subsequent years. Thus, already within two years the fine income generated at camera sites has fallen by almost 40%.

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\(^{57}\) Unfortunately AGS were not able to disaggregate the total fine income collected in the State.

\(^{58}\) As predicted by the Department of Justice (2005), although the quantum amounts they predicted differed substantially from the actual amounts collected to date.
5.4 Wider benefits

During the course of the analysis, a number of other, wider benefits were examined as follows:

Feedback from AGS suggested that the introduction of camera technology had released traffic officers to undertake alternative duties. This suggests that practical – and not simply theoretical – benefits were already being experienced by those agencies which bear the cost of accidents.

In policing terms, the potential for savings could be significant. Hooke et al (1996) suggested that in the UK almost 11% of traffic police time is devoted to dealing with road traffic accidents. Thus, a saving of just one per cent in traffic officer time could equate to a saving of up to £4 million at a national level.

**Increased criminal intelligence:** The study showed that photographic material which had been collected by speed and traffic light cameras had also been used in support of crime detection. For example, in identifying stolen vehicles or vehicles involved in crime.\(^{59}\)

**Greater community reassurance:** Whilst it is difficult to quantify, it is also likely that the local community (in which the camera site was positioned) derived some benefit from the knowledge that speed would be reduced and that accidents would fall. This was supported by factual evidence which shows that speed has reduced across the country on an annual basis for a number of years.\(^{60}\)

Monetary values could have been attributed to the above benefits to allow them to be incorporated into the cost benefit equation. Methods are available to calculate these values, although they would have been – to some degree – arbitrary and subjective. For example, the value of reduced speeds in environmental terms might have been costed in terms of average house prices in an area before and after the introduction of safety cameras. However, a number of other factors could influence such property prices and a subjective decision on the element attributable to safety cameras would have been required.

Regardless of how they were derived, the calculated values for the above benefits could have been open to question and could have undermined the validity of any cost benefit analysis based upon them. Furthermore their relative value in the overall cost-benefit ratio would in all likelihood have

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59 This corresponds to the initial thought expressed in Department of Justice (2005) who foresaw the cameras being used for more than just the detection of speeding offences. Indeed AGS advised that they hoped to see the cameras being used to prosecute offences such as driving without a seatbelt and driving whilst using a mobile phone once the technology was mature and reliable enough.

60 See for example the RSA’s Free Speed Survey (Urban and Rural) 2011.
been quite small. For these reasons, these benefits were not taken into account within the main cost benefit equation presented in Chapter 6.

The benefits should, however, be noted and can be treated as “added value” not reflected in the main cost benefit analysis.
Chapter 6  Cost Benefit Assessment

6.1 The CBA process

The essence of a cost benefit assessment is to bring together the whole range of relevant costs and benefits which are incurred and realised to determine whether an overall gain or loss is sustained for a project. It is through this approach that an assessment can be made as to the overall value of the project. Put simply, the cost-benefit equation subtracts the sum total of all costs from the sum total of all benefits. If the resulting figure is a positive one then the project is said to deliver a net benefit.

A fundamental concept within the cost benefit assessment is that of the Benefit Cost Ratio (BCR). This simply compares the ratio of benefits generated by a project with its associated costs. It is this figure that the cost-benefit analysis generates and is useful in comparing various different scenarios based on different assumptions around the camera regime. Where this figure exceeds one, then the project is said to have a net benefit over costs. The BCR also of course gives a useful benchmark to facilitate comparisons with other investment opportunities open to the State in the transport and other sectors.

In the current study, the cost benefit assessment was undertaken for a one-year period. Typically in transport related projects the analysis period would be much longer- sometimes up to 20 years. This is appropriate in most infrastructure cases as the payback period on an initial investment tends to be a number of years. From the figures in chapters 4 and 5, this is clearly not the case when it comes to safety cameras. Thus, the need for a ‘standard’ extended evaluation period is not deemed appropriate or necessary given that our aim is quite simply to arrive at an assessment as to whether or not it the level of investment currently being made on safety cameras makes economic sense to the State. This one-year approach also negates the need to use net present values or discount rates. The cost-benefit equation and BCR fulfil the same role in this ex-post evaluation.

It was assumed for the purposes of this assessment that the fixed costs associated with camera technology were spread over the first three full years of the camera’s operations- it is accepted that this is unlikely to have been the case but it facilitates the calculations in the overall CBA given the approach being taken is to work on a one-year basis. However, for analytical purposes, this assumption is unlikely to have any real impact on the final bottom line BCR figure given the low level of fixed costs incurred.
6.2 Estimation of overall costs and benefits

The results of the cost benefit assessment for traffic cameras are summarised in Table 16 below. It can be seen that safety cameras yielded a surplus of benefits over costs. The surplus was very significant due to high level of accident reductions estimated to have been achieved by, and attributable to, the cameras.

<table>
<thead>
<tr>
<th>Benefits</th>
<th>€</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accident Savings</td>
<td>80,070,3953</td>
</tr>
<tr>
<td>Fine revenue</td>
<td>6,905,600</td>
</tr>
<tr>
<td>(a) Total Benefits</td>
<td>86,975,995</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Costs</th>
<th>€</th>
</tr>
</thead>
<tbody>
<tr>
<td>GoSafe Contract</td>
<td>16,000,000</td>
</tr>
<tr>
<td>Signage etc.</td>
<td>103,667</td>
</tr>
<tr>
<td>Planning</td>
<td>4,522</td>
</tr>
<tr>
<td>Enforcement</td>
<td>149,988</td>
</tr>
<tr>
<td>Publicity</td>
<td>339,728</td>
</tr>
<tr>
<td>(b) Total Costs</td>
<td>16,597,905</td>
</tr>
<tr>
<td><strong>Net Benefits (a)-(b)</strong></td>
<td><strong>70,378,090</strong></td>
</tr>
<tr>
<td><strong>Benefit-Cost Ratio</strong></td>
<td><strong>5.24</strong></td>
</tr>
</tbody>
</table>

*Note: All figures represent the average yearly costs/benefits of the safety camera system in operation between 2011 and 2013.*

6.3 Sensitivity Analysis

Sensitivity analysis should always be carried out as part of a CBA (Boardman et al 2010) Sensitivity analysis describes the process of establishing the extent to which the outcome of the cost benefit analysis is sensitive to changes in the values of the input variables. It involves recalculating the BCR based on changes to the values of variables and assumptions. The Department of Public Expenditure and Reform (2009) noted that “It is important that sensitivity analysis is clearly presented and communicates whether or not a project is worth proceeding even if there are significant changes in the variables.”
A number of key assumptions were made prior to carrying out the cost benefit assessment- these were set out in chapter 2 but for convenience are reproduced below.

- Department of Transport estimates of the value of personal injury estimates are relevant and do not change substantially over time.
- Traffic levels at camera sites fell by 5.69% between the before and after periods.
- The sundry number of factors that exerted a downward influence on road safety casualties at a national level would have had an identical impact at sites where cameras were installed.
- Using data for a period of six-years before the introduction of safety cameras eliminates or severely dilutes any possible regression to mean (RTM) effects.
- There has been no change in the road layout or other road engineering methods between the periods
- The level of driver education and associated publicity campaigns particularly with respect to speeding did not appreciably change.

To ensure that the assumptions did not distort the results, a number of alternative scenarios were modelled to see if the overall conclusion that camera technology yields significant net benefits, changed. The scenarios modelled are grouped under four main headings:

- Adjustments for reduced accident benefits
- Adjustments for different levels of fine revenue
- Adjustments taking account of different traffic levels, and
- A fall in the general level of costs or benefits.

Firstly the overall figures are recalculated using the Department of Transport value of life as adjusted for the actual growth rates during the 2002-2013 period as opposed to the growth rates predicted at that time. Secondly an alternative figure for the value of life in Ireland is used- one generated by the European Transport Safety Council (ETSC) in 2011- this figure is more than 25% lower than the Department of Transport figure. Finally an assumption is a made that the value of accident savings is overestimated by the Department of Transport (2009) figures to the tune of 50%.

Assumptions are also made about the level of fine revenue generated by the cameras. Firstly it is assumed that the average level will fall by 50%- this would accord with the view taken by Department of Justice (2005) and is probably not unreasonable. Secondly the fine income is disregarded completely taking the view that this figure is not in fact a benefit but rather a transfer from the traffic violator to the State and therefore should not be treated as a societal benefit.
Traffic levels are also adjusted to arrive at alternative cost-benefit estimates. Firstly, the actual national change in traffic figure figures is used i.e. a reduction of 3.14%. Secondly an assumption is made that traffic figures did not change over the period.

Finally a blanket 20% reduction is applied to all cost items.

The results from modelling these alternative scenarios are shown in Table 17- a detailed results table is in Appendix F.

Substantial net benefits are generated for all scenarios. The baseline shows that benefits exceed costs by more than 5.24 to 1 and in absolute terms by more than €70 million. Even using the most cautious approach or set of valuations shows benefits still outweighing costs by almost €27 million or 2.62 to 1.

With the benefits from accident savings amounting to almost 92% of the total quantified benefits it can be seen that the only way that the bottom line BCR figure can be impacted in any serious way if the value assigned to the saving of a live and the avoidance of an injury is reduced. Thus, using the 2011 ESTC values, which are some 38% lower than the baseline Department of Transport values sees the BCR drop to 3.63. Reducing the Transport values still further – to 50% of their baseline- sees the BCR drop further still to 2.83. However, benefits still outweigh costs by a quantum of €30.3 million at this level.

It should be noted that revenue from fines makes a limited impact on the overall BCR figure. Excluding fines completely from the analysis i.e. assuming that fines were abolished- would still see benefits exceed costs by 4.83 to one. Note that this would not be a penalty-free situation as the motorist still receives two penalty points per speeding offence.
<table>
<thead>
<tr>
<th>Test</th>
<th>Title</th>
<th>Sensitivity Test Assumption(s)</th>
<th>Excess Benefit over Cost (€ million)</th>
<th>Cost: Benefit Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Basic/ Default</td>
<td>Traffic growth of -5.69%; Trend reduction of 35.19% and value of life as per Department of Transport (2009) figures adjusted to 2013 levels.</td>
<td>70.4</td>
<td>5.24</td>
</tr>
</tbody>
</table>

**Accident Savings Adjustments**

2.a  | Lower Value of Life GNP Adjusted | Basic assumptions except value of life figures used are adjusted using actual GNP growth rates rather than the estimated rates recommended by DoT                                                                                     | 78.5                               | 5.73                |
2.b  | Lower Value of Life ETSC         | Basic assumptions except value of life figures used are ETSC ones from 2011-approximately 38% lower than DoT values                                                                                                         | 43.7                               | 3.63                |
2.c  | Lower Value of Life (less 50%)   | Basic assumptions with value of life benefits reduced by 50%                                                                                                                                                            | 30.3                               | 2.83                |

**Fine Income Adjustments**

3.a  | Low Fine Income                | Basic assumptions but fine income set at 50%                                                                                                                                                                                  | 66.9                               | 5.03                |
3.b  | Zero Fine Income               | Basic assumptions but fine income completely excluded as a benefit                                                                                                                                                           | 63.47                              | 4.82                |

**Traffic Level Adjustments**

4.a  | Traffic reduction lower        | Basic assumptions but traffic growth assumed to reduce by the national average of 3.14%                                                                                                                                      | 78.70                              | 5.74                |
4.b  | Traffic levels to increase     | Basic assumptions but traffic growth assumed to have remained static between the periods.                                                                                                                                     | 81.57                              | 5.91                |

**All Benefits and/or Costs Reduced**

5.a  | Basic but benefits less 10%    | Basic assumptions but all benefits reduced by 10%. Costs held at same level.                                                                                                                                                | 61.68                              | 4.72                |
5.b  | Basic but benefits less 25%    | Basic assumptions but all benefits reduced by 25%. Costs held at same level.                                                                                                                                                | 48.63                              | 3.93                |
5.c  | Basic but benefits less 25%    | Basic assumptions but all benefits reduced by 25%. Costs held at same level.                                                                                                                                                  | 26.89                              | 2.62                |
6    | Basic but all costs increased by 20%. Benefits held at same level. | Basic assumptions but all costs increased by 20%. Benefits held at same level.                                                                                                                                            | 67.06                              | 4.37                |
Chapter 7  Conclusions

The cost benefit analysis (CBA) carried out in this Study has clearly demonstrated that the use of safety cameras has generated substantial net benefits to Ireland. In addition their ‘pay back’ period is practically immediate. From the first year of their operations the overall monetary value of the benefits they delivered far exceeded their costs. This was the case even when the data was remodelled using more pessimistic assumptions about the various values of costs and benefits.

With almost 92% of the benefits being delivered in the form of reduced road accidents and incidents it is clear that the benefits are primarily societal in nature.

The popular view in Ireland, perhaps reflecting the sceptical nature of its citizenry when it comes to its Government, has been that in some ways the cameras are only in place as money making machines. The facts show that this is far from the case. The revenue generated from safety camera fines covers less than 45% of their operational costs and is declining year on year.

Safety cameras may not be real revenue raisers but they are life savers. Evidence derived from the analysis has shown that almost 24 lives have been saved each year since 2011 because of the presence of safety cameras on the Irish road network. To put this into context this represents an approximate 12% saving on road fatalities based on the provisional data supplied by the Road Safety Authority in respect of 2013. A significant number of serious and minor injuries were also prevented from occurring simply because the cameras were in operation.

The type of evidence generated in this study may prove to be a useful input into deliberations regarding the continued use of safety cameras in Ireland. It is understood that there are plans to expand the network and indeed to completely replace the Garda’s own mobile speed fleet of vans with the private mobile cameras operated by GoSafe. The results of this analysis show that the mobile safety cameras operated by the GoSafe private consortium on Irish roads are clearly and unambiguously a cost-effective road safety measure.

It should be noted that despite the fact that they have a large benefit-cost ratio this does not of course necessarily mean that cameras are automatically worthy of continued significant investment. They will remain, like everything else, subject to the constraints of a limited national budget with many competing claims on it from a seemingly never ending list of national priorities. However, the results of this CBA may allow proposed investment in safety cameras to be better benchmarked
against other proposed investments in road safety or the wider transport sector and thus give them a ‘competitive advantage’ of sorts.

When evaluating the effectiveness of safety cameras into the future sight should not be lost of the fact of their original purpose namely to enforce speed limits and thus reduce incidents and accidents on the roads. By their very nature they should be a victim of their own success. The more they are used the less they should be needed. This is because their continued presence should actually lead to a greater national speed compliance culture. This will then mean a reduced benefit cost ratio for the cameras. However, this of course should it happen, will take many years (as the shift in culture that made drink driving socially unacceptable also took some considerable time) and if and when it does happen, should be lauded as a success. But it does point to the need for a continuous evaluation of the safety camera system and an awareness that a decreasing benefit-cost ratio is not something to be alarmed about.

The model followed by Transport for Scotland where they publish an annual statistical assessment of the impact of safety cameras is one worthy of consideration in an Irish context. As well as allowing a continuous performance monitoring to be carried out on the cameras it would also serve as a useful positive publicity and weapon for the cameras in what is likely to be a perhaps never-ending battle with a vocal minority of anti-camera car lobbyists who will continue to doubt. The more cameras that are put in place the more lives that are likely to be saved- the stakes could not really be any higher and there is a justification for continuing robust statistical analysis in this area to be produced and propagated.
References


Transportation Safety Council, Institute of Transportation Engineers (2009), *Before-And-After Study Technical Brief*. Washington: Institute of Transportation Engineers


Appendix A- Economic Costs of Road Safety in Ireland 2005-2013

Note: The economic cost of an accident is found by multiplying the estimated value of a life (as per the Department of Transport (2009)) lost in that accident and adding that to a residual accident figure. An assumption is made that only one person is killed or injured in each accident. This is accepted that it is likely to slightly overestimate the final figures. However, in the absence of very detailed data it is a practical approach especially as the difference between this approach and the final ‘real’ financial difference is unlikely to be overly significant as evidenced by the differences between the total casualty and accident figures in the table below.

<table>
<thead>
<tr>
<th>2005 Data</th>
<th>Accidents</th>
<th>Cost</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatalities</td>
<td>396</td>
<td>360</td>
<td>871,868,094</td>
</tr>
<tr>
<td>Serious Injury</td>
<td>1,021</td>
<td>787</td>
<td>256,553,278</td>
</tr>
<tr>
<td>Slight injury</td>
<td>7,580</td>
<td>5,386</td>
<td>166,302,270</td>
</tr>
<tr>
<td>Damage only</td>
<td>21,274</td>
<td>21,274</td>
<td>55,375,066</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2006 Data</th>
<th>Accidents</th>
<th>Cost</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatalities</td>
<td>365</td>
<td>321</td>
<td>825,122,284</td>
</tr>
<tr>
<td>Serious Injury</td>
<td>907</td>
<td>653</td>
<td>233,713,922</td>
</tr>
<tr>
<td>Slight injury</td>
<td>7,435</td>
<td>5,044</td>
<td>166,489,571</td>
</tr>
<tr>
<td>Damage only</td>
<td>22,399</td>
<td>22,399</td>
<td>59,877,571</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2007 Data</th>
<th>Accidents</th>
<th>Cost</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatalities</td>
<td>338</td>
<td>309</td>
<td>706,691,162</td>
</tr>
<tr>
<td>Serious Injury</td>
<td>860</td>
<td>618</td>
<td>164,368,568</td>
</tr>
<tr>
<td>Slight injury</td>
<td>6,817</td>
<td>4,540</td>
<td>110,614,911</td>
</tr>
<tr>
<td>Damage only</td>
<td>23,769</td>
<td>23,769</td>
<td>65,255,467</td>
</tr>
<tr>
<td>Year</td>
<td>Fatalities</td>
<td>Serious Injury</td>
<td>Slight Injury</td>
</tr>
<tr>
<td>--------</td>
<td>------------</td>
<td>----------------</td>
<td>---------------</td>
</tr>
<tr>
<td>2008</td>
<td>279</td>
<td>835</td>
<td>8,686</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2009</td>
<td>238</td>
<td>640</td>
<td>8,884</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td>212</td>
<td>561</td>
<td>7,492</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2011</td>
<td>186</td>
<td>472</td>
<td>6,606</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td>162</td>
<td>474</td>
<td>474</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>Fatalities</th>
<th>Serious Injury</th>
<th>Slight Injury</th>
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<td>2010</td>
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<td>all</td>
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<td>all</td>
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</tr>
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<td></td>
<td>2013 Accidents</td>
<td>2013 Cost</td>
<td>Totals</td>
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<td><strong>Total</strong></td>
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<td><strong>97,832</strong></td>
<td><strong>6,799,378,760</strong></td>
<td><strong>2,591,753,405</strong></td>
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Appendix B Detailed Summary of selected International Study Findings

A short summary of the details and results of various international studies on the effectiveness of safety cameras was set out in table 3. Below more detailed information is provided for each of those studies- the majority of which were rated as “High” quality by the comprehensive systematic review conducted by Wilson et al (2012)^61^.

Unless otherwise stated all are controlled “Before and After” studies with the standard combined period of six years being deemed to be the appropriate minimum by Wilson et al. Note that the study in this report uses a combined nine-year period i.e. six years “Before” (2005-2010) and three years after (2011-2013).

- In research carried out for the Traffic Authority of New South Wales, Kearns and Webster (1988) examined 14 rural highway sites in New South Wales each with a speed limit of 100 km/h or more. There were 14 experimental and 14 control sites in the study and speed observations were carried out by means of a police surveillance helicopter. They found a reduction of between 21 and 23% in crashes at the sites although it was noted that the ‘after’ period was less than one year and that RTM was discussed but not fully accounted for.

- In Queensland Australia Newstead and Cameron (2003) used a 4-year before and after period to examine the effects on up to 2500 sites throughout Queensland that had undergone a speed limit review and had a high crash and injury history. They found a 45% reduction in fatal crashes within 2 km of the camera sites. Corresponding reductions of 31%, 39%, 19% and 21% were estimated for hospitalisation, medically treated, other injury and non-injury crashes respectively. Lesser reductions were found as the distance from the cameras increased. No account was however taken of possible RTM effects.

- A 2002 study by Diamantopoulou and Corben, of one road only- the Domain Tunnel in Melbourne found an estimated 13% reduction in fatal crashes, a 10% reduction in serious injury and a 7% reduction in overall injuries. However, the overall combined study period was only about 20 weeks during 2000, and it was noted that during the ‘before’ period the cameras were visible in the tunnel although not operational. However, not all drivers would have known this and thus the final results may have been exaggerated.

- Hauer and Ahlin (1982) examined semi-rural road locations West of Toronto [Canada] during a five week period in late 1979. Four experiments were carried out on four experimental

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^61^ First published online in May 2010. Print publication in 2012.
sites. Nearby, ‘control’ sites were also used to compare the experiment results. The study was essentially a measurement of the impact of different types of enforcement - overt and covert - on speeds before, during and after the road sites. Average speeds reduced at the enforcement sites and a ‘time halo’ effect was also found.

- **A 2005 UK study by Hirst et al** of 62 experimental road sites with a 30 mph speed limit in various locations throughout the UK but all with a history of excessive speeding problems found after adjusting for a number of cofounders an overall reduction of 13% in fatal and serious injuries. Adjustments were made for RTM and traffic flow changes (including traffic migration effects). The comparison control group used was the UK national average for roads with a 30 mph speed limit.

- **In 2008 Jones et al** looked at 29 sites in Norfolk (UK) each with a speed limit of 60 mph or more. Their results showed a 19% reduction for all crashes and a 44% reduction for fatal and serious crashes between 1999 and 2004 i.e. a before and after period of 24 months. Similar sites near to the experimental sites were used for ‘control’ purposes (although not all sites had a matching control site). The results were net of RTM, crash migration, crash severity trends and possible road improvements between the two periods.

- **Goldenbeld and van Schagen (2005)** used an extensive 8-year before period and a five year after period for 12 rural roads with a speed limit of 80 km/h and 100 km/h when carrying out an analysis in the Dutch province of Friesland. There were 15 comparable roads used as a control group during the same periods. They found that the odds ratio for injury accidents fell by 21% although it was noted that this ratio had been calculated based on relatively small numbers. A possible co-founder was that extensive weekly media coverage and an education campaign was used in the after period. The authors argued that RTM did not need to be accounted for as the ‘before’ crash rate had remained similar throughout the 8-year timeframe.

- **Elvik (1997)** reported a significant reduction of 20% in injury crashes in his nationwide Norwegian study carried out over a study period from 1988 to 1993. He inferred that this would equate to about 62 injury crashes per year on the 64 road sections he analysed. The before period in this study was close to 4 years and the after period over 4.6 years. The control comparison group was the rest of Norway during the before and after period. Elvik also controlled for RTM, changes in traffic volume and general trends in the numbers of crashes.

- **Vaa (1997)** examined speed enforcement on semi-rural roads close to Oslo (Norway) during a four-month period in late 1991. Using radar and laser guns to measure speed in mainly
unmarked hidden cars it was observed that the proportion of drivers breaking the speed limits reduced by about 10%. One experimental 35km stretch of road was used broken down into six sites with a nearby control road also broken down into six sites. A time-halo effect of upto 8 weeks was shown to exist after the enforcement period.

- **Shin et al (2009)** reported a total crash reduction of 44-55% and an injury crash reduction of 46-46%. RTM, traffic flow and trend effects were accounted for but the overall study program was very short- only 9 months. The study focussed on one stretch of 6.5 mile urban freeway in **Scottsdale Arizona (US)** using six fixed safety cameras at six locations. The cameras were triggered only when speeds were more than 18% above the posted speed limit of 65 mph.

- A five-phase series of studies in **Victoria Australia** led by Cameron and Carvallo (1991) reported a reduction in Injury crash frequency of around 30% in Melbourne city with corresponding reductions of 14-20% in rural zones. This was a time-interrupted study carried out over a period of 10 years (1983-1993). Only phases 1 and 2 had a before and after period and thus only results for those two phases were tabulated. The study also looked at the impact of education and publicity measures on speeding and accidents. The control site used for Phases 1-2 was in another Australian State although it was claimed to be comparable in terms of economic activity and average distances travelled. Controls were also implemented to take account of a random breath test initiative that was going on at the same time as the trial.

- **Perez et al (2007)** carried out an interrupted time series study of a 24.1 km stretch of **Barcelona’s urban beltway** over a combined study period of four years from 2001 to 2005. They found a 26% reduction in total crashes and a similar 27% reduction in the number of injury crashes. No account was taken of possible RTM effects although general trend, seasonality and traffic flow were controlled for. The comparison sites used were very different from the beltway.
Appendix C - Costs

Costs to An Garda Síochána (AGS)

The AGS pay the overall cost of the contract for GoSafe. This covers the vast majority of the fixed and current costs associated with the safety camera system. In 2013 it was estimated that this cost €16.6 million. This brought the total cost over the three year period of 2011-2013- the ‘after’ period in the study- to €48 million or €16 million p.a. Unless otherwise stated it is assumed that all costs of the camera system are covered by this annual amount.

Fixed costs- planning

The AGS did have some fixed costs incurred prior to the deployment of the system. This entailed analysing road accident data to ascertain which sites qualified as “blackspots” and thus merited a camera being located there. The annual cost of this was estimated to be €4,522 and the calculations are shown in Box 2 below.

<table>
<thead>
<tr>
<th>Box 2- AGS Planning Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> Time Spent</td>
</tr>
<tr>
<td>• Six weeks work of two Garda working full time (source: NRA/AGS)</td>
</tr>
<tr>
<td>• Assuming 5 day week this equals 60 man days.</td>
</tr>
<tr>
<td><strong>Step 2</strong> Value of Time Spent</td>
</tr>
<tr>
<td>• Using AGS ‘A’ rate- mid-point of salary scale=€807.55 p.w= €9,691 in total.</td>
</tr>
<tr>
<td>• Assume an additional 40% to cover pension contributions plus travel expenses and allowances means €13,567 p.a over 3 years or €4,522 p.a.</td>
</tr>
</tbody>
</table>

Current Costs

The key recurrent costs to AGS arising out of the deployment of safety cameras in Ireland over the period 2011-2013 are as follows:

- **Enforcement**- prosecution of cases in the courts
- **Administration**- the fixed charge processing office (FCPO)
- **Management**- the cost of managing the contract with the private operator- GoSafe; and
- **Publicity and Liaison**: promoting awareness of the presence of safety cameras and dealing with media queries on the subject.

In relation to enforcement costs the AGS has to supply officers to prosecute those persons who do not pay their fine within the prescribed time limits. This means attendance at court and preparatory work in advance and follow-up work after their appearance. Box 3 shows the calculations for this element of cost over the 2011-2013 period.

The FCPO has been in existence since 2004. AGS estimate that there was no additional significance cost associated with the initial processing of the GoSafe offences given that much of the system was already in place and automated. However, the process of putting together the detailed information pack necessary to assist in the summonsing of those persons who did not pay the fine is a time consuming one. There are no estimates from the AGS for these costs. However, given that they could be reasonably high an attempt will be made to cover these in the sensitivity analysis.

![Box 3- Enforcement Costs- AGS](image)

No estimates are available from AGS re the cost of managing the GoSafe contract. However, it is likely to be a relatively small amount that would be unlikely to have a significant impact on the final benefit cost ration (BCR).

The AGS has a significant amount of material on their website in respect of safety cameras including a map showing the locations of each camera site. There would have been a small fixed cost associated with upgrading their website prior to the deployment of safety cameras on a national
basis in late 2010. Unfortunately no figures are available for this. In addition the website contains useful information about various aspects of the camera system and associated processes. This does not stop a number of members of the public calling the AGS seeking information and clarification on speeding fines generated by the GoSafe camera system. Furthermore, an additional expense is incurred by the Garda Press Office in dealing with media queries throughout the year in relation to the cameras. Again no figures were readily available from AGS on this. However, again they did indicate that the final amount was likely to be relatively small each year and decreasing as motorists and media became more familiar with the system.

**Costs to the Courts**

No fixed costs were identified for the courts service.

Recurrent costs identified for the courts include various administrative issues such as checking of summons’ by an officer of the court, entering appearance dates into the court diary and drawing up a court list and issuing warrants for non-compliers. Furthermore there is the cost of the court sittings themselves. Unfortunately, the investigation of associated costs was constrained primarily by the fact that the Courts Service does not have any estimate of the cost for their time by any metric (including those above) nor do they have any plans to work on such estimates in the near future. A further complication is the complexity of the process and the fact that most courts do not deal with camera cases separately, nor do they collect detailed information specifically about them. Thus unfortunately no cost estimates are included in this study in relation to the courts. However, the cost of the AGS and GoSafe in preparing and attending for days in court are included in the overall analysis- see Box 3.

**Costs to the Director of Public Prosecutions (DPP)**

Unlike the position in the UK, in Ireland the Office of the DPP has no involvement in the administration or prosecution of fixed charge notices generated by safety cameras.

**Costs to the Road Safety Authority (RSA)**

No fixed costs were identified for the RSA.

The RSA spends an amount each year on publicity and educational campaigns- advertising, printing, training etc. re speed awareness specifically in relation to safety cameras. This is a current cost for the Authority and was estimated to be €224,883.81 in 2012 and €454,572 in 2013.
Costs to the National Roads Authority (NRA)

The NRA paid for the installation of camera signage for every site prior to them becoming operational. Signs were needed as the cameras were overt and motorists had to be alerted to their possible presence on the various stretches of roads around the country. Signage was placed at an appropriate entry and exit point for each site. Most sites therefore had two signs but some had more than two depending on the length and layout of the stretch of road covered. The total cost incurred was €311,000.

In relation to the initial planning work necessary to identify the sites where cameras were to be placed NRA data was used in this process and the task was carried out on NRA premises by members of AGS granted access to the relevant NRA databases. However, no NRA staff time or other expense was involved.

It has yet to be finally agreed but it is understood that in future GoSafe will pay for signage costs and presumably this cost will then be covered in the amount paid by the State to GoSafe to cover their full contract.

No current costs were identified for the NRA.

Costs to the Department of Transport, Tourism and Sport (DTTAS)

No fixed costs were identified for the DTTAS.

DTTAS’s primary role was to pass the legislation necessary to allow the efficient and lawful use of safety cameras in Ireland. This was done in 2010 through certain provisions in that year’s Road Traffic Act. Section 81 of the Act allowed photographic evidence produced by an electronic device such as a safety camera to be used as evidence in court cases prosecuting speeding offences. An estimate could have been made of the time spent by various members of Department staff in this process. However, any such estimate would by its nature be arbitrary given that the Road Traffic Act had many provisions on many other aspects of road traffic law. This made it very difficult to isolate allocate time spent on these specific provisions by DTTAS staff. In any event, in overall relative terms the final amount would have been relatively small and thus its possible impact on a CBA minimal.

No current costs were identified for the DTTAS.
Appendix D  Detailed Calculations

The material in this appendix shows the calculations carried out to arrive at a figure for the value of accident benefit savings.

A number of different alternative calculations are shown.

(1) The value of life as per the figures in the Department of Transport (2009) are used adjusted to 2013 levels using the growth figures given in the document.

(2) The value of life as per the figures in the Department of Transport (2009) but adjusted for the real GNP growth rates rather than the Department of Transport estimates.

(3) The value of life using figures supplied by the European Transport Safety Council (2011) - some 38% lower than the Department of Transport figures.  

The approach taken in scenario (1) is shown below

The given figures 2002 price levels as follows

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</table>

These figures are then adjusted to 2013 price levels using the GDP growth rates suggested by the Department of Transport;

Growth 2002-2010 2.7%

Growth 2011-2013 2.37%

This gives the 2013 figures as below

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62 Note that the ETSC only supplied a figure for the value of a lost life and not for injuries. To assist in comparison the injury figures were reduced by the same percentage difference that existed between the fatality figures.
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<th>Accident Types</th>
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<td>Per Accident (€)</td>
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<td>8,987</td>
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<td>5,173</td>
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An assumption is then made that each fatality or injury occurred as part of one accident.

The cost of one fatality in 2013 was thus calculated to be the cost per casualty plus the cost per accident or

€2,679,353 + €21,086= €2,700,439.
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<th>Per Casualty (€)</th>
<th>Accident (€)</th>
<th>Per Accident (€)</th>
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<th>Average 11-13</th>
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<td>220</td>
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<td>166,302,270</td>
<td>2,028,393,488</td>
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</table>

**2013 Values:**
- Lives saved: 23,84
- Serious saved: 40,80
- Minor saved: 318,53
- Total: 86,070,395

**Basic & Exl. Damage:**
- Basic: 64,378,457
- Exl. Damage: 6,612,557

**Basic w/ National Traffic:**
- Basic: 44,242,316
- Exl. Damage: 337,542,068

**Basic w/ Zero Traffic:**
- Basic: 44,242,316
- Exl. Damage: 337,542,068

**Av Value:**
- Total: 44,242,316
Appendix E  Traffic Calculations

<table>
<thead>
<tr>
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<td>Ballicolag妇</td>
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<td>32125</td>
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OUTLIER

| N3       | 17931| 16731| 15792| 10647| 8012 | 8202 | 8240 | MHN303 | 352       | Dunshauglin | R147-19 Form | 15275.25T | 8151.33C | -46.636989 |

National Traffic Stats

CSO- Road Traffic Volumes by Type of Vehicle, statistical indicator and Year

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<td>Vehicle Population (Number)</td>
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<td>1,748,599</td>
<td>1,833,705</td>
<td>1,918,721</td>
<td>2,013,113</td>
<td>2,115,150</td>
<td>2,246,988</td>
<td>2,400,476</td>
<td>2,502,429</td>
<td>2,479,030</td>
<td>2,437,699</td>
<td>2,419,523</td>
<td>2,421,798</td>
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<tr>
<td>Kilometres Travailed (Million)</td>
<td>30,483</td>
<td>32,272</td>
<td>33,533</td>
<td>35,606</td>
<td>38,154</td>
<td>39,777</td>
<td>41,357</td>
<td>43,368</td>
<td>44,357</td>
<td>43,716</td>
<td>42,409</td>
<td>41,681</td>
<td>40,648</td>
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<tr>
<td>Average Kilometres Travelled (Kilometre)</td>
<td>18,289</td>
<td>18,456</td>
<td>18,287</td>
<td>18,557</td>
<td>18,953</td>
<td>18,806</td>
<td>18,406</td>
<td>18,067</td>
<td>17,725</td>
<td>17,634</td>
<td>17,397</td>
<td>17,227</td>
<td>16,784</td>
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<tr>
<td>% Change Kms travelled</td>
<td>5.87</td>
<td>3.91</td>
<td>6.18</td>
<td>7.16</td>
<td>4.25</td>
<td>3.97</td>
<td>4.86</td>
<td>2.28</td>
<td>-1.45</td>
<td>-2.99</td>
<td>-1.72</td>
<td>-2.48</td>
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</tbody>
</table>

1. The Vehicle Population represents the number of vehicles continuously active throughout the reference year. (All Vehicles)
2. Vehicle Kilometre and Average Kilometre estimates for Motor cycles and tractors and machinery are unreliable (minimal odometer data)
3. Data are subject to revision.

Road Traffic Volumes by Type of Vehicle, statistical indicator and Year

<table>
<thead>
<tr>
<th>2005-10</th>
<th>2011-13</th>
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</thead>
<tbody>
<tr>
<td>Average Kms travelled</td>
<td>18005.8333</td>
</tr>
<tr>
<td>% Change</td>
<td>-5.56</td>
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<tr>
<td>Total Kms travelled</td>
<td>42497.3333</td>
</tr>
<tr>
<td>% Change</td>
<td>-3.14</td>
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</table>
Appendix E- Note re Traffic Calculations:

- Ideally in order to remove any possible effects of a change in traffic between the two time periods a comparison would be made between the average traffic levels in the “before” period of 2005-2010 with the average traffic levels in the “after” period of 2011-13. Unfortunately there was no traffic data available for any of the safety camera sites for either period.

- As an alternative, traffic data for nearby stretches of road were used and the comparison was made with those road sections. Fifteen stretches of road were identified that were a) nearby to camera site locations and b) had traffic data for all or most of the period 2005-2013- as per the NRA traffic counter data (see [http://www.nra.ie/network-monitoring-and-management/traffic-data/](http://www.nra.ie/network-monitoring-and-management/traffic-data/))

- The average annual daily traffic figures for each of these 15 sites was then calculated for the two time periods and a comparison was made.

- One site- the N3 near Dunshaughlin in Co. Meath- was removed from the analysis before the comparison was made as the change in traffic was so dramatic – a decrease of almost 47% - that it would have distorted the overall figure. This was treated as an outlier and removed from the analysis.

- Once the comparison was made a figure for the change in traffic between the two periods was arrived at i.e. -5.69%.

- This figure of -5.659% was then taken to be a proxy for the change in traffic levels between the two periods for all camera sites.

- As an alternative calculation the national traffic figures for the two periods- for all vehicles- was sourced from CSO data. This showed a national fall of -3.14% between the two periods.
## Appendix F  Sensitivity Analysis Calculations

### Sensitivity Analysis

<table>
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<th>Benefits</th>
<th>Basic</th>
<th>Test 2a</th>
<th>Test 2b</th>
<th>Test 2c</th>
<th>Test 3a</th>
<th>Test 3b</th>
<th>Test 4a</th>
<th>Test 4b</th>
<th>Test 5a</th>
<th>Test 5b</th>
<th>Test 5c</th>
<th>Test 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accident Savings</td>
<td>80,070,395</td>
<td>88,229,228</td>
<td>53,385,134</td>
<td>40,035,198</td>
<td>80,070,395</td>
<td>80,070,395</td>
<td>88,392,149</td>
<td>91,257,638</td>
<td>72,063,356</td>
<td>60,052,796</td>
<td>40,035,198</td>
<td>80,070,395</td>
</tr>
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<td>Fine Income</td>
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<td>6,905,600</td>
<td>6,905,600</td>
<td>6,905,600</td>
<td>6,905,600</td>
<td>6,905,600</td>
<td>6,215,040</td>
<td>5,179,200</td>
<td>3,452,800</td>
<td>6,905,600</td>
<td>6,905,600</td>
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</tr>
<tr>
<td>(a) Total Benefits</td>
<td>86,975,995</td>
<td>95,134,828</td>
<td>60,290,734</td>
<td>46,940,798</td>
<td>83,523,195</td>
<td>80,070,395</td>
<td>95,297,749</td>
<td>98,163,238</td>
<td>78,278,396</td>
<td>65,231,996</td>
<td>43,487,998</td>
<td>86,975,995</td>
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### Costs

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<th>Planning</th>
<th>Enforcement</th>
<th>Publicity</th>
<th>(b) Total Costs</th>
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<td>Accident Savings</td>
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<td>149,988</td>
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<td>339,728</td>
<td>16,597,905</td>
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<tr>
<td>(b) Total Costs</td>
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<td>103,667</td>
<td>149,988</td>
<td>339,728</td>
<td>19,917,486</td>
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</tbody>
</table>

### Net Benefits (a)-(b)

| Net Benefits (a)-(b) | 70,378,090 | 78,536,923 | 43,692,829 | 30,342,893 | 66,925,290 | 63,472,490 | 78,699,844 | 81,565,334 | 61,680,491 | 48,634,092 | 26,890,093 | 67,058,509 |

### Benefit-Cost Ratio

| Benefit-Cost Ratio | 5.24 | 5.73 | 3.63 | 2.83 | 5.03 | 4.82 | 5.74 | 5.91 | 4.72 | 3.93 | 2.62 | 4.37 |

### KEY

- **Basic**: Traffic reduction of 5.69%; Trend reduction of 35.19% and value of life as per Department of Transport (2009) figures adjusted to 2013 price levels
- **Test 2a**: Basic assumptions except value of life figures used are adjusted using actual GNP growth rates rather than the estimated rates recommended by DoT
- **Test 2b**: Basic assumptions except value of life figures used are ESTC ones from 2011- approximately 25% lower than DoT values
- **Test 2c**: Basic assumptions with value of life benefits reduced by 50%
- **Test 3a**: Basic assumptions but fine income reduced by 50%
- **Test 3b**: Basic assumptions but fine income completely excluded as a benefit
- **Test 4a**: Basic assumptions but traffic growth assumed to reduce by the national average of 3.14%
- **Test 4b**: Basic assumptions but with no change in traffic levels between the periods
- **Test 5a**: Basic assumptions but all benefits reduced by 10%. Costs held at same level.
- **Test 5b**: Basic assumptions but all benefits reduced by 25%. Costs held at same level.
- **Test 5c**: Basic assumptions but all benefits reduced by 50%. Costs held at same level.
- **Test 6**: Basic assumptions but all costs increased by 20%. Benefits held at same level.