Work-related road accidents

Prepared for Road Safety Division, Department for Transport

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Executive Summary

Concern has existed for some years that people who drive for work might be at greater risk than other drivers of being involved in an accident. Previous TRL research (e.g. Lynn and Lockwood, 1998) confirmed that the risks were greater. Company drivers were found to have an accident liability between 29 and 50 per cent higher than private drivers who were otherwise similar in terms of age, sex and annual mileage. The work relied on questionnaire surveys of self-reported accidents, which are inevitably dominated by damage-only accidents. It therefore left open the question of whether different results would have been obtained if it had been possible to focus on injury accidents.

TRL was commissioned by the Department for Transport, Local Government and the Regions (now the Department for Transport) to carry out further research into this issue. The main objectives of the study were to determine whether company drivers carry an excess risk of injury accidents, to investigate differences between work-related and private driving in terms of self-reported driving behaviours and attitudes, and to examine whether such differences might contribute to any excess of accident-involvements among company drivers. This report presents the results of the study.

In principle, the methodology used involves surveying two samples of drivers:

a a representative sample of the whole driver population of interest; and

b a representative sample of drivers who have recently been involved in an injury accident (obtained via police records).

The characteristics of the two samples are then compared statistically to see which were over-represented among accident-involved drivers. In practice, to obtain a sample (a) that adequately represented the drivers of company vehicles, it was necessary to use a composite of two sub-samples. A sample of drivers of privately registered vehicles was identified from Driver and Vehicle Licensing Agency (DVLA) licensing records for vehicles up to three years old, and this was combined with a sample of the drivers arranged by direct contact with 57 companies from a variety of industry sectors.

A questionnaire was developed and sent to each sample of drivers. Twenty three thousand questionnaires were sent out in total, and 6,168 were returned. The response rate ranged from 21 per cent for the sample of accident-involved drivers to 28 per cent for the company sample and 35 per cent for the DVLA sample.

The main finding from the project was that car drivers with high proportions of work-related mileage have a much greater risk of injury accidents than other drivers of similar age, sex, annual mileage and percentage of mileage done on motorways. Drivers who drove more than 80 per cent of their annual mileage on work-related journeys had about 53% more injury accidents than otherwise similar drivers who did no work-related mileage; the 95% confidence interval for this estimate is between 25 and 87 per cent. Drivers whose work-related journeys accounted for 1-80 per cent of their total mileage had, on average, about 13 per cent more accidents than non-work drivers who were otherwise similar in terms of age, sex and mileage; the 95% confidence interval is between -1 and +29 per cent. Almost one quarter (23 per cent) of drivers who did work-related mileage drove more than 80 per cent of their mileage on these journeys.

The survey was not able to provide direct evidence linking the excess risk of work-related driving to particular attitudes and behaviours of company drivers, or to the situations in which they drive. This may have been because people tended to modify their attitudes and behaviours after experiencing an injury accident – preventing the survey from assessing the true ‘before accident’ situation regarding these variables. However, there was much indirect evidence on the risk-related aspects of company driving. In particular, the highest risk drivers (those with very high proportions of work-related mileage) drove more often:

- in situations known to make drivers susceptible to fatigue and drowsiness (e.g. driving on long journeys (more than 50 miles) after a full days work;
- when under time-pressure to reach a destination;
- when conducting potentially distracting in-car tasks such as mobile phone conversations, eating and drinking.

Given the existing evidence on the importance of fatigue in accidents (e.g. Maycock, 1997), the relation between speed and safety (e.g. Taylor, Lynam and Baruya, 2000) and the effects of mobile phone conversations on driver performance (e.g. Burns *et al*. 2002), these findings give a strong indication of where priorities for action should lie. They suggest, for example, that it will not be not sufficient for companies to attempt to deal with work-related road risk simply by improving driver training. Rather, they need to change the conditions under which their employees drive, so that time pressure and fatigue are reduced, and attention-demanding in-car tasks like mobile phone conversations are strongly discouraged.

Devising detailed policies to achieve such ends does not form part of this project, but there is clearly a need for employers to treat the problem seriously, and to introduce measures to tackle it.

Once companies recognise the need to improve, this project suggests that they should consider such policies as:

- Requiring drivers to retrieve telephone messages once they have stopped for a break, rather than have telephone conversations while driving.
- Examining work schedules to ensure that drivers are not pressured by time.
- Ensuring that people do not drive long journeys after a full day’s work. This could mean encouraging employees to work from home. It could also mean ensuring that there is a policy within the company to encourage employees attending distant meetings to stay in a hotel overnight rather than drive back the same evening.

Unless companies adopt such policies, the effectiveness of driver-centred interventions such as selection and training may be undermined by day to day working practices and pressures.

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1 Introduction

Concern has existed for some years that 'company drivers' (the term used throughout this report for drivers of company cars or vans, or people who do work-related driving in their own cars or vans) might be at greater risk than other drivers of being involved in an accident, and this has been confirmed by research (Downs, Keigan, Maycock and Grayson, 1999). Previous studies have used postal questionnaires asking drivers to report their accidents, mileage and other variables; consequently they were dominated by minor, damage-only accidents. The risk of such accidents will be strongly correlated with the risk of injury accidents, but it is in principle possible that company drivers have an excess accident liability for injury accidents that differs from that indicated by the earlier work on damage accidents. The excess might be lower if, for example, company drivers' accidents tend to be the result of careless low speed manoeuvring encouraged by immunity from repair bills. Alternatively, company drivers may tend to have high speed impacts (e.g. because of dropping asleep at the wheel, or because of generally higher driving speeds) and be even more at risk of injury than the previous research indicates. Such possibilities are suggested from time to time, and it is therefore desirable to find a way of assessing the relative risk of company drivers for injury accidents.

In 2001, TRL was commissioned by the Department for Transport, Local Government and the Regions (now the Department for Transport) to carry out further research into this issue, and this report presents the results that were obtained.

In principle, the methodology used involves surveying two samples of drivers, one a representative sample of the whole driver population of interest, and the other a representative sample of drivers who have recently been involved in an injury accident. In practice, to obtain a sample of the whole driver population that adequately represented the drivers of vehicles registered to employers, it was necessary to construct a composite sample. The files maintained by the Driver and Vehicle Licensing Agency (DVLA) have often been used for extracting representative samples of drivers, but these were not sufficient for this project because of the difficulty of contacting the drivers of vehicles registered to companies, (Section 3.3.1). Consequently it was necessary to construct a representative sample by combining a sample of drivers of privately registered cars and vans identified from the DVLA vehicle licensing records with a sample of car and van drivers arranged by direct contact with 57 companies from a variety of industry sectors. The sample of accident-involved drivers has already been mentioned; it was obtained via police records. The police and DVLA samples were restricted to drivers of vehicles up to three years old. The same questionnaire was sent to each sample.

The remainder of this report is arranged as follows. Section 2 reviews the literature relating to the accident liability of company drivers, focussing on findings that have emerged since the major review of this subject by Downs, Keigan, Maycock and Grayson (1999). Section 2 also covers the development of the questionnaire (which is reproduced in Appendix C). Section 3 describes the survey methodology and the three driver samples. Section 4 presents preliminary analyses of the survey data, while Section 5 presents multivariate analyses that provide the final statistical results. Section 6 discusses the conclusions that can be drawn from this research.

2 Literature review

This section provides a brief discussion of the existing literature that has investigated both work-related driving and the accident liability of company drivers. Downs, Keigan, Maycock and Grayson (1999) published a review of this literature, which has discussed in detail many of the studies included here. The focus of this section is to:

a summarise the major findings of the Downs *et al*. review;

b review research findings that have investigated the accident involvement of company drivers published since the earlier review was conducted; and

c outline possible explanations for the differences in the accident liability of company drivers and private motorists.

The scope of this review has been intentionally limited to a discussion of company vehicles up to 3,500kg gross vehicle weight (gvw). This review therefore discusses work-related driving and company drivers of cars and light vans up to large 'Transit' size.

2.1 Work-related driving

2.1.1 The 'company car' population

Cars and light vehicles (up to 3,500kg gvw) owned, financed, or registered in the name of a company make up a significant proportion of the fleet on the roads of Great Britain. In this respect, Britain is unlike most other European countries.

According to government figures, cars registered to a company made up 10.3% of the 24.4 million cars licensed in Great Britain at the end of 2000 (DTLR, 2001). Furthermore, of the 2.334 million new cars registered in Britain during 2000, 53% were company owned or financed. These figures are broadly in line with those reported in previous years (e.g. Grayson, 1999) and indicate that company cars continue to form a large proportion of the traffic on British roads.

2.1.2 Defining 'work-related driving' and 'company drivers'

Work-related driving is an activity that a large proportion of motorists within Great Britain will engage in at some point during their driving lifetime. Work-related driving is not restricted to company-registered vehicles. DTLR (2001) figures stated that between 1998 and 2000, 10.5% of the 8,400 average annual mileage of cars owned or registered privately (rather than in a company name) was spent on work-related travel. This did not include commuting to or from the drivers' place of work.

The actual annual mileage travelled by drivers on work-related journeys varies considerably between individuals, as do the type and purpose of such journeys, and the type of vehicle driven. Official figures consistently show that those individuals who drive as part of their job drive, on average, a much greater annual mileage than private motorists. For example, DTLR (2001) states that the average annual mileage of company cars is 21,590 miles per year, compared with 8,400 miles per year for private cars.

When factors such as differing annual mileage and variations in journey type and purpose are considered, it becomes clear that it is not a straightforward task to produce either a single, all encompassing definition of work-related journeys or a categorisation of those drivers who regularly make such journeys. Also, as demonstrated above, not all vehicles used for work-related journeys are owned or provided by a company. Likewise, not all vehicles owned or provided by a company are used solely, or even partly, for work-related purposes.

Just as work-related driving is extremely difficult to define, several researchers (e.g. Dimmer and Parker, 1999; Downs *et al.*, 1999; Chapman, Roberts and Underwood, 2001) have discussed the fact that individuals driving for work-related purposes are not a homogenous group. Reflecting the differences within this group, Dimmer and Parker (1999) observed that:

'Company car drivers include a range of road users from senior executives provided with a second car as a perk of the job, through those who drive non-liveried company-owned vehicles for both work and non-work purposes, to those employed to drive fleet cars, vans or other specialist vehicles'.

In a survey of company drivers within a single organisation, Chapman *et al.* (2001) further emphasised the diversity of the company driver population by identifying five categories of driver from which they obtained their sample. The categories were:

- *Own car drivers.* Employees within the organisation who regularly do business mileage in a vehicle owned by themselves or their spouse.
- *Company car drivers A.* Middle and senior managers who have the option of receiving a company car as part of their remuneration package, but who are not required to meet a minimum business mileage.
- *Company car drivers B.* First and second line managers who receive a company car if it is required for business purposes.
- *Company car drivers C.* Sales staff within the organisation who receive a car to allow them to drive for business purposes.
- *Liveried company vehicle drivers.* Employees who drive a liveried car, van or 4x4 vehicle for work purposes, which they may take home when convenient.

Chapman *et al.* questionnaire asked drivers for information relating to their driving experience and journey types, self-reported driving behaviours, and accident histories. The objective of the study was to investigate whether differences would be found to exist between the types of company drivers identified. Of the 635 respondents, the largest single group (31% of respondents) was *liveried company vehicle drivers*, followed by *company car drivers B* (23%). Only 12.6% were *own car drivers*. The results of the survey showed clear differences between the five types of company drivers both in terms of the distances travelled, and reported journey purpose. Slight differences were also identified in relation to the self-reported driving behaviours and accident involvement of the different groups, although the sample sizes were too small to allow statistical significance to be investigated.

Although the annual mileage of all five types of company driver surveyed was at least double the 8,400 miles annual average of private motorists, the reported average annual mileage varied between groups, from 17,822 miles per year (*own car drivers*) to 23,987 miles per year (*liveried company vehicle drivers*). Moreover, within each of the five groups the percentage of driving for different purposes varied widely, as did the ratio of business to private mileage. For example, whilst 71.9% of *type-C company car drivers'* annual mileage was classified as 'business mileage', only 56.7% of 'perk car' drivers' (*type-A company car drivers*) annual mileage was for 'business' (see Table 1).

Table 1 Mileage and journey purposes for the different driver groups

Driver group	*Business*	*Commuting*	*Leisure*	*Average annual mileage (st. dev.)*
Own	44.4%	20.6%	35.0%	17,822 (8,275)
CCDA	56.7%	15.7%	27.6%	21,528 (8,623)
CCDB	70.2%	9.7%	20.1%	23,159 (6,845)
CCDC	71.9%	8.3%	19.8%	23,633 (8,895)
LCVD	72.6%	6.4%	21.0%	23,987 (8,031)

Source: Chapman et al., 2001

Overall, the results of Chapman *et al.* study, based on an investigation of just one organisation, add weight to the argument that company drivers are not a homogenous group.

On a theoretical basis, generalising findings from such studies to 'company car drivers' globally must clearly be avoided without careful consideration of the exact population investigated by a particular study. However, on a practical note, it is very difficult to identify samples and conduct research studies that allow generalisable conclusions to be easily made.

The approach taken in the present study was to attempt to represent work-related driving in both company and privately registered vehicles, and to seek information in the survey on the type and mileage of the work-related driving.

2.2 The accident liability of 'company drivers'

It is is often held that individuals who drive company-registered cars, and/or those who drive work-related journeys (for the purposes of this report referred to as 'company drivers'), are at a greater risk of being involved in a road accident than 'private' motorists. Based on Royal Society for the Prevention of Accidents' (RoSPA) figures, Bibbings (1997) calculated that car drivers who are required to drive 25,000 miles a year as part of their job have a 1 in 8,000 chance of being killed in a road accident. Bibbings emphasised that this risk is almost comparable to that faced by employees in occupations where there is an accepted heightened risk of fatality during the course of their work, e.g. coal mining. Clearly the risk of a company driver being involved in a non-fatal, i.e. injury or damage-only, road accident is even greater. Given the lack of consistent reporting systems for work- related road accidents currently operated by commercial organisations, it is unsurprising that a national total of the absolute number of work-related road accidents is not available.

Despite the obvious conclusion that company drivers are at a greater risk of being involved in a road accident simply due to their increased mileage, research has proven that there are other factors at work. In a study reported by Lynn and Lockwood (1998), reviewed in detail by Downs *et al*. (1999), the accident liability of a sample of 4,479 company drivers (defined in that survey as ‘drivers of cars owned by a company or business’) was investigated and compared with that of a sample of 5,226 ‘ordinary’ drivers randomly sampled from the DVLA database.

Based on multivariate analyses of the self- reported 3-year accident history of the two groups of drivers, Lynn and Lockwood found that even when differences in annual mileage and demographic variables were controlled for, drivers of company owned or financed cars had an accident liability 29% greater than that of ‘ordinary’ motorists. Furthermore, once Lynn and Lockwood removed ‘perk’ drivers from their sample, thus focusing only on those motorists who ‘regularly drove their car for work purposes’, they found that the excess in accident liability increased to between 40 and 50%. Grayson (1999) has since termed this excess in accident liability the ‘fleet driver effect’.

In contrast, in their study of a single organisation, Chapman *et al*. (2001) investigated the differential accident involvement of drivers in each of five company driver categories. Although samples were too small to allow multivariate analysis, Chapman *et al.* suggested that the ‘fleet driver effect’ was not a single increase in accident liability applying to all employees driving within the organisation. Only two out of the five categories of company driver had an average rate of accidents per 10,000 miles greater than that of the general driving population. These two groups were (i) company drivers who were not required to meet a minimum business mileage, but who actually reported that 56.7% of their annual mileage was for business purposes (*type-A company car drivers*), and (ii) sales staff who drove a company provided car for business purposes (type-C *company car driver*). Despite the small sample sizes, this finding does suggest that there may be differences in accident liability between individual categories of company driver.

Only the study reported by Chapman *et al.* (2001) has investigated the *types* of accidents that company drivers are involved in. However, the study did not include any comparison between company and private motorists. Instead the researchers investigated differences in accident types reported by company drivers in each of five categories. As has been stated previously, the sample sizes involved in the study were not large enough to warrant significance testing of differences in the type of accidents that each group was involved in.

However, the results of the Chapman *et al*. study suggested that *type-A company car drivers* had a slightly higher ratio of active to passive accidents than the other categories of company driver. The findings also suggested that the proportion of right of way accidents (i.e. caused by the driver’s violation of another motorists’ right of way), was slightly higher for those company drivers who drove their own car for work purposes. The other four types of company driver, all of whom drove a company-owned vehicle, were involved in a slightly higher proportion of low speed manoeuvring accidents. Although these differences are not statistically significant, the study indicated that there is a need for research to further investigate the types of accidents that individual categories of company driver are involved in.

As regards the severity of company drivers’ accidents, Section 1 of this report pointed out that previous studies have concentrated on damage-only accidents and have provided little evidence on the size of the fleet-driver effect for injury accidents. The central aim of the present study was to collect such evidence.

2.3 Possible explanations for the ‘fleet driver effect’

As discussed above, it is inherently difficult to produce a single all-encompassing definition of the ‘company driver’. However, the Lynn and Lockwood findings have shown that both drivers of company owned or financed cars (regardless of whether or not they drive for business purposes), and non-perk company drivers who actively drive their car for work, have a significantly greater accident liability than private motorists once differences in mileage, age and sex have been adjusted for.

The increased accident liability of up to 50% faced by company drivers, as found in the Lynn and Lockwood study, and the size of the company driver population using roads in Great Britain presents a major issue for road safety. To address the problem, it is necessary to have a clear understanding of the reasons for company drivers’ increased accident liability.

By controlling for particular variables Lynn and Lockwood demonstrated that the obvious differences between company and private motorists - for example in mileage and certain demographic variables such as age and sex - are not responsible for company drivers’ excess accident liability. Although a number of speculative explanations of the excess have been put forward by both road safety practitioners and researchers, only a small number of research studies have investigated them.

Two additional issues exist when considering alternative explanations of the ‘fleet driver effect’. First, the causes of the fleet driver effect may vary between organisations or between different types of company driver or company driving. Studies within a single sub-population of company drivers or organisations are therefore unlikely to provide conclusions that can be generalised to the whole population of company drivers. Second, there are likely to be many factors that contribute to the fleet driver effect, both nationally and on an organisation by organisation basis.

The rest of this section outlines possible explanations for the fleet driver effect. The hypotheses, in many cases speculative, have been grouped into the following categories:

- Factors related to the vehicles driven by company drivers.
- Factors related to the journeys made by company drivers.
- Factors related to the drivers themselves.
- Factors related to requirements and expectations of the work performed by company drivers.
- Factors related to the procedures and 'culture' active within the organisations company drivers' work for.

2.3.1 Vehicle factors

Vehicle characteristics

The first possible factor that may contribute to the increased accident liability of company drivers relates to the vehicles driven. The intended scope of the current study was restricted to cars and vans up to large transit size (up to 3,500 kg). However, private motorists do not typically drive vans, and there are clear differences between the type of cars typically driven by company drivers and those driven by private motorists.

An annual survey reported in the RAC Report on Motoring (RAC, 2002) found that cars registered by companies were, on average, both newer and more expensive when new, than the vehicles owned and driven by private motorists. The report found that drivers of company registered cars hold onto their car for less time than private motorists (3.1 years versus 4.5 years), whilst the average value of company registered cars when bought new was approximately £18,000, compared with £11,800 for cars owned by private motorists. Based on DTLR figures, Grayson (1999) also stated that company-provided cars tend to have larger engines than privately owned cars, an average of 1900cc and 1500cc respectively.

The fact that company-provided cars are typically newer, more expensive, and more powerful than privately owned vehicles has implications for fleet driver safety. As vehicle characteristics were not included within the modelling process adopted by Lynn and Lockwood, their study was unable to control for these differences.

Research has demonstrated that aspects of driver behaviour can be influenced by vehicle performance characteristics. In a roadside observation study reported by Horswill and Coster (2001) car speeds were covertly measured for 569 cars travelling on a selection of residential roads all of which had a speed limit of 30mph. The researchers also collected information regarding the vehicle type and estimated driver demographics. Based on the results of the study, Horswill and Coster concluded that there was a statistically significant relationship between vehicle performance and drivers' speed, even when other variables such as drivers' age and sex, and road location and slope were controlled for.

In order to investigate the causal direction of their finding, i.e. whether drivers with less safe driving motivations (and correspondingly higher speeds) may simply select higher performance cars, or whether higher performance vehicles give rise to faster driving, the researchers conducted a Theory of Planned Behaviour based questionnaire study. This second study investigated both the car purchasing and driving speed preferences of a sample of 186 drivers. However, the findings of the study did not provide conclusive evidence for either hypothesis. On the basis of Horswill and Coster's findings, the hypothesis that the higher performance of company-provided cars may contribute to the increased accident liability of company drivers cannot be ruled out.

Earlier research by Stradling, Meadows and Beatty (1999), cited by Horswill and Coster (2001), has also provided some evidence for a link between vehicle performance and driving behaviour. The study found that greater engine size was associated with both higher intended speeds, and a greater number of speeding convictions. Drivers' speed choice has long been accepted as a behavioural measure strongly related to accident involvement (West *et al.*, 1993; Taylor, Lynam and Baruya, 2000), and accident severity (Joksch, 1993).

Again the Stradling *et al.* findings do not show whether drivers with less safe driving motivations select higher performance cars or whether it is the high performance car itself that encourages drivers to go faster.

A further study by Horswill and McKenna (1999) utilised a simulator to investigate drivers' speed choice found that participants drove faster when the level of internal car noise was reduced. In this study the potential importance of factors relating to vehicle performance was demonstrated whilst controlling for the possible confound of a selection bias.

Car selection policies in fleet-operating organisations in many cases allow employees a certain degree of flexibility in the car that they choose. Any tendency for less safe drivers to choose higher performance cars would, potentially, affect both company and private drivers. It might therefore be argued that this would not be an explanation of the excess accident liability of company drivers. However, if company drivers have easier access to expensive and powerful vehicles than they would have as a private motorist, this may prove a factor in influencing their accident liability[1].

Ownership

A further vehicle-related factor that has often been suggested as a potential explanation for the fleet driver effect is that company drivers drive less safely because they lack a feeling of ownership of the car they drive (termed the 'not mine' argument by Downs *et al*. (1999)). The argument is that company drivers take less care of their company car because the cost (to themselves) of an accident is less than that faced by a private motorist. This

[1] *However, the better occupant protection generally provided by larger vehicles is also relevant here.*

reduction in cost is both financial, and in terms of reduced inconvenience, since a replacement vehicle is readily available to meet the continuing demands of the business. It may also be that drivers of company-provided vehicles are less likely to adopt 'safer' driving styles because they are not responsible for other non-accident costs. For example, company drivers are generally not responsible for meeting maintenance and fuel costs. This may encourage them to adopt a driving style that involves high speeds, and harsh acceleration and braking – a driving style that may in turn lead to reduced safety.

No formal assessment of the effect of this factor has been conducted. However, Chapman *et al.* (2001) survey did indicate a possible reduction in the accident risk (in accidents per 10,000 miles) of company drivers who drove their own vehicle, when compared with those who drove a company-provided vehicle. Again it must be borne in mind that their survey was only based on a small sample within a single organisation.

2.3.2 Journey factors

As Lynn and Lockwood have demonstrated, the fleet driver effect for 'all accidents' persists even when the additional mileage of company drivers is controlled for. However, there may be other factors that relate to the types of journeys performed by company drivers, which may contribute towards the heightened accident liability of this group.

As has already been discussed, the type of journeys made by company drivers depends upon factors such as the type of company worked for and the category of company driver. For example, senior executives within a company are likely to drive for purposes entirely different from those of couriers or sales staff. Journeys made for business purposes are likely to include aspects that differ greatly from the journeys made by private motorists. Although it would be difficult to evaluate the effect of these differences on the accident liability of company drivers, it would be useful to at least investigate the actual differences in the types of work-related journeys driven by sub-groups of company drivers.

Journey-related factors worthy of investigation may include driving in adverse weather or traffic conditions; length of time spent in the vehicle, and driving at times of the day associated with fatigue-related accidents, or after a day's work.

A further aspect which may be relevant to the fleet driver effect, discussed by Downs *et al.* (1999), is that journey frequency has been shown to be a significant predictor of accident frequency (e.g. Forsyth *et al*., 1995, cited in Downs *et al*., 1999).

2.3.3 Driver factors

Company drivers' accidents during non-work driving

In addition to differences in the type of vehicle and journey driven by company drivers and private motorists, it is possible that the fleet driver effect is in some way explained by differences between the types of individuals within the driving populations themselves. Although the Lynn and Lockwood study controlled for between-sample differences in age and sex, other behavioural factors were not investigated.

It is possible that company drivers exhibit driving-related attitudes and behaviours that are significantly different from those found among private motorists, and which may lead to an increase in their accident risk. There may, for example, be a tendency for particular types of individuals, likely to adopt relatively unsafe driving behaviours, to take up jobs that involve driving. If so, their raised accident liability would be expected to apply to their private driving as well as to their work-related driving. It is also possible that the characteristics and demands of work-related driving may produce particular types of behaviour. It may be that these behaviours are limited to the work-related journeys, such that these drivers show a raised accident liability only on such journeys. However, it is also possible that the behaviours might carry over into private driving – in other words it could be that company drivers acquire behaviours, attitudes, or perceptions of risk that lead them to be relatively unsafe in all their driving.

The Lynn and Lockwood study did find some indication of an increased accident liability among company drivers whilst driving for leisure. In addition, the smaller-scale survey by Chapman *et al.* also provided a slight indication that the raised accident liability among company car drivers within their sample extended to journeys made when they were not driving for work purposes. However, these findings were not conclusive because the number of accidents involved was too small to demonstrate statistically significance.. No other published research studies appear to have investigated the differential accident rates of company motorists when driving for work and non-work purposes.

Driving behaviours of company drivers

One published study has compared the self-reported driving-related behaviours of company drivers with those of private motorists. Dimmer and Parker (1999) surveyed 1,100 drivers of non-liveried, company-owned cars within a single organisation. The questionnaire contained the well-established Driver Behaviour Questionnaire (DBQ) in a 28-item format that included six items on aggressive violations. Respondents were asked to rate the frequency with which they performed the 28 aberrant driving-related behaviours using a scale ranging from 'never' to 'all the time'. The responses were factor- analysed and the factor structure compared with findings of previous studies using the DBQ with motorists from the general driving population.

Responses from the general driving population commonly show three distinctive classes of aberrant driving: (i) relatively harmless slips or lapses, (ii) more potentially dangerous errors, and (iii) driving violations (i.e. deliberate departures from the rules of good, safe, driving). However, Dimmer and Parker found that company car drivers' responses indicated six underlying factors – i.e. six distinct classes of aberrant behaviour.

The results suggested some interesting differences between the company and other drivers. For example, in this sample, the items 'close following' and 'shooting traffic lights' loaded onto the 'errors' factor rather than a violations factor - unlike what happens with the general driving population, where these items group with 'violations'. The 6th factor identified by Dimmer and Parker was represented by three driving behaviours: (i) hitting something while reversing, (ii) diving into queuing traffic at the last minute, and (iii) forcing one's way out of a junction. The authors hypothesised that the three behaviours in some way reflected the pressure specific to company car driving, and that these behaviours occur when the driver feels under pressure and is in a hurry.

Company car drivers who scored highly on the speeding violations factor were not statistically significantly more likely than low violators to be accident involved. The same applied to aggressive violations. This contrasts with the pattern found in the general driving population. Dimmer and Parker speculated that this may indicate that company drivers are more capable 'violators' than ordinary drivers, and do not become involved in the accidents that are normally associated with such behaviours. They went on to suggest that this might be a function of company drivers' greater driving experience in terms of annual mileage. The 'under pressure' factor was statistically significantly related to accident involvement.

It is not possible, from studies reported to date, to determine whether these differences in self-reported driving behaviours result from the actual requirements of work-related driving, or from other differences between company and private drivers. One interesting hypothesis, not investigated so far, is that those individuals with personalities more suited to occupations involving a great deal of work-related driving (e.g. sales) may also be more accepting of driving behaviours associated with an increased accident risk. For example, it is possible to speculate that the forcefulness, competitiveness and aggression perhaps associated with successful sales staff may manifest itself on the road as risky, violational driving behaviour.

2.3.4 Work-related factors

Factors relating to the requirements of the job performed by the company driver that may translate into undesirable aspects of driving behaviour are clearly a potential contributor to the fleet driver effect. As has been discussed previously, the work-related journeys performed by company drivers vary considerably. However, company drivers required to drive a high mileage for business purposes face many factors that may directly, or indirectly, influence their ability to drive safely.

Direct influences include secondary in-car tasks 'required' by the driver's employer as part of the job. For example, company drivers travelling long distances to meetings are away from the office for long periods of the day. To maintain contact with office or customers during these periods, the use of mobile phones whilst driving may be encouraged or required.

Indirect influences might include time pressures placed on a company driver resulting from the need to attend numerous locations within the course of a day. Such requirements can clearly have negative consequences such as speeding, fatigue or stress.

Direct and indirect factors such as these may contribute to the fleet driver effect as they represent aspects of driving that are not faced to the same extent by private motorists. It is therefore desirable to investigate the extent to which company drivers are faced by factors likely to have negative consequences for road safety and, if possible, to investigate their effects on accidents.

The following three subsections discuss three such factors: in-car behaviours, time pressures, and fatigue.

In-car behaviour

If a company driver is spending a large amount of time in a vehicle, it is likely that the driver will engage in many in-car behaviours throughout the working day. These may range from using a mobile phone to eating at the wheel. Although not all secondary activities will have a negative impact on an individual's driving performance, any activities performed while driving could potentially have a negative effect. Research studies have provided clear evidence for the negative consequences of performing particular secondary tasks whilst driving, most notably mobile phone use (e.g. Alm and Nilsson, 1995; Cain and Burris, 1999; Haigney, Taylor and Westerman, 2000; Tunbridge and Rillie, 2001, Burns *et al.* 2002). It is now clear that hands-free mobile phones do not solve the problem, since the telephone conversation itself reduces the attention paid to driving, and degrades driving performance.

The extent to which individual company drivers engage in these behaviours while driving will vary considerably, and it is necessary to gain a clearer understanding of the actual in-car behaviours that are performed by company drivers while driving, and the extent to which they are performed. Only then can their likely contribution to the fleet driver effect be assessed.

Time pressures

The requirement faced by company drivers to travel to a particular location, or number of locations, during the working day may place time-pressure on the driver. This time-pressure may require or encourage drivers to engage in unsafe driving behaviours, most notably speeding and perhaps close following, and unsafe gap-acceptance and overtaking.

It has been firmly established that excess speed is related to increased accident involvement. It has also been shown that increased speed is associated with increased accident severity. The extent to which company drivers travel at excess speeds in order to meet their work schedules is not clear. However Adams-Guppy and Guppy (1995) in a survey of 572 British company car drivers, found that more than 50% of the company drivers in their sample reported regularly exceeding the motorway speed limit by *at least* 10mph. Of greater importance, Adams-Guppy and Guppy found that the drivers who reported more frequently travelling at this speed were also less likely to view speeding as an important risk factor and were more likely to view being on time for appointments as desirable.

Fatigue

A large number of research studies have discussed the effects of fatigue on driver behaviour and accident risk (e.g. Brown, 1994; Maycock, 1997; Horne and Reyner, 1998; Connor, Norton and Jackson, 1998). Drivers' propensity to suffer from fatigue while driving is difficult to identify. However, company drivers travelling longer distances, during the hours most associated with sleepiness, or after a hard day's work, are more likely to be at risk of fatigue than are most private motorists. It seems likely, therefore, that company drivers are at greater risk of suffering from fatigue and sleepiness while driving and that this may contribute in some part to the fleet driver effect.

2.3.5 Organisational factors

Downs *et al.* (1999) report the findings of a series of in-depth interviews and focus groups conducted with various groups of individuals including fleet managers and company drivers. One objective of this qualitative study, conducted as part of the review of the fleet driver effect, was to explore the organisational processes that may influence fleet driver safety. The researcher interviewed fleet managers in several organisations from various sectors and identified a broad spectrum of attitudes to safety and accident reduction policies existing within such companies. Although some companies pursued a policy of zero accidents with great dedication, other organisations believed they had a level of accidents tolerable within their sector. In some cases the companies falling into this latter category viewed getting business as a high priority and an active fleet of sales personnel was central to achieving this even if it carried with it increased driving risks.

Downs *et al.* (1999) emphasised the importance that the safety 'culture' within an organisation can have in relation to the accident liability of company drivers. The researchers outlined three kinds of culture that can play a role in influencing the safety of company drivers:

- The general safety culture of an organisation.
- The driving culture of an organisation.
- The driving culture in society as a whole.

Aspects of safety culture include policies relating to the provision of driver selection and training, accident reporting systems operated by the company, and reward or penalty schemes used to motivate safe driving or 'punish' individuals that are involved in an accident while driving. The relative merit of such schemes remain largely unproven, although Lynn and Lockwood (1998) did find that the accident liability of fleet drivers that had received driver training was a statistically non-significant 8% lower than those who had not received such training. Similarly, the study found that those company drivers who reported any form of reward scheme for accident-free driving operating within their organisation had a marginally significant reduction in accident liability.

A number of other studies have investigated the effectiveness of such measures. In a study of the accident frequency and cost within a vehicle fleet operated by Swedish Telecom Gregersen *et al.* (1996) investigated the relative effectiveness of four interventions compared with a control group of drivers within the organisation who received no intervention:

- driver training;
- a bonus scheme for accident free driving;
- company wide road safety campaign;
- group discussions about road safety.

The results of the study indicated that driving training, group discussions and bonus schemes each reduced accident rates significantly.

Schneider (1990) described a long term scheme in which professional drivers in a large German fleet were offered a financial reward for every half year of driving without blameworthy accidents. The result was reported to be a marked and sustained reduction in recorded accident rates.

Given the indications that factors associated with safety culture are important it is desirable to explore them further – both as potential explanations of between-company differences in driver safety, and as offering possible remedial action.

2.4 Summary

Cars registered in a company name form a sizeable proportion of Great Britain's vehicle fleet. However, producing a single, all-encompassing definition of company drivers is not a simple task. The extent to which company-provided vehicles are driven for work-related purposes varies considerably, as does the type of journeys driven. Whereas some drivers of company-registered cars receive their vehicle as an integral tool for completing their work, other drivers receive it as part of their remuneration package with no requirement to use it for work-related travel. A further complication is that many drivers of privately owned vehicles also undertake a considerable amount of work-related driving other than commuting. These facts make it difficult to investigate company drivers as a single population.

Research has demonstrated that drivers of company owned or financed cars and light vans, (averaged across the various uses of these vehicles), do have a greater accident liability than that of private motorists. Once differences in mileage have been controlled for, research findings indicate that they have an accident liability (for 'all accidents') up to 50% higher than private motorists. The reasons for this increased liability, termed by researchers as the 'fleet driver effect', are not currently known. Neither is it known whether the fleet driver effect applies to injury accidents as well as to the damage-only accidents that have dominated previous studies.

Many possible explanations underlying the fleet driver effect have been suggested by road safety researchers and practitioners: however most are speculative with little or no direct empirical support yet being available. This section has outlined a large number of potential reasons relating to inherent differences between private and company drivers. Such hypotheses include factors relating to (i) the cars driven by company drivers, (ii) the journeys that they make, (iii) differences between the driving behaviour of private and company drivers, (iv) requirements of the work that they perform, and (v) the procedures and cultures within the organisations that provide company vehicles.

The extent to which each, or a combination, of these factors may contribute to the fleet driver effect is unclear. Additionally, the extent to which the company driver population varies in terms of function and journeys made is not known. It is therefore important that these issues are investigated further.

3 The survey

3.1 Objectives

The main objectives of the study were to investigate a number of the issues identified in the above literature survey – namely:

- to estimate the size of the 'fleet driver effect' for injury accidents;
- to investigate differences between work-related and private driving in terms of self-reported driving behaviours and attitudes, and the incidence of driving while fatigued and/or distracted by in-car tasks;
- to attempt to ascertain whether such differences can be shown to contribute to any excess of injury-accident involvement among company drivers.

3.2 Survey methodology

3.2.1 Background

In the 1980s, an important advance was made at TRL in the methodology for studying accident risk. A postal 'accident liability survey' was sent to large numbers of car drivers who had been identified via the national licensing authority, the Driver and Vehicle Licensing Agency (DVLA). The sample who received the questionnaire was selected to be representative of the population of drivers as a whole. Generalised Linear Models were fitted to the data supplied by respondents to show how factors such as age, experience and annual mileage affected their likelihood of being involved in accidents. The results were reported by Maycock *et al.* (1991).

Subsequently, the methodology has been applied in a number of other projects, in particular to study the accident liability of motorcyclists (Taylor and Lockwood, 1990) and the effectiveness of ABS in reducing accident risk (Broughton and Baughan, 2000).

The fact that this previous method relies on the self reported accidents of general population samples of drivers or riders means that responses are dominated by minor, damage-only accidents. The number of injury accidents yielded is generally not sufficient to allow meaningful statistical modelling. In principle, this disadvantage could be overcome by increasing the size of the issued sample, but extremely large and expensive samples would be required. An alternative approach would be to use information from a sample of drivers already known to have been involved in an injury accident. This is the approach taken in the present study, and is described in the next section.

3.2.2 The method

The new methodology developed at TRL utilises two parallel surveys:

a a survey of a representative sample of drivers;

b a parallel survey, using the same questionnaire, of a representative sample of drivers known to have been involved recently in an accident.

Survey (a) is intended to establish the characteristics of the general population of drivers, while survey (b) is used to estimate the same characteristics for the accident-involved subset of this population. By asking the same questions of the accident-involved and the randomly selected drivers, the experiences and attitudes of the two groups can be compared directly, allowing those factors which are associated with elevated accident risk to be identified. Survey (b) can concentrate on drivers who have been involved in *injury* accidents, allowing the factors affecting the risk of such accidents to be studied directly without the need for prohibitively large samples.

This is analogous to the epidemiological approach applied by medical statisticians. Suppose the factors that increase a person's risk of suffering from a particular disease are to be studied. A list of potential risk factors would be drawn up, and the same questionnaire would be administered to:

a a representative sample of the full population;

b a sample of people who are known to suffer from the disease.

If, for example, a particular factor were reported by 50% of sample (b) but only 25% of sample (a), this would suggest that the factor tended to raise the risk of suffering from the disease.

Although the new approach has evolved from the earlier accident liability surveys, its practical details differ significantly. With the 'traditional' approach, the dependent variable is the driver's expected accident liability, and the analysis attempts to explain variations in this variable in terms of independent variables such as age and mileage. In the new approach, the data from the representative sample (sample (a)) could in principle be analysed in this way, but the data from the accident–involved sample (sample (b)) cannot since these drivers are known to have been involved in an accident

The new approach compares the characteristics of the two samples, not their accident-involvements. The representative sample is used to estimate the proportions of drivers with various characteristics in the population of interest – in this case, the population of drivers of cars and vans up to 3 years old. The accident-involved sample is used to estimate the proportions of drivers with the same characteristics in the accident-involved subset of that population. Appendix A develops the statistical method that will be used for the multivariate analyses of the survey data that will identify the principal factors that influence accident risk.

3.2.3 Questionnaire development

The study objectives guided the development of the questionnaire to be used in the survey. During preliminary meetings, the project team identified a number of factors that were felt to be worth exploring in terms of the accident liability of those involved in work-related driving. These ideas were supplemented by a review of earlier research (Sections 2.1 to 2.3).

A topic guide was designed, and used to run two focus groups of company vehicle drivers in order to ensure that the questionnaire would cover the relevant issues. The focus groups discussed the types of journey undertaken, attitudes towards driving and road safety; company policies on work-related driving, and the reasons for an increased accident liability amongst company vehicle drivers. Participants were asked about the pressures on them whilst driving and any in-car tasks they undertook whilst driving.

The length of the questionnaire had to be limited in order to maintain an acceptable response rate. As well as investigating the behaviour and attitude of the respondents, the survey asked about their driving patterns and accident history. The final version is reproduced in Appendix C.

3.2.4 Driver samples

It was estimated that 5000 completed questionnaires were needed to carry out the planned analyses, with roughly equal numbers from the two samples (accident-involved and representative). Recent experience suggested that the response rate would be approximately 20 per cent, so the intention was to send out 25,000 questionnaires.

When choosing the population from which the representative sample of drivers for this study would be drawn, it was important to achieve a balance between the coverage of work-related journeys and other types of journey. At one extreme, if the samples only included drivers who regularly made work-related journeys then there would be no information about other types of driver with which to compare their risks. Conversely, little could be said about the risks of work-related journeys without sufficient coverage of such journeys.

A source that has been widely used in previous research for drawing representative samples of drivers is the driver licence file maintained by the Driver and Vehicle Licensing Agency (DVLA). A representative sample from this source, however, would contain relatively few drivers who regularly make work-related journeys. A population more relevant to this study is the population of drivers of newer vehicles.

It was therefore decided to restrict both samples to the drivers of vehicles up to 3 years old. In Great Britain, approximately one half of cars up to 1 year old are company-owned (DTLR, 2001), while in total about one tenth of cars are company-owned. Consequently, 3 years is a suitable cut-off: relatively few cars over 3 years old are company-owned, yet many cars under 3 years old are privately owned so the survey should provide ample information about both work-related and other journeys.

3.2.4.1 Representative driver sample

The DVLA *driver* licence file contains no details of the vehicles driven by the licence-holders, so it could not be used to draw the desired sample. A suitable alternative was available, however; the sample could be drawn from the DVLA *vehicle* licence file. Each vehicle record contains the name and address of its 'registered keeper', so the sample was drawn from the registered keepers of cars up to 3 years old.

There was, however, one unfortunate consequence of this approach. The registered keepers of many company-owned vehicles are not their regular drivers, but the companies themselves. A questionnaire sent to the registered keeper of such a vehicle would presumably be delivered to the company's fleet manager, and would not necessarily then find its way to the regular driver without prior consultation with the company, which would be difficult to arrange for a sample drawn in this way.

Thus it was necessary to construct the representative sample from two components:

- The 'DVLA sample' - this was restricted to 'registered keepers' who were private individuals, so that the recipient of the questionnaire would probably be the regular driver of the vehicle.
- The 'Company sample' - a series of companies was asked to co-operate with the survey by distributing questionnaires in confidence to some of their employees.

The DVLA sample: DVLA was asked to provide a sample of 6,250 private registered keepers of vehicles up to 3 years old, including cars and vans up to 3,500kg. From this sample 2,192 responses were received: a response rate of 35%.

The Company sample: To cover the varied types of work-related driving, the sample needed to include drivers from a variety of industry sectors and at different levels within their organisations. A number of industries likely to include significant numbers of drivers of different types was identified. These fell in to a number of industry sectors: Couriers/Local Haulage, Haulage, Brewing, Pharmaceutical, Distribution/Wholesalers, Retail, Software, Finance, Manufacturers, Management Consultants, Building, Insurance. A list of companies in each of the selected industry sectors was purchased from Dun & Bradstreet.

The companies were approached and asked if they would distribute questionnaires to their drivers of company-owned vehicles. Care was taken to explain the types of drivers to be included. These were:

- *Own car* - employees own their own car but do business mileage.
- *Perk company car I* - middle and senior managers. Not required to meet a minimum business mileage.
- *Perk company car II* - 1st and 2nd line managers, required to do business mileage.
- *Sales* - Sales staff vehicle used for business purposes.
- *Liveried vehicles* .

Gaining agreement to participate from sufficient companies was a lengthy task. Some companies were reluctant to dedicate time for no concrete gain to the business. It would have been prohibitively expensive to offer financial incentives of any interest to commercial organisations. They were offered a summary of the results of the research, which was of interest to some. In many cases the individual contacted promised (often several times) to get back to the researcher, but failed to do so. In some companies it was impossible to access anyone with sufficient authority to agree to the request. A few companies were sympathetic to the request, but explained that they were in the process of withdrawing company cars and that as this was proving controversial they did not want to fuel discontent by allowing the survey.

Several of the companies approached, however, were very interested in the research and were in the process of planning or implementing initiatives to address accident levels amongst their drivers.

57 companies agreed to distribute questionnaires, in quantities varying from 6 to 600. In total 6,631 questionnaires were sent out. This was greater than the target figure because some companies were slow to confirm that they were willing to assist with the survey, so that by the time they did, replacement companies had already been recruited. The number of responses received was 1,838. There is no means of checking whether the individual companies actually distributed all of the questionnaires that they requested but, assuming they did, the response rate from individual drivers was 28%.

Clearly, it was not possible to control the ‘company sample’, apart from the guidelines mentioned above. The only control existed at the stage of data analysis when the company sample was combined with the DVLA sample to form the compound ‘representative driver sample’. Section 4.1 calculates the weighting factor needed to achieve the appropriate balance between the two, and Section 5 explains how the factor is used in the full analysis of accident risk.

3.2.4.2 Accident-involved driver sample

The national STATS19 accident database contains details of all drivers who have been involved in road accidents that involved personal injury, so it was the obvious source for drawing this sample. This database is assembled by DTLR staff from data supplied by individual police forces.

Initially, ten Police Forces were approached to discuss the extraction of names and addresses of drivers from their accident records: four agreed to participate. It became clear that individual forces hold and access their accident records in widely differing ways. Additional forces were needed for the survey, and those forces that kept their records in a computerised form were identified. A further eight forces were approached, of whom five agreed to participate. Some of the additional forces identified as having electronically held accident records were also unable to assist because names and addresses were not held on the main accident database. Unfortunately, due to lack of resources within the forces themselves, considerable time was required for them to check the feasibility of participating in the survey. From the nine forces that agreed to participate, 10,203 accident-involved drivers were identified and were sent a questionnaire.

The process of identifying samples and sending out questionnaires spanned several months and the process was eventually curtailed at a point where, despite the fact that the original target had not been reached, it was judged that sufficient responses would be received to permit meaningful analysis.

To avoid TRL needing access to the names and addresses of the drivers, questionnaires were sent out by the police on TRL’s behalf. 2138 responses were received from the accident-involved driver sample, a response rate of 21 per cent. One of the forces inadvertently sent questionnaires to a group who included non-drivers, as well as to the intended sample. Fortunately the responses coming from this sample could be identified, and these were coded in a way which allowed them to be separated from the main sample. There were 295 responses from this group.

4 Preliminary analyses

4.1 Weighting of DVLA and company samples

Section 3.2.4 explained that the DVLA and company samples were to be combined to form a single representative driver sample needed to investigate the factors which may influence accident risk. The aim was to provide a composite sample that reflected correctly the balance between company drivers and private drivers in the population of those who drive cars and vans up to 3 years old. This was done by examining the proportions of company-owned vehicles as reported by drivers in the DVLA and company samples, and ensuring that the proportion in the composite sample matched the proportion shown in the national statistics.

The relevant questions are Q20 (ownership of vehicle regularly driven on work-related journeys) and, for those who do not make work-related journeys, Q17 (ownership of vehicle most frequently driven on private journeys). Based on the questionnaires with full and consistent responses to these questions:

- 97 per cent of the vehicles regularly driven by the company sample were company-owned.
- 17 per cent of the vehicles regularly driven by the DVLA sample were company-owned.

These vehicles are up to 3 years old and about 38 per cent of British vehicles in this age range are company-owned (as shown by their DVLA registrations, (DTLR, 2001)). The factor of 0.43 applied to the company sample achieves the correct balance between company and private drivers in the combined sample. It is applied in Section 5 to weight the responses from the company driver survey in the statistical model of risk, so all valid survey responses contribute to the analysis. An analysis to investigate the sensitivity of the overall survey results to variations in the chosen weighting figure is reported in Section 5.1.2.

4.2 Characteristics of the samples

As explained in Section 3.2, the same questionnaire was sent to three separate samples of drivers: the sample of accident-involved drivers (A), the company sample (C) and the DVLA sample (D). Thirty two questionnaires were returned by drivers who did not have a full licence. The questionnaire directed such drivers to skip most questions, so their responses had to be discarded. Table 2 presents some initial comparisons of the three sets of respondents, and shows clear differences between the composition of the three samples of drivers.

Table 2 Comparisons of the three sets of respondents

		Representative sample	
	Accident -involved sample (A)	*Company sample (C)*	*DVLA sample (D)*
Number of valid responses	1831	1828	2176
% female	36	19	41
Mean age	43.0	41.5	50.1
% under 30	16.0	10.7	9.5
% over 60	8.4	0.9	26.9
% reporting accidents in last 12 months	49.0	16.3	8.8

Some valid responses were incomplete.

The final row shows that the proportion of respondents who reported that they had been involved in accidents was highest in sample A, so the strategy of identifying accident-involved drivers from police records has been effective. However, the fact that only half of the respondents responded positively to Question 9 (‘Have you had any accidents while driving during the last 12 months?’) may cause some surprise. The chief explanation seems to be that delays in extracting drivers’ details from police records and sending out questionnaires meant that many drivers were contacted more than 12 months after being involved in the accident that was recorded by the police. Thus, although they had indeed been involved in road accidents, these accidents had occurred outside the period specified in the questionnaire. There may also have been an element of under-reporting. Neither of these effects would have seriously altered the status of the sample as a sample of drivers who had recently been involved in an injury accident – which is what is required for analysis purposes

Accident liability is known to be influenced by a driver’s experience, which is often expressed as the number of years that a driving licence has been held. Table 3 analyses the responses to Question 1 and shows that all three samples of drivers tended to be highly experienced. Nonetheless, the sample of accident-involved drivers did contain the highest proportion of inexperienced drivers as would be expected from the well-established link between inexperience and accident liability.

Question 29 asks about the respondent’s ‘current work situation’, and Table 4 compares the distribution of responses in the three samples. Predictably, virtually all of the company sample were working full-time.

Table 3 Distribution of drivers’ experience (years of holding a driving licence)

Experience (yrs)	*Accident -involved sample (A)*	*Company sample (C)*	*DVLA sample (D)*
0-2	3.5%	0.4%	1.7%
3-5	3.9%	1.4%	3.2%
Mean	21	22	28

Table 4 Distribution of drivers’ current work situations

	Accident -involved sample (A)	*Company sample (C)*	*DVLA sample (D)*
Working full-time	73%	99%	55%
Working part-time	11%	1%	12%
Looking after home	3%	0%	5%
Student	2%	0%	1%
Retired	10%	0%	27%
Unemployed	2%	0%	1%

Question 16 asks about the type of journey made while driving a car or van, and Table 5 compares the distribution of journey types in the three samples. Perhaps the table’s most striking feature is the low level of sales journeys from all three samples – though respondents may have assigned some sales journeys to other categories in the list. The fact that more sales trips are reported by the accident-involved sample than the company or DVLA samples may indicate an increased accident risk among salesmen. It is also interesting that one-eighth of the company sample reported that they had not made work-related journeys – presumably these are perk cars used for commuting or other private mileage.

4.2.1 Mileage details

Questions 2 and 18 ask about the driver’s annual mileage and annual mileage on work-related journeys. Previous studies have shown that the former strongly influences a driver’s accident liability so it will be central to the analyses reported in Section 5. The two mileages are likely to be highly correlated, since a driver with a high work-related mileage must have a high annual mileage and one with a low annual mileage must have a low work-related mileage. It would not be satisfactory to include two highly correlated variables in the main analyses, and the solution is to include not the annual mileage on work-related journeys but the percentage of mileage that is undertaken on work-related journeys. Table 6 compares the distribution of this variable and of annual mileage in the three samples.

The table shows that the company drivers tend to drive much farther than the accident-involved drivers, who in turn tend to drive much farther than the DVLA drivers. Predictably, the company drivers also tend to have the highest work-related mileage, although it is interesting that almost one-sixth reported no work-related mileage (the same point arose in Table 5). The difference between the company and DVLA distributions for this key variable

Table 5 Distribution of types of work-related journeys

	Accident-involved sample (A)	*Company sample (C)*	*DVLA sample (D)*
Proportion of drivers who made no work-related journeys	39%	12%	59%
Distribution of work-related journey-types for those drivers who did make work-related journeys:			
Carry passengers	19%	19%	19%
Carry goods or deliver things	15%	12%	12%
Drive to go to meetings or other general business activities.	31%	37%	38%
Drive to make sales	9%	7%	5%
Other journeys to do with work	27%	24%	26%

Table 6 Distribution of annual mileage and percentage of mileage on work-related journeys

	Accident -involved sample (A)	*Company sample (C)*	*DVLA sample (D)*
Annual mileage			
0- 8100	25%	5%	38%
8101- 12100	27%	11%	35%
12101- 17100	12%	13%	11%
17101- 26100	17%	32%	10%
26101-	19%	39%	6%
% work-related mileage			
0	43%	16%	65%
1- 20	13%	14%	13%
21- 50	12%	20%	8%
51-	33%	50%	14%

emphasises the importance of contacting companies directly rather than relying on the 'representative' sample from DVLA to provide information about work-related journeys and the associated accidents.

One minor problem with the mileage data is that the work–related mileage (Question 18) exceeded the annual mileage (Question 2) in 14 cases. Arguably, such mis-reporting should cause these cases to be excluded, but they have been retained with the % of work-related mileage reset to 100%.

Total vehicle mileage in Great Britain is known from the National Road Traffic Survey while the number of fully licensed drivers is known from the National Travel Survey (DTLR, 2001). Motor vehicles travelled a total distance of 467.7 billion kilometres in Great Britain in 2000, and 32.3 million drivers had full licences, so drivers drove 9,000 miles per year on average. By comparison, the mean mileages reported by the three samples were:

Accident-involved 19,965.

Company 25,741.

DVLA 12,194.

When the company and DVLA samples are combined to form a composite 'representative' sample, using a weighting factor of 0.43 for the company sample, the mean mileage is 15,810 - 76 per cent more than the national travel survey figure of 9000 miles.

One factor contributing to a difference in this direction is that the samples were selected from drivers of vehicles up to three years old, and newer vehicles tend to have higher annual mileages than older vehicles. Other possible explanations are:

- Drivers with low mileage may be less likely to be sufficiently interested in the survey to take the time to respond (although, conversely, high mileage drivers may have less free time).
- Many drivers will have little or no factual information to help them to estimate their annual mileage, and there may be a tendency to exaggerate in these circumstances.

The likely explanations for this mileage 'inflation' probably apply equally to the accident-involved drivers. If this is true, the results of the more detailed analyses reported in Section 5 should be unaffected since the two sets of biases should cancel out. However, it is possible that the experience of an injury accident will reduce mileage – which could mean that the annual mileage figures reported by the accident-involved sample tend to under-estimate their 'before accident' annual mileage. This possibility is discussed further in Section 5.1.3.

The company and DVLA mileages presented above suggest that a company vehicle travels about twice as far on average as a 'typical' vehicle of the same age. As Table 6 showed, the DVLA sample contains many drivers who reported work-related mileage. When their mileage is compared with the mileage of drivers who did not report work-related mileage, the ratio is slightly less: 1.81. Also, the average mileage of those DVLA drivers who did report work-related mileage was only 64 per cent of the company figure of 25,741. Significant thresholds for business mileage were 2,500 and 18,000 miles per year under the rules that governed taxation of company car drivers at the time of the survey. It seems possible that, in spite of promises of confidentiality, some drivers may have raised their reported mileage to be consistent with the mileage reported to the Inland Revenue. Inspection of the frequency distribution of the responses suggests that this may have happened, but only on a very limited scale.

4.2.2 Company drivers and policies

The literature review of Section 2 described the diversity of the company driver population. This section will analyse the survey data to review this, and examine the extent to which drivers have been trained. First, Table 7 compares the responses to Question 20 about the provision of the vehicle usually used for work-related journeys. It is based on those drivers who reported (Question 16) that they sometimes made such journeys.

Table 7 Vehicle usually used for work-related journeys

	Accident -involved sample (A)	Company sample (C)	DVLA sample (D)
Vehicle usually used for work-related journeys is:			
Provided by employer	57%	91%	24%
Financed at least partly by employer	5%	6%	7%
Company vehicle (not always the same one)	7%	2%	5%
Privately owned by respondent	29%	1%	61%
Other	3%	0%	3%
All	100%	100%	100%

The table shows clear differences between the drivers who made work-related journeys and were contacted 'at random' via the DVLA files and those who were contacted via their employers. The vehicles of the drivers in the company sample were almost entirely provided by the company, while two-thirds of the drivers in the DVLA sample had to provide their own. This is not explained by differences between the drivers' positions within their companies (Question 27), although a higher proportion of the DVLA sample was self-employed. When allowance is made for these differences, the drivers in the company sample are almost twice as likely to have a vehicle provided by the company as the drivers in the DVLA sample who do work-related driving.

Another difference between the company and DVLA samples arises in their need to report work-related accidents (Question 24). 97 per cent of drivers in the company sample said they had to report these accidents to their companies, but only 71 per cent in the DVLA sample. Conversely, 21 per cent of drivers in the DVLA sample had to pay all of the costs of any accident, and a further 9 per cent had to pay some of the costs; the corresponding figures for the company sample are 1 and 14.

A further difference is shown in Table 8: the proportion of drivers who had received training was higher in the company sample than amongst those of the DVLA sample who made work-related journeys. Moreover, the training reported by the company sample tended to be more recent and the type of training differed. More generally, comparison of the sections of the DVLA sample who did and did not make work-related journeys indicates that companies play a positive role in training drivers. On the other hand, the proportion of accident-involved drivers who had received training is relatively high.

Table 8 shows the type of training received in the last year. The majority of courses attended by the A and D samples were described as 'other', so the descriptions provided for these courses have been examined. No type was reported frequently: the descriptions included police training courses, LGV/HGV courses, defensive driver training courses, driver improvement courses, various advanced courses and MIDAS courses (together these accounted for only two-fifths of descriptions).

Although various differences have been found between the company and DVLA samples, the two samples did match in one respect. Very few companies provided rewards or penalties to encourage accident-free driving (Question 25), although about 8 per cent of those who responded to this question did not know the answer.

Table 8 Driver training received (Question 28)

	Accident -involved sample (A)	Company sample (C)	DVLA sample (D)	
			D1*	D2*
Proportion of drivers who had:				
Received training in last year	9%	10%	5%	2%
Received training in any year	26%	28%	22%	12%
Types of training received in the last year:				
On road 'fleet driver training'	24%	64%	33%	0%
Driving range 'skid control/ avoidance' training	9%	11%	8%	0%
IAM/RoSPA 'advanced' driving test	12%	15%	13%	36%
Other	55%	10%	48%	64%
N (=100%)	164	179	40	22

** D1 = drivers from DVLA sample who made work-related journeys.*
D2 = remainder of DVLA sample.

The literature review mentioned that a company's reason for providing an employee with a vehicle depends upon the employee's position within the company. This is confirmed by Table 9, which is based on the responses to Questions 26 and 27 from the company sample (results from the DVLA sample are very similar).

Table 9 Company's reasons for providing employees with vehicles (Company sample)

	Vehicle is:		
	Essential	Occasion -ally needed	A perk
Senior management	54%	13%	33%
Middle management	64%	15%	21%
1st or 2nd line management	72%	12%	15%
Non-management professional etc worker	76%	9%	15%
Non-management skilled manual worker	98%	1%	1%
All	69%	11%	19%

Section 3.2.4 mentioned some of the difficulties of persuading sufficient companies to co-operate in this research, so it is probably inevitable that there would be 'selection bias', i.e. that those companies who agreed were more interested in road safety than those who refused. The high incidence of training relative to the DVLA sample suggests that this awareness may lead to measures to improve driving standards. The possible effect of such a selection bias on this study's estimate of the accident risk of company driving is discussed in Section 5.1.4.

4.2.3 Accident details

The questionnaire asked for details of up to two accidents within the past year. Six per cent of the sample of accident-involved drivers reported a second accident, with lower percentages in the other samples. Two company drivers reported that they had been involved in four accidents within the past year, but the maximum number reported by the other samples was three.

Question 13 asks about the severity of the casualties. Table 10 groups the accidents according to the most serious injury suffered by those involved, and shows that the accidents reported by sample A tended to be the most serious, as expected. Fatal accidents were excluded when identifying drivers for sample A, and indeed these respondents reported no fatal accidents. By contract, sample C reported 2 fatal accidents.

Table 10 Distribution of severity of accidents

	All driving accidents			*Road accidents*		
Sample	*A*	*C*	*D*	*A*	*C*	*D*
Number of accidents with:						
No injury reported	28%	82%	81%	28%	78%	79%
Slight injuries	56%	15%	16%	56%	17%	19%
Fatal or serious injuries	16%	4%	2%	16%	5%	2%
Mean number of accidents per driver*	0.54	0.17	0.09	0.53	0.14	0.08

* *i.e. The mean number of accidents whose details were reported per driver*

Question 11 asks about the type of road where the accident occurred. The final category covers off-road locations such as business premises, so these are not road accidents. They account for 2 per cent of the accidents from sample A, but 14 per cent for the other samples: all but 2 of these accidents involved no injury.

Figure 1 shows the distribution of *road* accidents by road type. Company drivers have a slightly higher proportion of their accidents on motorways and non built-up roads, and correspondingly fewer on built-up roads. Injury and non-injury accidents are shown separately to demonstrate that, as expected, the drivers of sample A reported a higher proportion of injury accidents in all locations.

Question 12 asks about the type of accident, offering 11 descriptions of 'who hit whom?'. For each sample of drivers, the most frequently chosen description was 'Another vehicle hit the rear of your vehicle', followed by 'Another vehicle hit the side of your vehicle'. The 11 descriptions have been combined into four groups to prepare Figure 2, which compares the accident types reported by the three samples of driver. Among multi-

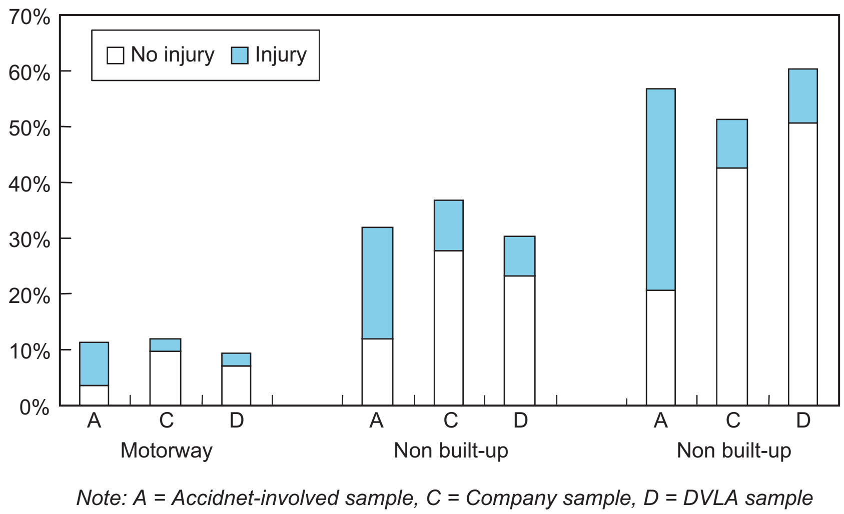

Figure 1 Distribution of road accidents by road type and accident severity

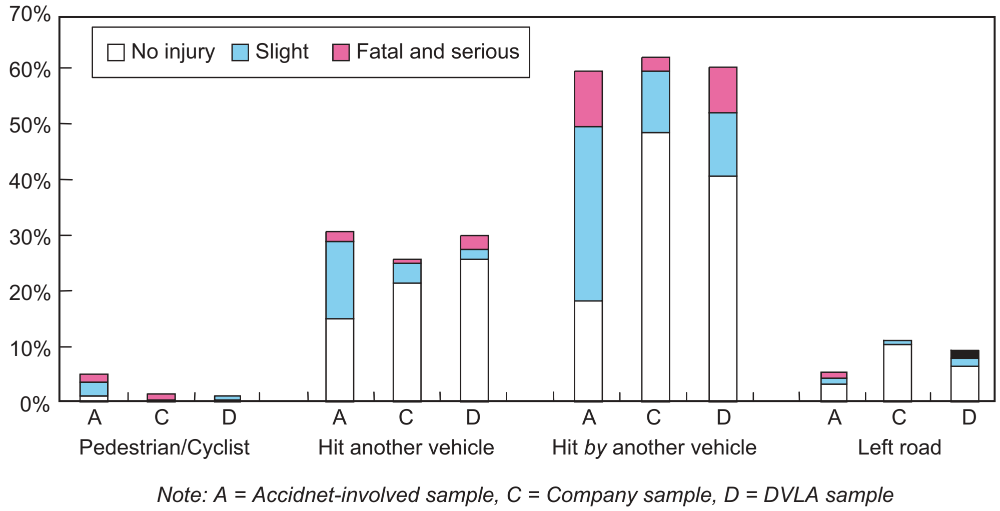

Figure 2 Distribution of accidents by accident type and accident severity

vehicle accidents, the reports of *hitting* another vehicle should roughly balance the reports of being *hit by* another vehicle, so there is clearly some bias in the reporting, although other surveys using the same question (Broughton and Baughan, 2000; Baughan *et al.*, 2003) have shown an excess of 'being hit' over 'hitting'. This may be due, in part, to multiple vehicle accidents in which a shunt into the end of a queue results in several 'being hit' collisions, but it seems unlikely that this is the full explanation. The imbalance probably results from a reporting or memory bias that favours passive, relatively blameless, interpretations of accidents.

The main differences between the three samples are that sample A reported a higher proportion of accidents with pedestrians and cyclists and a lower proportion in which their vehicle left the road. The former is probably linked to the higher proportion of injury accidents that these drivers report, but on the other hand the 'left the road' accidents also tend to be of above-average severity.

Question 14 asks about the vehicle being driven at the time of the two most recent accidents, while Question 15 asks whether the journey was work-related. Table 11 shows the distribution of responses from each sample of drivers. Even among the company sample, almost half of the accidents occurred during non-work journeys, predominantly while driving company vehicles. On the other hand, almost a quarter of the accidents reported by the DVLA sample occurred during work journeys, predominantly while driving their own vehicles.

The distribution of accidents between those occurring on work and non-work journeys provides an opportunity to check that the factor of 0.43 estimated in Section 4.1 provides the correct balance between company and private drivers within the representative sample constructed from the DVLA and company samples. The final row shows that 34% of the accidents reported by the drivers from the accident-involved sample (A) occurred on work journeys, while the proportion was higher in the company sample and lower in the DVLA sample. When the DVLA and company samples are combined (with a weighting factor of 0.43 applied to the company sample), 32% of accidents in the composite sample occurred on work journeys, very close to the figure from the accident-involved sample. These percentages are crucial since this study focuses on accidents on work journeys, and ideally the two percentages would agree precisely. Hence, the degree of agreement between these two figures is reassuring.

4.3 Initial analysis of risk

Section 2.2 outlined the new approach, based on comparing the questionnaire responses of:

- a survey of a representative sample of drivers (here comprising the composite company/DVLA sample);
- a parallel survey of drivers who are known to have been involved in an accident.

For example, if 50% of the representative sample reported a particular factor but only 25% of the accident sample did so, this would suggest that the factor tended to raise the risk of being involved in an accident. Appendix A shows how to calculate the relative risk by comparing the distributions of the factor in the two samples. To take the example of age, the accident risk of each age group in turn can be measured relative to the risk of a reference group such as drivers less than 25 years old.

Some of the factors presented in the previous tables will be reassessed for preliminary evidence that they might increase the risk of accident involvement, using *univariate* analyses. The final results about risk will come from the *multivariate* analyses to be reported in Section 5 that take account of interactions between variables. Results for the 'representative' sample of drivers are achieved by combining the company and DVLA samples, applying a weighting factor of 0.43 to the former.

Table 12 compares the distributions within the two samples of drivers of three variables: annual mileage, the percentage of this mileage on work-related journeys and the drivers' ages. It also includes the univariate estimates of relative risk. In each case the 'lowest' group is the reference which, by definition, has a relative risk of 1.00

The table shows that the accident-involved sample contains:

- relatively few older drivers and relatively many young drivers, so that an older driver is less likely to be involved in an accident;
- relatively few low-mileage drivers and relatively many high-mileage drivers, so that a high-mileage driver is more likely to be involved in an accident;
- relatively few drivers with low proportions of work-mileage and relatively many with high proportions, so that a driver with a high work-mileage is more likely to be involved in an accident.

Table 11 Distribution of accidents by type of journey and vehicle

	Accident-involved sample (A)			*Company sample (C)*			*DVLA sample (D)*		
Vehicle driven	*Work journey*	*Non -work journey*	*Either*	*Work journey*	*Non -work journey*	*Either*	*Work journey*	*Non -work journey*	*Either*
Your own vehicle	10%	50%	60%	1%	6%	7%	16%	74%	90%
Company vehicle, regularly driven	21%	11%	31%	48%	36%	84%	5%	1%	7%
Company vehicle, not regularly driven	4%	1%	5%	4%	3%	7%	1%	0%	1%
Someone else's vehicle	0%	3%	4%	0%	2%	2%	0%	1%	2%
All	34%	66%	100%	53%	47%	100%	23%	77%	100%

Table 12 Comparative distributions of three independent variables

Age	*-35*	*36-45*	*46-55*	*56-*	
Accident-involved sample	32%	27%	24%	18%	
Composite sample	22%	24%	25%	29%	
Relative risk	1.00	0.76	0.66	0.42	
Annual mileage	*0-8100*	*-12100*	*-17100*	*-26100*	*>26100*
Accident-involved sample	25%	28%	12%	17%	19%
Composite sample	30%	28%	12%	16%	14%
Relative risk	1.00	1.17	1.24	1.30	1.54
% work-related mileage	*0*	*1-24*	*25-49*	*50-74*	*75-*
Accident-involved sample	42%	14%	7%	13%	23%
Composite sample	51%	15%	8%	12%	15%
Relative risk	1.00	1.16	1.13	1.38	1.80

The last point is the first indication from the survey that ‘professional’ drivers (i.e. those who drive long distances in the course of work) may be over-involved in accidents. This initial finding could be partly or wholly caused by another variable, however, and the final conclusion must depend upon the full analysis that is described in Section 5.

36 per cent of accident-involved drivers were female, compared with 35 per cent of the composite sample. Hence, the accident risk is calculated to be 3 per cent higher for women than for men.

Table 13 makes the same comparison for the type of vehicle driven most frequently (Question 4a). In this case, some of the figures for relative risk do indicate that the composite sample of drivers may not be truly representative. National accidents statistics (e.g. DTLR, 2001) show that that the casualty rate of motorcyclists per kilometre travelled is much higher than the rate for car drivers, so the high figure for motorcycles is plausible. On the other hand, the same source shows that rates for van and lorry drivers are lower than for car drivers, so the figures for vans and lorries are not.

Table 13 Comparative distributions of vehicle type

Vehicle type	*Car*	*Motor -cycle*	*Van*	*Lorry*	*Truck*	*4x4*	*Other*
Accident-involved sample	82%	0.5%	11.0%	1.1%	0.5%	3.6%	0.9%
Composite sample	93%	0.1%	2.0%	0.4%	0.5%	3.3%	0.7%
Relative risk	1.00	5.75	6.33	3.19	1.25	1.21	1.43

Inappropriately high relative risks appear to have been generated for van and lorry drivers because the composite sample does not contain sufficient of these groups of driver. The company sample was intended to provide details of company vehicle operations, but it appears that these respondents tended to come from the white rather than the blue collar sectors, driving cars rather than commercial vehicles. The most suitable way of dealing with this in the risk analyses presented in Section 5 is to omit the records of drivers of commercial vehicles in each sample.

Section 2 raised the question of whether any excess accident risk among company drivers might be explained by the fact they are often not driving their own vehicles. Table 7 reported the ownership of the vehicles driven by the three samples for work-related journeys, so these data can be used to examine this possibility. When the percentages for the company and DVLA samples are weighted and combined, it is found that:

55 per cent of vehicles usually used for work-related journeys are provided by the employer;

6 per cent are financed by the employer;

4 per cent are provided by the employer (not always the same one);

33 per cent are the driver’s own vehicle.

Thus, there are proportionately fewer privately owned vehicles in the accident-involved sample in Table 7 (29%<33%). This appears to suggest that a driver’s accident risk when driving his or her own vehicle is less than when driving a company-owned vehicle. However, it has been demonstrated that risks need to be standardised by restricting the comparison to car drivers; with this restriction, 36 per cent of cars in the accident-involved sample were the driver’s own vehicle compared with 34 per cent in the composite sample. This suggests that ‘lack of ownership’ does not affect accident risk materially.

4.4 Driver attitudes and behaviour

The questionnaire contains four questions about drivers’ attitudes and behaviour, each asking for a response to a series of sub-questions. The full questions are included in Appendix C, they can be summarised as follows:

Q5 Attitudes to Driving Violations Scale.

This scale was developed by West and Hall (1997), and comprises seven evaluative statements about driving violations and speed limits (e.g. ‘People should drive slower than the speed limit when it is raining’; ‘Drivers who cause accidents by reckless driving should be banned for life’). Each statement is scored from one to five on a scale of agreement-disagreement, and the scores summed. The scale has reasonable internal consistency, with values of Cronbach’s alpha of 0.6 to 0.74 having been reported. West and Hall found the scale to be associated with fast driving and accident risk, after age, sex, experience and mileage had been taken into account. A subsequent study by West and Hall (1998) investigated the predictive value of the scale with novice drivers. They reported that the scores of learner drivers (who had not yet passed the driving test) were significantly associated with accident liabilities at six and twelve months post-test even when the effect of mileage was controlled. In a recent TRL survey of accidents in the first six months of post-test driving, the scale scores at six months after the test showed small though statistically significant associations with accident involvement.

Q6 Driving while tired, distracted or under time-pressure

As discussed in Section 2.4, one of the more obvious potential explanations of company drivers’ excess accident liability concerns work-related factors such as secondary in-car behaviours, time pressures, and fatigue. As reviewed in Section 2.3.4 there is already considerable evidence on the effects of mobile phone conversations on safety-related aspects of driver performance. Time pressure may potentially lead to speeding and other demonstrably risky behaviours, and the contribution of fatigue to accidents is well-documented.

To quantify the extent of such factors, Question 6 asked how often the respondent drove in 11 situations. Five of these were expected to be related to the likelihood of fatigue or drowsiness at the wheel; one dealt with time-pressure; and seven with in-car activities such as using mobile phones, eating or drinking, and thinking/worrying about issues not related to driving. Responses were on a six-point rating scale ranging from ‘never’ to ‘nearly all the time’.

Given existing evidence on the risky nature of such factors, it was felt that differences between the company and private drivers revealed by question 11 could be taken as at least partial explanations of company drivers’ excess accident liability, and would lead to suggestions for remedial measures. It was also intended to include these variables in the statistical modelling of accident liability.

Q7 Guppy scale of driving style

Respondents were asked to show what kind of drivers they were on ten bipolar seven-point scales – for example, attentive-inattentive, safe-risky, tolerant-intolerant. These scales originally proposed by Guppy *et al.* (1990) and have been used in several subsequent studies (e.g. Maycock and Forsyth, 1997; Quimby *et al.*, 1999). Factor analysis generally shows three orthogonal factors:

Factor 1: Attentive, careful, responsible and safe at one extreme, and inattentive, careless, irresponsible and risky at the other.

Factor 2: Placid, patient, considerate and tolerant at one extreme; irritable, impatient, selfish and intolerant at the other.

Factor 3: Confident and fast at one extreme; nervous and slow at the other.

Quimby *et al.* (1999) found that a driving style index using six of the Guppy scale items, effectively a combination of factors 1 and 2 above, was a strong predictor of accident liability. The strength of prediction was reduced, but only slightly, when statistical modelling was used to control for the effects of age, driving experience and mileage. In a recent TRL study of accidents during the first six months of post-test driving, accident-involved drivers tended to score higher than the others on factors 1 and 2, indicating that they were slightly more inattentive and irresponsible, and slightly more irritable and intolerant. For men, there was also a statistically significant relation for factor 3, such that accident-involved men tended to rate themselves as slightly more confident and fast.

Q8 Self-reported driving ‘violations’ from the Driver Behaviour Questionnaire (DBQ)

The DBQ was first used by Reason *et al.* (1990), who asked drivers how often 50 different behaviours occurred. These covered violations, mistakes, slips and lapses. Violations were departures from safe practice as defined by laws or unofficial norms, mistakes were errors in formulating intentions, and slips and lapses were seen as unwitting deviations of actions from good, safe, intentions.

Reason *et al.* factor analysed the responses and identified three underlying factors – deliberate violations involving risk, (ii) potentially dangerous errors (high risk slips and mistakes) and (iii)‘silly’ slips and lapses involving embarrassment or inconvenience rather than risk. These factors are often referred to in the driver behaviour literature as violations, errors and lapses. Subsequently, versions of the DBQ have been used in a number of studies that have generally found a similar factor structure. Dimmer and Parker (1999), in a survey of company car drivers, were able to distinguish six factors including an ‘under pressure’ factor and two ‘violations’ factors: ‘speeding violations’ and ‘aggressive violations’ (the version of the DBQ they used had items added to represent aggressive violations).

Previous studies have generally found that it is scores on DBQ violations that are associated with the likelihood of the driver having accidents. However, as mentioned in Section 2.3.3, Dimmer and Parker did not find this in a sample of company drivers, speculating company drivers, by virtue of their experience, may be more capable violators than other drivers.

The questionnaire for the present study included the 11 ‘violation’ items from Dimmer and Parker’s version of the DBQ, including the two items that Dimmer and Parker found to load on the ‘under pressure’ factor. Respondents used a 6-point scale ranging from ‘never’ to ‘nearly all the time’ to say how often they did behaviours such as ‘sound your horn to indicate your annoyance with another road user’, or ‘stay in a motorway lane that you know will be closed until the last minute before forcing your way into the other lane’.

4.4.1 Factor analysis of the behavioural and attitudinal questions

Responses to each of the above four questions were analysed in turn using principle axis factoring with varimax rotation on the pooled data from samples A, C and D. Appendix B shows the solutions obtained; they are summarised below. Section 5.2 examines the factor scores[2] as part of the full analysis of risk.

Question 5 – the Attitudes to Driving Violations Scale

97 per cent of respondents answered *Question 5* fully. As found in previous studies (e.g. West and Hall, 1997) there is a single underlying factor on which all items load strongly. This will be referred to as F5a.

[2] In fact, the summed item scores for items loading higher than 0.3 on a factor are used, rather than true factor scores.

Question 6 – driving while tired or distracted

93 per cent of respondents answered *Question 6* fully. A two factor solution was interpretable and represented the data satisfactorily; it may be summarised as follows:

F6a - fatigue.

F6b - distraction.

Question 7 – Guppy scale of driving style

95 per cent of respondents answered *Question 7* fully. As in previous research (e.g. Maycock and Forsyth, 1997) the factor analysis indicated that three factors represented the data satisfactorily, which may be expressed as follows:

F7a –Attentive / Careful /Responsible / Safe versus Inattentive / Careless / Irresponsible / Risky'.

F7b –Placid / Patient / Considerate / Tolerant versus Irritable / Impatient / Selfish / Intolerant'.

F7c – Nervous / Slow versus Confident / Fast'.

Question 8 – Self-reported DBQ 'violations'

97 per cent of respondents answered *Question 8* fully. The factor analysis indicated that two factors represented the data satisfactorily, which may be expressed as follows:

F8a - Dangerous violations.

F8b - Aggressive violations.

Scores for each of the above eight factors were obtained by averaging the item scores for items that loaded more than 0.3 on the factor. The scores were adjusted so that the mean score for each question was zero (each response was weighted equally). 'Safe/responsible' answers led to negative scores while 'unsafe/irresponsible' answers led to positive scores. A difference in score of one unit is equivalent to a difference in one point on the underlying five, six or seven point rating scales.

Table 14 presents two sets of comparisons of the mean scores:

- the company and DVLA samples are compared, bearing in mind that there are some company drivers in the DVLA sample;
- the accident-involved and composite samples are compared to see how the behaviour and attitudes of drivers who have been involved in accidents compare with those of a representative sample of drivers.

Drivers of commercial vehicles have been excluded for the reasons set out in Section 4.3.

The comparison of the company and DVLA samples reveals that in most respects the drivers in the company sample are relatively hostile to traffic laws, more likely to drive while tired or distracted, and less likely to consider themselves responsible and safe, or placid, considerate and tolerant. They are more likely to indulge in dangerous breaches of good, safe driving rules, and are slightly more likely than other drivers to drive in an aggressive manner.

As described above, previous research has shown that scores on these factors are positively correlated[3] with accident risk. The fact that each of the mean scores for company drivers (sample C) exceeds the corresponding mean for drivers of privately registered cars is thus important. If the analyses of Section 5 do confirm that accident risk is greater among drivers with high work-related mileages then these pronounced differences may well contribute to the extra risk.

By contrast to the comparison of the company and DVLA samples, the factor scores for the accident-involved and composite samples are very similar. Indeed, the accident-involved drivers show very slightly 'safer' mean scores on three of the eight factors, and no difference on two. This pattern of results is surprising at first sight, and certainly shows no sign of a relation between known risk factors and accidents. One possible explanation is that the experience of having an injury accident may itself have influenced drivers' attitudes and behaviours. In other words, the factor scores for sample A in Table 14 may be 'safer' than they would have been before the accident.

There is no way of checking whether this explanation is correct, since there is no information available on Sample A's attitudes and behaviours pre-dating their accidents. Few of the drivers in the composite sample had been involved in injury accidents, so the data from this sample should give a reliable indication of attitudes and behaviour in the general population of drivers of cars up to three years old. The only way of obtaining equivalent information about drivers who go on to have an accident would be to carry out a survey, then contact respondents two or three years later to check whether they had been involved in an injury accident. A very extensive survey would be needed to include sufficient drivers 'soon to be involved in an injury accident' to reach reliable conclusions.

[3] *Though Dimmer and Parker (1999) did not find this to apply to company car drivers 4.4.2 Level within company.*

Table 14 Mean factor scores

	Company sample (C)	*DVLA sample (D)*	*Accident-involved sample (A)*	*Composite of (C) and (D)*
F5a - Attitudes to driving violations	0.20	-0.13	-0.05	-0.04
F6a - Fatigue	0.43	-0.32	-0.08	-0.11
F6b - Distraction	0.50	-0.35	-0.12	-0.12
F7a - Attentive/Careful/ Responsible/Safe vs the opposite	0.20	-0.14	-0.05	-0.05
F7b - Placid/Patient/Considerate/Tolerant vs the opposite	0.23	-0.20	-0.01	-0.08
F7c - Nervous/Slow vs the opposite	0.07	-0.02	-0.06	0.01
F8a - Dangerous violations	0.23	-0.15	-0.07	-0.05
F8b - Aggressive violations	0.10	-0.09	0.00	-0.03

4.4.2 Level within company

Table 14 found that drivers in the company sample were very different from the DVLA sample in the attitudes and behaviours they reported. Question 27 asked about the respondent's level within the company that they currently work for, so it is possible to see whether the same pattern of factor scores applies over all levels of employment. Table 15 presents the mean score for each job level relative to the mean for all drivers in the company sample. Hence, senior managers were slightly more hostile to traffic laws than the average company driver, while 1st or 2nd line managers were slightly less. Relative scores are not included for the first or last group because they include so few respondents (5 and 6 respectively).

The relative scores are generally small, certainly by comparison with the difference between the company and DVLA scores in Table 14, so differences *within* the company sample are much less than the differences between the company and DVLA samples. Indeed, the differences for F6a, F7c and F8b are so small that they may well have occurred by chance. The greatest variance between job levels occurs for F8a (dangerous violations): scores tend to be higher (indicating more risky behaviour) among more senior employees.

On the other hand, Table 16 shows that mileage tends to be higher among more junior employees, as does the percentage that is work-related.

Table 16 Mean mileage (thousands) reported by the company sample

	Annual mileage	*Work -related mileage*	*% of mileage that is work -related*
Senior management	23.3	12.7	55%
Middle management	24.0	13.8	58%
1st or 2nd line management	25.1	15.2	60%
Non-management professional etc worker	27.4	18.4	67%
Non-management skilled manual worker	32.9	27.0	82%
All	25.5	15.9	63%

4.4.3 Mobile phones etc.

The two factors underlying the 13 items of Question 6 have been analysed above, but the responses to the individual items are also of great interest as they indicate some potentially important characteristics of company driving, some of which are known from other studies to be related to accident risk. The distribution of responses among the company sample has been compared with the distributions among 'private drivers', taken as those drivers in the DVLA sample who made no work-related journeys. The difference was greatest for Q6h (using hands-free mobile phone), followed by Q6c (long journey after a full day's work), Q6f (eating or drinking) and Q6i (reading a map). Figure 3 compares the responses to these questions, and also includes Q6g (using hand-held mobile phone). The distribution of results for all 13 items is presented in Appendix B.

Such differences between company and private drivers are not unexpected, because of the very nature of work-related driving. But it is instructive to have data, for the first time, on the extent of these practices in the company and private driver populations. For example, 7 per cent of the company sample reported that they used hands-free phones 'nearly all the time' while driving, while 48 per cent used a hands-free phone at least 'quite often' while driving. The corresponding figures for private drivers were 0.2 and 4 per cent. Another very striking finding is that 42 per cent of the company sample said they drove over 50 miles after a full day's work at least 'quite often'; 24 per cent said they did this frequently or nearly all the time. The corresponding figures for private drivers were 3.3 and 1.6 per cent.

When the same comparison is made for the accident-involved and composite samples, the two sets of responses are very similar. However, this does not allow us to conclude that none of these activities increases accident risk, since their effects may be masked by uncontrolled between-sample differences in other variables. Again, it could also be that drivers tend to modify their reported behaviour after being involved in an injury accident.

5 Full analysis of risk

This Section reports the application of the methodology described in Appendix A to analyse the survey data.

The results are the culmination of the process of developing the statistical model that best represents the survey data. This is an exploratory process, fitting the same form of model in a series of trials but iteratively attempting to improve the model by varying the details of its specification. In each trial, a set of explanatory variables $\{v^1, v^2 \ldots\}$ is first selected, guided by experience from previous research of this type. The percentage of

Table 15 Relative mean factor scores for the company sample (C)

	*Size**	*F5a*	*F6a*	*F6b*	*F7a*	*F7b*	*F7c*	*F8a*	*F8b*
Self-employed	0.3%								
Senior management	20%	0.08	0.03	-0.09	0.00	0.06	0.01	0.13	-0.05
Middle management	33%	0.03	0.02	0.00	0.06	0.05	0.03	0.04	-0.01
1st or 2nd line management	21%	-0.08	-0.02	-0.04	-0.05	-0.02	-0.02	-0.07	-0.03
Non-management professional etc. worker	17%	0.00	-0.03	0.05	0.06	-0.02	-0.04	-0.01	0.10
Non-management skilled manual worker	9%	-0.06	-0.04	0.26	-0.17	-0.21	-0.01	-0.24	0.06
Non-management semi or unskilled manual worker	0.3%								

* *Size = percentage of company sample at this level*

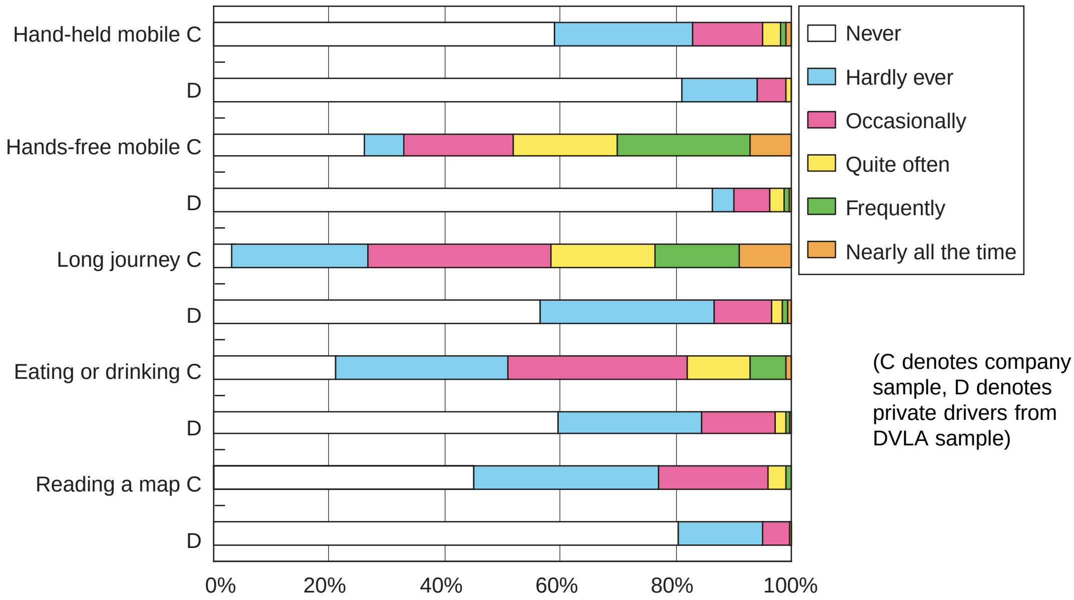

Figure 3 Responses to Question 6 from company and private dirvers

mileage on work-related journeys is the fundamental variable for this project as it represents the risk of company drivers relative to the risk of 'ordinary' drivers. Annual mileage and personal variables such as age are also important, but the principal reason for including them in the model is to minimise bias when estimating the effect of the work- related mileage variable.

The number of variables that can be used in the model is limited in practice by several considerations. The most immediate is that the number of records that can be included in the analysis falls as the number of variables rises. The reason is that only respondents who answered all relevant questions can be included in any particular analysis. Further, the nominal standard errors tend to rise with the number of coefficients to be estimated, although on the other hand the risk of bias as a result of model mis-specification should fall.

Suitable ranges then need to be chosen for each variable, with the aim of representing the effect of each variable parsimoniously. For example, tables in previous sections have used four age ranges: up to 35, 36-45, 46-55, 56 and over. This may be sufficiently detailed for the modelling, but more age ranges could be added experimentally and the model refitted to see whether any useful improvement had resulted.

Let v^i_j denote the j-th range of variable v^i. For each combination of ranges of the variables included in the current model, the number of respondents in the accident-involved sample with that combination of characteristics is determined from the survey data. Let this be X_A, and let X_R be the corresponding number in the representative sample. The GLIM program (Francis *et al.*, 1993) is then used to fit the following model to the data:

$$X_A\,(j_1, j_2\ldots) = X_R\,(j_1, j_2\ldots)\,.\,\exp(\alpha_1 + \alpha_2 + \ldots) \qquad (1)$$

The model fitting consists of taking each combination of ranges in turn, and finding for the coefficients α_1, α_2 … that best represent the joint variations in X_A and X_R. When this process is complete, the program lists various details of the fitted model, including the estimated coefficients and the standard error of each estimate.

One advantage of using GLIM is that a reference range v^i_0 can be specified for each variable. Appendix A shows that $\exp(\alpha^i_j)$ is the risk level associated with the j-th range *relative to* the level associated with the reference range. Suppose, for example, that the first age range was selected as the reference for age and that GLIM estimated the coefficient for the next age range as –0.1. This would show that the accident risk of the second range was exp(-0.1) = 0.90 times the risk of the youngest drivers – i.e. these drivers had 10 per cent fewer accidents than the youngest drivers when all other factors represented in the model were taken into account.

The records of those whose most frequently driven vehicle was a commercial vehicle were excluded from the analysis, as discussed in Section 4.3. Also, the records of the 32 drivers who did not have a full licence were excluded.

Section 3.3.1 discussed the need to weight the company sample to obtain the correct balance with the DVLA sample, and Section 4.1 obtained the value of 0.43. This takes effect when calculating $X_R(j_1, j_2\ldots)$. Let $X_D(j_1, j_2\ldots)$ and $X_C(j_1, j_2\ldots)$ be the number of respondents calculated from the DVLA and company samples, then

$$X_R(j_1, j_2\ldots) = X_D(j_1, j_2\ldots) + 0.43.X_C(j_1, j_2\ldots)$$

The sensitivity of the results to variations in choice of weight is described in Section 5.1.1.

5.1 Results

The full analysis was carried out first for all respondents who drove cars, as reported in Question 4b. However, the implicit focus of the project was to compare the accident liability of company drivers with that of similar non-company drivers. To improve this similarity, it was decided to repeat the analysis on that subsample of drivers who were in employment (based on Question 29). This allowed a check on whether the exclusion of drivers not in employment might dilute the effects of special interest. In fact there were only slight changes, but the second set of models (on the restricted sample) fitted the data rather better. Accordingly, the results presented below come from the analyses of data supplied by drivers in employment, while the results for all drivers are presented in Appendix A1.

5.1.1 The 'fleet driver effect' for injury accidents

The first two models to be described include the following explanatory variables: age, sex, annual mileage, percentage of mileage driven on motorways and, in Model 2 only, the percentage of mileage on work-related journeys. The reason for including the work-related mileage variable as a second step is to examine the consequences of its inclusion on other coefficients, especially that for annual mileage.

Table 17 lists the estimated coefficients together with their t-values and risk factors. The risk factor for a variable measures the extent to which it affects risk of being involved in an accident, compared with the risk associated with a reference level, so 1.00 implies no difference while 0.50 implies half the risk of the reference level.

Table 17 Model results

Explanatory variable	*Model 1*			*Model 2*		
Range	*Coeff -icient*	*t*	*Risk factor*	*Coeff -icient*	*t*	*Risk factor*
Age						
-35			1.00			1.00
36-45	-0.271	-3.9	0.76	-0.292	-4.1	0.75
46-55	-0.435	-5.9	0.65	-0.452	-6.1	0.64
>55	-0.486	-4.9	0.62	-0.501	-5.0	0.61
Sex						
Male			1.00			1.00
Female	0.113	1.78	1.12	0.128	2.00	1.14
Annual mileage						
-5100			1.00			1.00
-10100	0.086	0.79	1.09	0.095	0.87	1.10
-15100	0.085	0.76	1.09	0.074	0.66	1.08
-25100	0.113	0.93	1.12	0.056	0.45	1.06
>25100	0.178	1.41	1.19	0.079	0.61	1.08
% motorway mileage						
-25			1.00			1.00
26-50	-0.029	-0.43	0.97	-0.033	-0.49	0.97
>50	-0.143	-1.74	0.87	-0.146	-1.77	0.86
% work-related mileage						
0						1.00
1-30				0.122	1.57	1.13
31-55				0.077	0.80	1.08
56-80				0.057	0.62	1.06
>80				0.406	3.91	1.50

The lowest range for each variable is the reference and has risk factor=1.00

Most coefficients (and their derived risk factors) scarcely change when the work-related mileage variable is added to the model. The higher mileage coefficients fall, presumably because many high-mileage drivers have a high work-related mileage and part of the mileage effect is being taken up by the work-related mileage effect.

This raises the question of whether Model 2 is able to allocate reliably the extra accident risk of high-mileage drivers between the annual mileage variable and the work-related mileage variable. If these variables were highly correlated in the survey data then it would undoubtedly be difficult to isolate their effects in the statistical analysis, but this is not the case. Results from the GLIM program show that the correlation between the two highest mileage coefficients and the two highest work-related mileage coefficients lies between –0.19 and –0.29. Hence, the two sets of coefficients are largely independent and the modelling should indicate reliably the respective influences of annual mileage and percentage of work-related mileage on accident risk.

The principal result from Table 17 is that the accident risk of those who drive more than 80 per cent of their miles on work-related journeys is about 50 per cent greater than the risk for those who make no work-related journeys; i.e. the risk factor for over 80 per cent of mileage being work-related is about 1.5. There appears to be little variation among the three intermediate work-related mileage ranges; when they are amalgamated, the t-value of the coefficient rises to 1.84 and the risk factor is 1.13. Thus, among those who drive between 1 and 80 per cent of their miles on work-related journeys, the accident risk appears to be about 13 per cent greater than for drivers who make no work-related journeys.

Analysis of the survey data shows that a significant minority of drivers who made work-related journeys drove more than 80 per cent of their miles on work-related journeys. The percentage exceeded 80 for 30 per cent of the Company sample and 17 per cent of the DVLA sample. Combining these results gives a figure of 23 per cent for the composite sample.

5.1.2 Sensitivity to choice of weight

As explained in Section 4.1 the weighting factor of 0.43 was chosen so that the percentage of company-owned vehicles reported in the composite sample match the figure (38%) for company-owned vehicles up to three years old in Britain. Given the fact that the appropriate weighting factor is somewhat uncertain, it is important to examine the sensitivity of the key results presented in the previous section to the choice of weight. This has been done by refitting the model with two alternative weights, 0.36 and 0.50. For simplicity, this has been done with the model that combines the three intermediate work-related mileage ranges. As would be expected[4], when the weight increases, the last two annual mileage coefficients and the work-related mileage coefficients fall slightly: Table 18 shows the latter results in detail.

[4] As the weighting factor is increased, the proportion of drivers of company-registered cars in the composite sample increases. This decreases the apparent association of work-related driving and accidents since it makes the composite sample more like the accident-involved sample in terms of work-related driving.

Table 18 Sensitivity of work-related mileage coefficients to weighting factor

	1-80% of mileage work-related			*>80% of mileage work-related*		
Weight	*Coeff -icient*	*t*	*Risk factor*	*Coeff -icient*	*t*	*Risk factor*
0.36	0.15	2.25	1.16 (1.02,1.32)	0.45	4.39	1.57 (1.28,1.92)
0.43	0.12	1.84	1.13 (0.99,1.29)	0.42	4.13	1.53 (1.25,1.87)
0.50	0.10	1.47	1.10 (0.97,1.25)	0.40	3.89	1.49 (1.22,1.82)

95% confidence intervals for the estimated risk factors are shown in brackets.

It seems highly unlikely that the *true* weight is less than 0.36 or greater than 0.50. Thus, the conclusions drawn in the previous section about the risks of work-related mileage are largely insensitive to the exact choice of weight.

The confidence intervals in the table are calculated from the standard errors for the respective models. The central estimates of the risk factors are 1.13 and 1.53, corresponding to the estimate of 0.43 for the weight, but the true confidence intervals for these are a little wider than those shown since they should reflect the uncertainty over the true weight. This uncertainty cannot be quantified, so it is not feasible to estimate the true intervals. Nevertheless, the probability of the risk factor for the 1-80% range being greater than 1.00 is likely to exceed 0.95 while the factor for the >80% range is unquestionably greater than 1.00.

5.1.3 Annual mileage

The effect of annual mileage on accident risk, even in Model 1, is less than has been found in previous research. For example, Maycock *et al.* (1991) found that accident liability was proportional to mileage$^{0.28}$ (i.e. mileage raised to the power of 0.28) once factors such as age and sex had been taken into account. By contrast, the mileage risk factors for Model 1 are approximately equivalent to mileage$^{0.09}$. The mileage-related variation of the relative risk in Table 12 is closer to the earlier pattern, being equivalent to mileage$^{0.21}$, although the Table 12 risk analysis took no account of factors such as age and sex.

There appear to be two possible explanations for this. The first is that the mileage of some accident-involved drivers may have been reduced as a consequence of being involved in an accident. These were injury accidents, many of them serious, so some of these drivers may have been unable to drive for a period afterwards as a result of injury or loss of vehicle: others may have become less willing to drive. As a result of the survey design, these accidents were more serious on average than those reported by earlier surveys, and all drivers in sample (A) had been involved. This may have led to Sample A reporting an annual mileage lower than it would have been pre-accident. In contrast the composite sample would have been largely unaffected since these drivers were involved in very few injury accidents. The result would be to reduce the mileage of the accident-involved sample relative to the other samples and hence the apparent effect of mileage on accident risk. A similar suggestion was made in Section 4.4 regarding the attitudes and behaviours reported by the accident-involved sample – i.e. being involved in an injury accident may have affected drivers' attitudes and behaviour.

The other possible explanation is that the mileage reported by the company sample might be atypical. Section 4.2.1 compared the mileage of the company sample with the mileage of those drivers in the DVLA sample who reported work-related mileages. The DVLA figure was only 64 per cent of the company figure – suggesting, perhaps, that the mileage reported by the company sample may have been exaggerated. This would lead to a reduced mileage effect from the comparison of the accident-involved and composite samples. However, the evidence here is far from conclusive - company-registered vehicles may well tend to do higher mileages than privately registered vehicles used for work-related journeys.

Neither explanation implies that the estimated effect of other variables, in particular the proportion of work-related mileage, would be biased. However, the difference between the mileage effects found in this and previous studied is so great that these two explanations are unlikely to fully account for it. Thus, the possibility of bias cannot be excluded.

5.1.4 Selection bias

Section 4.2.2 pointed out that there is likely to have been some selection bias, in that companies with a better safety culture are probably more likely to have agreed to participate in the study. Such bias would only affect the estimated excess accident liability of company drivers reported above if the explanatory variables in the statistical model were themselves affected significantly by the selection bias. It seems unlikely that any of the variables actually included, such as age, sex, mileage and proportion of motorway mileage, were affected.

However, other types of result might have been affected. For example, the prevalence of 'unsafe' driving behaviours and attitudes amongst company drivers would tend to be under-estimated in the survey, so Table 14 may well underestimate the differences between company and 'typical' drivers. Similarly, the prevalence of training or other 'good' safety activities in the company driver population would tend to be over-estimated.

5.2 Effects of attitudes and behaviour

5.2.1 Factor scores as predictor variables in the statistical model

Section 4.4 described the factor analysis of the four questions relating to drivers' attitudes and behaviour. Expected differences in factor scores between accident and composite samples were not found, leading to the suggestion that responses of the accident-involved drivers may have been influenced by the experience of being involved in an injury accident.

One reason for including these questions in the survey was to introduce the responses into the risk analysis to see whether certain attitudes or behaviour may explain the high accident risk of company drivers to some extent. The possibility that the accident-involved drivers' responses to these questions are not the responses that they would have provided before being involved in an accident means that this cannot be tested rigorously, but the addition of these variables to the modelling might nevertheless be instructive.

Each of the eight factors was treated in turn. The data included in the new model for each respondent consisted of the data for the final model presented in Section 5.1, together with the quartile in which their score on that factor lay (the quartiles were established from the full responses to the relevant question provided by employed drivers). Thus, if their score was among the lowest 25 per cent of scores for that factor, they were in the first quartile and 1 was appended to their data. As reported in Section 4.4, respondents who had not answered all the relevant questions had to be excluded from the modelling process, so the model was fitted to a reduced set of respondents and the coefficient estimates differ slightly from those presented in Table 17. Nevertheless, the relative effects of adding this term to the model could then be assessed reliably.

The best way of expressing these coefficients is to compare the distribution of the accident-involved and composite samples of drivers between the four quartiles, once allowance has been made for the effects of the other factors included in the model. For example, if the result for the upper quartile for a particular question were -0.1 then the number of accident-involved drivers giving the 'least safe' answers to this question would be 90% of the number expected from the representative sample (exp[-0.1] = 0.90).

The results are presented in Table 19. The fit of a Generalised Linear Model is summarised by its 'scaled deviance', and the table includes the reduction of this statistic that resulted when each question was included. The questions are listed in declining order of the extent to which their inclusion improved the model. Indeed, the improvement provided by F7c is insufficient to justify its inclusion, while the the case for including F5a, F7b and F8b is not clear-cut. For example, the probability that the improvement apparently provided by F7b actually arose by chance is greater than 0.1, so the two samples could well match in respect of this factor.

The table shows the distribution of accident-involved drivers by score relative to the distribution of the composite sample, once allowance is made for the other variables included in the model. For example, 15 per cent fewer accident-involved drivers were in the upper quartile for F8a than would be expected from the answers of the representative sample of drivers, so accident-involved drivers were less likely than others to report 'dangerous violations'.

The factor that provides the greatest improvement to the model is the driving style factor (F7a) relating to self-assessment as an inattentive/careless/irresponsible/risky driver. Accident involved drivers are more likely than others to see themselves as 'safe' on this factor. The estimated coefficients for each quartile are statistically significant.. The next three factors show smaller shifts in the same direction, and all but two of the estimated coefficients are significant. Accident-involved drivers tended at the time of completing the questionnaire to describe themselves as less likely to commit dangerous violations, and to drive less often while tired or distracted by in-car tasks. Only one of the coefficients estimated for the remaining four factors is statistically significant, so there is little evidence here of any difference between accident-involved drivers and the rest.

The pattern in Table 19, which shows the effects of adding these factor scores to the full model is rather different from that of Table 14, which showed little difference between the raw mean scores for the injury accident-involved and composite samples of drivers. The earlier univariate comparison was not sufficient to bring out the full implications of these data.

Clearly, if it is true that reported attitudes and behaviours were affected by the experience of an injury accident, the coefficients in Table 19 should not be interpreted as risk factors. The responses reflect the *current* attitudes and behaviour of drivers who had been involved in injury accidents and do not necessarily indicate the pre-accident situation of the accident-involved drivers. This may be the explanation of the unexpected finding that accident-involved drivers scored as 'safer' than other drivers on some of these factors, and on the remainder scored about the same as other drivers.

5.2.2 Company drivers

In order to see whether certain attitudes or behaviour may help to explain the increased accident risk of company drivers, the intention was to examine the effect on the

Table 19 Interpretation of coefficients for each factor

		Relative size of:*			
Factor	*Improvement in fit*	*Lowest quartile*	*2nd quartile*	*3rd quartile*	*Upper quartile*
F7a - Attentive/Careful/Responsible/Safe vs the opposite	31.1	1.29	0.89	0.93	0.89
F8a - Dangerous violations	26.4	1.24	1.03	0.87	0.85
F6a - Fatigue	12.4	1.16	0.92	1.02	0.89
F6b - Distraction	10.9	1.17	1.01	0.93	0.89
F5a - Attitudes to driving violations	7.4	1.12	1.00	0.91	0.96
F7b - Placid/Patient/Considerate/Tolerant vs the opposite	5.6	1.03	0.93	0.94	1.10
F8b - Aggressive violations	3.9	1.02	0.94	0.95	1.08
F7c - Nervous/Slow vs the opposite	0.7	1.04	0.97	1.00	1.00

* *A value of 1.00 would denote that the accident-involved and composite samples had equal proportions of drivers with scores in that quartile once allowance has been made for the influence of the variables listed in Table 17 . Lowest quartile scores are those that would be expected to be most 'safe'.*

coefficients for Model 2 of adding the behavioural and attitudinal factor scores to the model. Naturally, the effects on the work-related mileage coefficients were of particular interest. This plan was frustrated by the finding in Section 5.2.1 that accident-involved drivers tended to score as 'safer' on these factors than did other drivers. If, as suggested above, that finding was due to the effects of injury accidents on subsequent attitudes and behaviour, then post-accident attitudes and behaviours can hardly be considered as possible predictors of accident liability. In fact, with one exception, the changes to the model coefficients are trivial by comparison with the standard errors of the coefficients. The exception is when F8a (Dangerous Violations) is added to the model, but even in this case the pattern of the changes does not allow higher accident risk to be explained in terms of higher violations.

The analyses described above do not rule out the possibility of attitudes or behaviour helping to explain company drivers' accident risk because accident-involved drivers' answers to these questions may have been affected by their experiences. However, there is an alternative, less direct, way of examining the issue that does not rely on the responses of accident-involved drivers. Section 5.1 showed that the accident risk increases modestly among drivers with up to 80 per cent of their mileage work-related, but that the increase is much greater among drivers with higher proportions of work-related mileage. Are there questions which these two groups of drivers answered differently? Table 14 presented the main results of the factor analysis; Table 20 develops Table 14 to compare drivers in the two work-related mileage ranges. Results are more reliable for the company sample because of the greater number of respondents, especially among those with high work-related mileages.

In both samples, the notable differences occur with F6a and F6b, the drivers with high proportions of work-related mileage tending to give answers that are 'less safe' – ie they have a greater tendency to drive while tired and while doing distracting in-car tasks. Differences are much less for the other six factors, and some scores are lower for the drivers with higher work-related mileages. This suggests that the increase in accident risk among drivers with higher work-related mileages may be related to the conditions under which they operate, rather than to their attitudes and style of driving.

In order to examine this result in more detail, Table B1 (Appendix B) presents the distribution of the responses to all items of Question 6 for the two groups in the Company sample. The chief differences are as follows, in diminishing order of magnitude:

Drivers with high proportions of work-related mileages:

a drive more between 2 and 5pm (Q6l);

b drive more often while using a hands-free mobile phone (Q6h);

c drive more often while eating or drinking (Q6f);

d drive more often when under time pressure to reach the destination (Q6b);

e drive more often on long journeys (more than 50 miles) after a full days work (Q6c).

Item (a) may simply reflect the amount of time spent driving rather than any intrinsic risk of driving at this time of the day. As regards mobile phone usage, it is interesting that the main difference between drivers who do more than 80% of their mileage for work purposes, and other drivers, arises mainly with hands-free phones (i.e. Q6g , dealing with hand-held phones, is not on the list). The risks of driving while using hand-held or hands-free mobile phone have been demonstrated by other research. It should be remembered, however, that concerns about the accident record of company drivers predate the widespread use of mobile phones, so this can only be a relatively recent contributory factor. The remaining three items relate to the pressures under which these drivers work. Item (c) loads very strongly on the 'distracted' factor, while items (d) and (e) load on both the distracted and the fatigue factors.

Questions 6e (driving while tired) and 6m (driving between midnight and 6am) do not appear in this list since the differences between the two groups are much less than for the five questions included. Drivers with high proportions of work-related mileages do tend to score as 'less safe' in both cases, however.

This alternative, indirect method of relating drivers' attitudes and responses to the results of the statistical modelling has led to some interesting conclusions. The results suggest that the increase in the accident risk of drivers with high proportions of work-related mileage may be related to the pressures under which they work, and the need for long car journeys after work, rather than any general characteristics of their driving behaviour. It should

Table 20 Mean scale scores from the Factor Analysis, by percentage of mileage that is work-related

	Company sample (C)		*DVLA sample (D)*	
Proportion of mileage that is work-related	*>80%*	*≤80%*	*>80%*	*≤80%*
F5a - Attitudes to driving violations	0.18	0.22	0.07	0.05
F6a - Fatigue	0.60	0.37	0.24	0.03
F6b - Distraction	0.75	0.42	0.12	-0.02
F7a - Attentive/Careful/Responsible/Safe vs the opposite	0.13	0.23	-0.13	0.00
F7b - Placid/Patient/Considerate/Tolerant vs the opposite	0.13	0.28	-0.18	0.02
F7c - Nervous/Slow vs the opposite	0.13	0.07	0.07	-0.02
F8a - Dangerous violations	0.22	0.24	0.04	0.01
F8b - Aggressive violations	0.11	0.09	-0.06	-0.01

'Safe/responsible' answers lead to negative scores while 'unsafe/irresponsible' answers lead to positive scores

be noted, however, that there is no direct evidence *arising from this study* that these pressures are causally related to accidents. Rather, the study demonstrates that a group of drivers with very high proportions of work-related mileage tend to have an elevated accident risk and tend also to drive while fatigued and while potentially distracted by in-car tasks. Other research, referenced earlier, demonstrates that these are indeed risk factors in driving.

6 Conclusions

1 This project applied a new methodology that focused on injury accidents, and enabled a direct estimate to be made of the excess liability of company drivers to such accidents. The methodology used by previous research into accident liability has involved surveying general population samples of drivers. This meant that their reported accidents were mainly 'damage-only' because of the relatively low incidence of injury accidents in Great Britain. Thus, the previous work provided estimates of the excess liability of company drivers for damage-only accidents, but left open the question of whether a similar excess would exist for injury accidents.

2 The main analysis consisted of fitting a statistical model to the responses to a selected set of questions of the accident-involved and composite samples. The results showed drivers who drove more than 80 per cent of their annual mileage on work-related journeys had about 53 per cent more injury accidents than otherwise similar drivers who did no work-related mileage. The 95% confidence interval for this estimate is between 25 and 87 per cent. Drivers whose work-related journeys accounted for 1-80 per cent of their total mileage had, on average, about 13 per cent more accidents than non-work drivers who were otherwise similar in terms of age, sex and mileage (95% confidence interval between -1 and +29 per cent). These results are largely insensitive to credible variations in the value of the weighting factor used to combine the company and DVLA samples. Almost one quarter (23 per cent) of drivers who did work-related mileage drove more than 80 per cent of their mileage on these journeys.

3 High-mileage drivers also tend to have high work-related mileages, so in principal it might have proved impossible to separate the effects on accident risk of annual mileage and of the proportion that is work-related. The diagnostic statistics for the model show that this was not a problem. The data set contained enough high-mileage drivers with a high non-work mileage to allow the effects to be identified separately.

4 The estimated effect of total mileage on accident risk was less than had been found by previous research. That is, accident-involved drivers did tend to have higher annual mileages than others drivers, but the effect was less than had been found in previous research. One possible explanation is that some drivers may have been unable to drive for a period as a result of injury or loss of vehicle, while others may have become less willing to drive following their injury accident. This may have caused the overall mileage reported by accident-involved drivers to under-estimate their annual mileage *before* the accident, which is what is needed for the statistical modelling of risk. It seems unlikely, however, that this would account fully for the difference.

5 A simple comparison between the company sample and the DVLA sample largely reinforced 'received wisdom' about the differences between company drivers and other drivers. Company drivers' responses showed them to be relatively hostile to traffic laws, more likely to drive under time-pressure, while tired, and while undertaking distracting or cognitively demanding tasks, and less likely to consider themselves responsible and safe drivers. Their reported willingness to perform 'dangerous violations' (potentially dangerous departures from the rules of good, safe driving was greater than for drivers in the DVLA sample, but their reported level of aggressive driving behaviour was only slightly greater. There were smaller differences among the company sample relating to their level within the company. For example, senior managers were more likely report dangerous violations than staff at lower levels in the company. Conversely, annual mileage and the proportion of that mileage that was work-related were lower among the higher levels in the company.

6 A similar comparison between the accident-involved and composite (representative) driver samples gave an unexpected result. While it was expected that accident-involved drivers would be 'more risky' on most of the above behavioural variables, the scores of the two samples were in fact very similar. A possible explanation for this similarity is that the accident-involved drivers' attitudes and behaviour had been affected by the experience of being involved in an injury accident, and that these effects persisted at the time when they answered the questionnaire.

7 Adding the factor scores for the behavioural questions to the statistical model also produced unexpected results. After adjustment for the effects of the other variables in the model, accident-involved drivers were *more* likely than other drivers to describe themselves as responsible and safe, and *less* likely to report dangerous violations while driving, driving while fatigued, or driving while distracted. Again, this is interesting (although not conclusive) evidence that being involved in an injury accident may have a salutary effect, at least temporarily, on a driver's behaviour and attitudes.

8 To explore the possible reasons for company drivers' excess accident liability, the original intention was to see whether incorporating the above behavioural variables in the statistical model influenced (and thus helped to explain) the apparent importance of proportion of work-related mileage as a predictor of accidents. In fact, this analysis did not produce useful results – as the findings described at item 7 would imply. An alternative

approach was then followed to identify differences between company and private drivers that might help to explain their differences in accident liability. The responses of drivers whose work-related journeys accounted for up to 80 per cent of their total mileage were compared with the responses of those whose percentages exceeded 80 – the latter group having been shown to have the greater accident risk.

9 The results suggest that the increase in the accident risk of drivers with high proportions of work-related mileage are related to the pressures under which they work, and the need for long car journeys after work, rather than to general characteristics of their driving behaviour. It should be noted, however, that there is no direct evidence *arising from this study* that these pressures are causally related to accidents. Rather, the study demonstrates that a group of drivers with very high proportions of work-related mileage tend to have an elevated accident risk and tend also to drive while fatigued, under time-pressure, and while distracted by in-car tasks. Other research demonstrates that these are indeed risk factors in driving.

10 More detailed analysis showed that using a hands-free mobile phone, being under time pressure to reach a destination, driving while eating and drinking, and having to make a long journey after a full day's work were the items that particularly distinguished between those company drivers who do very high proportions of work related mileage, and other company drivers.

7 Recommendations

The main finding from this project greatly strengthens the case for action to tackle the risks of work-related driving. Car drivers with high proportions of work-related mileage have about a 50% greater risk of *injury* accidents than other drivers of similar age, sex, annual mileage and motorway mileage. This reinforces findings from earlier research, which found an excess liability for 'all accidents' (mainly damage-only accidents).

The survey was not able to provide direct evidence linking the excess risk of work-related driving to particular attitudes and behaviours of company drivers or to the situations in which they drive. This may have been because people tended to modify their attitudes and behaviours after experiencing an injury accident – preventing the survey from assessing the true 'before accident' situation regarding these variables. However, there was much indirect evidence on the risk-related aspects of company driving. In particular, the highest risk drivers (those with very high proportions of work-related mileage) drove more often:

- in situations known to make drivers susceptible to fatigue and drowsiness (e.g. driving on long journeys (more than 50 miles) after a full days work;
- when under time-pressure to reach a destination;
- when conducting potentially distracting in-car tasks such as mobile phone conversations, eating and drinking.

Given the existing evidence on the importance of fatigue in accidents, the relation between speed and safety, and the effects of mobile phone conversations on driver performance, these findings give a strong indication of where priorities for action should lie. They suggest, for example, that companies should not attempt to deal with the work-related road risk simply by introducing measures aimed at improving driver training. Rather, they need to change the conditions under which their employees drive, so that time pressure and fatigue are reduced, and attention-demanding in-car tasks like mobile phone conversations are strongly discouraged.

Devising detailed policies to achieve such ends does not form part of this project, but there is clearly a need for employers to treat the problem seriously, and to introduce measures to tackle it. Better quantification of the costs that work-related road accidents impose on employers might help to improve the situation.

This project suggests that they need to consider such policies as:

- Requiring drivers to retrieve telephone messages once they have stopped for a break, rather than have telephone conversations while driving.
- Examining work schedules to ensure that drivers are not pressured by time.
- Ensuring that people do not drive long journeys after a full day's work. This could mean encouraging employees to work from home. It could also mean ensuring that there is a policy within the company to encourage employees attending distant meetings to stay in a hotel overnight rather than drive back the same evening.

Unless companies adopt such policies, the effectiveness of driver-centred interventions such as selection and training may be undermined by day to day working practices and pressures.

8 Acknowledgements

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Appendix A: Statistical method

Section 3 gave a general introduction to the principle of the new methodology. This appendix now develops the statistical method used to analyse the survey responses to assess the factors that influence accident risk. This will refer to an ‘idealised’ project, the main report has shown that the application of the technique to the current project was a little more complicated.

Table A1 Model results (equivalent to Table 16)

Explanatory variable	*Model 1*			*Model 2*		
Range	*Coeff -icient*	*t*	*Risk factor*	*Coeff -icient*	*t*	*Risk factor*
Age						
-35			1.00			1.00
36-45	-0.259	-3.8	0.77	-0.276	-4.0	0.76
46-55	-0.392	-5.6	0.68	-0.406	-5.8	0.67
>55	-0.806	-10.2	0.45	-0.795	-10.0	0.45
Sex						
Male			1.00			1.00
Female	0.067	1.17	1.07	0.078	1.35	1.08
Annual mileage						
-5100			1.00			1.00
-10100	0.117	1.33	1.12	0.123	1.40	1.13
-15100	0.134	1.43	1.14	0.126	1.32	1.13
-25100	0.160	1.52	1.17	0.102	0.93	1.11
>25100	0.210	1.89	1.23	0.107	0.91	1.11
% motorway mileage						
-25			1.00			1.00
26-50	-0.024	-0.41	0.98	-0.029	-0.48	0.97
>50	-0.148	-1.89	0.86	-0.152	-1. 94	0.86
% work-related mileage						
0						1.00
1-30				0.076	1.02	1.08
31-55				0.056	0.60	1.06
56-80				0.050	0.56	1.05
>80				0.384	3.82	1.47

The lowest range for each variable is the reference and has risk factor=1.00

As mentioned in Section 3 there are two samples:

sample R - a Representative sample of drivers,

sample A - a parallel representative sample of drivers who are known to have been involved recently in an Accident, surveyed using the same questionnaire.

The same selection criteria should in principle be applied in selecting each sample. For example, the sample of accident-involved drivers in the current project was restricted to drivers of cars up to 3 years old, in order to maximise the coverage of work-related travel. Consequently, the parallel representative sample was also restricted to cars from the same age range.

Consider a particular binary factor F that might influence accident risk and was included in the questionnaire. Suppose for the moment that the drivers in the two samples are matched for items such as age, sex and mileage. Let:

P_R = proportion of drivers in representative sample R who reported factor F;

P_A = proportion of accident-involved drivers who reported factor F;

L = likelihood that the driver *without* factor F will be involved in an accident in a year (or other time period chosen for the survey);

$\theta.L$ = likelihood that the driver *with* factor F will be involved in an accident in a year – so θ measures the influence of factor F on accident risk.

If sample R is truly representative then P_R is the proportion of drivers with factor F in the population of cars and drivers covered by the survey. In a group of drivers *from the same underlying population* with overall exposure = X driver-years, we would expect:

$X.(1-P_R).L$ drivers *without* factor F to have been involved in an accident;

$X.P_R.\theta.L$ drivers *with* factor F to have been involved in an accident.

Hence

$$P_A = X.P_R.\theta.L/\{X.P_R.\theta.L + X.(1-P_R).L\}$$
$$= P_R.\theta/\{P_R.\theta + (1-P_R)\}$$

$$\text{so } \theta = \{ P_A.(1-P_R) \} / \{ P_R.(1-P_A) \} \qquad (1)$$

If $P_A = P_R$ then $\theta = 1$, i.e. factor F has no effect on accident risk. If 50% of drivers have factor F then $P_R = 0.5$ and $\theta = P_A / (1-P_A)$: if $P_A < 0.5$ then $\theta < 1.0$ and factor F is associated with relatively few accidents, whereas if $P_A > 0.5$ then $\theta > 1.0$ and it is associated with relatively many.

The essence of the technique is that P_R is estimated from the representative sample (Sample R) of the driver population of interest, and P_A is estimated from the representative sample of accident-involved drivers (Sample A) Note that the proportion of drivers in either sample who have had accidents is not used in the analysis.

It has been assumed that factor F was binary, e.g. sex of driver. The approach can be developed for use with multiple variables that have three or more possible values. The GLIM program is used to model the survey data, so its treatment of *categorical* variables is highly relevant. For each categorical variable, a reference value is specified and GLIM estimates the effect of the other values relative to the effect of this reference value. In the example of driver sex, male could be taken as the reference value so that GLIM would estimate the accident risk for female drivers relative to the risk for males.

This approach will be followed in developing the equation (1). Suppose that variable V has the possible values $\{v_0, v_1 \ldots v_n\}$ and that v_0 is the reference value. For

$v \neq v_0$, let $P_R(v)$, $P_A(v)$, $L(v)$ and $\theta(v)$ be defined as follows:

$P_R(v)$ = proportion of drivers in representative sample R who report this value for variable V;

$P_A(v)$ = proportion of accident-involved drivers (sample A) who report this value for variable V;

$L(v_0)$ = likelihood that a driver who reported the reference value for variable V will be involved in an accident in a year;

$\theta(v).L(v_0)$ = likelihood that a driver who reported value v will be involved in an accident in a year – so $\theta(v)$ measures the accident risk of this value relative to the risk associated with the reference value v_0.

If sample R is truly representative then $P_R(v)$ is the proportion of drivers in the population of covered by the survey with value v. In a group of drivers *from the same underlying population* with overall exposure = X driver-years, we would expect:

$X.P_R(v).\theta(v).L(v_0)$ drivers with value v to have been involved in an accident;

$X.P_R(v_0).L(v_0)$ drivers with the reference value v_0 to have been involved in an accident.

Hence in A, the sample of accident-involved drivers, the expected ratio of the number of drivers with value v to the number with value v_0 is:

$$P_A(v) / P_A(v_0) = \{P_R(v).\theta(v)\} / P_R(v_0)$$

$$\text{so} \quad \theta(v) = \{ P_A(v) / P_A(v_0) \} / \{ P_R(v) / P_R(v_0)\} \qquad (2)$$

Suppose, for example, that v occurs as frequently as v_0 in the random survey R [so that $P_R(v)=P_R(v_0)$] but less frequently in the survey of accident-involved drivers, A [so that $P_A(v)<P_A(v_0)$]. This would mean that v was associated with less risk than v_0, and indeed from (2) we have $\theta(v)<1$. For a binary variable such as sex of driver, $P_R(v_0) = 1- P_R(v)$ and $P_A(v_0) = 1 - P_A(v)$, so (1) is a special case of (2). (2) can be re-arranged:

$$\theta(v) = \{ P_A(v) / P_R(v)\} / \{ P_A(v_0) / P_R(v_0)\} \qquad (3)$$

so the influence of v can be modelled as

$$X_A(v) = X_R(v) . f(v)$$

where X_A and X_R are the respective counts in the survey data and f is a suitable function of v.

This can be generalised to include multiple explanatory variables, i.e.

$$X_A(v) = X_R(v) . f(v^1, v^2 \ldots)$$

f is taken as the exponential function because of the multiplicative nature of risk, so the following model is fitted:

$$X_A(v) = X_R(v) . \exp(\alpha^0 + \alpha^1 + \alpha^2 \ldots)$$

where $\alpha^0, \alpha^1, \alpha^2 \ldots$ are coefficients to be determined.

A1 Results for all drivers

The introduction to Section 5.1 explained that a full analysis was carried out for data from:

all respondents,

drivers in employment.

Results from the second set of models were presented in Section 5.1, and this Appendix presents the results from the first set for comparison.

The chief effects of removing the restriction to employed drivers have been to increase the '% work-related mileage' coefficients and to reduce the 'annual mileage' coefficients slightly. The risk factor for the oldest drivers is reduced, but the new model fits the data less well. Table A2 shows a similar level of sensitivity to the weighting factors, but the coefficients are less and the significance of the effect for the lower mileage range is reduced.

Table A2 Sensitivity of work-related mileage coefficients to weighting factor (equivalent to Table 17)

	1-80% of mileage work-related			*>80% of mileage work-related*		
Weight	*Coeff -icient*	*t*	*Risk factor*	*Coeff -icient*	*t*	*Risk factor*
0.36	0.12	1.88	1.12 (1.00,1.27)	0.42	4.26	1.53 (1.26,1.86)
0.43	0.09	1.45	1.09 (0.97,1.23)	0.40	3.99	1.49 (1.22,1.81)
0.50	0.06	1.04	1.07 (0.95,1.20)	0.37	3.74	1.45 (1.19,1.76)

95% confidence intervals for the estimated risk factors are shown in brackets.

Appendix B: Factor structures

Shaded columns indicate the factor solutions selected.

Question 5. Please indicate your level of agreement or disagreement with the following statements?

[Strongly agree / Agree / Neither agree nor disagree / Disagree / Strongly disagree]

	Single Factor
(a) Decreasing the speed limit on the motorways is a good idea.	0.546
(b) Even at night time on quiet roads it is important to keep within the speed limit.	0.579
(c) Drivers who cause accidents by reckless driving should be banned from driving for life.	0.456
(d) People should drive slower than the speed limit when it is raining.	0.463
(e) Cars should never overtake on the inside lane even if a slow driver is blocking an outside lane.	0.417
(f) In towns where there are a lot of pedestrians the speed limit should be 20mph.	0.410
(g) Penalties for speeding should be more severe.	0.729
Percentage of variance	28%

Question 6. How often do you drive …

[Never / Hardly ever / Occasionally / Quite often / Frequently / Nearly all the time]

	Number of factors generated		
	Two		One
	1	2	1
(a) Sound your horn to indicate your annoyance to another road user.		0.564	0.348
(b) Pull out of a junction so far that the driver with right of way has to stop and let you out.	0.346		0.420
(c) Disregard the speed limit on a residential road.	0.641		0.577
(d) Become angered by another driver and give chase with the intention of giving him/her a piece of your mind.		0.399	0.332
(e) Stay in a motorway lane that you know will be closed until the last minute before forcing your way into the other lane.	0.437		0.481
(f) Overtake a slow driver using an inside lane.	0.484		0.524
(g) Race away from traffic lights with intention of beating the driver next to you.	0.460	0.330	0.571
(h) Drive so close to the car in front that it would be difficult to stop in an emergency.	0.498		0.528
(i) Cross a junction knowing that the traffic lights have already turned against you.	0.381		0.445
(j) Become angered by a certain type of a driver and indicate your hostility by whatever means you can.		0.609	0.480
(k) Disregard the speed limit on the motorway.	0.694		0.613
Percentage of variance	19%	11%	24%
Cumulative percentage	19%	30%	24%

Question 7. As a driver do you think you are … ?

[Choice of seven tick boxes]

	Number of factors generated					
	Three			Two		One
	1	2	3	1	2	1
(a) Attentive or Inattentive	0.685			0.699		0.579
(b) Careful or Careless	0.783			0.768		0.716
(c) Irritable or Placid		-0.743			-0.667	-0.474
(d) Nervous or Confident			0.721			
(e) Patient or Impatient		0.690			0.759	0.631
(f) Responsible or Irresponsible	0.724			0.696		0.715
(g) Safe or Risky	0.778			0.758		0.711
(h) Selfish or Considerate		-0.533			-0.502	-0.549
(i) Slow or Fast			0.464		0.348	
(j) Tolerant or Intolerant		0.713			0.752	0.622
Percentage of variance	24%	21%	8%	23%	22%	33%
Cumulative percentage	24%	45%	53%	23%	45%	33%

Question 8. When driving, how often do you do each of the following?

[Never / Hardly ever / Occasionally / Quite often /Frequently / Nearly all the time]

	Number of factors generated					
	Three			Two		One
	1	2	3	1	2	1
(a) … after having had less than a full night's sleep?	0.602				0.621	0.558
(b) … when under time pressure to reach your destination?	0.575	0.304	0.325	0.433	0.586	0.725
(c) … on long journeys (more than 50 miles) after a full days work?	0.383		0.498	0.467	0.419	0.633
(d) … while thinking/worrying about other non-driving related issues?	0.580			0.392	0.579	0.689
(e) … when tired?	0.760			0.310	0.743	0.726
(f) … while eating or drinking?		0.627	0.309	0.670		0.647
(g) … while using a hand-held mobile phone?		0.566		0.395		0.415
(h) … while using a hands-free mobile phone?			0.774	0.494		0.544
(i) … while reading a map?		0.536		0.633		0.538
(j) … while searching for signs or directions?		0.342		0.455		0.507
(k) … while smoking?						
(l) … between the hours of 2pm and 5pm?						
(m) … between the hours of midnight and 6am?					0.308	
Percentage of variance	16%	12%	10%	17%	17%	29%
Cumulative percentage	16%	28%	38%	17%	34%	29%

Responses to Question 6

Figure 3 (Section 4.4.2) compared the responses of company and private drivers to certain items of Question 6 (private drivers were those in the DVLA sample who made no work-related journeys). Table B1 provides the responses to all items, differentiating between company drivers according to their work-related mileage. A ‘mean score’ is included to allow a simple but crude comparison: it is calculated by scoring 1 for ‘never’, 2 for ‘hardly ever’…6 for ‘nearly all the time’.

The largest differences between the two groups of company drivers arise with 6h (use of hands-free mobile phone), 6b (time pressure) and 6c (long journey after work), although it is interesting that there is little difference overall with 6h (driving while tired) and 6m (driving between midnight and 6am). Another large difference arises with 6l (driving between 2 and 5pm), which is reported to be more common among drivers with low work-related mileages.

The detailed results for Questions 5, 7 and 8 for company drivers have also been disaggregated by the percentage of mileage that is work-related. There are no differences of note, certainly none to be compared with those in Table B1, so these results are not presented.

Table B1 Distribution of responses to Question 6

Question 6. How often do you drive …

	Never	*Hardly ever*	*Occas -ionally*	*Quite often*	*Freq -uently*	*Nearly all the time*	*Mean score*
(a) … after having had less than a full night’s sleep?							
C1	6%	38%	40%	10%	5%	1%	2.7
C2	7%	32%	42%	10%	8%	2%	2.9
D	27%	42%	22%	5%	3%	1%	2.2
(b) … when under time pressure to reach your destination?							
C1	2%	13%	43%	26%	15%	2%	3.4
C2	2%	10%	34%	26%	23%	6%	3.8
D	18%	36%	33%	9%	4%	1%	2.5
(c) … on long journeys (more than 50 miles) after a full days work?							
C1	2%	25%	36%	17%	13%	6%	3.3
C2	5%	20%	25%	20%	17%	13%	3.6
D	57%	30%	10%	2%	1%	1%	1.6
(d) … while thinking/ worrying about other non-driving related issues?							
C1	1%	13%	37%	27%	19%	3%	3.6
C2	3%	14%	32%	22%	22%	7%	3.7
D	15%	30%	40%	10%	4%	1%	2.6
(e) … when tired?							
C1	2%	19%	50%	19%	9%	0%	3.1
C2	3%	21%	41%	21%	13%	1%	3.2
D	21%	36%	33%	6%	2%	0%	2.3
(f) … while eating or drinking?							
C1	22%	34%	31%	8%	4%	0%	2.4
C2	19%	26%	32%	13%	8%	2%	2.7
D	60%	25%	13%	2%	1%	0%	1.6
(g) … while using a hand-held mobile phone?							
C1	61%	24%	11%	2%	1%	0%	1.6
C2	57%	23%	14%	5%	1%	1%	1.7
D	81%	13%	5%	1%	0%	0%	1.3
(h) … while using a hands-free mobile phone?							
C1	31%	7%	20%	18%	21%	4%	3.0
C2	18%	6%	18%	20%	28%	11%	3.7
D	87%	4%	6%	2%	1%	0%	1.3
(i) … while reading a map?							
C1	46%	32%	19%	2%	0%	0%	1.8
C2	44%	31%	18%	5%	2%	1%	1.9
D	81%	15%	5%	0%	0%	0%	1.2
(j) … while searching for signs or directions?							
C1	5%	15%	52%	19%	8%	1%	3.1
C2	7%	15%	39%	23%	13%	3%	3.3
D	18%	27%	45%	7%	2%	0%	2.5
(k) … while smoking?							
C1	81%	2%	4%	3%	7%	2%	1.6
C2	81%	2%	3%	4%	6%	4%	1.6
D	89%	2%	3%	2%	2%	2%	1.3
(l) … between the hours of 2pm and 5pm?							
C1	3%	16%	32%	19%	21%	9%	3.7
C2	3%	12%	17%	14%	24%	30%	4.3
D	7%	13%	22%	25%	27%	7%	3.7
(m)… between the hours of midnight and 6am?							
C1	11%	60%	23%	3%	2%	0%	2.2
C2	13%	54%	26%	4%	3%	1%	2.3
D	31%	50%	14%	2%	2%	0%	1.9

C1 = Company drivers with 80% of mileage work-related.
C2 = Company drivers with >80% of mileage work-related.
D = DVLA drivers who made no work-related journeys.

DRIVING SURVEY

Please complete this questionnaire by ticking the appropriate boxes and filling in the spaces as required. It will only take about 15 minutes to complete and any information you provide will be *completely anonymous* and will be treated in the *strictest confidence* and used for research purposes only.

SECTION A: YOUR DRIVING EXPERIENCE

Q1 Do you have a full driving licence? (*Tick one box only*)

Yes ☐1 ➡ **IF 'YES', for about how long have you had your licence? (*Please write in years*)**

____________ **years**

No ☐2 ➡ **Go to Q29**

Q2 Approximately, how many miles do you drive per year?

________________ miles

Q3 What percentage (%) of your annual mileage would you estimate driving on each of the following...?

(i) Motorways ____
(ii) Roads in built-up areas ____
(iii) Roads in non-built up areas ____

Total ***100%***

Q4 (a) What is the make and model of the vehicle that you drive MOST FREQUENTLY? (*Please write in full*)

Make (e.g. Vauxhall) __________________ Model (e.g. Corsa) __________________

(b) What type of vehicle is it? (*Please tick one box only*)

(i)	Car (including 'people carriers')	☐1	(v)	Truck	☐5
(ii)	Motorcycle	☐2	(vi)	4x4	☐6
(iii)	Van (up to 3500kg/ large transit size)	☐3	(vii)	Other (please write in) ______________	☐7
(iv)	Large van/ lorry (over 3500kg)	☐4			

(c) What colour is this vehicle? (*Please write in full*)

____

Q5 Please indicate your level of agreement or disagreement with the following statements?

		Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
(a)	Decreasing the speed limit on the motorways is a good idea	☐1	☐2	☐3	☐4	☐5
(b)	Even at night time on quiet roads it is important to keep within the speed limit	☐1	☐2	☐3	☐4	☐5
(c)	Drivers who cause accidents by reckless driving should be banned from driving for life	☐1	☐2	☐3	☐4	☐5
(d)	People should drive slower than the speed limit when it is raining	☐1	☐2	☐3	☐4	☐5
(e)	Cars should never overtake on the inside lane even if a slow driver is blocking an outside lane	☐1	☐2	☐3	☐4	☐5
(f)	In towns where there are a lot of pedestrians the speed limit should be 20mph	☐1	☐2	☐3	☐4	☐5
(g)	Penalties for speeding should be more severe	☐1	☐2	☐3	☐4	☐5

Q6 How often do you drive... : (*Tick one box per line*)

		Never	Hardly ever	Occas-ionally	Quite often	Freq-uently	Nearly all the time
(a)	...after having had less than a full night's sleep?	☐1	☐2	☐3	☐4	☐5	☐6
(b)	...when under time pressure to reach your destination?	☐1	☐2	☐3	☐4	☐5	☐6
(c)	...on long journeys (more than 50 miles) after a full days work?	☐1	☐2	☐3	☐4	☐5	☐6
(d)	...while thinking/ worrying about other non-driving related issues?	☐1	☐2	☐3	☐4	☐5	☐6
(e)	...when tired?	☐1	☐2	☐3	☐4	☐5	☐6
(f)	...while eating or drinking?	☐1	☐2	☐3	☐4	☐5	☐6
(g)	...while using a hand-held mobile phone?	☐1	☐2	☐3	☐4	☐5	☐6
(h)	...while using a hands-free mobile phone?	☐1	☐2	☐3	☐4	☐5	☐6
(i)	...while reading a map?	☐1	☐2	☐3	☐4	☐5	☐6
(j)	...while searching for signs or directions?	☐1	☐2	☐3	☐4	☐5	☐6
(k)	...while smoking?	☐1	☐2	☐3	☐4	☐5	☐6
(l)	...between the hours of 2pm and 5pm?	☐1	☐2	☐3	☐4	☐5	☐6
(m)	...between the hours of midnight and 6am?	☐1	☐2	☐3	☐4	☐5	☐6

Q7 As a driver, do you think you are....? (Put a tick nearer to the word that best describes your driving; the closer a tick is to a word the more you agree with its description of your driving).

(a)	Attentive	☐1	☐2	☐3	☐4	☐5	☐6	☐7	Inattentive
(b)	Careful	☐1	☐2	☐3	☐4	☐5	☐6	☐7	Careless
(c)	Irritable	☐1	☐2	☐3	☐4	☐5	☐6	☐7	Placid
(d)	Nervous	☐1	☐2	☐3	☐4	☐5	☐6	☐7	Confident
(e)	Patient	☐1	☐2	☐3	☐4	☐5	☐6	☐7	Impatient
(f)	Responsible	☐1	☐2	☐3	☐4	☐5	☐6	☐7	Irresponsible
(g)	Safe	☐1	☐2	☐3	☐4	☐5	☐6	☐7	Risky
(h)	Selfish	☐1	☐2	☐3	☐4	☐5	☐6	☐7	Considerate
(i)	Slow	☐1	☐2	☐3	☐4	☐5	☐6	☐7	Fast
(j)	Tolerant	☐1	☐2	☐3	☐4	☐5	☐6	☐7	Intolerant

Q8 When driving, how often do you do each of the following? (*Tick one box per line*)

		Never	Hardly ever	Occas-ionally	Quite often	Freq-uently	Nearly all the time
(a)	Sound your horn to indicate your annoyance to another road user	☐1	☐2	☐3	☐4	☐5	☐6
(b)	Pull out of a junction so far that the driver with right of way has to stop and let you out	☐1	☐2	☐3	☐4	☐5	☐6
(c)	Disregard the speed limit on a residential road	☐1	☐2	☐3	☐4	☐5	☐6
(d)	Become angered by another driver and give chase with the intention of giving him/her a piece of your mind	☐1	☐2	☐3	☐4	☐5	☐6
(e)	Stay in a motorway lane that you know will be closed until the last minute before forcing your way into the other lane	☐1	☐2	☐3	☐4	☐5	☐6
(f)	Overtake a slow driver using an inside lane	☐1	☐2	☐3	☐4	☐5	☐6
(g)	Race away from traffic lights with intention of beating the driver next to you	☐1	☐2	☐3	☐4	☐5	☐6
(h)	Drive so close to the car in front that it would be difficult to stop in an emergency	☐1	☐2	☐3	☐4	☐5	☐6
(i)	Cross a junction knowing that the traffic lights have already turned against you	☐1	☐2	☐3	☐4	☐5	☐6
(j)	Become angered by a certain type of a driver and indicate your hostility by whatever means you can	☐1	☐2	☐3	☐4	☐5	☐6
(k)	Disregard the speed limit on the motorway	☐1	☐2	☐3	☐4	☐5	☐6

SECTION B: ACCIDENTS

In this section we are interested to know about any accidents that you may have had whilst driving (NOT as a passenger) during the last 12 months. By accident we mean any incident which involved damage to property, damage to your vehicle or someone else's, or injury to you or another person, and which may have occurred on a public road or company owned 'site' or business premises.

If you have not been involved in an accident during the last 12 months please tick the appropriate box in Q9 and go to Q16 Section C.

Q9 Have you had any accidents while driving during the last 12 months?

Yes ☐1 ➡ IF 'YES' how many? ____________

No ☐2 ➡ **Go to Q16**

The rest of this section asks questions relating to accidents that you have been involved in while driving during the last 12 months. If you have had more than 2, please tell us about the 2 most recent ones

Please answer the following questions as honestly as you can, remembering that all answers you give will be treated in the **strictest confidence**.

Q10 In what month and year did each accident happen? (e.g. Jan/2001)

Most recent accident __ __ __ / __ __ __ __

Accident before that __ __ __ / __ __ __ __

Q11 On what type of road did the accident(s) occur?

		Most recent accident	Accident before that
(i)	Motorway	☐1	☐1
(ii)	Road in a built up area	☐2	☐2
(iii)	Road in a non-built up area	☐3	☐3
(iv)	Within Business premises/Company 'site'/ etc.	☐4	☐4

Q12 Below is a list of statements describing what may have occurred during the accident(s). Please read *all* of the alternatives and tick which statement *best* describes the *first* impact in each accident?

		Most recent accident	Accident before that
(a)	Your vehicle hit a pedestrian	☐1	☐1
(b)	Your vehicle hit a cyclist	☐2	☐2
(c)	Your vehicle hit the rear of another vehicle	☐3	☐3
(d)	Your vehicle hit the side of another vehicle	☐4	☐4
(e)	Another vehicle hit the rear of your vehicle	☐5	☐5
(f)	Another vehicle hit the side of your vehicle	☐6	☐6
(g)	Your vehicle was hit by an oncoming vehicle in *your* lane	☐7	☐7
(h)	Your vehicle hit an oncoming vehicle in *their* lane	☐8	☐8
(i)	Your vehicle hit a road side object	☐9	☐9
(j)	Your vehicle left the road without hitting any other object	☐10	☐10
(k)	Your car rolled over	☐11	☐11
(l)	Other (please specify)____________	☐12	☐12

Q13 What injuries were received by anyone involved in the accident(s)?
(If no one was injured in the accident(s), please show this by ticking the appropriate box).

		Most recent accident	Accident before that
(a)	**YOU**		
(i)	Not injured	☐1	☐1
(ii)	Slight injuries (e.g. cuts/bruises)	☐2	☐2
(iii)	Serious injuries (e.g. broken bones, or any permanent damage)	☐3	☐3
(b)	**Any passenger(s) in your vehicle** ***(Tick all that apply)***		
(i)	No passenger(s) in your vehicle	☐1	☐1
(ii)	No passenger(s) injured	☐2	☐2
(iii)	Slight injuries (e.g. cuts/bruises)	☐3	☐3
(iv)	Serious injuries (e.g. broken bones, or any permanent damage)	☐4	☐4
(v)	Fatal	☐5	☐5

		Most recent accident	Accident before that
(c)	**Driver or passenger in other vehicles (including motorcycles)** ***(Tick all that apply)***		
(i)	No other vehicle involved	❑1	❑1
(ii)	No injuries in any other vehicle	❑2	❑2
(iii)	Slight injuries (e.g. cuts/bruises)	❑3	❑3
(iv)	Serious injuries (e.g. broken bones, or any permanent damage)	❑4	❑4
(v)	Fatal	❑5	❑5
(d)	**Pedestrian(s) or pedal-cyclist(s)** *(Tick all that apply)*		
(i)	No pedestrians or cyclists involved	❑1	❑1
(ii)	No pedestrians etc. were injured	❑2	❑2
(iii)	Slight injuries (e.g. cuts/bruises)	❑3	❑3
(iv)	Serious injuries (e.g. broken bones, or any permanent damage)	❑4	❑4
(v)	Fatal	❑5	❑5

Q14 Did the accident(s) happen while you were driving:

		Most recent accident	**Accident before that**
(i)	Your own (privately-owned) vehicle?	❑1	❑1
(ii)	A vehicle provided (or financed at least partly) for you by your employer, which you regularly use?	❑2	❑2
(iii)	A company vehicle which you do not regularly use (e.g. a pool or fleet vehicle)?	❑3	❑3
(iiv)	Someone else's vehicle (e.g. a friend or relative)?	❑4	❑4

Q15 Did the accident(s) happen while you were driving on a work-related journey (We are NOT asking here about commuting between home and work)

		Most recent accident	**Accident before that**
(i)	Work- related journey	❑1	❑1
(ii)	Non work- related journey	❑2	❑2

SECTION C: WORK-RELATED DRIVING

Q16 Do you ever drive a car or van (up to 3500kg / large transit size) on any of the following types of journey to do with your work? Please do not include commuting between home and work.

(Tick all that apply)

(i) Carry passengers ❑1
(ii) Carry goods or deliver things ❑2
(iii) Drive to go to meetings or other general business activities ❑3
(iv) Drive to make sales ❑4
(v) Other journeys to do with my work ❑5
} **Go to Q18**

(vi) None ❑6 ➡ **Go to Q17**

IF YOU HAVE TICKED ANY OF THE BOXES (i) to (v) IN Q16, PLEASE GO TO Q18

Q17 Is the vehicle that you most frequently drive on private journeys (e.g. commuting, leisure) provided by your employer, or financed at least partly by your employer?

(i) Yes - employer provided ❑ ➡ **Go to Q21**
(ii) - financed at least partly by your employer ❑ ➡ **Go to Q21**
(iii) No (I use my own (privately-owned) vehicle) ❑ ➡ **Go to Q28**

Q18 Approximately, how many miles do you drive per year on work-related journeys? (*Please write in miles*)

_____________ miles

Q19 What percentage (%) of this work-related mileage would you estimate driving on each of the following…?
(Please remember we are NOT asking here about commuting between home and work)

(i) Motorways ____
(ii) Roads in built-up areas ____
(iii) Roads in non-built up areas ____
Total ***100%***

Q20 Is the vehicle you usually use for these work-related journeys…:

(i) Provided by your employer? ❑1
(ii) Financed at least partly by your employer? ❑2
(iii) A company vehicle, but not always the same one? ❑3 ➡ **Go to Q23**
(iv) Privately owned by yourself? ❑4 ➡ **Go to Q28**
(v) Other (please write in)______________________ ❑5

Q21 Is this vehicle the same one that you described in Q4?

Yes ❑1 ➡ **Go to Q23**
No ❑2

Q22 What is the make and model of this vehicle? (*Please write in full*)

Make (e.g. Vauxhall) __________________ Model (e.g. Corsa) __________________

What type of vehicle is it? (*Please tick one box only*)

(i)	Car (including 'people carriers')	❑1	(v)	Truck	❑5
(ii)	Motorcycle	❑2	(vi)	4x4	❑6
(iii)	Van (up to 3500kg/ large transit size)	❑3	(vii)	Other (please write in) ____________	❑7
(iv)	Large van/ lorry (over 3500kg)	❑4			

What colour is this vehicle? (*Please write in full*) __________________

Q23 Does this vehicle's paint- work or body- work advertise the company that you work for?

Yes ❑1
No ❑2

Q24 If you are involved in an accident while driving on a work-related journey, or while driving a company provided or financed vehicle, do you have to…?

(a) … report the accident to your company?

- Yes ☐1
- No ☐2
- Don't know ☐3

(b) … pay all, or some, of the associated accident costs?

- Yes - all accident costs ☐1
- Yes - some of the accident costs ☐2
- No ☐3
- Don't know ☐4

Q25 Does your company offer any financial or non-financial rewards or penalties to encourage 'accident free' driving? (Tick all that apply)

		Please write a brief description
A financial reward (e.g. a bonus) for accident-free driving	☐1	______
A financial penalty if you have an accident (or several accidents)	☐2	______
A non-financial reward for accident-free driving	☐3	______
A non-financial penalty if you have an accident (or several accidents)	☐4	______
None	☐5	
Don't know	☐6	

Q26 Why do you think the company provided you with, or helped you to buy, this vehicle?

- (i) Vehicle is essential to my work ☐1
- (ii) Vehicle is occasionally needed for work (e.g. meetings) but not essential ☐2
- (iii) Vehicle (or allowance) is part of my remuneration package (i.e. a 'perk') ☐3

Q27 Please tick the box best describing your level within the company you currently work for?

- (i) Self- employed ☐1
- (ii) Senior Management ☐2
- (iii) Middle Management ☐3
- (iv) First or second line management ☐4
- (v) Non-management professional, clerical, administrative etc worker ☐5
- (vi) Non-management skilled manual worker ☐6
- (vii) Non-management semi- skilled or unskilled manual worker ☐7

SECTION D: ABOUT YOU

Q28 Have you attended any driver training/improvement courses since gaining your driving licence?

- Yes ☐1
- No ☐2

IF 'YES' what type of course(s) have you attended? (*Please tick all that apply*)

		In the last year	More than a year ago
(i)	On road 'fleet driver training' course	☐1	☐1
(ii)	Driving range 'skid control/avoidance' training course	☐2	☐2
(iii)	'IAM'/'RoSPA' 'advanced' driving test	☐3	☐3
(iv)	Other (please describe) ______	☐4	☐4

Q29 Please tick the box best describing your current work situation? (*Tick one box only*)

- Working full-time ☐1
- Working part-time ☐2
- Looking after the home/family ☐3
- Student ☐4
- Retired from paid work ☐5
- Unemployed ☐6

Q30 Are You?

- Male ☐1
- Female ☐2

Q31 How old were you on your last birthday?

__ __ Years

Please return your completed questionnaire in the envelope provided

MANY THANKS FOR YOUR HELP

Abstract

TRL was commissioned in 2001 to carry out research into the question of whether people driving for work-related purposes might be at greater risk than other drivers of being involved in an injury accident.

A questionnaire was sent to a sample of drivers of vehicles up to three years old identified from police reports of accidents that involved personal injury. It was also sent to a general sample of drivers of vehicles up to three years old. This included drivers of company-registered vehicles and drivers of privately registered vehicles (both of which may or may not do work-related mileage). This methodology allowed, for the first time, the excess risk of injury accidents arising from work-related driving to be estimated. Previous studies have only been able to estimate the excess liability or work-related drivers to 'all accidents' - which are dominated by damage-only accidents.

The results show that car drivers with more than 80 per cent of their annual mileage on work-related journeys had about 50 per cent more injury accidents than other car drivers who were otherwise similar in terms of age, sex and mileage. Drivers whose work-related journeys accounted for 80 per cent or less of their total mileage had, on average, about 13 per cent more accidents than otherwise similar drivers doing no work related mileage.

Drivers whose work related journeys accounted for more than 80 per cent of their total mileage differed from other drivers in their responses to a number of behavioural questions. In particular they were more likely to drive when fatigued, under time pressure, and when conducting distracting in-car activities like mobile phone conversations. While such differences will increase the risk of work-related driving and thus help to explain its excess accident liability, in fact the survey was not able to demonstrate this directly. Neither did the survey find the expected associations between accident risk and violational driving behaviour, driving style, or attitudes to driving violations. One possible explanation discussed in the report is that drivers' responses were influenced by their having been recently involved in an injury accident, such that the responses did not give a true picture of behaviour and attitudes as they were before the occurrence of the accident.

Related publications

TRL547 *How dangerous is driving with a mobile phone? Benchmarking the impairment to alcohol* by P C Burns, A Parkes, S Burton, R K Smith and D Burch. 2002 (price £40, code JX)

TRL317 *The accident liability of company car drivers* by P Lynn and C R Lockwood. 1998 (price £25, code E)

TRL318 *The use of mobile phones while driving: a review* by A Stevens and D A O Paulo. 1997 (price £15)

RR61 *The transport implications of company-financed* motoring by J M Hopkin. 1986 (price £25, code G)

CT80.2 Driver behaviour update (2001-2002*) Current Topics in Transport: selected abstracts from TRL Library's* database (price £20)

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