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Trends and context to rates of workplace injury

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Trends and context to rates of workplace injury

Rhys Davies and Paul Jones
Warwick Institute for Employment Research
University of Warwick
Coventry
CV4 7AL

In the context of overarching targets for the reduction of workplace injury rates, the aim of this report is to provide an assessment of what factors within the broader economic environment may contribute towards changes in the incidence of workplace injuries over time. Analysis reveals that the rates of major injury follow a pro-cyclical pattern over the course of the business cycle. This pro-cyclical pattern appears to be related to changes in the incidence of new hires over the business cycle. In terms of understanding downward trends in injury rates, these are largely driven by changes in the occupational composition of employment; particularly in terms of the balance between manual and non-manual occupations. Geographical variations in workplace injury rates can also be explained by differences in the personal, establishment and job related characteristics of those working within these regions. Based upon detailed occupational projections of employment, rates of workplace injury are expected to decline by approximately 6 to 8% by 2012. Whether comparisons of injury rates are being made over time, across regions, between industries or along other dimensions, these rates should be occupationally specific to ensure that 'like with like' comparisons are being made.

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CONTENTS

TABLES

FIGURES

EXECUTIVE SUMMARY

BACKGROUND

In the *Revitalising Health and Safety Strategy Statement* (DETR, 2000) the government has, for the first time, set out over-arching national targets for significant improvements in workplace health and safety. The establishment of such targets reflects a desire to demonstrate that the regulatory regime can have a positive impact on 'bottom line' measures of health and safety. However, are there other factors within the broader economic environment that can influence rates of workplace injury which are beyond the control of the regulatory regime?

The aim of this report is to provide an assessment of what factors may contribute towards changes in the incidence of workplace injuries and workplace injury rates over time. In particular, we consider whether the incidence of workplace injuries varies over the course of the business cycle and how structural changes in the labour market contribute trends in workplace injury rates. We note at the outset that this report ***does not*** aim to provide a detailed assessment of whether *Revitalising Health and Safety* (RHS) targets are either currently being met or are likely to be achieved. However, the results are considered in the context of the RHS targets, with a focus upon whether rates of workplace injury provide an objective measure of health and safety against which to judge to the performance of the regulatory regime.

CHANGES IN WORKPLACE INJURY RATES

Analysis of RIDDOR data over the period 1986 to 2004 reveals a general downward trend in the rates of both over-3-day injuries among males. In contrast, the rate of over-3-day injuries amongst women was trended upwards prior 1994 but has since fallen. Major injuries show a notable downward trend prior to 2000. Since 2000 there has been a notable increase in major injuries amongst both men and women, which bucks the general downward trend over time. Analysis by sector reveals something of a polarisation in terms of trends in accident rates. In the traditional industrial sectors and in the public sector accident rates have continued to decrease throughout the period 1986 to 2004. This is the case for both over-3-day and major accidents the productive sectors, construction and in the public sector. Within the private services sector, injury rates have tended to remain relatively stable.

WORKPLACE INJURIES AND THE BUSINESS CYCLE

What factors can be demonstrated to be related to these movements in injury rates? During the late 1980's GDP grew rapidly and above trend whilst at the same time unemployment decreased. After 1989 this situation was reversed with a contraction of economic activity and rising unemployment. The business cycle bottomed in 1993 and the economy began a sustained recovery which has continued until 2004, the longest post war economic boom in the UK.

Across all sectors of the economy, analysis reveals that a 1% increase in GDP above trend is associated with a 1.4% increase in the rate of major accidents, with similar effects for both male and female rates. This equates to an increase in the rate of major accidents during a boom of approximately 11 – 12 per cent per cent compared to the rates observed within a recession. More detailed analysis by industry sector reveals that pro-cyclical patterns are particularly prominent with the construction and manufacturing sectors.

Two main mechanisms have previously been cited to explain the pro-cyclical pattern in accidents. Firstly, accident rates will increase with the hiring of new staff, since newer workers are more at risk of injury. Secondly, accident rates will increase at times of increased worker effort, for example as overtime working increases in response to higher demand. Analysis reveals that a percentage point increase in the share of new hires leads to a 1.7-2.5% percentage increase in the rate of major injuries and a 1-1.5% increase in the rate of over-3-day injuries. In terms of worker effort, an increase in the ratio of actual to usual hours was estimated to be associated with higher rates of workplace injury.

FACTORS INFLUENCING AN INDIVIDUALS RISK OF WORKPLACE INJURY

An alternative source of data to RIDDOR relating to workplace injuries is the Labour Force Survey (LFS). This data was used to investigate what personal, establishment and job characteristics were associated with an increased risk of an individual having suffered a reportable workplace injury during the previous 12 months.

In terms of personal characteristics, we found that:

- Higher rates of workplace injury exhibited by males compared to females can be almost entirely explained by differences in other job and establishment characteristics.
- The strong regional gradient observed in workplace injury rates can be explained by differences in the observable personal and job related characteristics within these regions, there is no evidence of a 'regional effect'.

In terms of employment characteristics, we found that:

- The dominant influence that contributes to an individual's risk of injury is their occupation. The 5 most hazardous occupational categories were identified as being Construction Labourers; Metal, Wood and Construction Trades; Vehicle Trades; Agriculture and Animal Care Occupations and Stores/Warehouse Keepers.
- The risk of workplace injury declines rapidly as employment tenure increases. The increased risks associated with tenure a particularly apparent during the first 4 months within a new job.
- In terms of the length of the working day, after correcting for exposure, those working less than 10 hours per week were most likely to report having had a reportable workplace injury per hour worked.
- Among other employment characteristics, we observed that shift working, working in the public sector were associated with individuals being more likely to indicate that they had suffered a reportable workplace injury. Being self-employed and working within small establishments (less than 10 employees) were each associated with a reduced likelihood of individuals reporting that they had suffered a reportable workplace injury.

EXPLAINING PAST MOVEMENTS IN WORKPLACE INJURY RATES

If the composition of the workforce changes over time, either in terms of the personal characteristics of those employed or the nature of the work tasks undertaken, we would expect workplace injury rates to also vary over time. Key in this respect are changes in the occupational composition of employment. Analysis of RIDDOR data indicates that the rate of over-3-day injury and major injuries have declined by approximately a third between 1986 and 2003. Based on changes in occupational structure, analysis reveals that we would have expected these rates to have declined by approximately 20 per cent.

While changes in occupational composition over time would appear to be the dominant effect underlying, changes in other personal, job and establishment characteristics may also contribute to observed movements in workplace injury rates over time. To consider how all these factors contribute to variations in workplace injury rates over time, we compare predicted rate of reportable injury derived from the Labour Force Survey with actual rates for the period 1993 to 2004.

Analysis by gender, age group, region and industry reveals that predicted values fit closely to the actual accident rate series. We can infer from this that both actual variations in rates of reportable injury between groups and movements in accident rates over time can be explained by differences in the occupational, personal, establishment and other job related characteristics of these groups.

The convergence of accident rates for men and women since 1993 reflects the fact that the mode of working (with respect to hours worked, shift working, etc) amongst men and women and the jobs they are likely to undertake are becoming more similar over time. Whilst regional differentials in accident rates persist, trends in accidents rates over time were found to be similar by region. Analysis by industry suggests that no sector exhibits a decline in its rate of workplace injury beyond that which would have been expected to occur based upon predicted values of workplace injury rates.

LOOKING TOWARDS THE FUTURE

As occupation is the dominant influence upon an individual's risk of suffering a workplace injury, then future changes in rates of workplace injury over time are likely to reflect future changes in the occupational composition of employment. Based upon detailed occupational projections of employment to 2012, derived projections of workplace injuries derived from the LFS suggest that the rate of reportable non-fatal injuries would be expected to decline by approximately 6 per cent between 2004 and 2012. Estimates based upon RIDDOR suggest that the rate of reported injuries would be expected to decline by 7-8% over the same period. The largest declines in workplace injuries are estimated to occur in those sectors that are projected to exhibit a relative large movement away from employment within manual occupations such as F: Construction and I: Transport, Storage and Communication. Whilst projected changes in the occupational composition of employment appear to be working in favour of HSE, these could be either offset or reinforced depending upon the relative position of the economy within the business cycle.

INJURY RATES AS AN OBJECTIVE MEASURE OF WORKPLACE SAFETY?

Among the over-arching targets set out in the *Revitalising Health and Safety Strategy Statement* is the achievement of a 10% reduction in the rate of fatal and major injury accidents by 2010. However, our analysis calls into question whether over-arching targets for health and safety provide an objective measure against which to judge to the performance of the regulatory regime. Shifts in demand between sectors and technological advances within sectors can contribute to changes in the occupational composition of employment that will influence rates of workplace injury. Rates of workplace injury can also be affected by the location of the economy within the business cycle.

If injury rates are to be used as a basis upon which to judge workplace safety, it is important to ensure that their presentation makes 'like with like' comparisons. As the main determinant of an individual's risk of workplace injury, most useful in this respect is the presentation of injury rates by occupation. Whether comparisons of injury rates are being made over time, across regions, between industries or along other dimensions, these rates should be occupationally specific wherever possible. In the context of the RIDDOR data, it is therefore important that the resources are available to ensure the accurate and consistent coding of occupational information if accurate occupational injury rates are to be derived from this source.

CHAPTER 1: INTRODUCTION

1.1 CONTEXT TO THIS REPORT

In the documents *Revitalising Health and Safety Strategy Statement* (DETR, 2000) and *Securing Health Together*, the government set out national targets for health and safety. This 10-year strategy seeks significant improvements in workplace health and safety by, for the first time, setting a number of over-arching targets for Great Britain. These targets are to:

- reduce working days lost per 100 thousand workers from work related injury and ill-health by 30%;
- to reduce the rate of fatal and major injury accidents by 10%;
- and to reduce the incidence rate of cases of work-related ill-health by 20%.

It was further proposed that half of the improvements in each of these target areas should be achieved by 2004. The accompanying action plan designed to ensure delivery of these targets encompasses measures to motivate employers, engage small firms, improve health and safety in the public sector and to instigate changes to the National Curriculum to secure greater coverage of risk concepts in education (see DETR, 2000, pp20-41).

Regulatory regimes impact upon workplace safety through a variety of complex mechanisms including legislation, standard setting, research and development, campaigns, initiatives, as well as inspection, investigation and enforcement measures. A number of studies have been conducted over the last 3 decades that point to a variety of positive impacts of the regulatory regime within Great Britain upon workplace safety (see HSE (1985, 1991)). However, such evaluations tend to employ intermediate outcome measures that can be related to real objectives rather than attempting to identify a direct link between workplace injury rates and the regulatory environment. Such outcome measures include levels of compliance with legal requirements, number of safety helmets purchased, exposure levels to toxic substances and numbers of workers who have access to occupational health and safety services.

Attempting to identify a direct impact of regulatory activities upon workplace injury rates is further complicated by the dynamics of enforcement and inspection activities. For example, in the short term we may expect inspection activity to be concentrated in those areas that have exhibited poor levels of health and safety. We may also expect the impact of any intensification of safety enforcement measures can occur with a lag due to the time involved in making the capital investments or organisational changes required for compliance with safety standards (see Viscusi, 1986, Lanoie, 1992). Without the availability of detailed information regarding the dynamic relationship between workplace injury rates and the regulatory regime, it may prove problematic to demonstrate the effectiveness of particular dimensions of regulatory activity upon rates of workplace injury.

The establishment of over-arching targets for health and safety reflects a desire to demonstrate that the regulatory regime can have a positive impact on ‘bottom line’ measures of health and safety. The Health and Safety Executive (HSE) has published two statistical progress reports as supplements to its annual report in order to report as to whether improvements in these target measures have been achieved since the base year[1,2]. In terms of progress towards meeting the

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1 *Delivering health and safety in Great Britain - Health and safety targets: how are we doing? 2002/03.*

2 *Health and Safety Targets: How are we doing? 2001/02.*

target for the rate of fatal and major injury, reports that no discernible improvement has occurred since the base year of 1999/2000. *The step change in improved health and safety performance has yet to be delivered.*

There are likely to be a number of factors within the economic environment which are beyond control of the HSE that will influence the incidence of workplace injuries. The lack of progress towards meeting targets for the reduction in injury rates has to be considered in the context of relatively tight labour market conditions. A decline in the unemployment rate from 6% in 1999 to 5% by 2004 (see Figure 4.1) indicates continued high levels of economic activity since the baseline year for HSE targets. Particular sectors which are of importance to the HSE are also experiencing different demand conditions. Since the introduction of the RHS targets, the construction sector has experienced a period of relatively strong economic growth. This sector is of considerable importance to the HSE, both in terms of the number and rates of workplace injury. Real improvements in safety at the workplace could therefore be offset by changes in demand that may lead to an increase in the incidence of workplace injuries.

1.2 AIM AND STRUCTURE REPORT

The aim of this report is to provide an assessment of what factors within the economic environment may contribute towards changes in the incidence of workplace injuries and workplace injury rates over time. The analysis focuses upon 2 main issues. Firstly, we consider whether the incidence of workplace injuries varies over the course of the business cycle. Secondly, how do structural changes in the labour market contribute trends in workplace injury rates? We utilise information from the 2 main sources of workplace injury data for Great Britain; administrative data collected under the Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (RIDDOR) and survey data collected from the Labour Force Survey (LFS).

This report presents results derived from a variety of statistical procedures. To ensure that the report is as accessible as possible to those who have an interest in the subject matter but not the statistical detail, details of the modelling procedures undertaken and the full results of the analyses can be found in the annexes to this report. In the main body of the report, where possible we translate the results of the statistical models to demonstrate the practical implications of these results. The remainder of this report is structured as follows.

In Chapter 2 we provide an overview of why we may expect the changing economic environment to have an influence upon rates of workplace injury. The discussion focuses on how the business cycle, changes in the occupational and industrial composition of employment and changes in the nature of employment such as increases in part time employment may be expected to influence rates of workplace injury.

In Chapter 3 we present a primarily descriptive analysis of workplace injuries reported to HSE over a period of 18 years since the introduction of the RIDDOR regulations during 1986. The analyses presents estimates of injury rates derived from RIDDOR, with adjustments made to these series to account for changes in the incidence of part time employment, changes in levels of reporting and changes to the definitions of reportable workplace injuries during 1996.

In Chapter 4 we utilise these injury rate time series derived from the RIDDOR data to consider whether the business cycle can be demonstrated to have an influence upon rates of workplace of injury. We demonstrate the effect upon workplace injury rates of moving from a period of recession to boom and investigate the nature of the mechanisms that are hypothesised to contribute to higher workplace injury rates during periods of increased demand; namely increases in work effort and the higher proportion of new hires.

In Chapter 5 we utilise data derived from the other main source of information relating to workplace injuries; the Labour Force Survey. In this chapter we present cross-tabulations of injury rates derived from the LFS for the period 1993 to 2004 and compare these to results derived from a more detailed statistical analysis which considers the estimated effects of a range of personal, establishment and job related characteristics upon the risk of an individual suffering a reportable workplace injury. The relative importance of these factors in contributing to our understanding of what influences an individual's risk of suffering a workplace injury is also considered.

In Chapter 6 we utilise results derived from the analyses presented in Chapters 4 and 5 to demonstrate how these results enable us to understand movements in aggregate injury rates over time. We firstly consider the importance of changes in the occupational composition of employment in contributing to observed movements in workplace injury rates derived from RIDDOR for the period 1986 to 2003. The chapter then compares and contrasts movements in actual rates of reportable injury derived from the LFS with predicted movements in injury rates derived from the results of the statistical analysis presented in Chapter 5.

In Chapter 7 we present projections of workplace injuries to 2012. These projections are based upon detailed projections of employment by occupation. By combining these employment projections with occupational injury rates derived from both RIDDOR and the LFS, we present projections of both expected changes in workplace injury rates and the changes in the number of workplace injuries over the period 2004 to 2012.

Finally, Chapter 8 draws together the main findings of our analyses. We note at the outset that this report ***does not*** aim to provide a detailed assessment of whether RHS targets are either currently being met or are likely to be achieved by 2010. However, the results of the analyses are discussed in the context of the RHS targets, with a focus upon whether over-arching targets for health and safety provide an objective measure against which to judge to the performance of the regulatory regime.

CHAPTER 2: WORKPLACE INJURIES AND THE ECONOMIC ENVIRONMENT

2.1 INTRODUCTION

This chapter considers the potential role of the broader economic environment in terms of understanding changes in workplace injury rates over time. In Section 2.2 we discuss hypotheses as to why the incidence of workplace injuries may be expected to vary over the course of the economic cycle. Section 2.3 then discusses the influence of structural changes within the economy that may be expected to contribute to trends injury rates over time. We focus upon changes in the industrial and occupational composition of employment and the increasing incidence of part time employment.

2.2 WORKPLACE INJURIES AND THE BUSINESS CYCLE

The business cycle refers to recurrent fluctuations in total business activity. The periods of economic growth (recovery) and decline (recession) which characterise the cycle are accompanied by changing levels of consumption and industrial production across the economy, which in turn impact upon the labour market. In a recovery businesses increase production, create jobs and reduce aggregate unemployment. In contrast, a recession is characterised by a contraction of output, decreased demand for labour, and resulting increases in aggregate unemployment[3].

We now consider how changes in the level of economic activity may be related to the incidence of workplace injuries. Early studies on the relationship between the economic cycle and industrial accidents date back to the 1930s and 1940s. Kossoris (1938, 1943) showed that a pro-cyclical relationship existed between the incidence of workplace injuries within the US manufacturing sector and the number of people employed in the sector. Two main reasons as to why we may expect workplace injury rates to follow a pro-cyclical pattern are as follows:

2.2.1 Recruitment, redundancy and work experience

During a period of economic downturn, redundancies tend to be concentrated amongst the most recent hires. Such workers will be less experienced in their current job and may be less familiar with equipment and machinery, with the work system and the signals of system failure, and with the work habits and routines of fellow workers. The average job tenure of those remaining in employment will therefore increase leaving a relatively more experienced workforce who are less prone to accidents. Conversely, periods of economic expansion will lead to an increase in the recruitment and employment of less experienced workers. This will reduce the average tenure of those in employment and increase the risks of workplace accidents.

2.2.2 Worker effort

Two different dimensions of worker effort can be distinguished; ‘extensive’ work effort, meaning the time spent at work, and ‘intensive’ work effort, meaning the intensity of work during that time. However, it is acknowledged that periods of ‘extensive’ work effort are likely to coincide with periods of ‘intensive’ work effort. During a period of economic downturn, redundancies tend to lag behind reductions in the level of production. During such periods, the

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3 For a general guide to business cycle concepts see: *www.statistics.gov.uk/articles/labour_market_trends/Turningpoints_nov03.pdf*

level of work effort will tend to decline until the size of the workforce is reduced in line with demand. The decline in worker effort may reduce the likelihood of workplace accidents due to fatigue and stress; i.e. lower levels of intensive worker effort. Alternatively, firms may adjust the level of hours downwards in line with demand; i.e. lower levels of extensive worker effort. Conversely, during periods of economic expansion, increases in intensive and extensive worker effort to meet increases in demand may increase the risk of workplace accidents.

2.2.3 The economic cycle and the labour market

The above hypotheses as to why we might expect the business cycle to have an influence upon workplace injuries are based upon certain assumptions as to the relationship between the economic cycle and the labour market. The issue therefore arises as to whether these mechanisms still prevail within today's labour market?

Millard, Scott and Sensier's (1997) study of the impact of the UK business cycle on the labour market conclude that:

- hours worked and employment both move pro-cyclically;
- the adjustments to total hours worked are divided equally between changes in average hours worked and changes in employment;
- changes in employment usually lag changes in output whilst changes in average hours worked lead changes in output;

Beatson (1995) considers changes in labour market sensitivity for two periods, 1960 to 1979 and 1980 to 1994 and concludes that:

- the majority of short term adjustment occurs via variations in output per capita rather than employment levels;
- employment has become more responsive to output changes over time.

Gregg and Wadsworth (2002) utilise information from the General Household Survey which, with a continuous measure of tenure since 1974, provides a reliable measure of job tenure over the longest period for Great Britain. They demonstrate that estimates of median job tenure are highly counter-cyclical, indicating that median tenure falls in tight labour market conditions as workers move from job to job and the share of new jobs increases. Research therefore points to the continued potential influence of the economic cycle upon the incidence of workplace injuries resulting from increased levels of work effort and a higher proportion of new hires.

Although worker effort and labour tenure have generally received the most attention within previous research that has considered the effects of the business cycle upon workplace injury rates, other mechanisms may also be present. For example, the vintage capital hypothesis suggests firms operating beneath full capacity are likely to use their most efficient operating machinery first. During periods of economic expansion, the utilisation of older machinery may be expected to increase the level of workplace injuries. Conventional wisdom also suggests that training tends to be curtailed in recessions, although national level evidence shows only a small reduction in training during the recession of the early 1990s (Green and Falstead, 1994). Both of these hypotheses would further support the view workplace injuries would be expected to follow a pro-cyclical pattern over the business cycle.

In contrast, hypotheses have also been presented which suggest that the incidence of workplace injuries may be expected to follow a counter-cyclical pattern over the business cycle. Steele (1974) suggests that we should observe an inverse relationship between accident rates and the state of economic activity because the cost of injuries in terms of both interrupted production and the replacement of injured workers will increase with the upswing in the business cycle. Nichols (1986, 1989, and 1999) suggests that during periods of economic expansion, workers are better able to resist the introduction of unsafe working practices or work intensification by management. The effect of the business cycle upon the incidence of workplace injuries may therefore be the net outcome of opposing pro-cyclical and counter-cyclical influences.

2.3 WORKPLACE INJURIES AND ECONOMIC RE-STRUCTURING

The preceding section considered the importance of the economic cycle in determining the incidence of industrial injuries. Such cyclical factors however cannot be considered in isolation of structural influences acting independently of the economic cycle. There have been a number of structural changes in the British economy that are likely to have had an influence on occupational health and safety. These include a shift in the industrial mix from the manufacturing to the service sectors, changes in the occupational composition of employment and changing nature of employment.

2.3.1 Changes in the industrial composition of employment

The past 50 years have seen major changes in the industrial composition of employment across all developed economies. A complex mix of interdependent factors such as technological change, productivity growth, international competition, specialisation and sub-contracting, and economic growth have resulted in very large increases in real incomes and dramatic shifts in patterns of expenditure. These in turn have resulted in the demise of many major areas of employment including agriculture, coal mining and substantial parts of manufacturing. In contrast there have been major increases in employment in other areas, especially those sectors involved in the processing and handling of information, and those providing services to both consumers and businesses.

The key features of changes in the industrial composition of employment over the past 2 decades are presented in Table 2.1. Since 1982 it can be seen that there has been a clear shift in employment away from Primary industries, Utilities and Manufacturing towards the service sectors. Between 1982 and 2002, employment in manufacturing fell from 22.7% to 13.2% of the workforce. Manufacturing has exhibited negative employment growth, with employment declining by approximately 2.5% per annum between 1982 and 1992 and then by 1.2% per annum between 1992 and 2002. Although smaller in terms of its employment share, the largest relative reductions in employment have occurred within the Primary and Utilities sector. Employment in this sector declined by approximately 3.4% per annum between 1982 and 1992 and then by 3.1% per annum between 1992 and 2002. In contrast, the share employment within Business and Miscellaneous services increased from 16.5% to 25.6% between 1982 and 2002, while non-marketed services and the Transport and Distribution sectors exhibited smaller rates of employment growth.

Table 2.1 Employment by broad industrial sector, 1982-2002

Industrial Sector	***Employment Share (col %)***		
	1982	***1992***	***2002***
Primary and utilities	5.2	3.5	2.2
Manufacturing	22.7	16.6	13.2
Construction	6.7	7.0	6.3
Distribution, transport etc	28.3	29.0	29.6
Business and misc. services	16.5	21.1	25.6
Non-marketed services	20.6	22.7	23.1
All industries	25,186	26,639	29,336
	100	100	100
		Employment growth (% p.a.)	
		1982/92	***1992/02***
Primary and utilities		-3.4	-3.1
Manufacturing		-2.5	-1.2
Construction		1.1	-0.1
Distribution, transport etc		0.8	1.1
Business and misc. services		3.1	2.6
Non-marketed services		1.6	1.0
All industries		0.6	0.9

Source: CE/IER Estimates

2.3.2 Changes in the occupational composition of employment

Changing patterns of industrial employment have had profound implications for the demand for different types of occupations. The decline of employment in Primary and Manufacturing industries has resulted in a reduction in the need for many skills associated with the production of the output of these industries. A smaller manufacturing sector therefore no longer requires the same number of skilled engineering and other types of specific craft skills as previously. In contrast, the growth in service sector employment has lead to the expansion of jobs in a number of occupations. For example, an increase in the share of employment within Non-marketed Services has lead to additional jobs for professional, managerial and clerical workers in public administration; for doctors and nurses in health services; and for teachers in education services. Similarly, growth in employment within private sector marketed services has resulted in many new jobs within leisure and other personal service occupations, sales occupations and professional, clerical and secretarial occupations in business and financial services.

These developments have taken place against a background of technological change that has lead to significant changes in the nature of particular jobs within industries and a restructuring of the way in which work is organised. The wider application of information technology has been of particular importance. The application of IT has lead to the displacement of many clerical and secretarial jobs previously concerned with information processing using paper technology. The application of IT in manufacturing has also lead to the displacement of many skilled workers whose jobs have been taken over by computer controlled machinery. On the other hand, information technology has opened up many new areas in which information services can be provided that were previously not feasible. This has tended to create jobs of a professional, associate professional and managerial nature.

Table 2.2 provides information as to the occupational composition of employment in the UK since 1982. Since 1982 it can be seen that there has been a clear shift in employment away from more traditional, blue collar manual occupations. Between 1982 and 2002, employment within Skilled Trades Occupations fell from 17.0% to 11.4%, whilst employment among Transport and Machine Operatives fell from 11.8% to 8.4%. In contrast, employment amongst Managers and Senior Officials increased from 10.7% to 14.9% between 1982 and 2002. The share of employment within Personal Service Occupations also increased from 3.7% to 7.3% between 1982 and 2002.

Table 2.2 Employment by broad occupational group, 1982-2002

Occupation	***Share of Total Employment (col %)***		
	1982	***1992***	***2002***
1. Managers and Senior Officials	10.7	12.6	14.9
2. Professional Occupations	8.0	9.4	11.3
3. Associate Professional and Technical Occupations	9.6	11.3	14.0
4. Administrative, Clerical and Secretarial Occupations	15.5	15.8	13.2
5. Skilled Trades Occupations	17.0	14.6	11.4
6. Personal Service Occupations	3.7	4.9	7.3
7. Sales and Customer Service Occupations	6.1	6.7	7.9
8. Transport and Machine Operatives	11.8	9.7	8.4
9. Elementary Occupations	17.7	15.0	11.6
Total	25,186	26,639	29,336
	100	100	100

Source: CE/IER Estimates.

In addition to the effects of the business cycle, a number of structural changes have therefore occurred that may be expected to have a significant influence on the risks of incurring a workplace injury. The likelihood of an industrial accident will depend upon the degree of exposure to hazards which will vary between industries. Shifts in employment from manufacturing to service sector industries are likely to reduce the incidence of industrial injuries over time. Even within industries, technological developments that have lead to a reduction in the share in employment within manual occupations characterised by an increased exposure to workplace hazards should be expected to contribute to further reductions in rates of workplace injuries over time.

2.4 THE CHANGING NATURE OF WORK

The past few decades have seen dramatic shifts in the pattern of employment by status and by gender. Women now account for almost half of the workforce and there has been a huge shift in favour of part-time as opposed to full time jobs. Many of these changes can be linked to changes in the industrial composition of employment discussed above. In particular, the decline of employment opportunities within the primary and utilities sector and in the manufacturing sector has resulted in the loss of many full-time jobs traditionally held by men. The growth of jobs in the services sector, by contrast, has created many employment opportunities for women, particularly those wanting to work part time. These demand side factors have been complemented by supply side factors, such as the increasing participation of women within education and equal opportunities policies, which have reflected the increasing propensity of women to want to take an active role in the formal economy.

Table 2.3 shows how the patterns of employment have varied over the last 2 decades according to both gender and the level of part time employment for the total UK workforce. It can be seen that across all sectors, the share of female employees as a proportion of total employment increased from 42% to 47% between 1982 and 2002. Similarly, the share of part-time employees increased from 22% to 28% over the same period. The share of female employment and part-time employment is highest within the Non-marketed Services sector and is generally lowest within the Primary and Utilities sector. The increasing share of part time employment applies to most industrial sectors over this period.

Table 2.3 The changing nature of work: 1982-2002

	1982	*1992*	*2002*
Primary and utilities (col %), of which	**5.2**	**3.5**	**2.2**
Female employees (%)	16.4	22.1	25.0
Part-time employees (%)	6.8	9.0	12.6
Manufacturing (col %), of which	**22.7**	**16.6**	**13.2**
Female employees (%)	30.2	31.5	27.5
Part-time employees (%)	9.4	9.2	8.4
Construction (col %), of which	**6.7**	**7.0**	**6.3**
Female employees (%)	9.9	10.6	9.9
Part-time employees (%)	4.2	4.0	5.2
Distribution, transport etc (col %), of which	**28.3**	**29.0**	**29.6**
Female employees (%)	42.9	46.2	46.9
Part-time employees (%)	29.4	33.1	35.8
Business and other services (col %), of which	**16.5**	**21.1**	**25.6**
Female employees (%)	46.7	49.4	47.2
Part-time employees (%)	20.2	21.0	23.9
Non-marketed services (col %), of which	**20.6**	**22.7**	**23.1**
Female employees (%)	66.0	70.6	70.5
Part-time employees (%)	35.5	40.4	39.2
All industries (col %), of which	**100**	**100**	**100**
Female employees (%)	41.9	46.7	47.0
Part-time employees (%)	21.7	25.4	27.5

The growth in part time employment is particularly important within the context of female participation in the labour market. The employment share of females is demonstrated to be highest among those sectors which have the highest rates of part time employment (e.g. Non-marketed Services). These are also shown to have exhibited the largest increases in their employment share (e.g. Business Services). The changing nature of work introduces practical difficulties in terms of the estimation of workplace injury rates. The increasing incidence of part time employment means that a simple count of the number of people in employment is a less satisfactory indicator of the amount of work done in the economy. In terms of the calculation of an injury rate time series, an increasing incidence of part time employment may lead to an increase in the employment base over time, although actual exposure to risk in terms of work done may remain unchanged (e.g. a full time job may be replaced by two part time jobs). We shall consider this issue further in the following chapter.

CHAPTER 3: WORKPLACE INJURIES REPORTED TO HSE: 1986-2004

3.1 INTRODUCTION

In this Chapter we present a primarily descriptive analysis of workplace injuries reported to HSE over a period of 18 years since the introduction of the RIDDOR regulations during 1986. Section 3.2 firstly provides a brief overview of the RIDDOR reporting regulations. Section 3.3 then details the construction of an injury incidence time series from the RIDDOR data. Section 3.4 then presents estimates of injury rates derived from RIDDOR, with subsequent adjustments made to these series to account for changes in the incidence of part time employment. Section 3.5 shows the effect on these series of taking into account changes in levels of reporting over this period. Finally, Section 3.6 presents injury rate time series separately for 10 industry sectors.

3.2 RIDDOR REPORTING REGULATIONS

Workplace injury data are collected by the HSE via reports made to enforcing authorities under the Reporting of Injuries, Diseases and Dangerous Occurrences (RIDDOR). Workplace injury data collected by HSE under RIDDOR is held in the form of individual accident records, which includes the date of the accident, information about personal and workplace characteristics, how the injury occurred and the severity of the injury. The duty to report workplace injuries lies with 'responsible persons'. Under current reporting regulations, employers are responsible for reporting workplace accidents where employees or self employed subcontractors are killed or sustain a major injury or injuries that result in an absence from normal work of more than three days. Employers must also report accidents where a member of the public is killed or requires hospital attention as a result of operations under the control of an employer. The self-employed are also required to report injuries that occurred whilst working on their own premises. The main exception is the non-reporting of road traffic accidents involving people travelling in the course of their work as these are covered by road traffic legislation.

Injuries are classified as fatal, major or over-3 days. There is a degree of discontinuity in injury data collected before and after April 1996 because of the introduction of new reporting regulations (RIDDOR 95 replacing RIDDOR 85). Under the new reporting regulations, the definitions of major and over-3-day injuries were expanded. Work undertaken by HSE indicates that the introduction of RIDDOR 95 resulted in substantial changes in the published numbers of workplace injuries. The expansion of the major injury definition was estimated to account for approximately 70% of the increase in major injuries between 1995/6 and 1996/7, and to have had a depressing effect upon the incidence of over-3-day injuries. Due to the recording definitions used, it is not possible to identify all new injuries that became reportable under RIDDOR 95 and to derive a consistent measure of reportable workplace injuries directly from the data.

3.3 AGGREGATE TIME SERIES OF WORKPLACE INJURIES: 1986-2004

HSE supplied individual accident records for the period covered by the RIDDOR regulations; i.e. 1986/7 to 2003/4. Individual accident records could be recompiled into an aggregate series covering a period of 18 years. Figure 3.1 presents time series plots of aggregate injury data derived from the RIDDOR data, based on the total number of injuries incurred by all employees, male employees and female employees respectively. Note at the outset we exclude injuries reported by the self-employed due to the low levels of reporting among this group. Due to their relatively small numbers and for ease of exposition, workplace injuries resulting in fatalities are not included in these figures. To provide as much detail as possible about seasonal variations, in this instance the time series plots provide information on a monthly basis.

Figure 3.1 indicates the presence of a cyclical pattern in the number of over-3-day injuries reported under RIDDOR. The number of over-3-day injuries reported per month shows a general increase from April 1986 until October 1990, when the monthly total for over-3-day injuries amongst all employees peaked at 14824 workplace accidents reported. The monthly total then shows a general decline, reaching a low of 7244 in December 1995. Following the introduction of RIDDOR 95, the number of workplace injuries reported per month did not continue to decline as had previously been the case since 1990. Indeed, there is some indication that the number of reported injuries increased slightly between 1996 and 2000, since when the total number of over-3-day injuries has levelled off. Seasonal variations can also be identified in the reporting of over-3-day injuries. The lowest number of workplace injuries notified to HSE consistently occurs during December reflecting the lower number of working days. The highest numbers of over-3-day injuries are generally reported during October.

In terms of major injuries, there is a clear step shift in the monthly series related to the widening of the definition of major injuries that accompanied the introduction of RIDDOR 95 from April 1996. During the 10-year period prior to the introduction of RIDDOR 95, on average 1405 major injuries to employees were reported per month. During the 8-year period following the introduction of RIDDOR 95, on average 2304 major injuries were reported per month. A cyclical pattern in the incidence of major injuries is observed, with the incidence of major injuries exhibiting a gradual increase between 1986 and 1990 and then a subsequent decline until 1995. Due to the expansion of the major injury definition that accompanied the introduction of RIDDOR 95 in April 1996, it is difficult to establish whether this low represents a real ‘trough’ in the monthly injury time series. However, the monthly total for major injuries amongst all employees has increased notably since April 2001. The lowest number of major injuries are again reported during December, although seasonal variations are less apparent compared to that exhibited by the over-3-day series.

Figure 3.1 also reveals very different patterns being exhibited by males and females over the period of analysis. The lower two panels of the diagram present the monthly series of the number of accidents reported for male and female employees respectively. The shape of the injury profile exhibited for male employees is similar to shown for all employees, which is to be expected since most accidents tend to happen to men rather than women. As for all employees, the number of over-3-day injuries reported per month shows a general increase from April 1986 until October 1990, when the monthly total peaked at 11521 workplace accidents reported. The monthly total then shows a general decline, reaching a low of 5232 in December 1995. Monthly totals of workplace injuries remain relatively stable thereafter. In terms of major injuries, the presence of a cyclical pattern can also be observed before the step shift that accompanies the introduction of RIDDOR 95. For both over-3-day and major injuries, monthly totals remain relatively stable during the period after the introduction of RIDDOR 95.

Figure 3.1 Number of accidents reported under RIDDOR, employees only

The shape of the injury profile exhibited for female employees in Figure 3.1 shows little resemblance to that shown for male employees. The number of over-3-day injuries reported per month among female employees approximately doubles over the period from April 1986 until October 1990, reaching a monthly total number of injuries to female employees of 3304. However, while the male series then exhibited a decline during the period prior to the introduction of RIDDOR 95, the female series remains relatively stable. Between 1990 and 2004, the number of over-3-day injuries to female employees remains generally between 2,500 and 3,000 per month. In terms of major injuries, it is not possible to identify the presence of a cyclical pattern before the step shift that accompanies the introduction of RIDDOR 95. However, it is notable that the number of major accidents has increased most notably amongst female employees in recent years, from its lowest value of 440 injuries in April 2001 to 706 in March 2004, the last monthly count available.

3.4 CONSTRUCTION AN INJURY RATE TIME SERIES

Such variations in the incidence of workplace accidents may simply reflect variations in the size of the population at risk over time. To consider whether the risk of workplace accidents has varied over time, it is necessary to calculate an injury rate by deflating the aggregate injury data by an appropriate employment base. Subsequent statistical analyses will attempt to explain whether changes in injury rates over time are related to the business cycle. The employment base estimates and business cycle indicators that will be used in this analysis are generally available on a quarterly basis. From this point onwards, we therefore construct quarterly time series of injury rates derived from the RIDDOR data. For the employment base, we use ONS estimates of seasonally adjusted employment derived from the Labour Force Survey. The LFS was only available annually prior to Spring 1992 and quarterly thereafter. A quarterly series before 1992 has therefore been created by interpolating values between annual estimates available from the LFS.

The shift to a more flexible labour market over recent years means that a simple count of the number of people in employment is a less satisfactory indicator of the amount of work done in the economy. In terms of the calculation of an injury rate time series, an increasing incidence of part time employment may lead to an increase in the employment base over time, and hence have a depressing effect upon the employee injury rate. However, the exposure to risk in terms of work done may remain unchanged (e.g. a full time job may be replaced by two part time jobs). Similarly, the higher incidence of part time employment among females will deflate the injury rate relative to males as a simple employment count will overstate the total level of work done by females.

An alternative method of measuring labour inputs is required. The total number of hours worked is less likely to be affected by changes in the patterns of work. The LFS collects information on the average weekly hours worked, distinguishing between those in full time and part time employment. Table 3.1 presents estimates of average weekly hours worked by those in full time and part time employment. Aside from a possible discontinuity in the series between 1988 and 1989, it can be seen that average full time hours among male and female employees have remained relatively stable between 1989 and 2004. However, larger increases have been observed in the average hours worked by those in part time employment, particularly among women. As a result, part time hours expressed as a percentage of full time hours has increased steadily. During 1989, part-time hours as a percentage of full time hours were estimated to be 44 per cent for males and 50 per cent for females. By 2004 this rate increased to 52 per cent for males and 55 per cent for females.

Table 3.1 Average weekly hours worked by employees

	Males			***Females***		
	Full time hours	***Part time hours***	***Overall mean***	***Full time hours***	***Part time hours***	***Overall mean***
1986	44.8	16.5	43.5	39.6	17.9	32.2
1987	45.1	17.5	43.7	39.7	17.7	32.2
1988	45.5	16.4	43.9	40.1	18.0	32.7
1989	47.0	20.8	45.3	42.4	21.3	34.2
1990	47.0	20.0	45.3	42.3	21.9	34.6
1991	46.9	20.7	45.0	42.5	21.7	34.4
1992	47.3	20.2	45.3	43	21.8	34.7
1993	47.1	22.0	45.1	42.8	21.8	34.5
1994	47.3	20.0	45.1	43	21.9	34.4
1995	47.4	20.8	45.1	42.8	22.1	34.5
1996	47.4	20.7	44.9	43.1	22.2	34.5
1997	47.6	21.8	45.0	43.2	22.3	34.7
1998	47.5	21.5	44.9	43.2	22.3	34.7
1999	47.4	21.7	44.8	43.5	22.5	35.0
2000	47.8	23.1	45.2	43.9	23.0	35.5
2001	47.9	22.9	45.3	44.2	23.4	35.8
2002	47.8	22.5	45.0	44.0	23.5	35.8
2003	47.8	22.0	44.9	44.0	23.5	35.8
2004	47.7	24.7	44.8	44.0	24.1	36.1

Source: Labour Force Survey

Taking these issues into account, we therefore present injury rates based on two separate employment denominators. Firstly we construct injury rate series (expressed per 100,000 employees) using the raw totals of number of employees each quarter as a denominator. These are referred to as ***unadjusted*** injury rates. Secondly, we use an alternative adjusted employment denominator based on a rescaling of total employment to a full time equivalent level based on a full time employee working 40 hours per week[4]. In this way, male employment is increased slightly since on average males tend to work more than 40 hours per week, whilst the number of female employees is decreased significantly since many more women work part time hours. The injury rates in this case are referred to as ***full time equivalent (FTE)*** rates.

Figure 3.2 presents the unadjusted and full time equivalent (FTE) employee injury rates (per 100,000 employees) for all employees and male and female employees respectively, using quarterly data from 1986q2 to 2004q1. In addition to the correction for employment base described above a further adjustment is made to aid presentation of the data. The structural break in the series due to changes in RIDDOR definitions in April 1996, apparent in previous diagrams, is removed from the data. Figures for injury rates before April 1996 are adjusted to the new reported levels to account for the effect of the changes in RIDDOR reporting. This adjustment is done using a one off step-shift dummy derived from a time series model of injury rates as presented in Annex 4. The injury rate series are also shown using a 4 quarter moving average to smooth seasonal effects.

[4] *The figure of 40 hours per week is of course arbitrary. However, this corresponds to a well known and recognisable benchmark figure for full time working which has been utilised in previous work. The term "full time equivalent" employment is therefore synonymous with "40-hour equivalent" employment in this instance.*

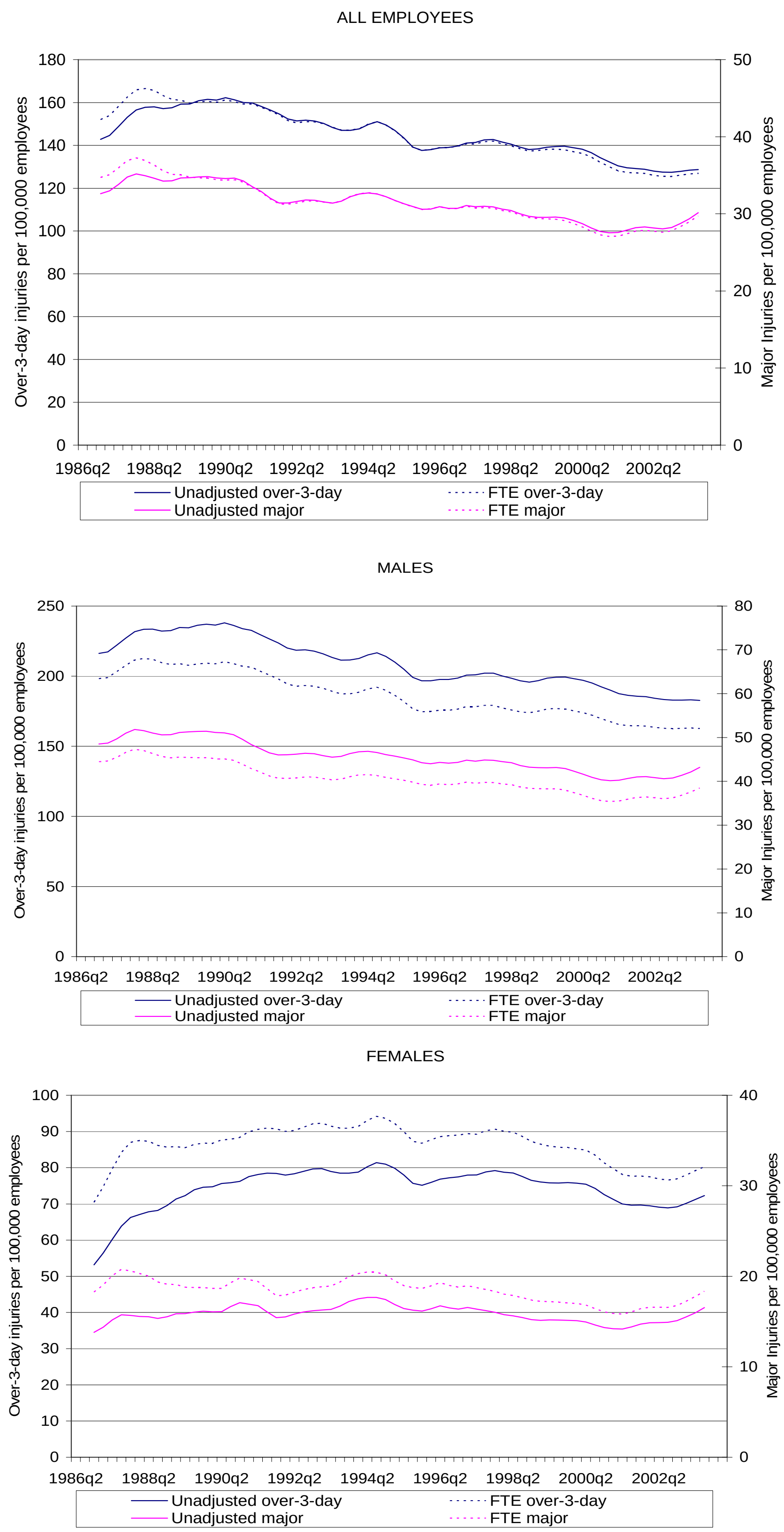


Figure 3.2 Employee accident rates derived from RIDDOR

Figure 3.2 reveals a general downward trend in rates of over-3-day injuries throughout the period. Based on full time equivalent (FTE) rates, the rate of over-3-day injuries for all employees fell from 167 injuries per 100,000 employees per quarter in 1988 to a low of 125 injuries per 100,000 employees in 2003. Moreover, the rate of over-3-day accidents amongst males has decreased most notably; from 213 per 100,000 employees in 1988 to 162 per 100,000 employees in 2003. The rate of over-3-day injuries amongst women trended upwards prior 1994 but has since fallen, based on FTE rates down from 94 injuries per 100,000 employees in 1994 to 80 injuries per 100,000 employees currently.

Figure 3.2 also shows trends in major injuries. Major injuries show a notable downward trend prior to 2000. The rate of major injuries per 100,000 employees decreased from a peak of 37 in 1989 to 27 in 2000 based all employees, with again male rather than female rates driving down the average over time. However, since 2000 there has been a notable increase in major injuries amongst both men and women. Since 2001q1 major injuries amongst men have increased from 35.3 to 38.6 per 100,000 employees, whilst amongst women the increase in from 15.8 to 18.4 per 100,000 employees.

3.5 ACCOUNTING FOR CHANGING LEVELS OF REPORTING

Previous analyses have revealed that non-fatal injuries are substantially under-reported within the RIDDOR data, particularly among the self-employed (Stevens, 1992). We may expect reporting rates to vary over time, particularly during periods surrounding the introduction of new health and safety campaigns, initiatives or regulations (e.g. RIDDOR 95). Increased reporting levels may therefore disguise the effects of real improvements in work place safety upon injury rates. It is therefore desirable to adjust the injury rate time series for variations in reporting levels.

The main alternative source of data relating to workplace injuries is the quarterly Labour Force Survey (LFS). Since 1993, a set of questions specially commissioned by the HSE relating to workplace injuries has been included in the LFS. During the winter quarters (Dec-Feb) of the LFS, survey respondents are asked whether they have been injured in a work related accident during the past 12 months, whether this injury was caused by a road traffic accident and how soon after the accident they were able to return to work. Information collected from these questions can be used to compute injury rates from all work-related accidents and injury rates from ‘reportable’ workplace accidents (i.e. non-road accidents resulting in more than 3 days absence from normal work).

The advantage of the LFS is that it provides a benchmark against which the level of under-reporting within RIDDOR can be assessed. The LFS however does not routinely collect information on the nature and severity of the injury sustained. Analysis of workplace injury data from the LFS is therefore not able to distinguish the occurrence of major injuries and of over-3-day injuries. In adjusting the injury rate time series for under-reporting, we therefore have to make the assumption that employers underreport major and over-3-day injuries to the same extent. The estimate of the reporting rate of non-fatal injuries within RIDDOR is therefore simply the ratio of the number of major plus over-3-day injuries derived from RIDDOR to the number of reportable injuries derived from the LFS.

Estimated rates of reporting are presented in Figure 3.3 for the period 1993 to 2003. To provide an indication of the movement in reporting rates over a longer period, Figure 3.3 also presents the reporting rate for 1990 as estimated by Stevens (1992). It would appear that reporting rates are following an upward trend. The published reporting rate for 1990 for all injuries is 32 per cent. Our own estimates, which commence in winter 1993, indicate that the RIDDOR reporting rate is 36 per cent. By winter 2003, the rate of reporting among all employees has increased to approximately 46 per cent. Rates of reporting for female employees are generally 10 to 15 percentage points lower than that exhibited for males. We suspect that this reflects the increased awareness of reporting responsibilities among employers in higher risk sectors where males predominantly undertake such jobs.

It can be seen that there is considerable variation in the estimates of reporting rates which may simply reflect sampling variability within the LFS. The straightforward application of these annual reporting rates to the RIDDOR data to correct for under-reporting would lead to variability in the adjusted injury rate time series. Furthermore, rates of under-reporting are not available before 1993. To overcome these issues, we undertook a ***modelling exercise*** to interpolate predicted values for reporting rates. An overview of the procedure used to predict rates of reporting is shown in Annex 1. Weighting the reporting rates by FTE equivalent levels, we obtain smoothed fitted values of reporting rates presented in Figure 3.3. For both males and females combined, average reporting rates are estimated to increase from 33% in 1986 to 43% in 2003. However, rates of reporting amongst males continue to be notably higher than those of females although this is partly due to compositional effects from the sectors in which females tend to work (as discussed further in the following section).

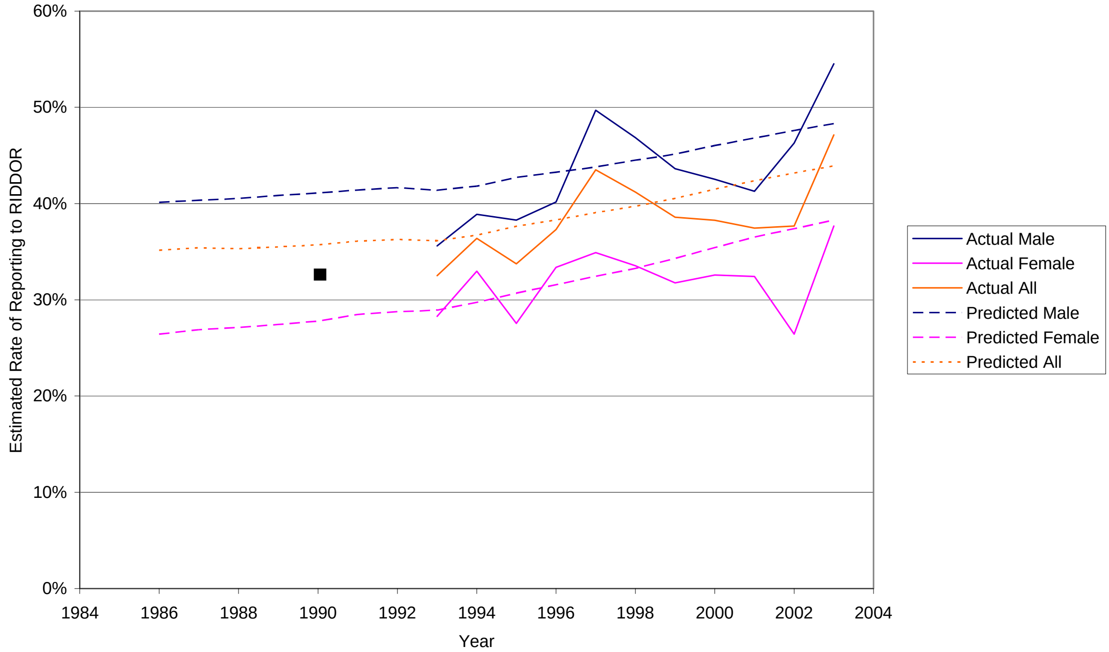


Figure 3.3 Estimated trends in reporting levels

Figures 3.4 shows the effects of adjusting employee injury rate time series for the effects of under-reporting. The charts plot the FTE injury rates for all, male and female employees respectively, as previously derived. On the same graph each of these series is adjusted for under-reporting based on (predicted) reporting rates shown in Figure 3.3. In each case the obvious result of correcting for under-reporting is the upward shift in the position of these injury rate time series. This is particularly the case among female employees for whom rates of reporting of accidents are generally lower. In addition, since rates of reporting are increasing over time for both gender groups, adjusting for higher rates of reporting over time increases the injury rates during the early part of the series by a greater scaling factor than is the case later in the time series. The effect of this in each case is to accentuate the effect of the downward trend in injury rates.

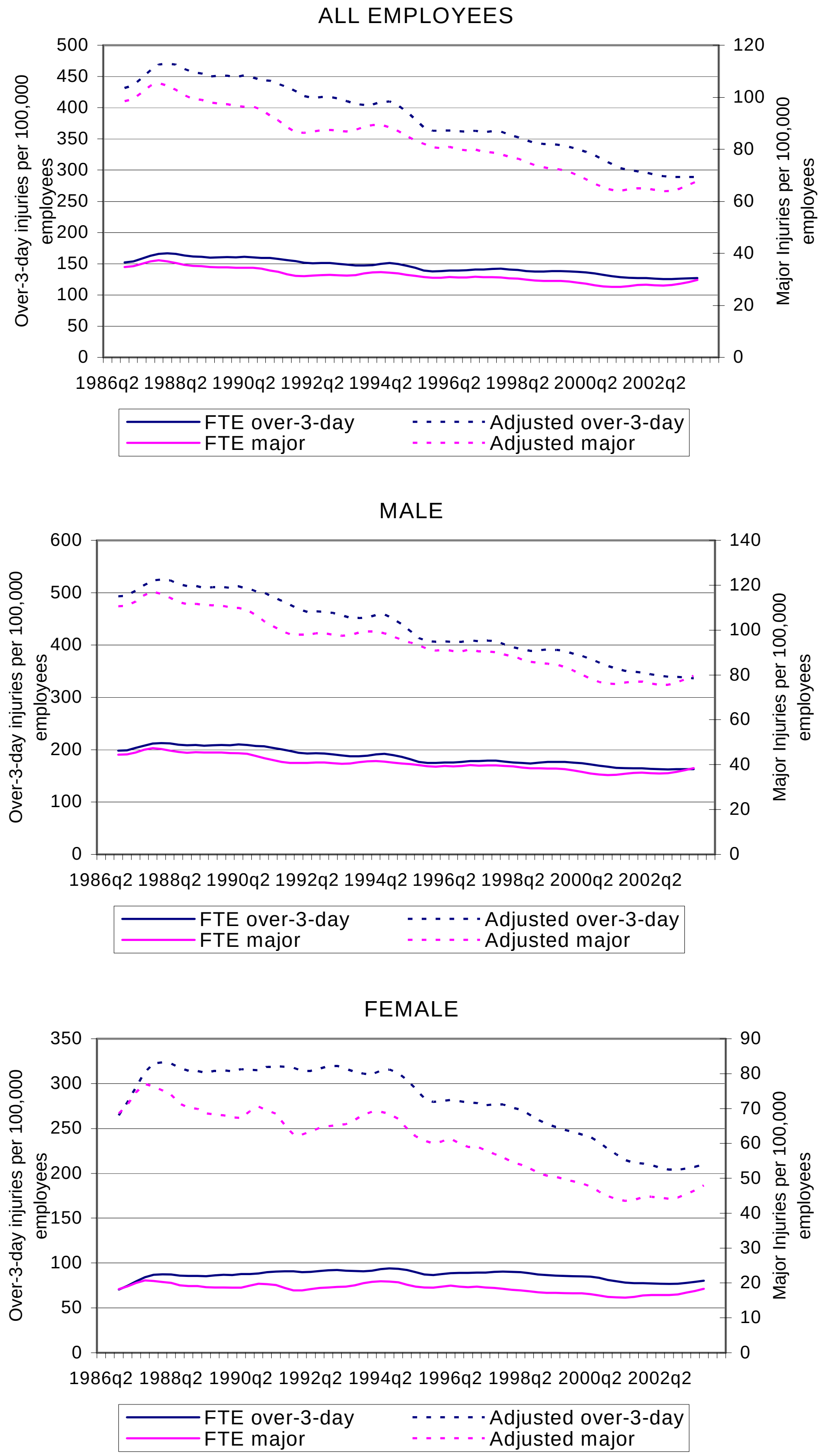


Figure 3.4 Injury rates adjusted for under-reporting

3.6 INJURY RATE TIME SERIES BY INDUSTRIAL SECTOR

The overall employee injury rates presented in the previous section represent the weighted average of accident rates across all sectors. Such time series plots of the overall injury rate may hide the presence of divergent trends that could exist within different sectors. Aggregating sectors is also problematic in terms of identifying whether workplace injury rates relate to the business cycle; we may expect variation in accident rates with business activity to be more apparent in some sectors rather than others (e.g. the private sector compared to the public sector). Business cycles may also not be synchronised across sectors. For example, evidence suggests that at the time of writing the UK is experiencing an expansion of the service sector, but a contraction in manufacturing sector output. Aggregating across sectors would not fully capture this information and lead to any apparent effects being diluted.

To overcome these problems we next present time series plots of employee injury rates by sector. The categorisation of sectors used is based on the Standard Industrial Classification (SIC) of economic activity. However, later in the report we also depend on the availability of measures of economic activity by sector to which we can relate accident rates. We therefore merge sectors in order to be consistent with the GDP measures provided by the Office for National Statistics (ONS). Therefore injury rates are presented separately for 10 broad sector, some based on single SIC categories (F, I, L, M, N) and others based on merged SIC categories (AB, CDE, GH, JK, OPQ)[5]. The definitions of these sectors are presented in Table 3.2.

Injury rates are calculated separately for each of the ten sectors. In each case, we present both an unadjusted injury rate series and an adjusted series which makes adjustments for both full time equivalence and under-reporting. The unadjusted rate is calculated as the number of injuries (over-3-day and major are treated separately) divided by the number of employees in the sector, and normalised per 100,000 employees. Adjustments to take into account the under-reporting of accidents are based on the modelling exercise of reporting rates, as described in Annex 1. As demonstrated in Figures 3.2 and 3.4, we note that the difference between the adjusted and unadjusted injury rate series is primarily driven by our corrections for under-reporting.

Table 3.3 shows the estimated reporting rate for 1986 and 2004, by sector and gender. The figures reveal that in all cases females have lower rates of reporting of accident rates than males. In addition to this, some sectors have much higher rates of reporting than others. In particular, the highest rates of reporting are in the Public Administration & Defence sector (L) and the Transport, Storage & Communication sector (I), whereas the service sectors generally show lower rates of reporting of accidents compared to other areas of the economy. Reporting rates are shown to exhibit an upward trend in most sectors and especially in areas where reporting rates were very low at the start of the period, for example in sectors Financial Intermediation (J), Real Estate, Renting & Business Activities (K) and Health & Social Work (N). Reporting rates are shown to be relatively stable within those sectors that have already reached ‘mature’ levels of reporting.

[5] *Note that in 1992 the SIC system was changed so that the categorisation of sectors moved from SIC1980 to SIC1992 standards. Our classification of sectors takes these changes into account and maps SIC1980 into SIC1992 prior to 1993.*

Table 3.2 Defining ten industrial sectors

Aggregated sectors	*Industry classes*
AB: Agriculture, Fishing	A: Agriculture, Hunting & Forestry;
	B: Fishing
CDE: Mining, Manufacturing, Utilities	C: Mining, Quarrying;
	D: Manufacturing;
	E: Electricity Gas & Water Supply
F: Construction	F: Construction
GH: Retail, Hotels, Restaurants	G: Wholesale, Retail & Motor Trade;
	H: Hotels & Restaurants
I: Transport, Storage and Communication	I: Transport, Storage & Communication
JK: Financial Intermediation, Real Estate and Business	J: Financial Intermediation;
	K: Real Estate, Renting & Business Activities
L: Public Sector and Defence	L: Public Administration & Defence
M: Education	M: Education
N: Health and Social Work	N: Health & Social Work
OPQ: Other Community, Social, Personal	O: Other Community, Social & Personal;
	P: Private Households with Employed Persons;
	Q: Extra - Territorial Organisations And Bodies

Table 3.3 RIDDOR reporting rates by gender and by sector from modelling exercise

	Male		*Female*	
Sector	*1986*	*2004*	*1986*	*2004*
AB: Agriculture, Fishing	32%	54%	24%	45%
CDE: Mining, Manufacturing, Utilities	53%	53%	44%	44%
F: Construction	33%	42%	25%	33%
GH: Retail, Hotels, Restaurants	29%	38%	20%	29%
I: Transport, Storage and Communication	36%	63%	27%	54%
JK: Financial Intermediation, Real Estate and Business	15%	46%	6%	38%
L: Public Sector and Defence	53%	72%	45%	63%
M: Education	57%	37%	48%	29%
N: Health and Social Work	20%	54%	11%	46%
OPQ: Other Community, Social, Personal	22%	36%	13%	27%

Note: Estimated reporting rates for 1987 – 2003 can be obtained by linear interpolation for each gender and sector category.

Figure 3.5 presents the adjusted and unadjusted accident rates for each of sector. For ease of presentation injury rates for males and females combined. Once again, both over-3-day and major accident rates are adjusted separately to take into account the effect of the changes in RIDDOR definitions from 1996q2 onwards. This removes the step-shift in the data that was previously present. All series are presented as 4 quarter moving averages in order to remove seasonal variation.

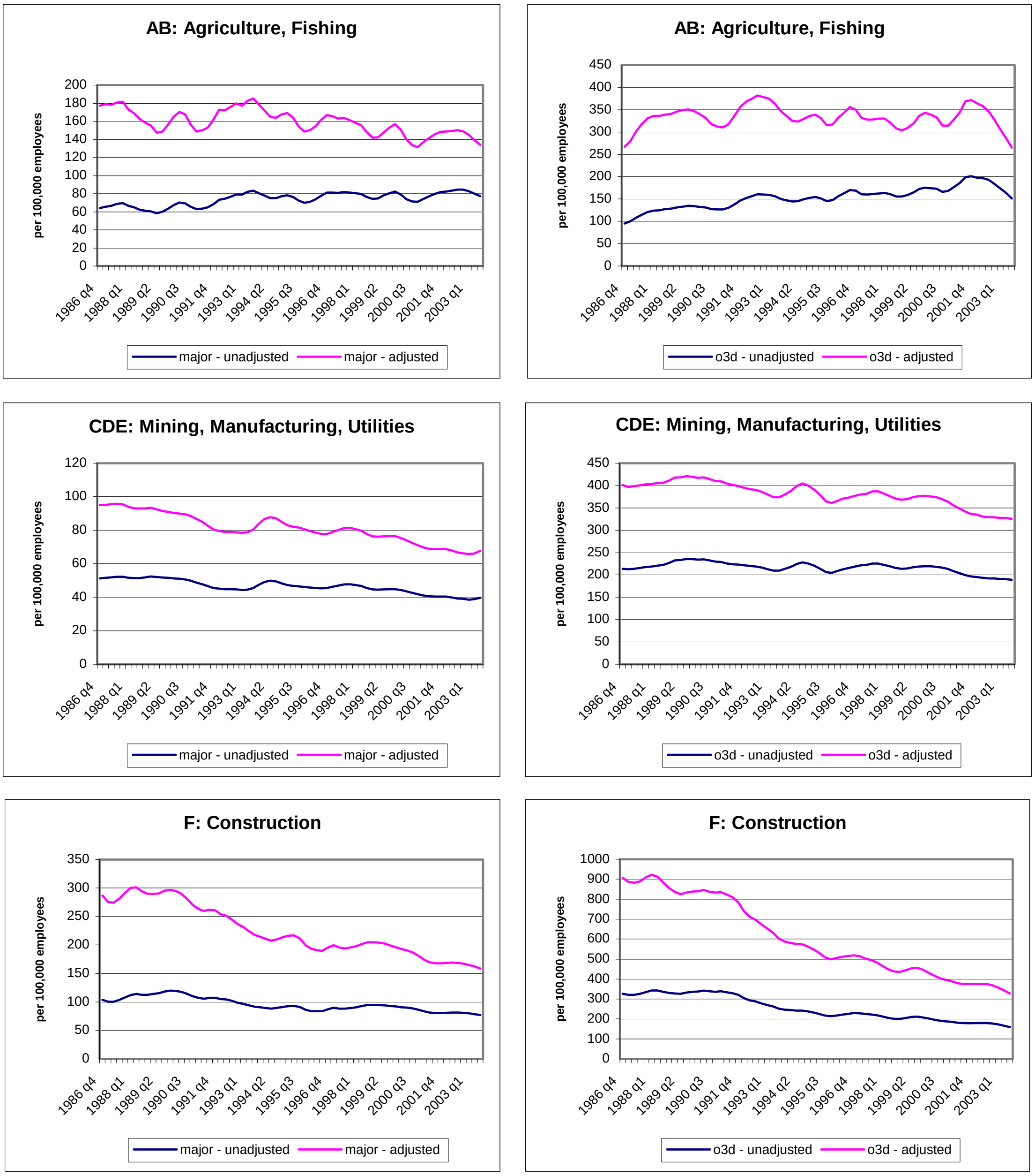


Figure 3.5 Employee injury rates by sector

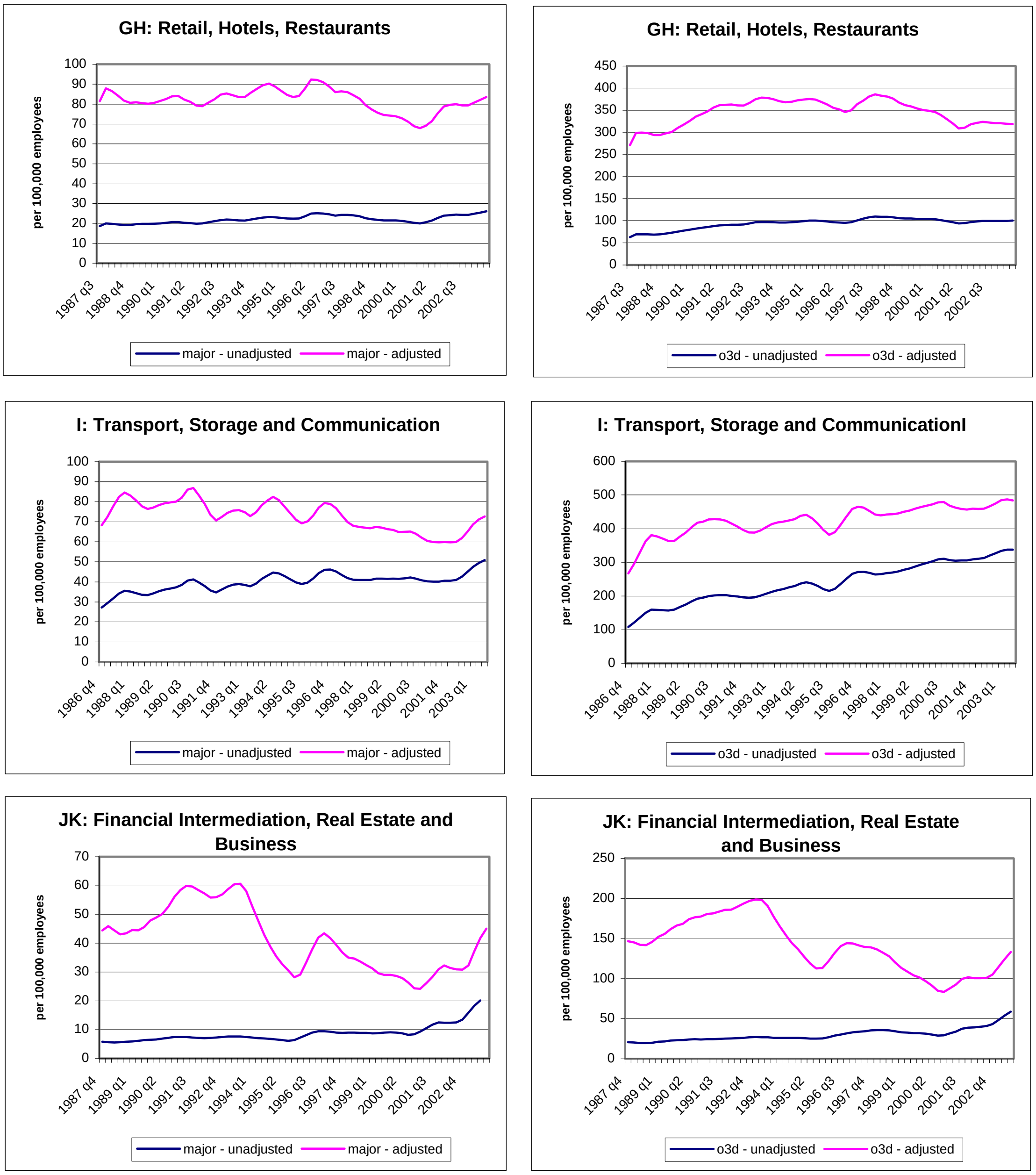


Figure 3.5 (continued) Employee injury rates by sector

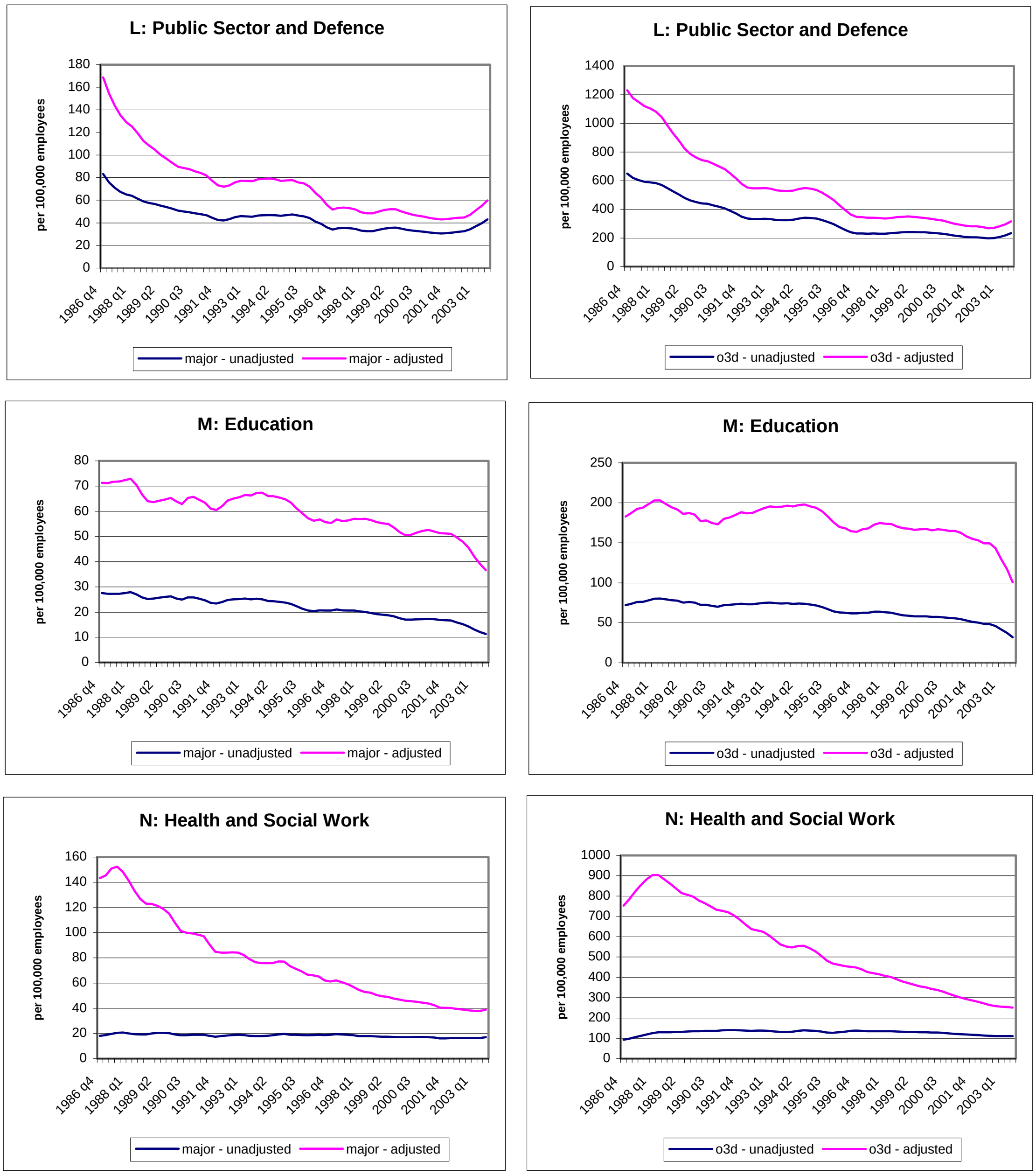
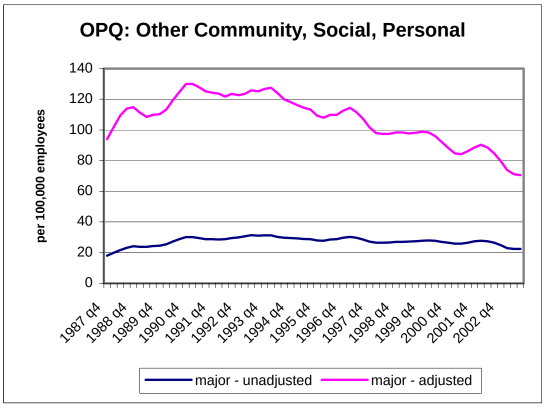
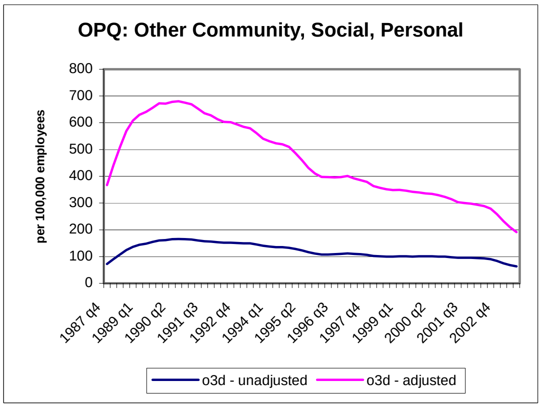


Figure 3.5 (continued) Employee injury rates by sector





Note: Injury rate series are shown using a 4 quarter moving average to smooth seasonal effects.

Figure 3.5 (continued) Employee injury rates by sector

The figures show something of a polarisation by sectors in terms of trends in accident rates. In the traditional industrial sectors and in those sectors dominated by public sector provision, accident rates have continued to decrease throughout the period 1986 to 2004. This is the case for over-3-day and major accidents in agriculture including fishing (sector AB), the productive sectors (CDE), construction (F), and in the public sectors (L,M,N). In the latter three cases for over-3-day and major accident rates have decreased by more than a half, taking into account reporting rates, and once we adjust for the effect of the changes in RIDDOR definitions in 1996.

As noted above, rates of reporting have remained relatively stable within the productive sectors and construction. Therefore, the effects of correcting for under-reporting within these sectors are observed in terms of a relatively uniform upward shift in the rates of workplace injury over the period of analysis. In contrast, improved rates of reporting in the public services (L, M, N) and social and community services (OPQ) means that the unadjusted series do not capture the downward trend in accident rates that are observed in the adjusted series within these sectors.

CHAPTER 4: IDENTIFYING THE EFFECT OF THE BUSINESS CYCLE ON WORKPLACE INJURY RATES

4.1 INTRODUCTION

The aim of this chapter is to identify whether rates of workplace injury vary over the course of the business cycle. This is done based on the quarterly series of accident rate data derived from RIDDOR data presented in the previous chapter. Section 4.2 presents an overview of the business cycle for the period covered by the accident rate data. The discussion considers the change in GDP across the whole economy and by sector. Section 4.3 then presents the results of a modelling exercise that considers the relationship between GDP growth and the movement in workplace injury rates. In Section 4.4 we investigate the nature of the causal mechanisms that are hypothesised to underpin the relationship between workplace injury rates and the business cycle; namely the effect of worker effort and new hires. Finally, in Section 4.5 we investigate whether worker effort and the incidence of new hires can be demonstrated to be related to movements in workplace injury rates over time.

4.2 OVERVIEW OF THE BUSINESS CYCLE

For the purposes of this discussion we use Gross Domestic Product (GDP) as a measure of business cycle activity. GDP for the economy as a whole measures output based on the valuation our aggregate production at market prices. Since this series tends to be trended (increasing year on year with economic growth) we transform the data in order to create a series based on deviation of output from long term trend[6]. The benefits of this approach are that we can more readily identify those periods during which the economy is growing either faster or slower than average during the period of analysis and that the turning points in the business cycle can be more easily identified.

Figure 4.1 shows the phases of the business cycle since 1986 based on the GDP measure described above[7]. This series is also compared to the ILO unemployment rate. The International Labour Organisation (ILO) measures unemployment based on a count of individuals who are either: (a) without a job, want a job, have actively sought work in the last four weeks and are available to start work in the next two weeks, or (b) out of work, have found a job and are waiting to start it in the next two weeks[8]. We can see that these two series correspond quite closely in terms of capturing phases of the cycle. During the late 1980's GDP grew rapidly and above trend whilst at the same time unemployment decreased. After 1989 this situation was reversed with a contraction of economic activity (GDP) and rising unemployment. The business cycle bottomed in 1993 and the economy began a sustained recovery which has continued until 2004, the longest post war economic boom in the UK.

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6 *In order to do this the logarithm of GDP is regressed against a time trend and quarterly dummies (1986-2004, quarterly) in order to take into account systematic time series variation. The series are adjusted to constant prices using an RPI deflator in order to measure GDP in real terms. The residual values transformed to percentage values show the difference from trend. This methodology follows Dickerson (1994).*

7 *GDP data is taken from National accounts: 'GDP: expenditure at current market prices 1946 – 2004' (Office for National Statistics (ONS)). The series are adjusted to constant prices using an RPI deflator in order to measure GDP in real terms.*

8 *In the UK, ILO unemployment data is collected via the Labour Force Survey (LFS) and is published quarterly by the ONS. Seasonally adjusted rates are used, and rates are expressed as a percentage relevant economically active population.*

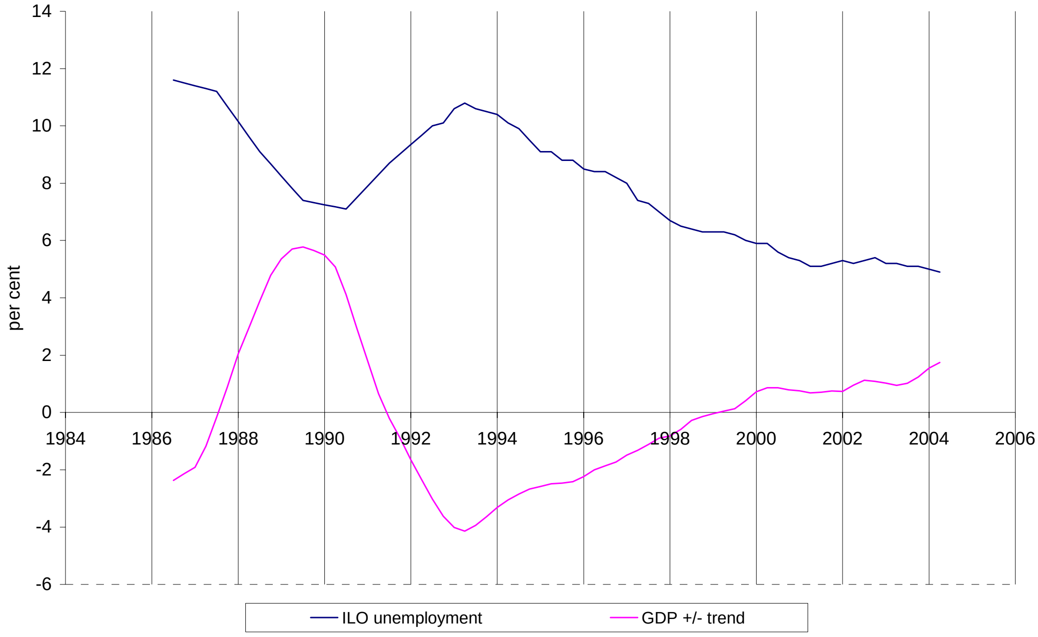

Figure 4.1 Aggregate business cycle indicators: GDP and the ILO unemployment rate

The overall rate of GPD growth will represent the (weighted) average of that observed in different sectors. However, business cycles may be not be synchronised across sectors. For example, evidence suggests that at the time of writing the UK is experiencing an expansion of the service sector, but a contraction in manufacturing sector output. Aggregating across sectors would not fully capture this information and lead to any apparent effects being diluted. In Figure 4.2 we therefore present our measure of GDP growth for different sectors of the economy. The rate of unemployment cannot be presented by industry sector and so this measure is not used within the analyses that follow. The definitions of industrial sectors are those that were used in the construction of the sector specific injury rate series presented in Chapter 3.

Analysis of GDP growth by sector highlights the different circumstances faced in different sectors of the economy. Within sectors such as M: Education and N: Health and Social Work, no obvious cyclical pattern emerges and only relatively small deviations in the GDP growth from trend can by identified. However, in these sectors which are dominated by the public sector, expenditure will be driven by political decisions as opposed to market forces. Similarly, the peaks and troughs of expenditure in sector L: Public Administration and Defence, do not align with those exhibited in areas of the economy dominated by the private sector. Within the agricultural sector, movements in output have clearly been influenced by the effects of BSE and subsequent export ban (mid 1990s) and the outbreak of *foot and mouth* disease during 2001. At the time of writing we observe that while the manufacturing sector (CDE) is experiencing a slow down, the construction sector (F) is experiencing a period of relatively high demand. The financial and business services sector (JK) and the wholesale and retail sectors (GH) have both experienced steady recoveries in demand following the recession of the early 1990s.

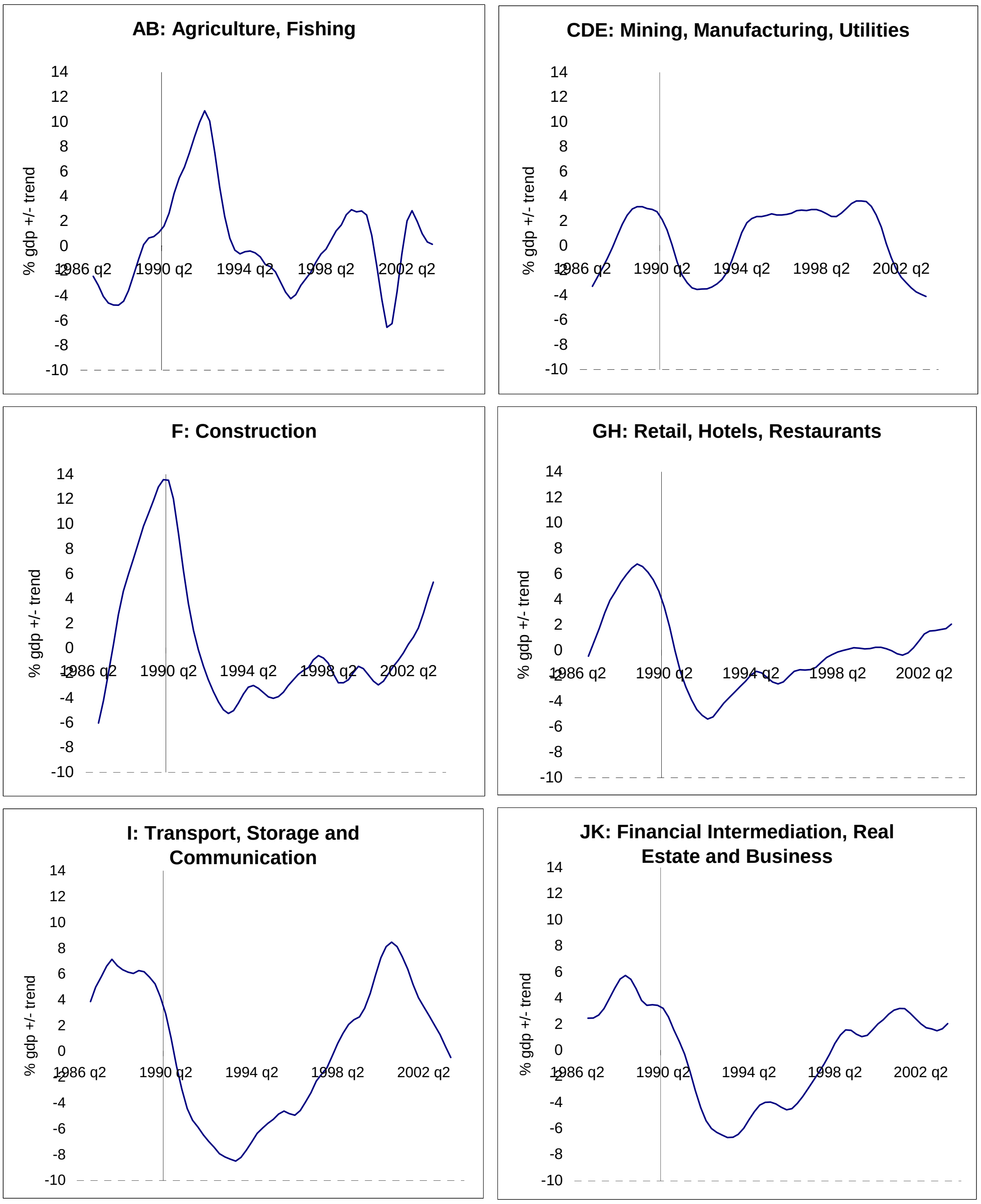

Figure 4.2 GDP growth by industry

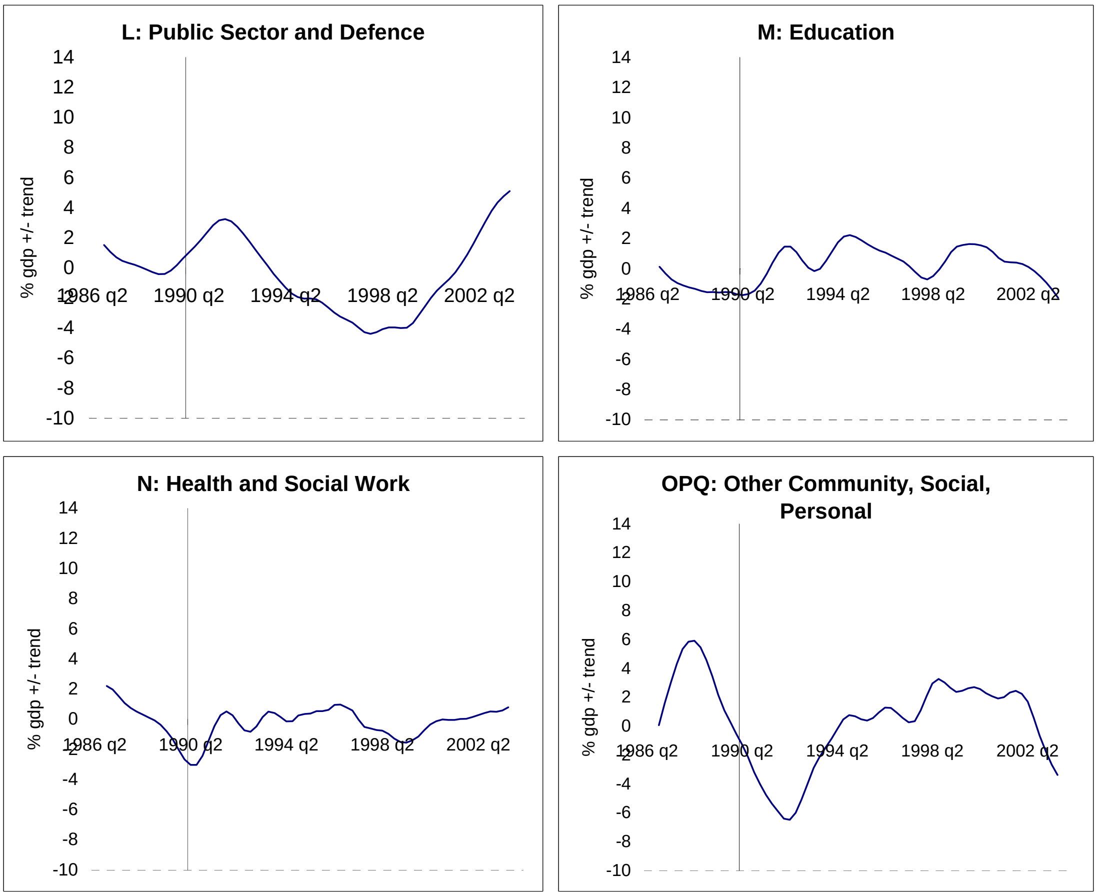

Figure 4.2 (continued) GDP growth by industry

4.3 IDENTIFYING THE EFFECT OF THE BUSINESS CYCLE UPON WORKPLACE INJURY RATES

In this section we consider whether the business cycle can be demonstrated to have an influence upon the rate of workplace injuries through the estimation of statistical time series regression models. For ease of exposition, regression models will be estimated for two types of accident rate series. The first series is referred to as the 'unadjusted series'. The denominator used within the unadjusted series is simply based upon quarterly estimates of the number of employees with no further adjustments being made for under-reporting. The second series converts the denominator of the injury rate to full time equivalent (FTE) employees and also adjusts for under reporting of accidents. The analysis is based on a regression modelling exercise of accident rates against GDP also taking into account a trend, seasonal effects and composition of employment by industrial sector. The specification of the models is discussed in Annex 2. The full results of these analyses are presented in Annex 4.

The results for the all sector model are reported in Table 4.1. Note that regression coefficients are transformed to percentage changes. The results show that a 1% increase in GDP above trend is associated with a 1.4% increase in the rate of major accidents, with similar effects for both male and female rates[9]. However, based on the all sector model, no statistically significant relationship is found to exist between GDP and rates of over-3-day injury.

We also present the results in an alternative manner to provide more intuition regarding changes in accidents over the cycle. Based on historic transitions in GDP, shown in Figure 4.1, we define a typical business cycle based on the fluctuations in GDP around the trend. For convenience we use the following benchmark figures relating to a boom and recession, based on data from 1986 to 2004.

- GDP 4 per cent *above* trend (boom) compared with 4 per cent *below* trend (recession) – a recession to boom increase in GDP of 8% above trend

Given that economic cycles can vary in terms of their severity, it is acknowledged that these figures are not exact. However, they provide a useful benchmark for comparing changes in accident rates over the cycle. Based on coefficients estimated in the model, the lower half of Table 4.1 shows the percentage increase in accidents in a boom compared to a recession. Interpreting the results, we can therefore see that a boom increases the rate of major accidents by approximately 11 to 12 per cent per cent compared to the rates observed within a recession. No significant effect exists for over-3-day accidents.

Table 4.1 Change in accident rates, based on all sector models

	Major		***Over-3- day***	
	Male	***Female***	***Male***	***Female***
% of all accidents reported under RIDDOR (1986-2004)	10.5%	3.5%	65.1%	20.9%
% change in accidents due to a 1% increase in GDP (above trend)				
Unadjusted	1.409	1.362	n.s.	n.s.
Adjusted	1.392	n.s.	n.s.	n.s.
% change in accidents in a boom compared to a recession				
Unadjusted	11.8	11.4	-	-
Adjusted	11.7	-	-	-

Notes: "n.s." indicates that the coefficient is not statistically significant

We now repeat the analysis for the ten industry sectors outlined earlier. Individual sector models of the accident rates are more useful in that they are able to capture sector specific and differences in the level of demand across the economy. The results of these regressions are shown in Table 4.2, where coefficients are again transformed to percentage changes. The results show a great deal of variation by sector. Some sectors produce results in line with what we would expect, suggesting that an increase in economic activity within the sector is associated with an increase in injury rates in the sector. In particular heavier industries where accident rates are highest tend to produce these results, and especially for male accident rates (results for females are generally

[9] *Note that the effect on adjusted rate for females is of a similar magnitude but marginally insignificant.*

mixed or less likely to be significant). For the manufacturing sectors (CDE) we find that a 1% increase in GDP above trend is associated with a 0.6 to 1.3 % increase in accident rates based on all accident rate series and irrespective of gender. In construction (F) a 1% increase in GDP above trend is associated with a 0.6 to 0.7 % increase in accident

Table 4.2 Change in accident rates, %, effect of GDP growth

1% increase in GDP (above trend)				
Sector	***Major***		***Over-3-days***	
	Male	***Female***	***Male***	***Female***
AB: Agriculture, Fishing				
Unadjusted	n.s.	n.s.	n.s.	1.737
Adjusted	n.s.	n.s.	n.s.	1.417 *
CDE: Mining, Manufacturing, Utilities				
Unadjusted	1.017	1.119	1.271	0.987
Adjusted	0.781	0.698 *	1.034	0.567
F: Construction				
Unadjusted	0.685	n.s.	0.726	n.s.
Adjusted	0.569	n.s.	0.609	n.s.
GH: Retail, Hotels and Restaurants **				
Unadjusted	n.s.	-1.089	-1.786	-2.385
Adjusted	n.s.	-1.067	-1.665	-2.363
I: Transport, Storage and Communication				
Unadjusted	n.s.	n.s.	n.s.	n.s.
Adjusted	n.s.	n.s.	n.s.	n.s.
JK: Financial Intermediation, Real Estate and Business **				
Unadjusted	n.s.	n.s.	n.s.	n.s.
Adjusted	n.s.	-2.534	n.s.	-3.067
L: Public Sector and Defence				
Unadjusted	2.885	n.s.	2.339	n.s.
Adjusted	3.021	n.s.	2.473	n.s.
M: Education				
Unadjusted	2.602 *	4.222 *	n.s.	6.541*
Adjusted	2.492	3.613	n.s.	5.919
N: Health and Social Work **				
Unadjusted	1.377	n.s.	-2.405	n.s.
Adjusted	2.584	n.s.	-1.243	-1.497
OPQ: Other Community, Social, Personal **				
Unadjusted	n.s.	n.s.	n.s.	n.s.
Adjusted	n.s.	n.s.	n.s.	n.s.

***Notes*:** Results indicate significance at the 5 % error level. * indicates significance at the 10 % error level. ** In these instances the first year of data is excluded from the regressions

rates for male employees. In Public Administration & Defence (L) the results are stronger, a 1% increase in GDP above trend is associated with a 2.4 to 3.0 % increase in accident rates for male employees. Similarly, Education (M) behaves in a similar manner with a 1% increase in GDP above trend is associated with a 2.4 to 6.5 % increase in accident rates. Other sectors, however, do not show clear links between the business cycle and changes in rates of accidents based on the results of the model. We also find counter-cyclical relationships in some sectors, especially for accident rates of female employees. However these instances tend to occur in sectors which contribute only a very small number of accidents to the overall total.

In order to provide a more intuitive interpretation of these findings, we again present these results in terms of the effect of a typical business cycle. Again we base our estimates of changes in business activity on movements in GDP around the trend. Table 4.3 shows the minimum and maximum values of the GDP residuals (i.e. percentage above or below trend) for each sector based on the period 1986 to 2004. Since these values are only indicative and may be extreme rather than typical in some instances, we base our measure of the boom to recession transition in GDP on 2/3rds of this range. Although arbitrary, this serves as useful benchmarking tool. We can see that the magnitude of changes in economic activity over the business cycle varies from sector to sector. The construction sector is particularly volatile, with GDP varying by an estimated 20% over the cycle; whereas at the other extreme the public sector tends to have very low volatility over the cycle, for example GDP varies by only 4% within Education and Health sectors.

Table 4.3 changes in GDP over cycle, 1986 - 2004

Sector	***(minimum , maximum)***	***2/3rds Range***
AB: Agriculture, Fishing	(-8.3% , 12.5%)	13.9%
CDE: Mining, Manufacturing, Utilities	(-5.3% , 4.0%)	6.2%
F: Construction	(-15.2% , 15.5%)	20.5%
GH: Retail, Hotels, Restaurants	(-5.9% , 7.1%)	8.7%
I: Transport, Storage and Communication	(-8.7% , 8.8%)	11.7%
JK: Financial Intermediation, Real Estate and Business	(-6.9% , 6.6%)	9.0%
L: Public Sector and Defence	(-4.8% , 7.0%)	7.9%
M: Education	(-3.7% , 2.4%)	4.1%
N: Health and Social Work	(-3.6% , 3.0%)	4.5%
OPQ: Other Community, Social, Personal	(-7.4% , 6.2%)	9.1%

Applying these measures to the regression coefficients, we are able to estimate the change in accident rates from recession to boom. These estimates are shown in Table 4.4. Results vary from sector to sector and mirror the effects already described. To provide context to these results, we again present the proportion of all accidents reported to under these categories. This procedure highlights significant pro-cyclical relationships tend to be concentrated in those sectors that account for the highest volume of accidents reported under RIDDOR. Almost 60% of accidents are estimated to occur within sectors where workplace injury rates follow a pro-cyclical pattern, with a majority of these accidents being concentrated within the construction and manufacturing sectors. The emergence of a counter-intuitive result within the Health and Social Work sector (N) is perhaps not surprising as this sector is dominated by public sector employment, where demand based upon societal needs may be expected to exhibit less fluctuation over the course of the business cycle. Indeed, an alternative interpretation of this finding could be that health and safety improves when more resources are diverted towards this sector. It is less apparent why a counter-cyclical relationship should emerge within the Retail, Hotels, Restaurants sector (GH).

Table 4.4 Percentage increase in accidents in a boom compared to a recession

Estimated change in accident rate over business cycle				
Sector	***Major***		***Over-3-days***	
	Male	***Female***	***Male***	***Female***
AB: Agriculture, Fishing				
% of accidents	0.3	0.0	0.7	0.1
Unadjusted	-	-	-	24.0
Adjusted	-	-	-	19.6
CDE: Mining, Manufacturing, Utilities				
% of accidents	4.0	0.6	26.4	4.4
Unadjusted	6.3	6.9	7.8	6.1
Adjusted	4.8	4.3	6.4	3.5
F: Construction				
% of accidents	2.0	0.0	7.3	0.1
Unadjusted	14.0	-	14.8	-
Adjusted	11.6	-	12.4	-
GH: Retail, Hotels and Restaurants				
% of accidents	1.1	0.8	6.3	4.1
Unadjusted	-	-9.5	-15.6	-20.9
Adjusted	-	-9.3	-14.6	-20.7
I: Transport, Storage and Communication				
% of accidents	1.0	0.1	8.4	1.1
Unadjusted	-	-	-	-
Adjusted	-	-	-	-
JK: Financial Intermediation, Real Estate and Business				
% of accidents	0.4	0.2	1.4	0.8
Unadjusted	-	-	-	-
Adjusted	-	-23.1	-	-28.0
L: Public Sector and Defence				
% of accidents	0.8	0.4	9.1	2.4
Unadjusted	22.4	-	18.2	-
Adjusted	23.4	-	19.2	-
M: Education				
% of accidents	0.3	0.6	1.0	1.8
Unadjusted	10.4	16.8	-	25.8
Adjusted	10.0	14.4	-	23.4
N: Health and Social Work				
% of accidents	0.2	0.6	2.4	5.6
Unadjusted	6.1	-	-10.9	-
Adjusted	11.4	-	-5.6	-6.7
OPQ: Other Community, Social, Personal				
% of accidents	0.4	0.2	2.0	0.5
Unadjusted	-	-	-	-
Adjusted	-	-	-	-

4.4 THE BUSINESS CYCLE, EMPLOYMENT TENURE AND WORK EFFORT

This section moves the analysis forward by investigating the nature of the link between the business cycle and workplace accidents. The previous analyses established a pro-cyclical relationship between accident rates and the business cycle based on GDP output indicators, particularly within those sectors that account for a majority of accidents reported to HSE. We now investigate the link more closely, examining hypotheses relating to the mechanisms which link business activity to the occurrence of workplace accidents. We investigate the two main mechanisms cited to explain the pro-cyclical pattern in accidents. Firstly, accident rates will increase with the hiring of new staff, since newer workers are more at risk of injury. Secondly, accident rates will increase at times of greater worker effort, for example as hours worked increases or overtime working increases in response to higher demand.

The above hypotheses as to why we might expect the business cycle to have an influence upon workplace injuries are based upon certain assumptions as to the relationship between the economic cycle and the labour market. The issue therefore arises as to whether such changes in tenure and intensity over the course of the business cycle are actually observed. Figure 4.3 presents information on recruitment and work experience derived from the Labour Force Survey. This is compared with the GDP indicator of the business cycle from Figure 4.1. In terms of the change in employment, it can be seen that the ‘boom’ of the late 1980s coincided with a high rate of employment growth. Employment growth then declined rapidly as the economy moved into recession during the early 1990s but has since recovered during a sustained period of economic growth.

The lower panel of Figure 4.3 shows the proportion of those in employment who have been in their current jobs for (a) less than 6 months and (b) less than 1 year. As expected, there is a high degree of correlation between the proportion of new hires and the rate of change of employment. Periods of relatively high employment growth are characterised by a higher proportion of workers who have been in their jobs for a short period of time. This pattern is observed for both definitions of new hires utilised. Therefore, if new hires are vulnerable to suffering a workplace injury, we may expect the rate of workplace injuries to follow a pro-cyclical pattern over the course of the business cycle.

The second hypothesis relating workplace injuries to the business cycle focussed on the issue of worker effort. For present purposes we distinguish between ‘extensive’ work effort, meaning the time spent at work, and ‘intensive’ work effort, meaning the intensity of work during that time at work. Although a number of studies have considered measures of ‘intensive’ work effort (see Green, 2001), such measures are not available as consistent time series. We therefore concentrate on measures of ‘extensive’ work effort which are more readily available from survey data. However, it is acknowledged that periods of ‘extensive’ work effort are likely to coincide with periods of ‘intensive’ work effort.

Measures of average hours worked may not capture the true extent of extensive work effort, as a higher proportion of workers doing long hours may simply be offset by a higher proportion of workers doing relatively few hours (e.g. if part time workers are recruited to meet demand). Figure 4.4 presents time series plots of 3 measures of ‘extensive’ work effort. The upper panel shows the proportion of full time workers who report working longer than 50 hours per week. A cyclical pattern in the proportion of people working long hours is observed, however this is less apparent than that observed for new hires. It can be seen that the proportion working long hours increased steadily during the 1990s, peaking at 16 per cent during 1998. Since this time, the proportion of full time workers working long hours has steadily declined, falling to 13% by 2004.

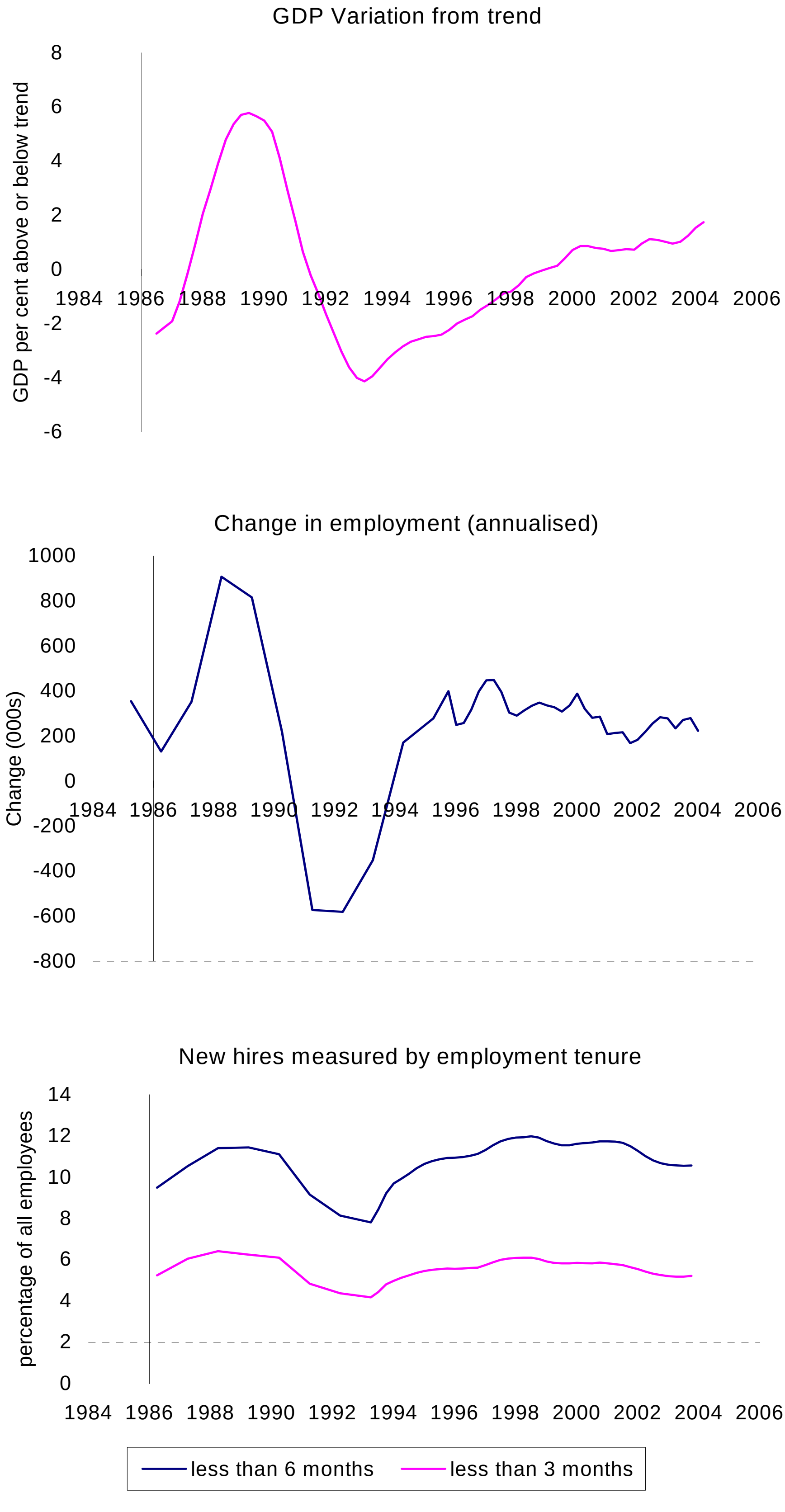

Figure 4.3 Change in GDP, employment and new hires

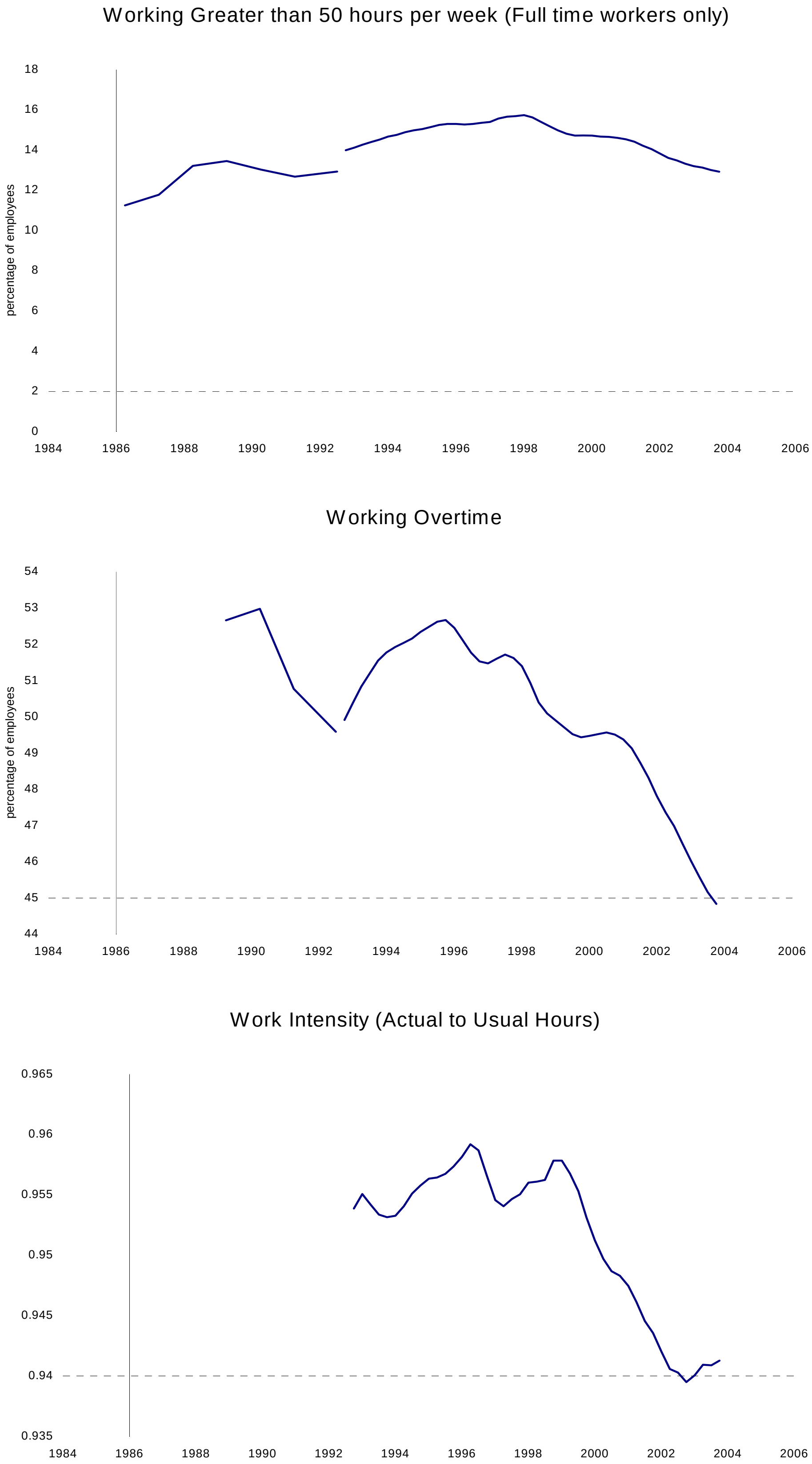

Figure 4.4 Long working hours, overtime and work intensity

Changes in work intensification are however not restricted to those in full time employment. Therefore, the 2 lower panels of Figure 4.4 provide alternative measures of 'extensive' work effort. The second panel shows the proportion of all workers who report that they have worked overtime, whether paid or unpaid, during the survey reference week[10]. Compared to long hours working, a clearer cyclical pattern emerges. During the recession of the early 1990s, there is a obvious fall in the proportion of workers who indicate that they had worked overtime, falling from 53% in 1990 to 49% in 1992. The proportion who report working overtime then increases, returning to 53% by 1996. However, in contrast to employment growth and the proportion of new hires, the proportion who report working overtime declines after 1996. This would seem to confirm the view that increased working hours is a short term response by employers, while recruitment represents a longer term response to increased levels of demand.

The final measure of 'extensive' work effort is referred to as work intensity and is estimated as the ratio of actual hours worked to usual hours worked. A justification for using this measure is as follows. In the LFS individuals are asked their actual hours worked (in the reference week when they were surveyed) and their usual hours of work, including overtime. Although individuals may not accurately recall these figures (recall error), their responses will tend to reflect whether or not they are working longer or shorter than usual. For the period 1993 to 2004, it can be seen that the pattern is in fact similar to that found for overtime working, i.e. a general downward trend during the period[11]. Also note that the ratio tends to be below one for all periods, suggesting that stated actual hours worked are on average less than usual hours. The reason for this, however, is not clear. The sharp decline in overtime working and work intensity during the latter half of the 1990s may reflect the introduction of the *Working Time Directive* during 1998 which stipulates that working time should not exceed an average of 48 hours.

The diagrams above show trends in employment tenure and work intensity based on working hours for the economy as a whole based on an aggregation of the ten sectors used in this study. However, since these measures are likely to vary across sectors and, moreover, show different inter-temporal patterns, it is informative to consider trends by sector. Figure 4.5 compares trends in aspects of labour market activity, including (1) the percentage of employees with job tenure of less than three months, (2) the percentage employees working overtime and (3) work intensity measured by the ratio of actual to usual hours worked. For each sector we also present plots of the adjusted and unadjusted *combined* rates of major and over-3-day injuries derived from RIDDOR. These charts are restricted to the period 1993 to 2004, corresponding to the availability of these indicators on a quarterly basis from the Labour Force Survey. For the economy as a whole, new hires peak in 1997 and subsequently decrease, particularly since 2000. Similar patterns are seen across all sectors, however, we note a recent increase in new hires as a percentage of the workforce particularly in the service sectors. In terms of the two measures of work effort, a consistent picture of declining overtime and work intensity emerges.

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[10] *Availability of consistent question means that this series can only be constructed from 1989 onwards.*
[11] *Availability of consistent question means that this series can only be constructed from 1992 onwards.*

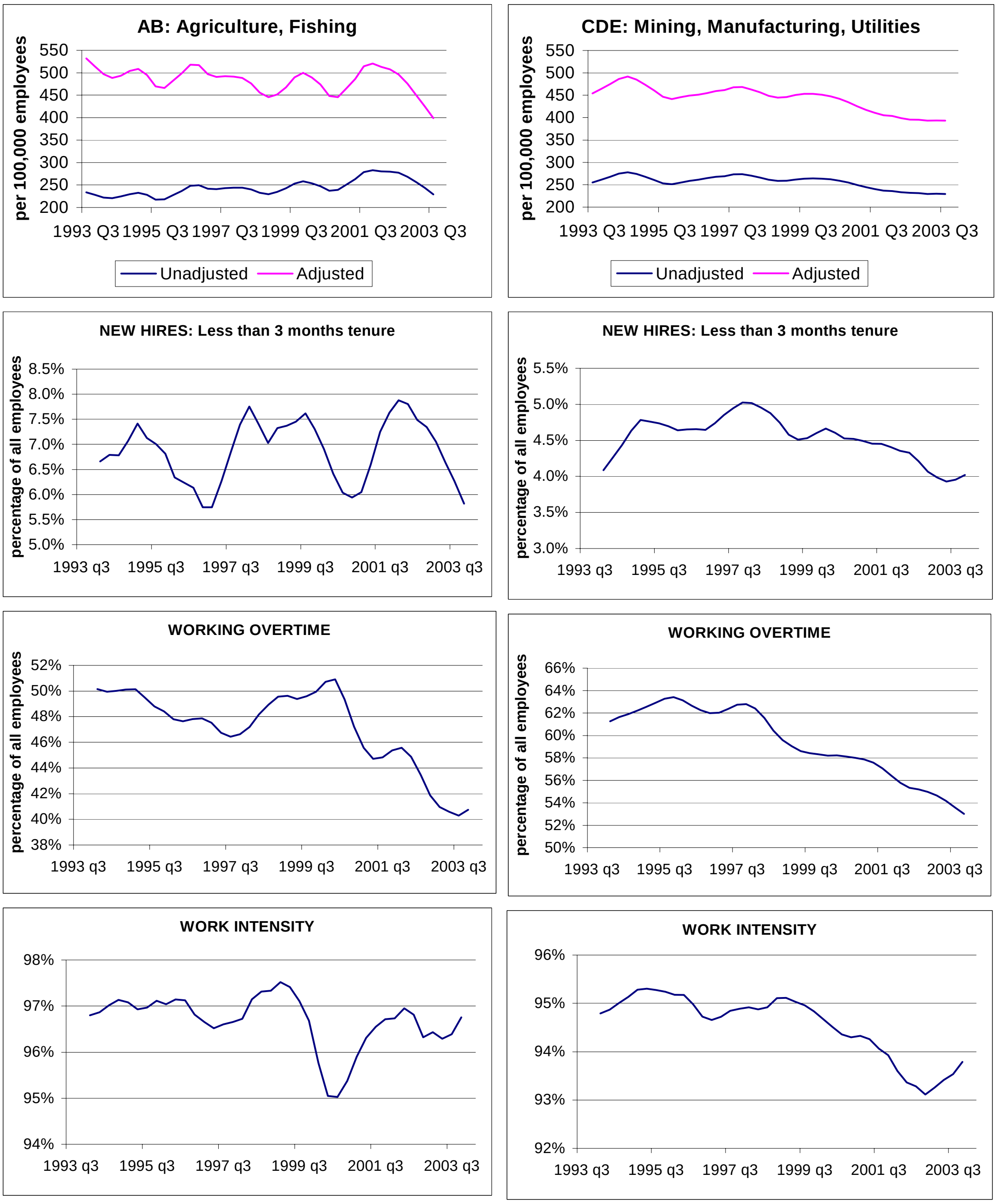

Figure 4.5 Injury rates, new hires and work intensity by sector

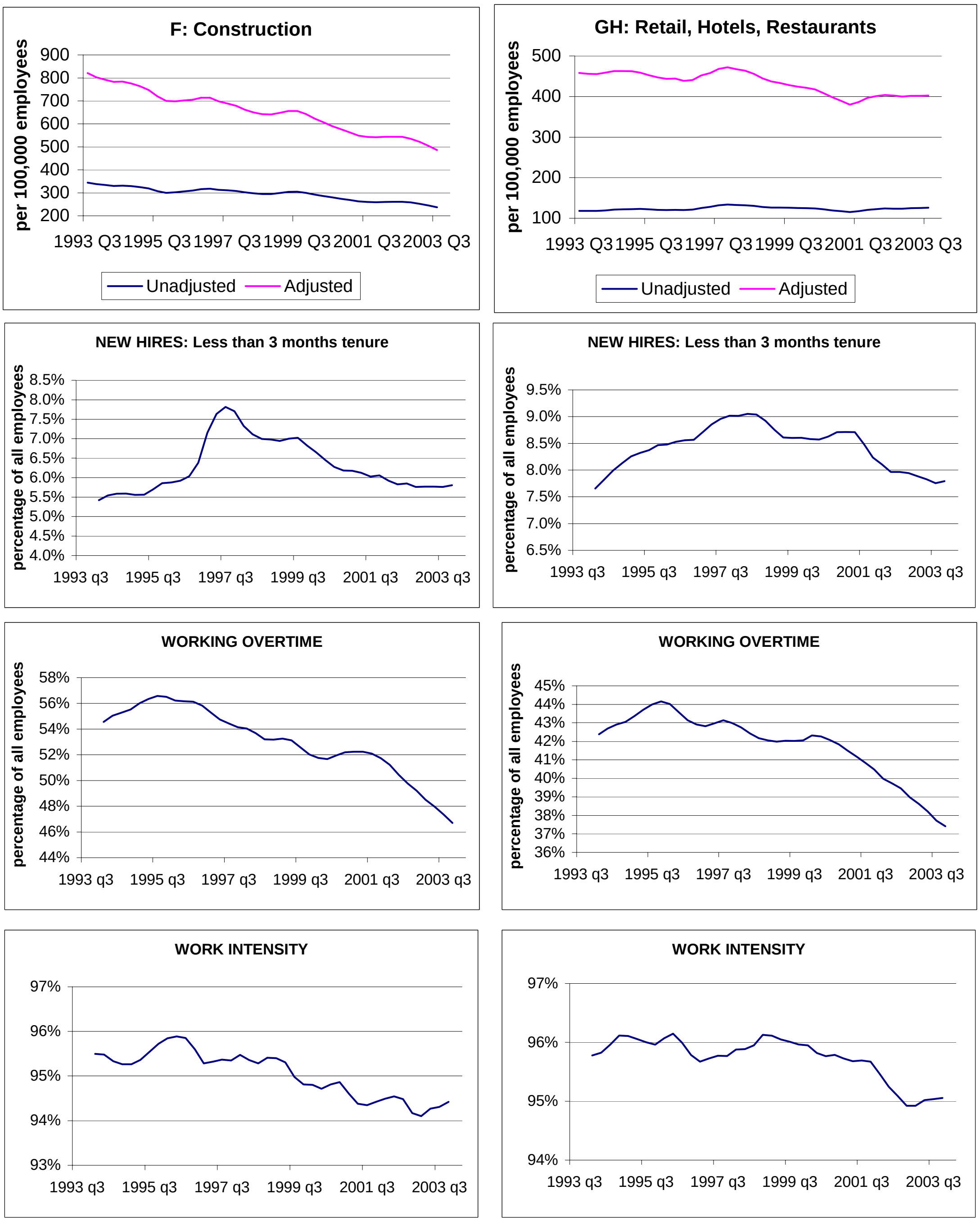

Figure 4.5 (continued) Injury rates, new hires and work intensity by sector

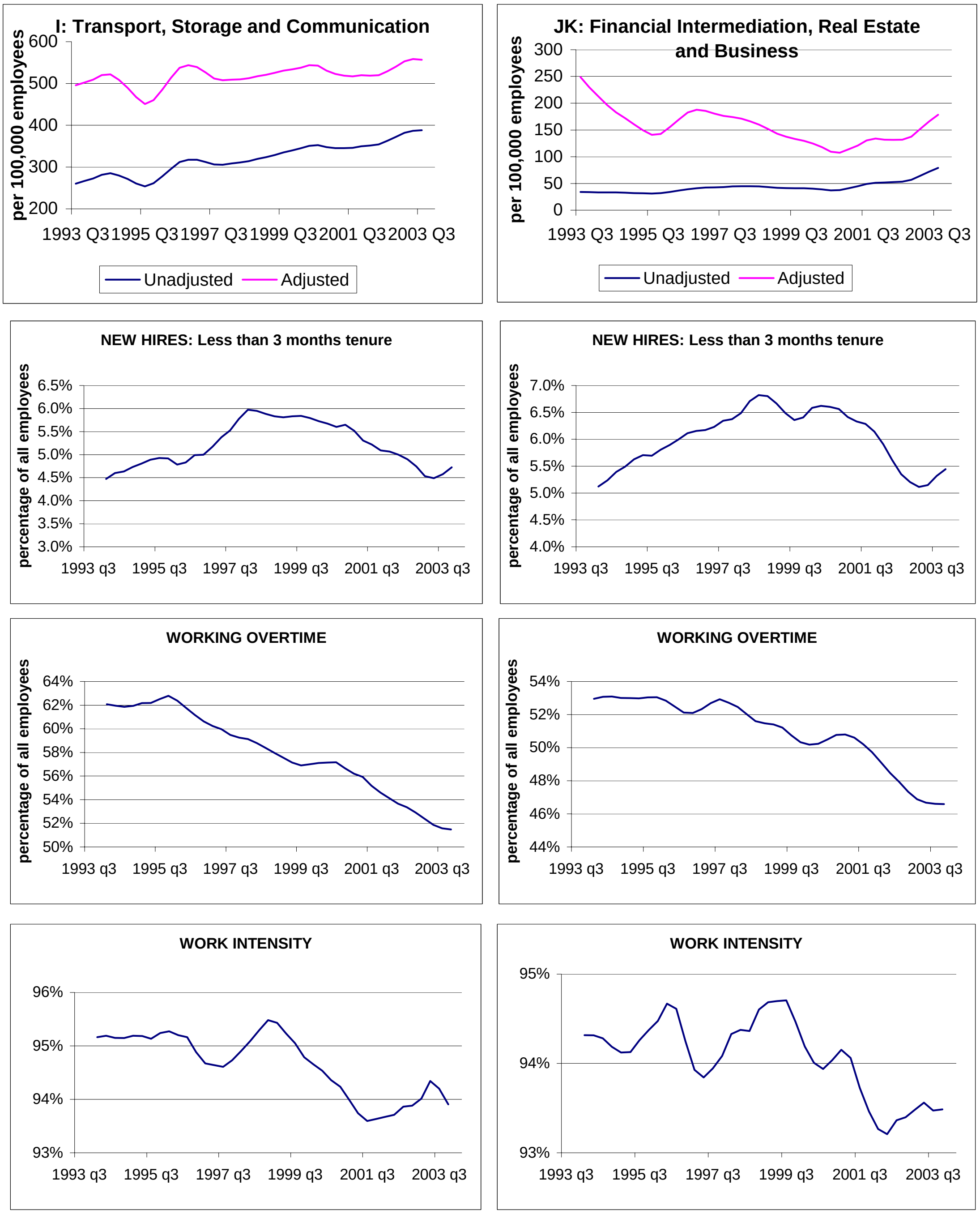

Figure 4.5 (continued) Injury rates, new hires and work intensity by sector

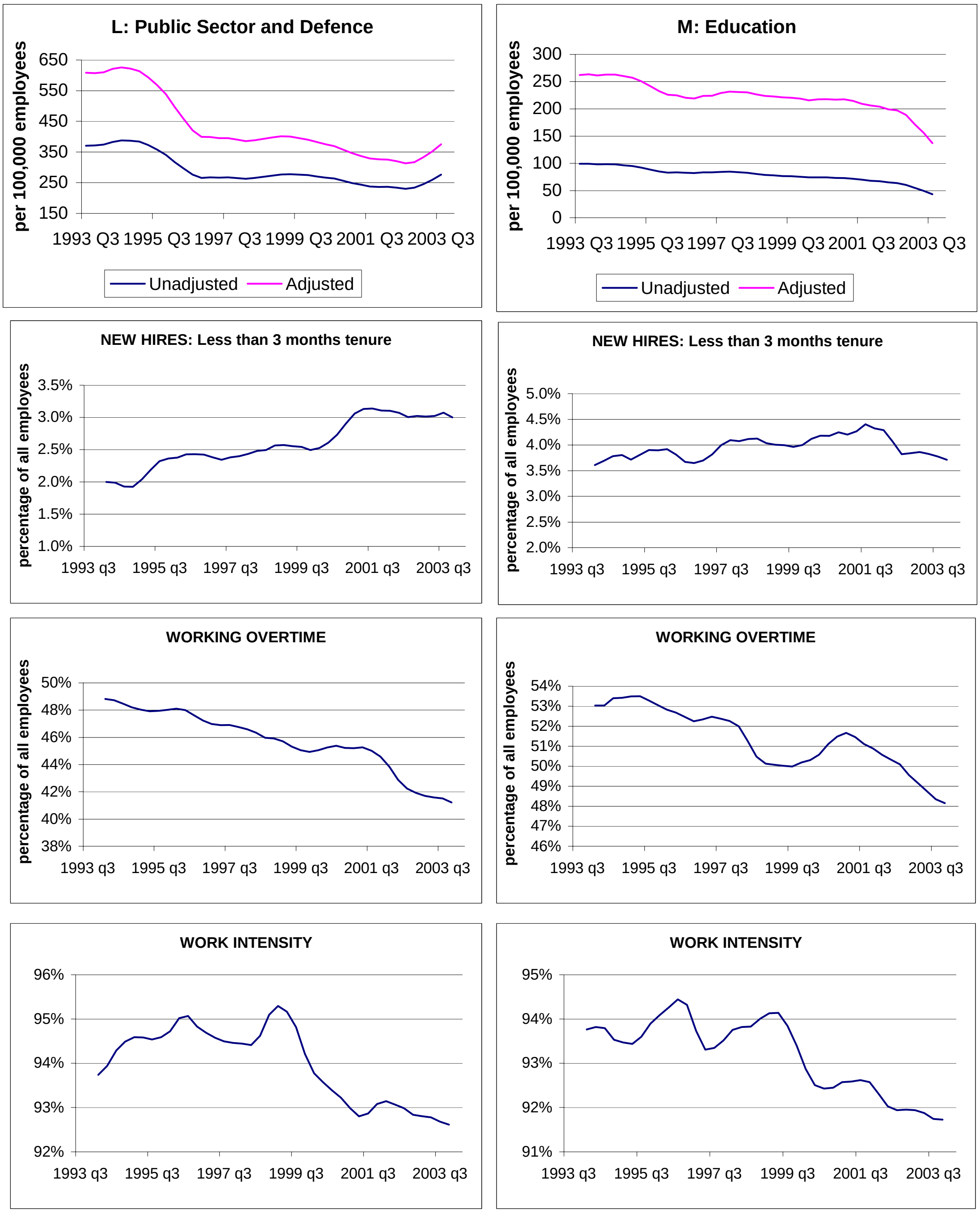

Figure 4.5 (continued) Injury rates, new hires and work intensity by sector

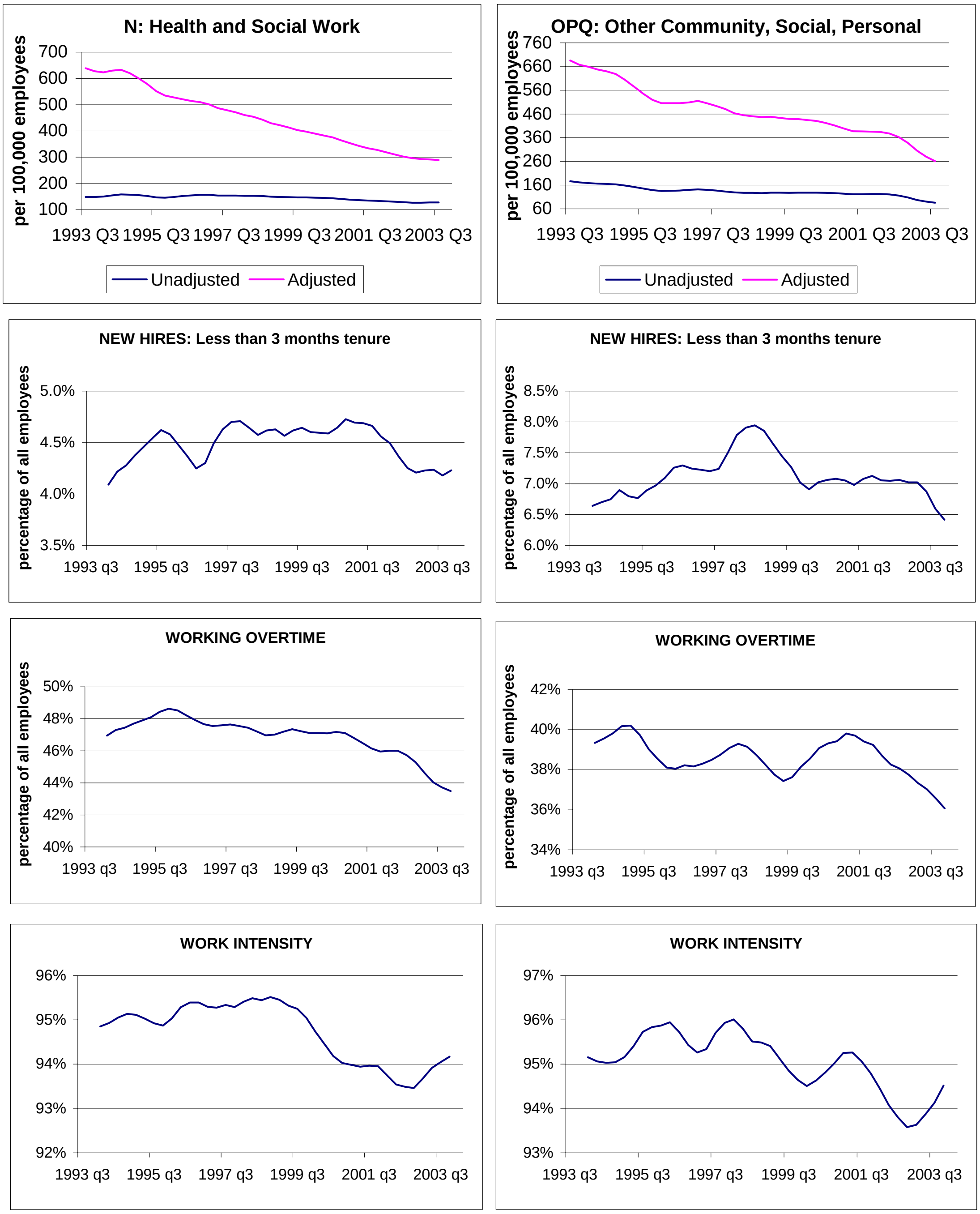

Figure 4.5 (continued) Injury rates, new hires and work intensity by sector

4.5 EMPLOYMENT TENURE, WORK EFFORT AND WORKPLACE INJURY RATES

The results from selected studies that have attempted to control for the effects of the economic cycle upon the rate of workplace injuries are presented in Table 4.5. Where the effects of employment tenure are considered, this is generally proxied by measures of the recruitment rate or change in employment (e.g. Currington 1986, Viscusi 1986 and Robinson 1988). Where the effects of work intensity are considered, this is generally proxied by measure of the number of hours or overtime hours worked (e.g. Steele 1974, Viscusi 1986 and Wooden and Robertson 1997). However, the omission or inclusion of different explanatory variables in such analyses makes it difficult to fully understand the effects of the business cycle upon workplace injury rates. For example, some studies only include a measure of tenure or a measure worker effort to control for the effects of the business cycle. Such analyses are therefore not able to confirm whether both of these factors make a separate and additional contribution to movements in workplace injury rates. Several studies also include broader measures of labour market conditions such as unemployment. If measures of tenure or worker effort are also included, it is not clear what these effects additional labour market variables are trying to capture.

Table 4.5 Business cycle and injury rates: previous results

Study	***Experience***	***Intensity***	***Labour Scarcity***
Steele (1974)		Overtime (+)	Vacancy to Unemployment Ratio (-)
Robinson (1988)	Recruitment Rate (+)	Productivity (+)	Unemployment Rate (+)
Wooden (1989)	Change in Employment (?)		Unemployment Rate (-)
Currington (1986)	Recruitment Rate (+)	Hours (?)	
Viscusi (1986)	Change in Employment (+)	Overtime (+)	
Lanoie (1992)		Overtime (?)	
Barroah et al (1997)			Unemployment Rate (+)
Wooden and Robertson (1997)	Tenure (?)	Overtime (+)	
Fairris (1998) (Separate Models)	Recruitment Rate (+)		Unemployment Rate (-)
Bouvet and Yahou (2001)	Employment (+)	Production Margins (+)	
Guadalupe (2003)		GVA Growth (?)	Unemployment Rate (?) Vacancies (+)

Note: +/-/? refers to the estimation of a statistically significant positive/negative/insignificant relationship

In Table 4.6 we present the results of our own analyses of whether changes in workplace injury rates over time can be demonstrated to be related to both the incidence of new hires and worker effort. We conduct a multivariate analyses on pooled time series/cross sectional data, with the cross sectional unit of analysis being defined by industrial sector. The cross sectional aspect of the data allows us to take into account different economic and labour market conditions faced by different sectors of the economy, resulting in different pressures on working arrangements. The full specification of the model is discussed in further detail in Annex 2, while a full set of regression results is presented in Annex 5. In the model accident rates are specified as logarithms whereas right hand side variables are measured as percentages (i.e. the percentage of employees in manual occupations). The coefficients generated by the model can therefore be interpreted as the percentage change in rate of accidents corresponding to a percentage point change in the chosen explanatory variable.

Two sets of models are estimated to reflect the availability of 2 measures of worker effort; the proportion of employees working overtime and the derived measure of work intensity. Therefore, in contrast to previous studies, we examine the effects of new hires and work intensity on workplace injury rates in a systematic manner. In addition, we include information in the model relating to the percentage of employees working in manual occupations and the percentage of employees working for firms of less than 25 employees, a proxy for *small* firms. Clearly whether employees work in manual or non manual occupations will affect their exposure to risk of accidents and therefore the proportion of employees working in manual occupations would be expected to be an important determinant of workplace injury rates. The expected effect of working for small firms is not clear. Empirical evidence seems to support the view that larger establishments face economies of scale in accident prevention (see Reilly, Paci and Holli, 1994 and Nichols, Dennis and Guy, 1995), although rates of reporting may also be expected to be lower within smaller establishments.

The findings are generally supportive of the hypotheses that new hires and increased worker effort lead to higher rates of major and over-3-day accidents. The coefficients on new hires (percentage of employees employed for less than 3 months) are positive and significant for all but one of the eight regression models we ran, offering strong evidence of the link between new hires and accidents. A percentage point increase in the share of new hires leads to a 1.7 to 2.5% percentage increase in the rate of major injuries and a 1 to 1.5% increase in the rate of over-3-day injuries. The proportion of employees working overtime was not found to be related to workplace injury rates. However, an increase in the ratio of actual to usual hours was estimated to be associated with higher rates of workplace injury, with a 1% increase in the ratio of actual to usual hours being associated with an increase in accident rates of 1.4 to 2.0%.

In terms of the other variables included in the regressions, coefficients on manual employment are unambiguously positive and significant in all cases, as we would expect. A decline in the share of manual employment within a sector is estimated to be associated with a reduction in the injury rate of 1-2% depending upon the injury rate series being considered. The results regarding working for small forms are mixed. They suggest that a greater proportion of employees working for small firms significantly decreases the rate of over-3-day accidents. Given that this effect is estimated to be small within the adjusted series, this may point towards the effects upon aggregate injury rates of under-reporting within smaller establishments.

Table 4.6 Estimated effects of new hires and worker intensity on workplace injury rates

Variable	***Accident Rate***			
	Major		***Over-3-day***	
	Unadjusted	***Adjusted***	***Unadjusted***	***Adjusted***
Model 1: Over time working				
Tenure < 3 months	2.587 (0.487)	2.563 (0.498)	1.279 (0.439)	1.468 (0.476)
Overtime working	n.s.	n.s.	n.s.	n.s.
Manual Employment	2.776 (0.227)	1.203 (0.174)	2.034 (0.301)	1.203 (0.227)
Employed by small firms	n.s.	0.937 (0.183)	-1.103 (0.286)	-0.847 (0.196)
Model 2: Work intensity				
Tenure < 3 months	1.899 (0.543)	1.708 (0.528)	n.s.	1.032 (0.537)
Work intensity	1.731 (0.538)	2.022 (0.537)	2.085 (0.557)	1.444 (0.529)
Manual Employment	3.035 (0.158)	1.154 (0.151)	2.586 (0.174)	0.768 (0.209)
Employed by small firms	n.s.	0.828 (0.140)	-1.930 (0.168)	-0.682 (0.166)

Note: (1) All results shown are significant at the 5 % error level, standard errors shown in parentheses

CHAPTER 5: THE RELATIVE RISKS OF WORKPLACE INJURY: ANALYSIS OF THE LABOUR FORCE SURVEY 1993-2004

5.1 INTRODUCTION

Chapters 3 and 4 considered the movement of ***aggregate*** injury rates derived from administrative data collected by HSE. To complement these analyses, this chapter examines the correlations that exist between an individual's characteristics and the occurrence of a work-related accident utilizing individual level data from the Labour Force Survey. Previous research into the incidence of workplace injuries has shown that some people appear to be more likely to suffer a workplace injury. However, much of this research is unable to determine whether certain groups of individuals with high injury rates are 'accident-prone' or are more likely to be employed in 'high risk' jobs (see Stevens, 1992). To develop a better understanding of the relationship between the risk of workplace injury and the variety of factors that contribute to this risk, we utilise a statistical approach that is able to identify a range of personal, job and workplace characteristics contribute to the risk of an individual suffering a workplace injury.

The remainder of this chapter is structured as follows. Section 5.2 covers the main data issues, including the nature of the information on workplace injury rates collected in the LFS. Section 5.3 presents the results of descriptive analyses where we consider how the rate of workplace injury derived from the LFS varies for different groups of survey respondent. Section 5.4 presents results derived from our statistical analysis where we estimate the effect various personal, job and establishment characteristics upon an individual's risk of workplace injury. Finally, due to its relative importance, Section 5.5 considers the importance of occupation in terms of understanding which individuals are most likely to suffer a workplace injury.

5.2 WORKPLACE INJURY DATA COLLECTED FROM THE LABOUR FORCE SURVEY

There are two main sources of information on injuries in the UK. In chapters 3 and 4 we utilized data collected by the HSE via reports made to enforcing authorities under the Reporting of Injuries, Diseases and Dangerous Occurrences (RIDDOR). An alternative source of data relating to workplace injuries is the Labour Force Survey (LFS). The LFS is a quarterly household survey covering approximately 60,000 households in the United Kingdom. Since 1993, a set of questions specially commissioned by the HSE and relating to workplace injuries has been included in the LFS. During the winter quarters (Dec-Feb) of the LFS, survey respondents are asked whether they have been injured in a work related accident during the past 12 months, whether this injury was caused by a road traffic accident and how soon after the accident they were able to return to work. Information collected from these questions can be used to compute injury rates from all work-related accidents and injury rates from 'reportable' workplace accidents (i.e. non-road accidents resulting in over 3 days absence from normal work).

The LFS is a rich data source providing information on individuals' jobs as well as their personal characteristics. The breadth of the information covered in the LFS makes it a useful source from which to gain a better understanding of the factors associated with the risk of an individual suffering a workplace injury. In comparison with RIDDOR, the advantage of the LFS is that non-fatal injuries are substantially under-reported within the RIDDOR data, particularly among the self-employed (Stevens, 1992). However, there are limitations associated with the analysis of workplace injury data collected by the LFS. These are as follows.

5.2.1 Severity of injury

Firstly, the LFS does not routinely collect information on the nature and severity of the injury sustained. Analysis of workplace injury data from the LFS is therefore not able to distinguish the occurrence of major workplace injuries, which form the basis of current targets for reduction in injury incidence rates. While it is likely that a majority of major injuries will be recorded by respondents to the LFS (i.e. as long as the injury resulted in longer than 3-days normal absence from work), the reportable injuries recorded in the LFS will be dominated by over-3-day injuries.

5.2.2 Recall bias

The questions relating to workplace injuries collect information on the preceding 12 month period. These estimates are likely to underestimate the actual number of accidents occurring in a 12 month period due to both recall error and the fact that information is only collected on one injury per respondent. Furthermore, around one-third of all workers recorded in the LFS provided information through a proxy respondent. The quality of information provided by proxy respondents is considered to be of a generally acceptable level. However, in some areas it has been shown that proxy respondents under-report the incidence of events and that such under-reporting is evident over fairly short recall periods (Arulampalam *et al.*, 1998). Due to the length of the recall period required in response to the accident questions and the nature of the information required the issue of proxy response will need to be addressed in any statistical modelling work.

5.2.3 Sample restriction

Many LFS respondents will not have remained in the same job over the 12 month period used in the recording of work-related accidents. Workers sustaining an injury may be more or less likely to have changed jobs after an accident (or even changed status of economic activity) than other workers. Using information in the LFS it is possible to identify whether an accident occurred in an individual's current main job, current second job, a different job three months ago or their last job if the person is not currently in employment but has been in the previous 12 months. However, in order to compute injury rates by a range of detailed job characteristics and due to the detailed information on job characteristics required in the statistical modelling, it is necessary to restrict the sample to workers who suffered their workplace injury in their current main job. Given that some people may have either changed job since the occurrence of a workplace injury or be unemployed at the time of the survey, both the number of accidents and the overall accident rates presented in this report will be slightly lower compared to if this restriction was not in place. Analysis conducted by HSE indicates that more than 90% of accidents reported by respondents to the LFS have occurred within a respondent's current or most recent main job. We also note that these job characteristics may have changed since the occurrence of the injury (e.g. the hours that they worked during the survey reference week may not have been the hours they worked during the week in which they had their injury).

5.2.4 Changes to occupational classification

An important factor that contributes to an individuals' risk of a workplace injury is the occupation they hold (see McKnight et al 2001). At the time of writing, workplace injury data is available for twelve quarters of the LFS for the period 1993 to 2004. The Standard Occupational Classification (SOC) provides a national standard for categorising occupational information. SOC forms the basis of occupational classification in a variety of national surveys that collect statistical information, including the LFS. However, from the spring quarter (March-May) of 2001, the classification of occupational information contained within the LFS moved from 1990 Standard Occupational Classification (OPCS, 1990) to the 2000 Standard Occupational Classification (ONS, 2000).

There is no direct one-to-one mapping between the constituent occupational groups of SOC90 and SOC2000 in all areas of the classification. To overcome this problem, we utilised data from a special file prepared by the Office for National Statistics from the winter 1996/7 quarter of the Labour Force Survey which contained dual coded occupational information (SOC2000 and SOC90) to derive a 'best fit' map between the 2 classifications. The details of this exercise are outlined in Annex 3. The cross-classification exercise resulted in the derivation of 49 'composite' occupational groups. In terms of accuracy, analysis revealed that 76% of cases within the dual coded LFS would be allocated to the same 'composite' occupational category on the basis of their SOC90 and SOC2000 occupational codes.

5.3 DESCRIPTIVE ANALYSIS OF WORKPLACE INJURY RATES

In this section we present a descriptive analysis of workplace injury data recorded in the LFS between winter 1993/94 and winter 2004/05. We present estimates of the average number of workplace accidents recorded by respondents to the LFS over this 12 year period and for rates of workplace injury (created by deflating the number of workplace injuries by total employment). Estimates of both the number of injuries and of injury rates are based upon weighted data. As mentioned earlier, from the LFS it is possible to present injury rates based upon three separate definitions. Over this period it is estimated that the average number of workplace accidents reported by respondents to the LFS is approximately 710 thousand. When excluding road traffic accidents, this falls to approximately 650 thousand. Finally, the average number of reportable workplace accidents (i.e. non-road traffic accidents resulting in more than 3 days normal absence from work) is 260 thousand. In terms of workplace injury rates, the overall rate of workplace injury for all accidents is 3.6%. This falls slightly to 3.3% when excluding road accidents and then further to 1.4% when considering the rate of reportable workplace injury. For the remainder of this chapter, the discussion will focus upon numbers and rates of reportable workplace injury.

Table 5.1 presents rates of workplace injury and the number of workplace injuries according to different personal characteristics. It can be seen that the workplace injury rate among males is almost twice the rate observed among females. It should be noted that such comparisons take no account of differences which arise due to the characteristics of individuals who occupy these groups. For example, if men are more likely to be employed in high risk occupations than women, a higher male injury rate may be an artefact of this difference in the structure of employment rather than an inherent difference between men and women in the risk of workplace injury they face. The statistical modelling in the next section is designed to identify and separate the risk factors associated with personal and employment characteristics. In terms of absolute numbers, males account for more than two-thirds of accidents recorded within the LFS. This will reflect both the higher participation of males in employment and relative concentration of males within more hazardous occupations.

In terms of age, it is estimated that those respondents aged 20 to 34 generally exhibit the highest rate of workplace injuries, with rates of workplace injury declining thereafter. In terms of ethnicity, we observe that individuals of Indian, Pakistani and Bangladeshi descent report lower rates of workplace injury. This finding is supported by previous analyses based on both the Health Survey for England and the Labour Force Survey (see HSE RR221). We must be cautious in interpreting this result, as it may simply reflect a preference for working in safer occupations or under-reporting among such groups as opposed to a real 'ethnicity effect'. More than 96% of all accidents are reported by white respondents.

Table 5.1 LFS reportable rate: by personal characteristics

Personal characteristics	*Rate (% rate)*	*Accidents (col %)*
Gender		
Male	1.7	67.8
Female	0.9	32.2
Age Group		
Age 16 to 19	1.0	4.0
Age 20 to 24	1.4	9.1
Age 25 to 34	1.4	25.8
Age 35 to 44	1.4	26.4
Age 45 to 54	1.3	22.1
Age 55 plus	1.3	12.6
Ethnicity		
White	1.4	96.3
Caribbean	1.4	0.9
African	1.4	0.5
Indian	0.8	0.9
Pakistani	0.9	0.4
Bangladeshi	0.2	0.0
Chinese	0.8	0.2
Other	1.0	0.9
Average Annual Rate /Col %	1.4	100.0
Average Number of Accidents Per Annum		264,200

Table 5.2 presents information on workplace injuries for 10 sectors of economic activity. These sector definitions are consistent with those utilised during previous chapters. It can be seen that almost a quarter of all injuries recorded within the LFS occur among those respondents working within the Mining, Manufacturing and Utilities sector (CDE). Those working within Retail, Hotels and Restaurants (GH) account for almost a further fifth of all accidents. However, after accounting for differences in the level of employment between industrial sectors, we observe that the highest rates of workplace injury occur within the Construction (F), Agriculture (AB) and Transport, Storage & Communication (I) sectors. Within these sectors, rates of reportable workplace injury each exceed 2%.

Table 5.3 presents estimates of workplace injury rates by region of residence (location of workplace is not available for the full 12 year period). In terms of the number of accidents recorded, it can be seen that approximately one fifth of all recorded accidents are reported by respondents living within the South East (excluding Greater London). It must be noted however that as these figures are presented on the basis of residence. While levels of economic activity are high in this area, it must also be noted that many of these accidents may have occurred among those who were actually working within Greater London. This may also account for the relatively low rates of workplace injury that are observed within London. The highest rates of workplace injury are observed within Wales, Yorkshire, Tyne and Wear and the Rest of the Northern region. It is suspected that such geographical variations in rates of workplace injury reflect geographical variations in the industrial composition of employment. While the concentration of employment within the South East contributes to high absolute numbers of workplace injury, the low rates of workplace injury suggest that this employment is concentrated within relatively low risk sectors.

Table 5.2 LFS reportable rate: by industrial sector

Sector	***Rate (% rate)***	***Accidents (col %)***
AB: Agriculture, Fishing	2.1	2.4
CDE: Mining, Manufacturing, Utilities	1.8	24.1
F: Construction	2.2	11.5
GH: Retail, Hotels, Restaurants	1.2	17.5
I: Transport, Storage and Communication	2.0	10.0
JK: Financial Intermediation, Real Estate and Business	0.5	5.6
L: Public Admin and Defence	1.5	6.7
M: Education	0.8	4.6
N: Health and Social Work	1.5	12.3
OPQ: Other Community, Social, Personal	1.2	5.4
Average Annual Rate/Col %	1.4	100.0
Average Number of Accidents Per Annum		264,200

Table 5.3 LFS reportable rate: by region

Region	***Rate (% rate)***	***Accidents (col %)***
Inner London	1.0	3.2
Outer London	1.2	6.7
Rest of South East	1.2	18.2
Strathclyde	1.3	3.6
Greater Manchester	1.3	4.1
South West	1.3	8.7
Rest of Scotland	1.4	5.5
Rest of Yorkshire	1.4	3
Rest of West Mids	1.4	5.3
East Midlands	1.4	7.9
West Midlands (MC)	1.5	4.7
Rest of North West	1.5	4.6
East Anglia	1.5	4.3
Tyne & Wear	1.5	1.9
Merseyside	1.6	2.4
Wales	1.6	5.4
Rest of Northern	1.6	3.8
West Yorkshire	1.6	4.3
South Yorkshire	1.8	2.7
Average Annual Rate/Col %	1.4	100.0
Average Number of Accidents Per Annum		264,200

Table 5.4 shows rates of workplace injury according to different measures of employment status. In terms of being self-employed, we observe that injury rates among the self-employed are lower than those observed among employees. Note that as an anonymous individual survey, we should not expect the rates of injury derived for the self-employed to suffer the same problems of under-reporting as those rates based upon RIDDOR data. Employees account for approximately 90% of all accidents recorded within RIDDOR. Rates of workplace injury are broadly similar when comparing those who work in the private and public sector. In terms of union membership, it is observed that those who are a member of a union or consultation committee exhibit significantly higher rates of workplace injury. In terms of shift working, we also observe that rates of workplace accidents are more than twice as high among those respondents who report working shifts. However, we note that union membership and shift-working are both likely to be relatively concentrated in traditional heavy industries that are characterised by more hazardous occupations.

Table 5.4 LFS reportable rate: by employment status

Employment status	*Rate (% rate)*	*Accidents (col %)*
Employment status		
Employee	1.4	90.2
Self-employed	1.0	9.8
Sector of employment		
Private	1.3	74.3
Public	1.5	25.6
Union/staff association member		
Member	2.1	43.6
Non-member	1.1	56.4
Size of establishment		
1-10 employees	1.0	21.0
11-19 employees	1.2	7.2
20-24 employees	1.3	3.9
25-49 employees	1.5	12.3
50+ employees	1.6	53.4
DK < 25 employees	1.1	1.0
DK > 25 employees	1.6	1.0
Shift-working		
Non shift-worker	1.1	68.9
Shift-worker	2.7	31.1
Average Annual Rate/Col %	1.4	100.0
Average Number of Accidents Per Annum		264,200

In terms of establishment size, the LFS has generally not asked respondents working in the largest establishments to provide an accurate measure of the number of employees working at the local unit. The highest category for establishment size that is available across all years covered by the present analysis is 50+ employees. For the limited range of establishment sizes recorded within the LFS, we observe that injury rates are lowest within establishments with 1 to 10 employees and highest in those establishments with 50 or more employees. It would appear that the available establishment size bandwidths are not sufficient to capture hypothesised lower injury rates in larger establishments that are attributable to economies of scale in health and safety expenditure. In terms of absolute numbers of workplace injuries, over half of accidents occur among respondents who report that they work in establishments with more than 50 employees.

Table 5.5 presents estimates of injury rates according to job tenure. With the exception of individuals with job tenure less than one year, unadjusted injury rates fall as job tenure increases. Unadjusted rates are highest among those with 1 to 2 years job tenure and then decline steadily, with those who have more than 20 years job tenure exhibiting the lowest injury rates. The relatively low injury rates within the unadjusted series among those who have less than 12 months tenure in their current job will reflect differences in exposure to workplace accidents. The question covering workplace injuries in the LFS refers to the last 12 months. Individuals who have experienced a workplace accident in their current job and have been in their current job for less than 12 months consequently have a shorter time for which they are at risk of suffering a workplace injury.

Table 5.5 LFS reportable rate: by tenure

Tenure	*Rate (% rate)*	*Accidents (col %)*	*Annual equivalent rate (% rate)*
1 month or less	0.5	1.0	5.5
2 months	0.6	0.8	3.6
3 months	0.7	1.1	2.8
4 months	1.1	1.7	3.2
5 months	0.9	1.3	2.1
6 months	1.0	1.2	2.0
7 months	0.9	1.0	1.5
8 months	1.4	1.4	2.1
9 months	1.4	1.3	1.9
10 months	1.3	1.2	1.6
11 months	1.3	1.1	1.4
1 to 2 years	1.4	11.4	1.4
2 to 5 years	1.5	22.6	1.5
5 to 10 years	1.6	20.1	1.6
10 to 20 years	1.4	21.4	1.4
20+ years	1.3	11.3	1.3
Overall Rate/Col %	1.4	100.0	
Number of Accidents		264,200	

We explore this issue of 'exposure time' further via a detailed analysis of injury rates for those who have been employed in their current job for less than one year. The right hand side of Table 5.5 shows the affect of adjusting injury rates for the time spent in a job (exposure). The adjustment process computes the 'equivalent 12 month injury rate' based on the assumption that individuals in each tenure group would sustain the same injury rate for a full 12 month period. For example, 0.5% of individuals who have been in their current job for less than 1 month suffer a workplace injury of some kind. If this group of workers continued to sustain this rate of workplace injury over a full 12 month approximately one twentieth would suffer a workplace injury. This illustrates well the very high risk of suffering a workplace injury during the first month of employment. The steady decline in the annualised workplace injury rate illustrates how the risk of workplace injury declines with work experience along with the very high risks in the first few months of employment.

In Table 5.6, we present information on workplace injuries according to two variables that reflect the length of the working day; hours worked and travel to work time. Hours of work is another variable which needs to be adjusted for differences in exposure to workplace hazards. The unadjusted series shows that rates of workplace injury increase steadily with hours worked due to increased exposure. Once again, we compute an equivalised rate to take account of exposure. This is achieved by computing the average number of hours usually worked for each of these bandwidths based upon information from the LFS and computing the adjustment factor required to estimate the equivalent risk of individuals working a 40 hour week.

The results from the 'exposure adjusted' injury rates (or 'full time equivalent' rate) show that individuals who work a low number of weekly hours have particularly high injury rates and that equivalent injury rates fall as the number of weekly hours worked increases. In particular, those individuals working less than 5 hours per week exhibit the highest full time equivalent injury rate, although rates are generally higher among those working less than 35 hours per week. We must be clear about the interpretation of these results. Individuals who work full time are more likely to report having had a workplace injury compared to those who work part time, as demonstrated by the unadjusted injury rates. However, after adjusting for the reduced hours worked by part time staff, their rates of injury per hour worked are higher than those of full time staff.

Table 5.6 LFS reportable rate: by length of working week

Length of working week	*Rate (% rate)*	*Accidents (col %)*	*Full time equivalent rate (% rate)*
Hours worked			
0-5 hours	0.2	0.2	2.1
5-10 hours	0.4	0.9	1.8
10-15 hours	0.6	1.7	1.8
15-20 hours	0.8	3.0	1.7
20-25 hours	0.8	3.7	1.4
25-30 hours	1.3	3.6	1.8
30-35 hours	1.5	5.0	1.8
35-40 hours	1.3	21.9	1.3
40-45 hours	1.6	23.5	1.5
45-50 hours	1.7	14.5	1.4
50-55 hours	1.6	8.6	1.2
55-60 hours	1.9	4.5	1.3
60+ hours	1.7	9.0	1.0
Travel to work time			
30 mins to work	1.5	72.1	na
30-59 mins to work	1.2	21.3	na
60+ mins to work	1.0	6.6	na
Overall Rate/Col %	1.4	100.0	
Number of Accidents		264,200	

The specification of injury rates on a full time equivalent basis does not appear to provide evidence of increased injury rates among those working very long hours due to the effects of fatigue. However, this descriptive analysis is not able to simultaneously control for other influences upon the risk of workplace. For example, those respondents reporting having worked long hours may be employed within relatively low-risk office based occupations. In terms of absolute numbers, approximately 9% of all accidents are reported by those individuals working longer than 60 hours per week.

Finally, in terms of time travelled to work, the lower half of Table 5.6 indicates that longer journey times are associated with lower rates of workplace injury. This result may again seem to be counterintuitive. However, it should be noted that these lower rates among long distance commuters do not represent the separate and additional effect of commuting upon the risk of incurring a workplace injury and could be the result of higher paid non-manual workers commuting further. The statistical analysis of section 4 will be better placed to identify the separate influence of long hours and commuting upon an individual's risk of workplace injury.

5.4 MODELLING THE RISK OF A WORKPLACE INJURY

The preceding section illustrates some of the variations that exist when workplace injury statistics are analysed by various characteristics of the workforce. A problem underlies these variations, in that it is not clear what *separate and additional* contribution is made to our understanding of these different dimensions to the risk of experiencing a workplace injury. For example, is the variation by shift-working simply a consequence of the different occupational structure of those who work shifts, or does shift working *per se* contribute to an increased risk of workplace injury? Is the difference in injury rates between men and women a consequence of the fact that men tend to predominate in manual occupations which carry a higher risk of workplace injury or is there a separate and additional *gender effect*?

To answer these questions we employ a multivariate statistical technique which allows us to estimate the separate systematic influence of these factors on the 'risk' of a workplace injury. The concept of 'risk' is fundamental to the interpretation of the results presented in this section. Before presenting these results, we describe what we mean by risk and how we estimate risk factors within a statistical model.

5.4.1 Defining relative risk

Most people are familiar with the concept of risk as a probability. For example, from Table 5.1 it was shown that the 'risk' of a male experiencing a reportable workplace injury was 1.7%, or approximately a 1 in 59 chance. Among females, the risk of a workplace injury was lower at 0.9%, or approximately a 1 in 111 chance. We therefore observed, based upon a comparison of injury rates, that males exhibit a higher relative risk of incurring a workplace injury. An alternative way of expressing this increased risk is to say that relative to females, males experience a 90 per cent higher risk of workplace injury. Such differentials based upon a comparison of injury rates between particular groups of workers are subsequently referred to as 'unadjusted differentials'.

To detect 'relative' risk factors we examine a large body of data which tells us whether or not an individual has experienced a workplace injury in the preceding 12 months *and* which contains details about the nature of each individual's job and relevant personal characteristics. All of the results presented in this section show the 'raw' or 'unadjusted' relative risks derived from injury rates and contrast these with the adjusted relative risks which are derived from a multivariate statistical model known as logistic regression. Full details of the model specification are presented in Annex 2, while the full results from the logistic regression are presented in Annex 6. Multivariate statistical modelling is a technique for determining the separate 'contribution' that each piece of information about an individual's job or their personal characteristics makes to the observed pattern of workplace injuries. These contributions to our understanding of risk factors are referred to as 'adjusted' relative risk. The 'adjusted' risks take account of the separate contributions made simultaneously to the overall risk from a wide range of characteristics describing individuals and their jobs.

The analysis once again focuses upon 'reportable injuries' as derived from the LFS. In the following set of charts the 'adjusted' differentials in relative risks, derived from the coefficients in the logistic regressions, are represented as red bars. These represent the separate risk factors associated with particular characteristics having taken account of all other risk factors in our statistical model. These adjusted risk factors presented in the following charts are therefore derived from the same statistical model which incorporates controls for a range of personal, job and establishment characteristics. We present the results on separate charts purely for ease of exposition. Where 'adjusted' differentials were found to be statistically insignificant the bars are clear[12]. The unadjusted relative risks are shown as blue bars. These unadjusted risks are derived from the cross tabulations shown in the preceding section.

5.4.2 Main findings of the analysis

The main results from the multivariate analysis are presented in Figures 5.1 to 5.5. In terms of the influence of personal characteristics (Figure 5.1) we estimate that:

- Males are approximately 9% more likely to have a reportable workplace injury compared to females (ref). It is therefore observed that more that almost all of the gender differential based upon comparisons of injury rates can be accounted for by observable other factors controlled for within our model;
- Those aged 16-19 are least likely to report having had a workplace injury. However, adjusted differentials indicate that age does not have a statistically significant influence upon the risk of a workplace injury;
- Those of Indian and Pakistani descent are approximately 36 to 37 per cent less likely than Whites (ref) to report having had a workplace injury. Bangladeshi's are least likely to report having had a workplace injury. We must be careful in interpreting this result as it not clear whether these ethnicity effects are genuine or whether those from ethnic minority backgrounds are less likely to report the occurrence of a workplace injury within the LFS;
- Proxy respondents are 24% less likely than direct respondents (ref) to report the occurrence of a workplace injury. This highlights the importance of taking into account recall bias in information collected from personal surveys.

In terms of regional differentials (Figure 5.2), we estimate that:

- The strong gradient observed in terms of the 'unadjusted' relative risk of workplace injury is not apparent within the 'adjusted' differentials. Differences in the rate of workplace injury can therefore be explained by differences in the observable personal and job related characteristics of respondents across the regions.

In terms of employment characteristics (Figure 5.3), we estimate that:

- Self-employed are 28% less likely to report having had a reportable workplace injury compared to employees (ref); Further analysis (results not shown) revealed that this relationship was also observed for the broader definitions of workplace injuries and can therefore not be attributed simply to the self-employed returning to work faster after the occurrence of a workplace accident;
- After controlling for other factors, public sector employees are 23% more likely than those in the private sector (ref) to report having had a reportable workplace injury. As

[12] *In other words, a bar which is clear denotes that there is no significant difference between the category it represents and the 'reference' category within the logistic regression.*

with the self-employed, further analysis revealed that this finding was also observed among the broader definitions of workplace injuries;

- After controlling for other factors, union members are 49% more likely than non-union members (ref) to report having had a reportable workplace injury. Half of the 'unadjusted' differential can therefore be accounted for by other observable factors within the model. The remaining differential may reflect the inability of the statistical model to adequately control for the characteristics of those in the most risky occupations who may join unions as a means of insurance;
- In terms of size of establishment, those working in smaller establishments are least likely to report having had a reportable workplace injury;
- After controlling for other factors, those working shifts were estimated to have a significantly higher risk of workplace injury compared to those who did not work shifts.

In terms of employment tenure (Figure 5.4), we estimate that:

- After correcting for exposure[13], those with current employment tenure of less than 1 month are almost 400% more likely to have a workplace injury than those with 20 years or more experience in their current job (ref). The increased risks associated with tenure a particularly apparent during the first 4 months within a new job.

In terms of the length of the working day (Figure 5.5), we estimate that:

- After correcting for exposure (assuming a full time job is 40 hours per week), those working less than 10 hours per week are 90% more likely to report having had a reportable workplace injury ***per hour worked*** than those working 40-45 hours (ref). Based upon these hours categories, after correcting for exposure there is no evidence to indicate that those working long hours (60 plus) are more at risk per hour worked than those working 40-45 hours;
- After controlling for other personal and job related characteristics, no significant relationship emerged between travel to work time and the risk of workplace injury; The 'unadjusted' differential which appeared to indicate that those who took longer to travel to work were at less risk of having a workplace injury can be attributed to other characteristics of these workers.

There are some important caveats to the finding that working long hours is not associated with an increased risk of workplace injury. Firstly, the hours worked recorded in the survey reflect the number of hours worked during the survey week and not the actual number of hours worked at the time that their workplace accident occurred. Secondly, this finding is based upon a cross section of individuals working within all sectors of the economy undertaking both manual and non-manual occupations. While the estimated coefficients represent the 'average' relationship between hours worked and the risk of workplace injury across all workers, this relationship may differ between different occupational groups.

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[13] *As with the descriptive analysis, we transform results for the effects of tenure and hours worked to take into account variations in exposure. These adjustments are made in the same manner as described in Section 5.3. The post estimation adjustments are a scaling exercise made only for presentational purposes. The adjustments made for exposure to variables relating to hours worked and tenure does not affect the results derived from the remainder of the statistical model.*

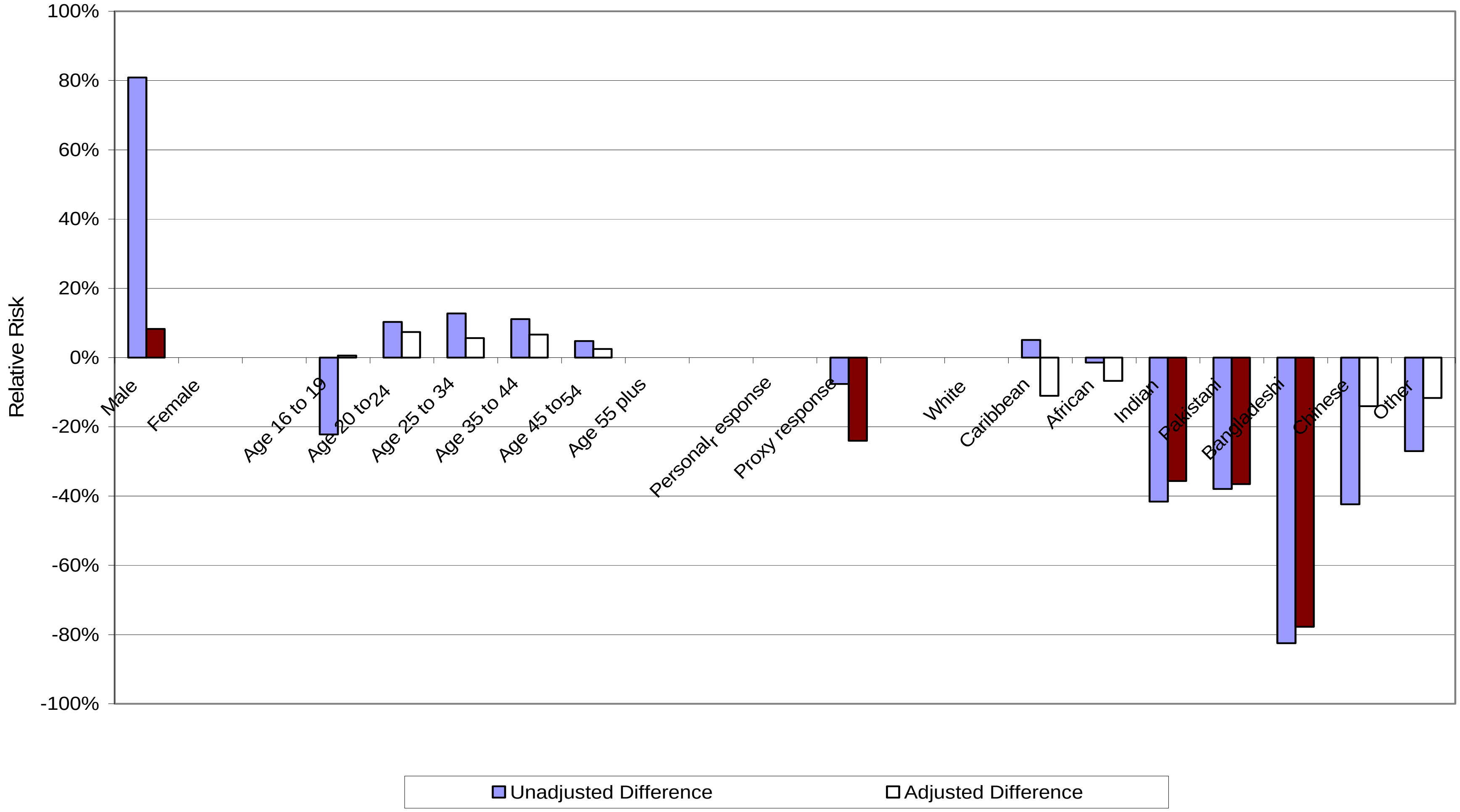

Figure 5.1 Relative risk of workplace injury by personal characteristics

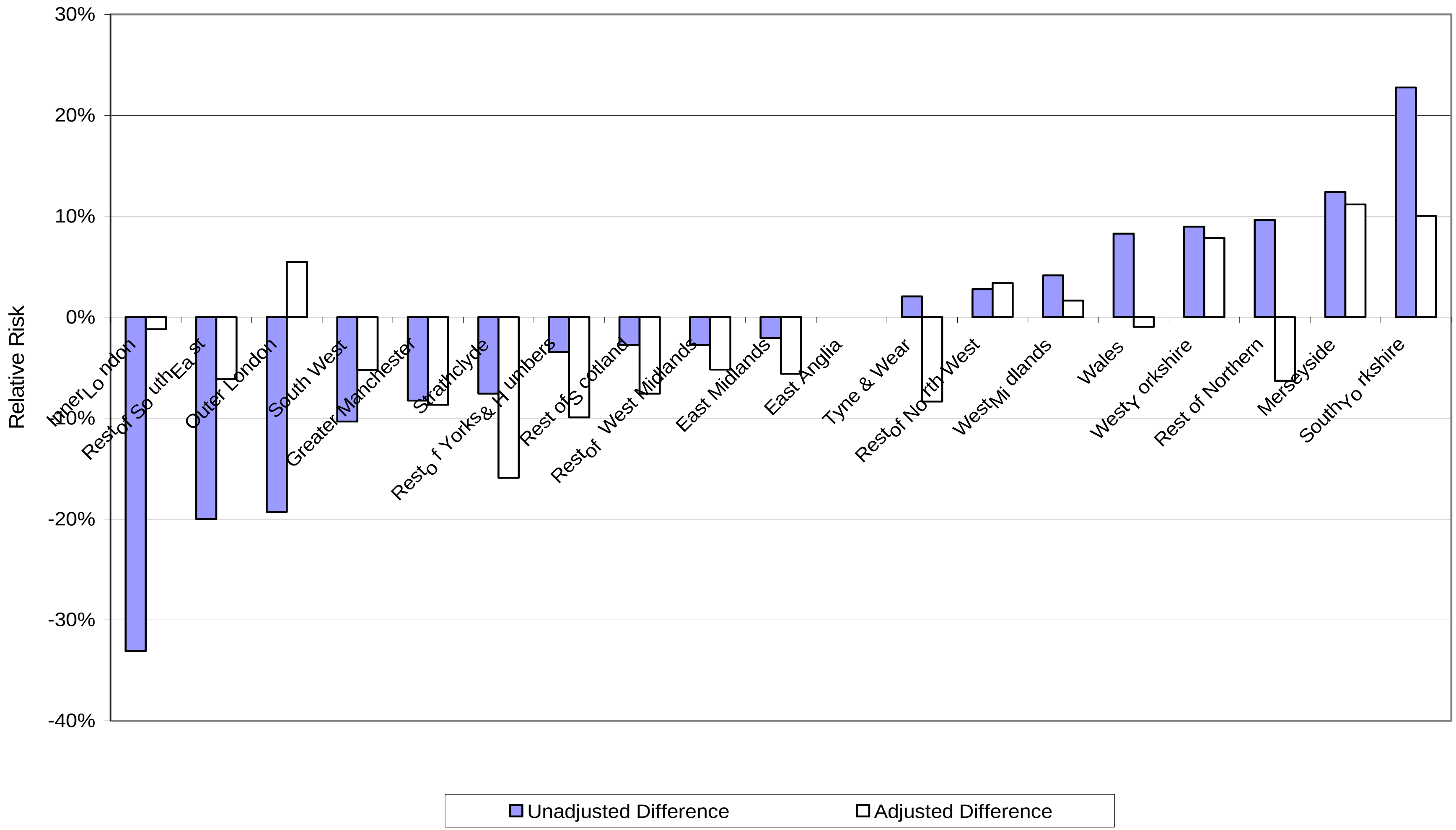

Figure 5.2 Relative risk of workplace injury by region

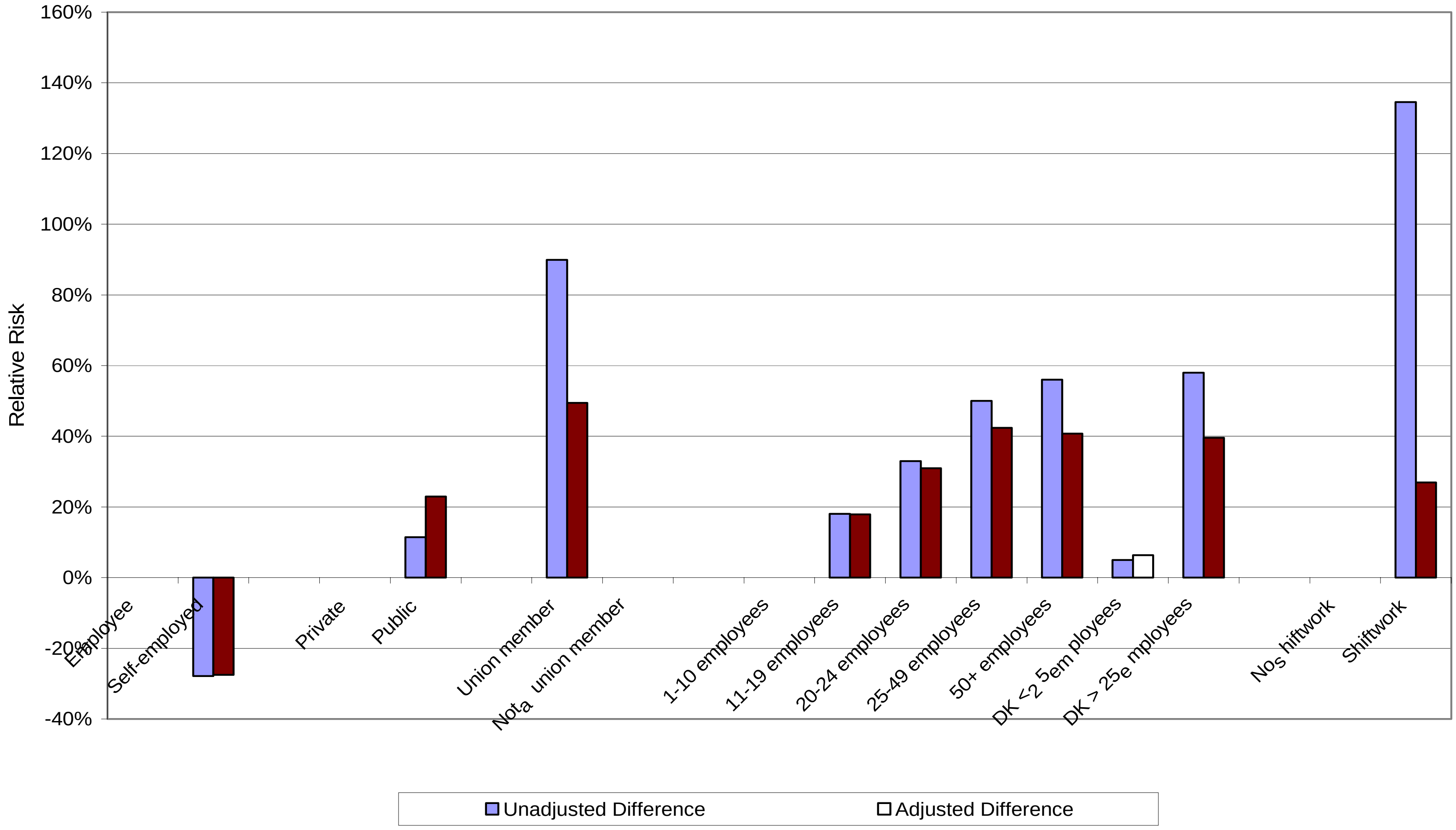

Figure 5.3 Relative risk of workplace injury by employment status

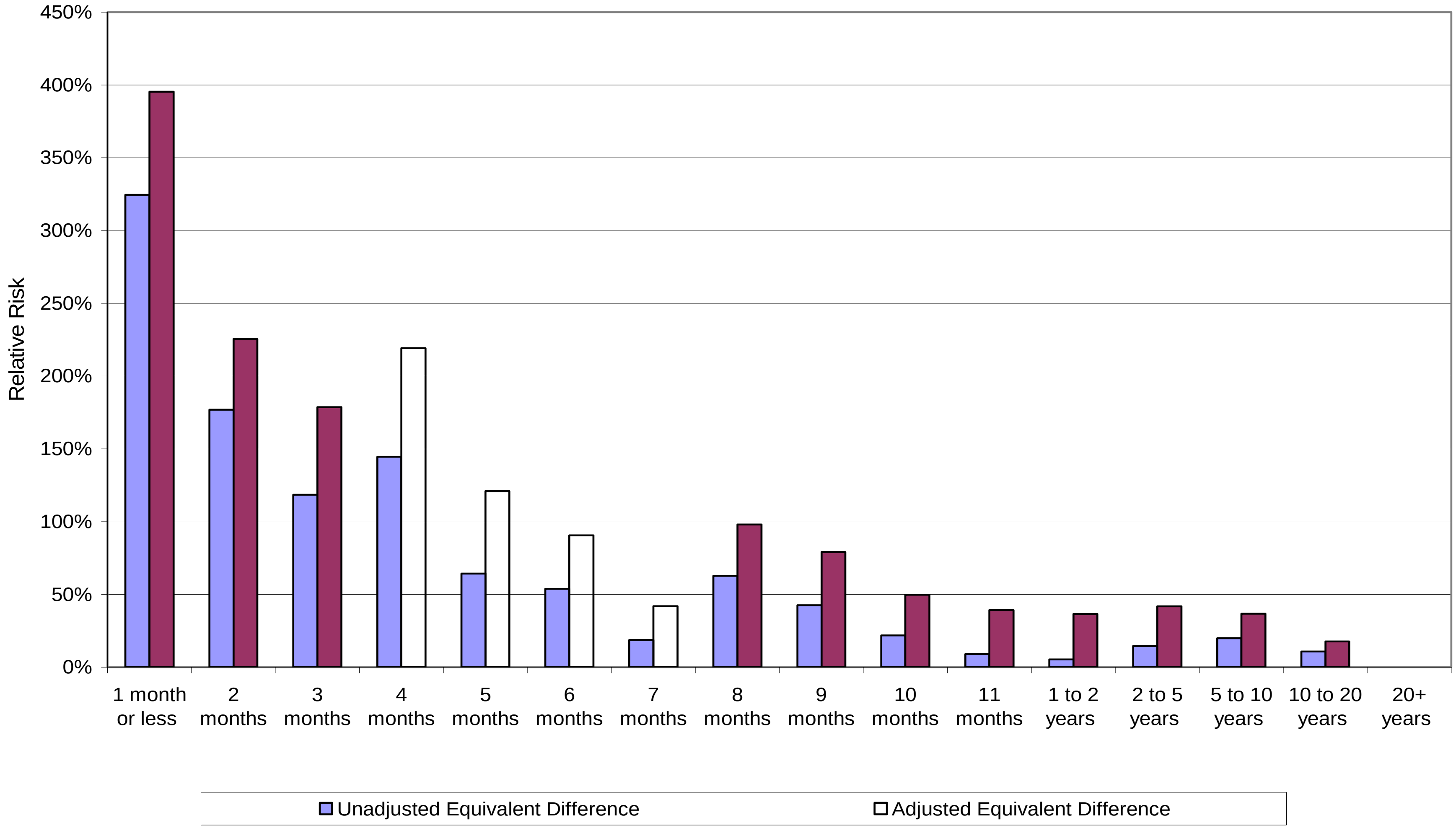

Figure 5.4 Relative risk of workplace injury by tenure

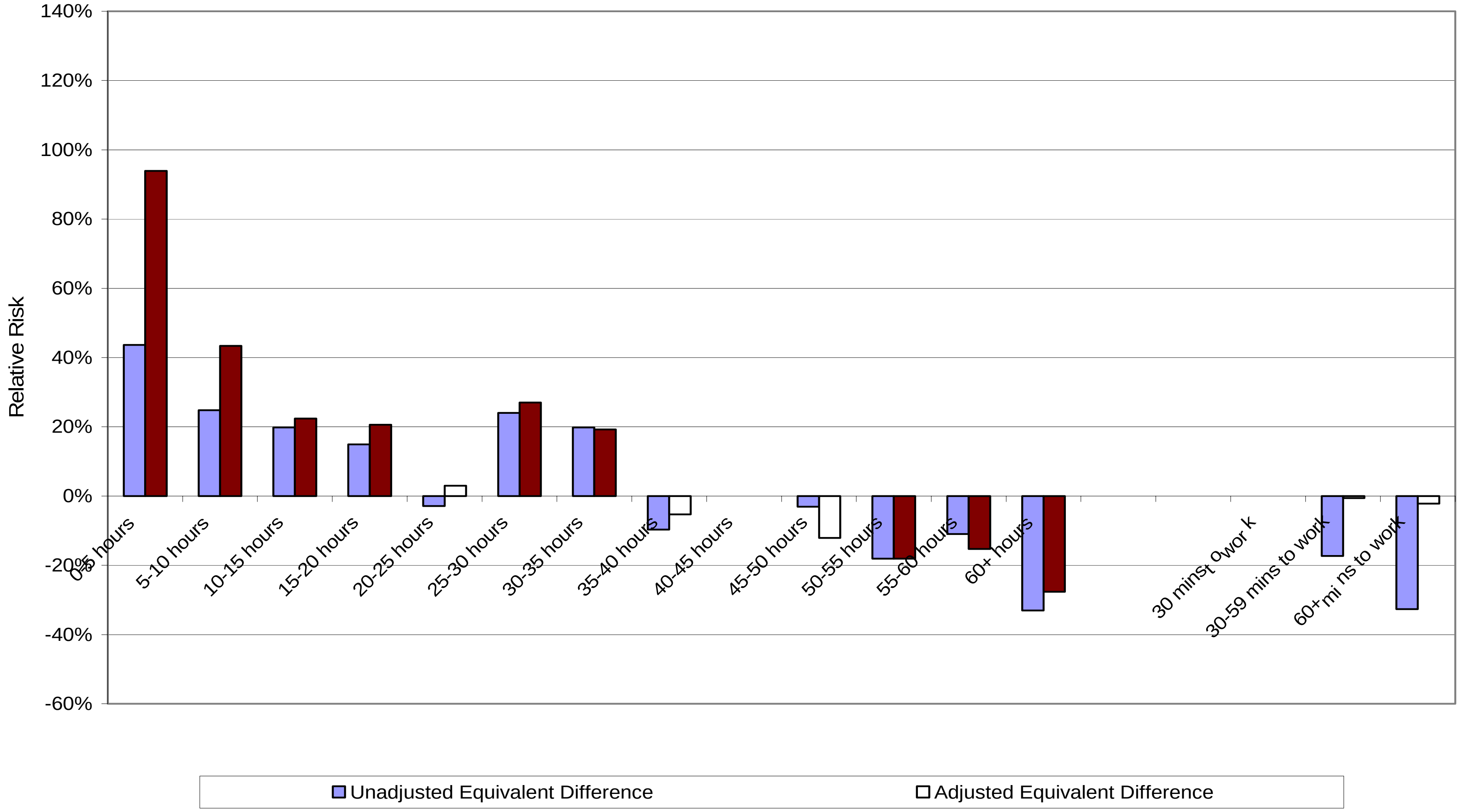

Figure 5.5 Relative risk of workplace injury by length of working week

To consider this issue, we repeated the analysis for those only working in manual occupations as we would expect the effects of fatigue upon the risk of workplace injury to manifest itself more prominently among manual occupations (results not shown). Once again the analysis did not indicate a higher risk of workplace injury *per hour worked* among those working the longest hours. However, while the 'average' relationship among manual occupations does not appear to indicate the presence of fatigue effects among those working the longest hours, such effects may be important among particular manual occupational groups.

5.5 OCCUPATION AND THE RISK OF WORKPLACE INJURY

Table 5.6 presents rates of workplace injury for the 49 derived occupational categories used within the modelling exercise as described in Annex 3. For ease of exposition, these categories have been ordered according to their 'adjusted' relative risk as derived from the logistic regression. The percentages differentials are relative to the reference occupational category 37: Child Carers. This occupation was chosen to act as the reference category as it was found to be the median occupational group in terms of its 'adjusted' relative risk (i.e. this groups came 25th when ranking the occupational categories in terms of their adjusted relative risk derived from the statistical model).

It is observed that the 5 most hazardous occupational categories in terms of their 'unadjusted' relative risks are 47: Construction Labourers; 45: Mobile Machine Drivers; 42: Process and Plant Operatives; 26: Stores/Warehouse Keepers; and 31: Vehicle Trades. We observe that 'unadjusted' differentials are generally larger than the 'adjusted differentials'. This could indicate that risky occupations attract individuals who have personal characteristics that are also associated with an increased risk of workplace injury or that these occupations are also associated with other characteristics that increase the risk of workplace injury (e.g. short tenure). When we take account of these other factors, the 5 most hazardous occupational categories in terms of their 'adjusted' relative risks are 47: Construction Labourers; 28: Metal, Wood and Construction Trades; 31: Vehicle Trades; 46: Agriculture and Animal Care Occupations and 26: Stores/Warehouse Keepers. These categories account for approximately 1 in 5 of all reportable accidents recorded by respondents to the LFS.

Finally, Table 5.7 provides further information about the nature of work tasks performed by those employed within these five most hazardous occupational categories. The purpose of this table is to provide a clearer indication of the types of workers who are categorised to these broader occupational categories which, by necessity, have been allocated generic titles. It should therefore be noted that these tasks are representative of those undertaken by people employed in these areas and may not necessarily be the tasks that associated with the greatest risk of workplace injury.

The results of the statistical analysis have indicated that a variety of personal, establishment and job characteristics can be associated with an increased risk of experiencing a workplace injury. For example, those with shorter job tenure were demonstrated to be at more risk than those with longer periods of job tenure. However, it is not clear which groups of characteristics are most important in terms of explaining whether an individual is likely to suffer a workplace injury. For example, does tenure as a whole play a more important role than occupation in contributing to an individual's risk of suffering a workplace injury or vice versa?

Table 5.6 Relative risk of workplace injury by occupation

Occupation	*Rate (% rate)*	*Accidents (col %)*	*Unadj diff*	*Adj diff*
47: Construction Labourers	3.8	1.8	332%	231%
28: Metal, Wood and Construction Trades	3.1	10.0	252%	188%
31: Vehicle Trades	3.2	2.4	272%	179%
46: Agriculture and Animal Care Occupations	2.7	1.2	206%	173%
26: Stores/Warehouse Keepers	3.3	4.4	282%	139%
44: Road Transport Operatives	3.1	6.6	251%	138%
42: Process and Plant Operatives	3.4	3.8	290%	125%
45: Mobile Machine Drivers	3.5	1.9	297%	117%
5: Farmers and Farm Managers	2.3	2.9	161%	113%
43: Construction and Plant Operatives	3.0	3.2	241%	109%
49: Cleaning Occupations	1.7	5.5	99%	106%
48: Elementary Administration Occupations	2.9	2.0	237%	102%
29: Metal Machining Trades	2.8	3.6	221%	100%
21: Welfare and Social Care Occupations	2.4	6.6	179%	91%
32: Routine Process Occupations	2.1	5.3	144%	76%
35: Armed Forces and Security Occupations	3.0	4.7	249%	74%
30: Electrical Trades	2.2	3.0	156%	62%
34: Food Preparation and Service	1.4	3.2	56%	47%
33: Printing Trades	1.9	0.6	115%	40%
39: Domestic Staff	1.8	0.7	109%	37%
17: Ship, Aircraft Officers and Controllers	2.1	0.3	139%	33%
41: Sales Assistants	0.9	4.3	7%	18%
22: Artistic and Sports Professionals	1.0	1.3	15%	12%
36: Travel Assistants and Personal Services	1.3	0.6	44%	3%
37: Child Carers (ref)	**0.9**	**1.4**	**0%**	**0%**
18: Health Associate Professionals	1.4	2.9	61%	-8%
4: Senior Protective Service Officers	1.5	0.2	68%	-18%
15: Scientific Technicians	1.1	0.8	23%	-19%
14: Public Service Professionals	1.0	0.5	14%	-24%
3: Retail, Distribution and Service Managers	0.7	3.1	-15%	-32%
40: Sales Agents	0.6	1.0	-30%	-37%
13: Librarians	0.7	0.1	-15%	-40%
38: Hairdressers, Beauticians	0.5	0.2	-45%	-40%
7: Engineers	0.5	0.8	-39%	-49%
2: Production and Quality Managers	0.6	0.9	-31%	-49%
9: Teaching Professionals	0.5	1.7	-39%	-50%
19: Legal Associate Professionals	0.4	0.0	-57%	-60%
20: Business and Public Associate Professionals	0.4	0.7	-54%	-61%
24: Clerks, Cashiers	0.4	1.0	-57%	-62%
25: General Administrative Occupations	0.4	1.5	-54%	-63%
6: Natural Scientists	0.3	0.1	-63%	-66%
12: Architects, Draughtsmen and Surveyors	0.3	0.2	-66%	-68%
8: Health Professionals	0.3	0.2	-67%	-69%
27: Secretaries & Receptionists	0.3	0.8	-68%	-72%
11: Business and Financial Professionals	0.2	0.2	-77%	-73%
1: Corporate and Public Service Managers	0.3	1.5	-68%	-75%
23: Public Service Administrative	0.4	0.4	-57%	-75%
16: ICT Professionals	0.2	0.2	-75%	-76%
10: Legal Professionals	0.1	0.0	-86%	-83%
Overall Rate/Col %	1.4	100.0		
Number of Accidents		264,200		

Table 5.7 Tasks typically performed within high risk occupational areas

Rank	*Occupational group*	*Examples of tasks performed*
1st	Construction Labourers	• conveying materials to the work area; • erecting ladders, scaffolding and work platforms; • digging trenches and foundations; • cleaning equipment and clearing work areas; • basic decorating, painting, plumbing, joinery, and other maintenance and repair tasks.
2nd	Metal, Wood and Construction Trades	• shape, cast, finish and join metal; • erect, install, maintain and repair metal structures and fixtures; • cut, shape and lay stone, brick and similar materials; • cover roofs and exterior walls; • install, maintain and repair plumbing, heating and ventilating systems; • construct and install frameworks and fittings, fit glass into windows and doors; • apply plaster and cement mixtures to walls and ceilings; • lay flooring covers and apply protective and decorative materials to walls and ceilings;
3rd	Vehicle Trades	• repair, service and maintain the bodies, engines, parts, sub-assemblies, internal trimmings, upholstery and exterior surfaces of vehicles;
4th	Agricultural and Animal Care Occupations	• cultivate and harvest crops; • breed and rear animals; • catch and breed fish and other aquatic life; • care for animals in stables, kennels, zoos and veterinary establishments; • capture stray or unruly dogs;
5th	Stores/Warehouse Keepers	• load and unload cargo from ships, boats and barges; • unload and convey furniture, goods and other equipment in and around warehouses, depots and similar establishments; • accompany motor vehicle and other road vehicle drivers;

The ability of a model to predict whether an individual will sustain a workplace injury is referred to as the ***explanatory power***. Each piece of information included within the statistical model will contribute to a greater or lesser degree to the overall explanatory power of the model. To consider how various personal, establishment and job characteristics contribute to our overall understanding of an individual's overall risk of workplace injury, we present the results of a procedure called an ANOVA test (Analysis of Variance). This procedure identifies which those factors which are most important in contributing to our understanding of the occurrence of workplace injuries.

The results of this exercise are presented in Figure 5.6. We observe that the most important dimension that contributes to the overall explanatory power of the model is occupation. It is estimated that information about occupation contributes to almost 40% of the overall explanatory power of the model[14]. In terms of our overall understanding of whether an individual is likely to suffer a reportable workplace injury, occupation is clearly demonstrated to dominate all other factors. Being a staff association or trade union member and job tenure are the second and third most important factors in determining whether an individual has had a reportable workplace injury. However, each of these dimensions contributes to less than 4% of the overall explanatory power of the model. A variety of personal characteristics such as age, gender, ethnicity and region contribute very little to our overall understanding of who is most likely to sustain a workplace injury compared to the dominant influence of occupation.

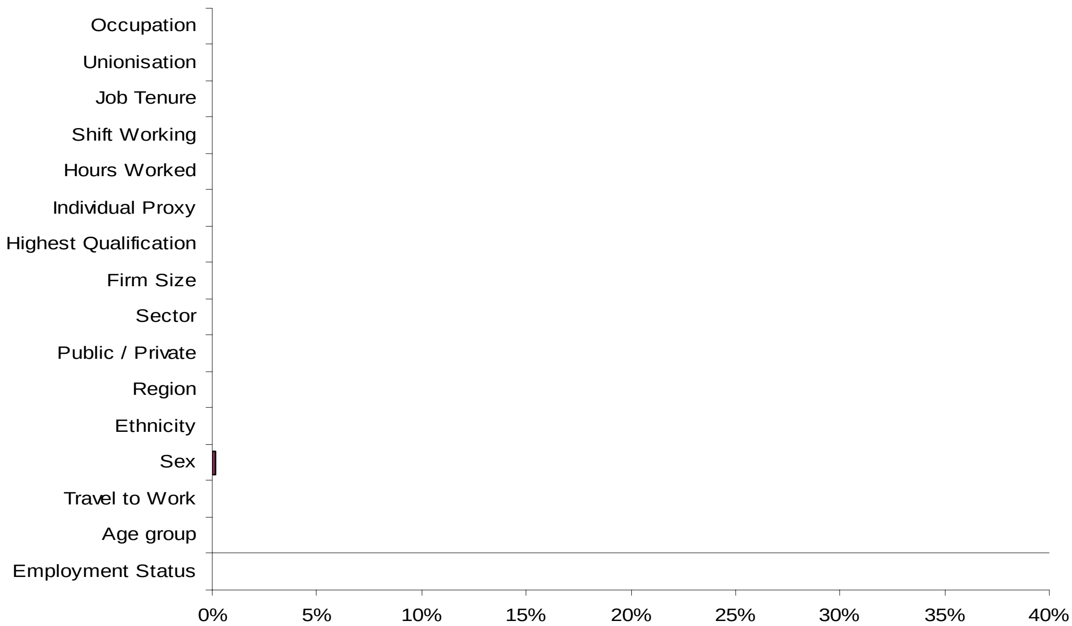

Figure 5.6 Contribution to explanatory power

It should be noted at the outset that these results should be treated as indicative. For example, it is observed that the individual contributions of these dimensions to the overall explanatory power do not sum to 100%. This is because the ANOVA procedure identifies the separate and independent influence of these personal, job and establishment characteristics to the overall

14 *Further analysis revealed that the use of more detailed occupational categories beyond the 49 utilised in the present analysis does not lead to a large improvement in the overall explanatory power of the model or influence the size and significance of coefficients on other explanatory variables within the model.*

explanatory power of the model and does not account for the presence of interaction effects between these separate dimensions. However, this caveat should not detract from the main finding the occupation is by far the dominant influence that contributes to an individual's risk of suffering a workplace injury.

6: UNDERSTANDING TRENDS IN WORKPLACE INJURY RATES

6.1 INTRODUCTION

The aim of this chapter is to bring together the work of the previous chapters, and in particular the results of the modelling exercise, in order to achieve a greater understanding of the changing pattern of accidents over time. The construction of RIDDOR accident rates in Chapter 3 revealed gradually falling major and over-3-day rates injury rates over time from 1986 to the latest available figures in 2003. We now examine aspects of this decline over time.

In Section 6.2 we focus on the effect of changing occupational structure on the rate of major and over-3-day rates injury rates. The results of the modelling exercise in the previous chapter revealed not only that the rate of injuries varies considerably by occupational group, but also that an individuals occupation is itself the key explanatory factor in terms of predicting the probability of injury. Given this striking feature of the analysis, section 6.1 analyses the change in the rate of accidents between 1986 and 2003 in terms of the effect of changes in the occupational composition of employment which have occurred during that period.

Section 6.3 analyses changes in the rate of injury at a more disaggregated level. The results of the analysis of the modelling exercise presented in Chapter 5 are utilised to show actual and predicted rates of injuries since 1993 for various dimensions of the data which are of interest. In particular, we show how changes in occupational structure along with other aspects of working (job tenure, hours worked, unionisation, etc) are able to explain changes in injury rates over time. This analysis is done on the basis of gender, age group, region and industrial sector.

6.2 THE EFFECT OF CHANGING OCCUPATIONAL COMPOSITION

The occupational composition of the workforce has changed considerably over the period 1986 to 2003. Moreover, the results of the analysis of the previous chapter (see Figure 5.6) suggest that occupation is a key explanatory factor in predicting the occurrence of workplace injuries. This section therefore investigates the extent to which the gradual decline of workplace injuries during the period 1986 to 2003 may be attributed to changes in the occupational composition of employment.

The changes in occupational composition over this time period may be analysed using information on employment derived from the Labour Force Survey (LFS)[15]. This is done based on the 49 occupation categories used previously in the modelling exercise which map standard occupational classification (SOC) categories based on SOC 1990 and SOC 2000 onto a common standard. Before and including 1990 the classification of occupations is based upon the Key Occupations for Statistical Purposes (KOS) classification system. In order to derive a consistent occupational series for 1986 onwards, we therefore map KOS codes onto the 49 occupation categories. Details of this mapping exercise are provided in Annex 3.

Although there are complex changes in the structure of employment across all occupational groups, a simple decomposition of employment based on a manual versus non manual employment provides a useful early insight into the potential importance of changes in occupational classification upon workplace injury rates, since it is primarily in areas of manual employment where the highest rates of workplace injury are likely to occur. Figure 6.1

[15] *This information is available on a quarterly basis after 1991 and annually before this time.*

summarises the changes in occupational composition since 1986 based on percentage of employees in manual employment[16]. Over time the percentage of employees in manual employment has fallen from just under 45 per cent in 1986 to less than 38 percent in 2003, with a clear continuing downward trend.

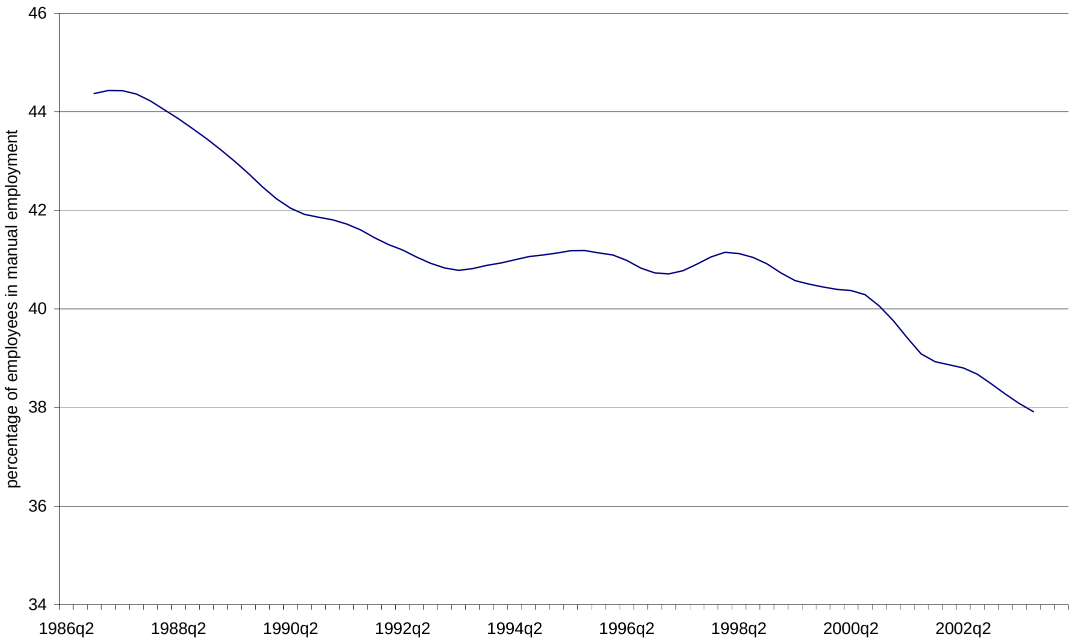

Figure 6.1 Percentage of employees in manual employment

The effects of changing occupational structure on the rate of workplace injuries are analysed as follows. The rate of major and over-3-day injuries adjusted for under-reporting is available from RIDDOR by occupation for 2002/3[17]. Applying these rates to the composition of employment by occupation in 2003, we obtain an overall quarterly rate of major injury of 67 per 100,000 employees and a rate of over-3-day injury of 289 per 100,000 employees. These rates should be already familiar from Figure 3.4. The same rates of injury by occupation are then applied to the occupational composition of each year[18], back to 1986. The resulting series is the expected rate of injury which we expect to see based on changes in occupational composition over time. The resulting injury rate series is shown in the upper panel of Figure 6.2 (based on major injuries) and Figure 6.3 (based on over-3-day injuries) compared with the actual rate of injuries.

The results show that the changing occupational structure over the period does in fact result in the expected incidence of accidents falling over time. Based on changes in occupational structure, we expect to see the quarterly rate of major accidents fall from 84 to 67 per 100,000 employees between 1986 and 2003. Similarly, we would expect to see the quarterly rate of over-3-day accidents fall from 360 to 289 per 100,000 employees between 1986 and 2003. Although large these decreases (both representing approximately a 20 per cent decrease based on 1986 levels) are smaller than the actual decreases in the rate of accidents. The lower panel of Figures 6.2 (major injuries) and Figure 6.3 (over-3-day injuries) shows the incidence of accidents in each year compared to 2003. This percentage differential is decomposed into the effect of

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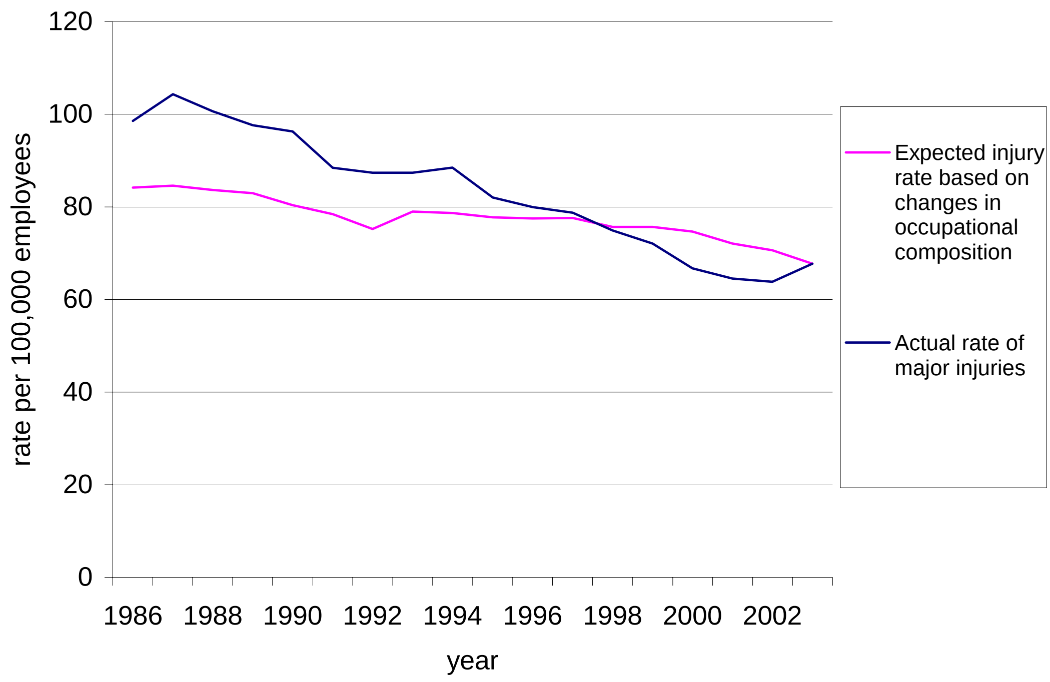
[16] *For details on the allocation of occupations to manual and non manual categories see Annex 3.*
[17] *Note that RIDDOR data for 2002/3 provides the first available opportunity to analyse accidents by occupation. Detailed occupation data is not available before this time.*
[18] *The occupational composition is based on an annual average, restricted to employees only.*

occupational changes, as described above, and all other changes which form a residual component.



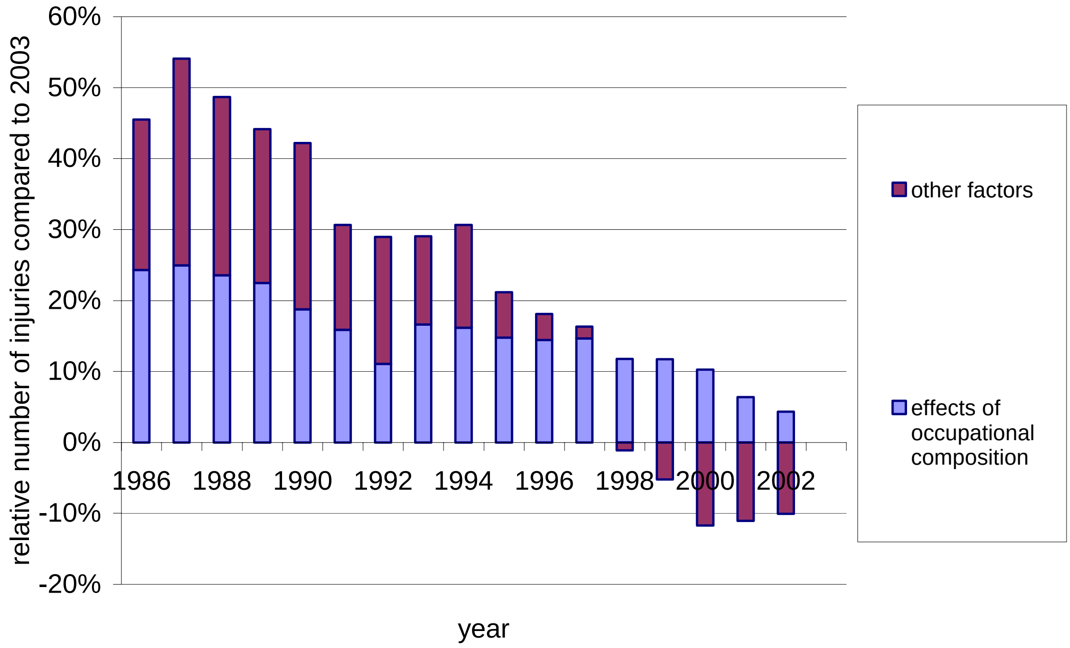
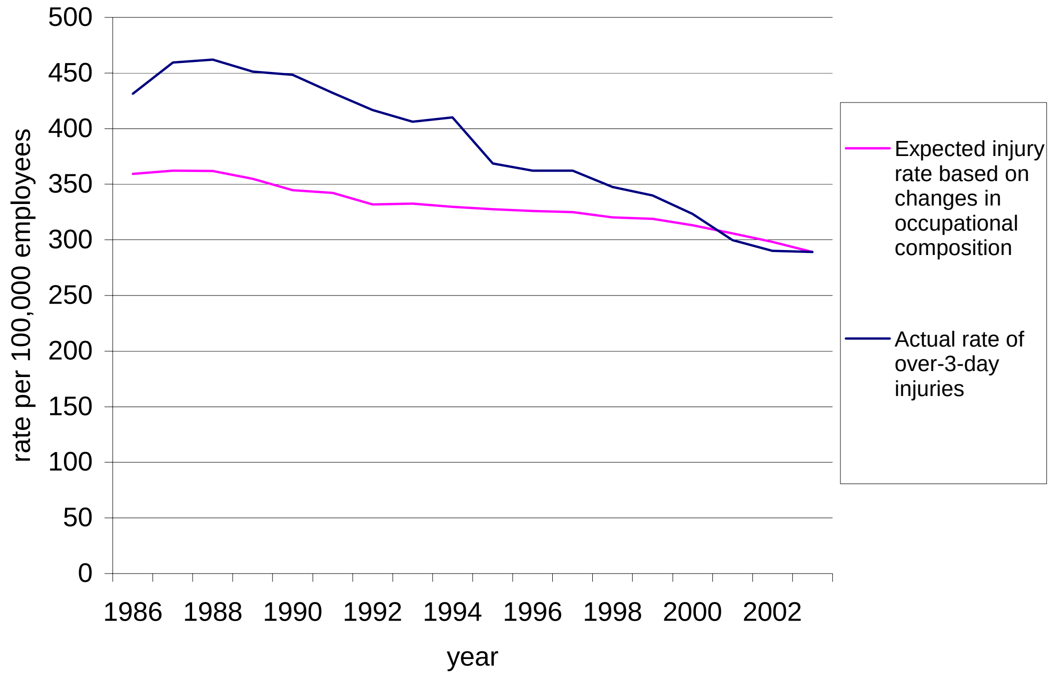


Figure 6.2 Major injury rates and the effect of occupational composition



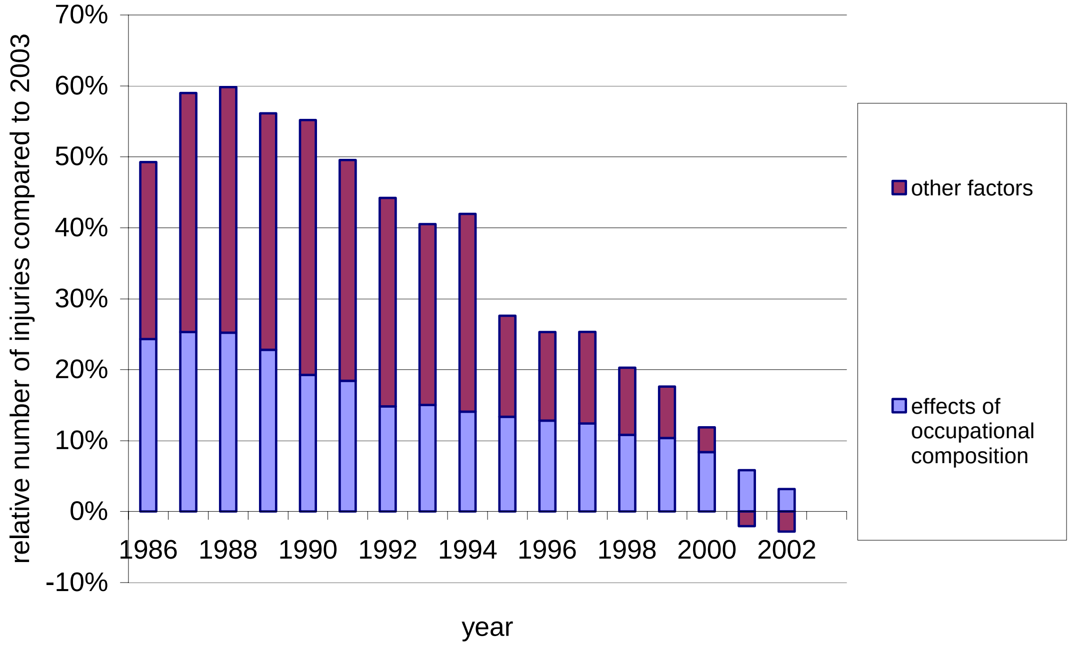


Figure 6.3 Over-3-day injury rates and the effect of occupational composition

During 1986, it can be seen that the rate of major injuries is 45 per cent higher than that observed in 2003. Similarly, the rate of over-3-day injuries is 49 per cent higher than that observed in 2003. Based on our knowledge of changing occupational composition over this period, we would have expected the rates of both major and over-3-day injuries to have been 23 per cent higher in 1986 compared to those observed in 2003. Therefore, the decrease in that actual rate of workplace injury observed over this period can be apportioned on an approximately 50:50 basis between occupational factors and to other residual effects. Or, expressed alternatively, the occupational and residual effects are approximately equal taken over the whole period. With regards to the residual decrease in injury rates, a number of otherwise unidentified factors may be at play. Firstly, there is the possibility of secular decreases in the rate of injury within occupations over time as a result of real improvements in health and safety over time. Secondly, while occupation is the dominant influence upon an individual's risk of suffering a workplace injury, there may be other compositional changes which are not controlled for in this exercise. These include changes in gender composition of employment, hours worked and part time working, unionisation, job tenure and so on. Each of these in part may contribute to structural changes in the workforce which drives down the overall rate of accidents. Finally we note that the increase in major injuries after 2001 is not explained based on changes in occupational composition.

6.3 UNDERSTANDING TRENDS BY GENDER, AGE GROUP, REGION AND SECTOR

The analysis of the previous section provides a powerful insight into the key driving force behind changes in injury rates over time: i.e. the importance of occupational composition. This analysis was based on an analysis of the RIDDOR data. However, as noted, there are other factors in particular relating to workforce composition which will affect the rate of occurrence of workplace injuries. While these factors cannot be considered within the analysis of the RIDDOR data, they are controlled for within the analysis of individual accidents in the LFS as presented in Chapter 5. We therefore now move the analysis forward by focussing upon results derived from the analysis of LFS data. In doing this, we restrict our analysis only to accidents which occur during or after 1993 reflecting the availability of LFS data. By utilising the results derived from the statistical analysis of Chapter 5, we can consider how well predicted movements in injury rates since 1993 match actual movements in injury rates over this period.

The model of individual accidents from the LFS, presented in the previous chapter, determines a hypothetical probability of each individual within the sample suffering a workplace injury resulting in over three day's absence from work, based on an annualised rate. This probability is generated from the fitted (or predicted) value of the model which takes into account many details relating to the individual other than just occupation. As outlined in chapter 5, these factors available in the LFS data include an array of personal characteristics (such as gender, age and region) and job related characteristics (such as hours worked, tenure, shift working and so on) which are shown from the results presented so far to be relevant to the occurrence of workplace injuries.

To consider how changes in the composition of the workforce contribute to variations in workplace injury rates over time, we use the results from the statistical model to estimate the predicted injury rate that would be expected to occur given the characteristics of all those included within the sample for the period 1993 to 2004. This analysis is performed along the dimensions of gender, age group and region as these dimensions are generally of interest to HSE and have provided the basis of previous discussions as to the incidence of workplace injuries. We also analyse injuries over time by industrial sector of employment, in keeping with the analysis of previous chapters.

The analysis is useful in two respects. Firstly, it allows us to consider the predictive power of the model based on a comparison of actual and predicted rates of accidents. If the composition of the workforce changes over time, either in terms of the personal characteristics of those employed or the nature of the work tasks undertaken, then we would expect predicted injury rates to also vary over time. The closeness of actual and predicted injury rates therefore reveals to what extent the model presented in the previous section fully captures the important compositional effects on workplace injuries. Secondly, it allows us to consider trends in residuals (actual minus predicted rates) over time to detect evidence of other influences not controlled for by the model. For example, if actual rates exceeded predicted rates, this would indicate that workplace injury rates are lower than what would be expected given the characteristics of the workforce.

6.3.1 Trends in injury rates by gender

Figure 6.4 compares actual and predicted injury rates by gender since 1993. Throughout this section the predictions are derived from the winter quarter of the LFS. The graph reveals a sharp decline in accidents amongst males with average rates of reportable accidents falling from 2.1 to 1.3 percent per annum among during the period. Accident rates amongst females have fallen from a lower base but less dramatically so. For females, average rates of reportable accidents derived from the LFS declines from 1.1 to 0.7 percent per annum among during the period.

The predicted values from the model fit closely to the actual accident rate series and residuals (actual minus predicted rates) are generally small. We can infer from this that the decline in accident rates over time, especially amongst males, is explained by factors in the model which relate to personal characteristics and modes of working. The residuals do not show a trend over time, with the possible exception that accidents rates during the past two years have been somewhat lower than we would expect. The decline in accident rates therefore reflects composition effects such as both male and female workers increasingly working in safer occupations. Moreover, the convergence of accident rates for men and women since 1993 reflects the fact that the mode of working (with respect to hours worked, shift working, etc) amongst men and women and the jobs they are likely to undertake are becoming more similar over time.

6.3.2 Trends in injury rates by age group

Figure 6.5 compares actual and predicted injury rates by age group. Recall that age is reduced to six categories in the logistic regression model: age 16-19 years, 20-24 years, 25-34 years, 35-44 years, 45-54 years and over 55. We analyse actual and predicted rates of accidents amongst each of these groups separately.

It is interesting that the overall decline in accident rates is not uniform across age groups. As with gender the model has strong predictive power and therefore changes in accident rates over time reflect changing modes of working and changing occupational choice by age group. Since residual values do not show any pronounced patterns over time, the best indication of these changes is captured by the predicted value of the model which captures the downward trend. It is most striking that the downward trend in accidents rates is much stronger amongst those aged 20-24 years and 25-34 years. Amongst these groups average rates of accidents (based on the trend) have declined by over a quarter since 1993. Actual rates of reportable injuries for the two groups have decreased from 1.9 to 1.0 percent per annum and 1.7 to 1.1 percent per annum, respectively.

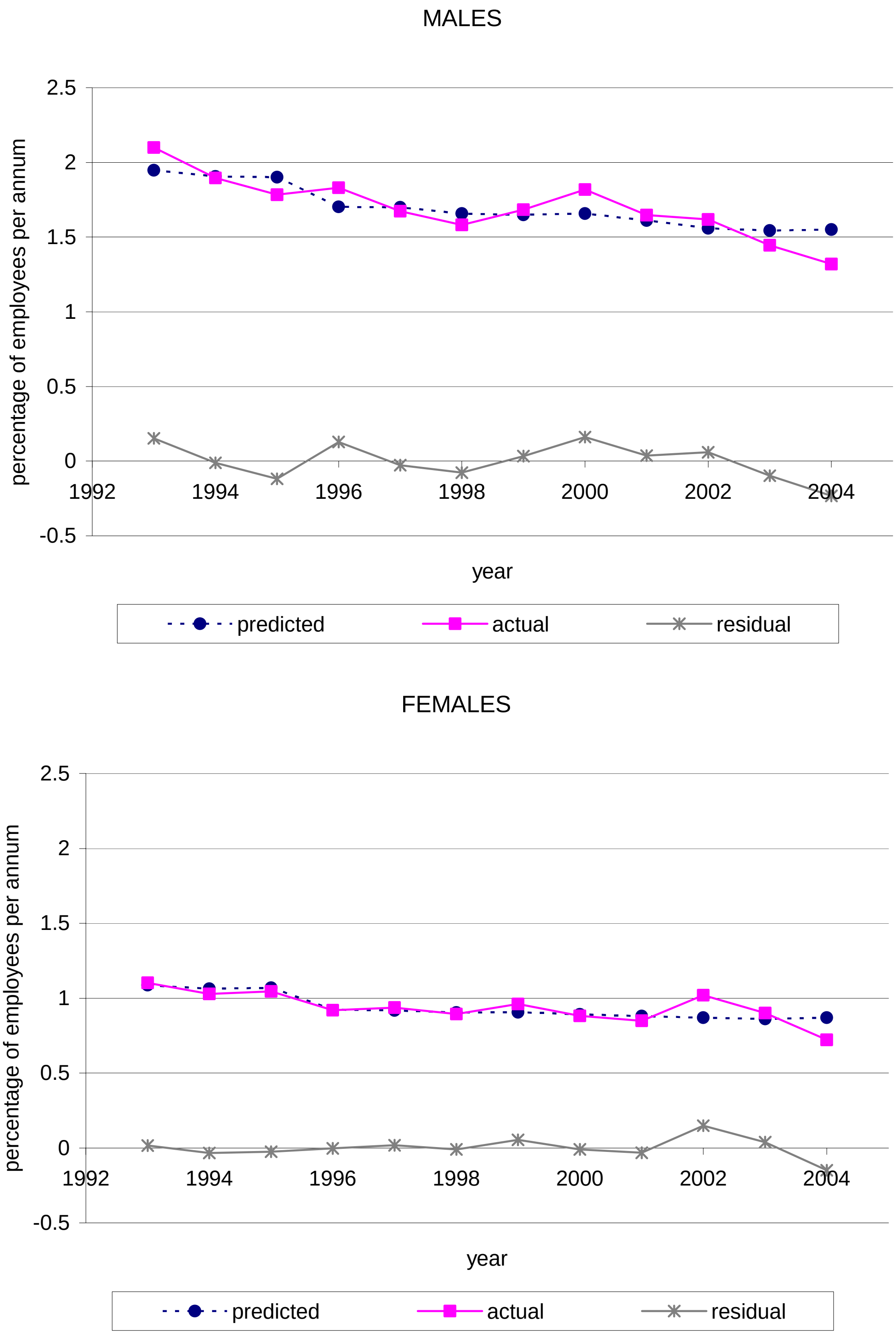


Figure 6.4 Trends in injury rates by gender

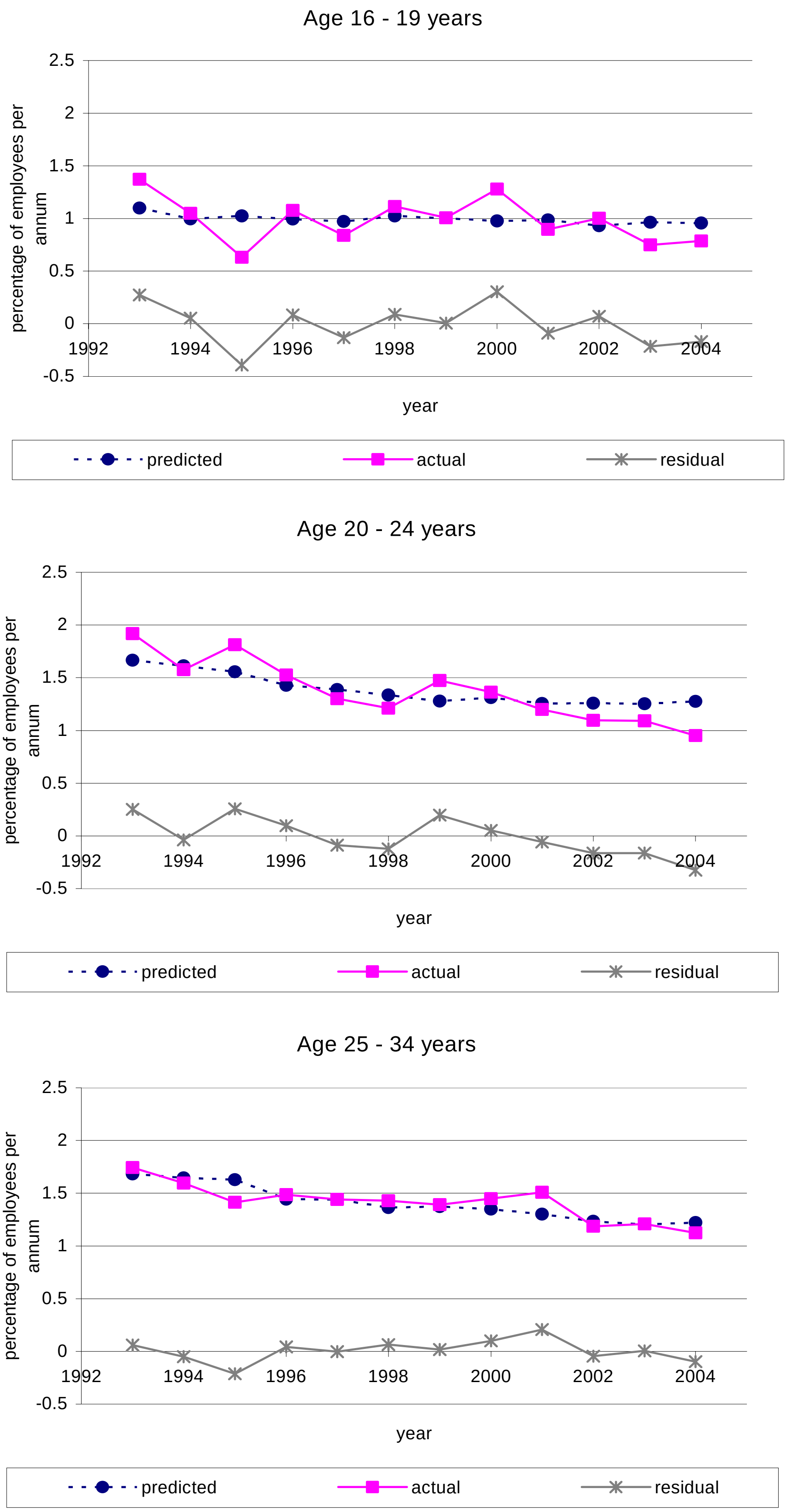


Figure 6.5 Trends in injury rates by age group

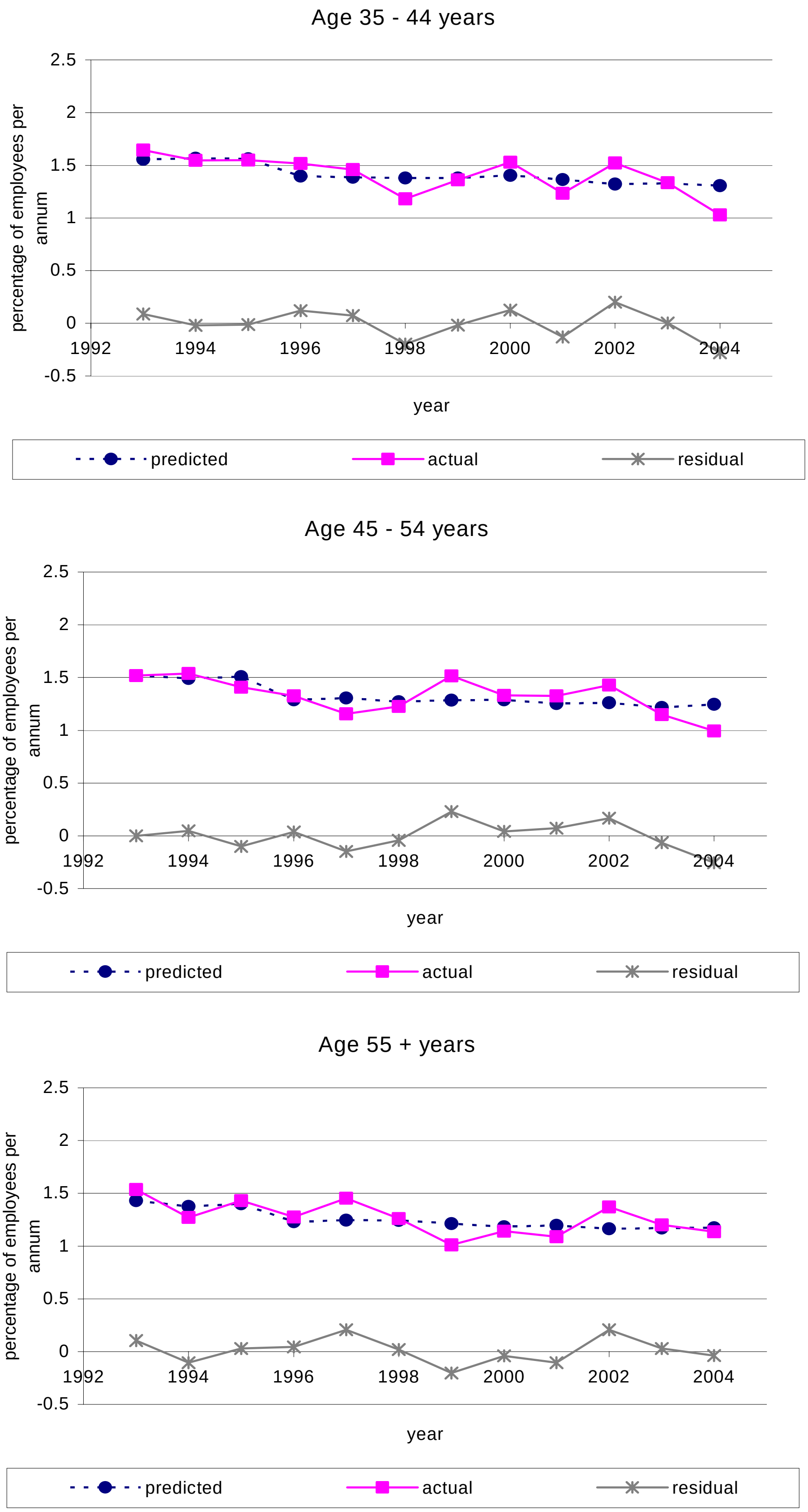


Figure 6.5 (cont) Trends in injury rates by age group

Outside these two age groups, predicted accident rates are declining for all categories, but less dramatically so. For example amongst those aged 16-19 years, predicted accident rates have remained relatively flat since 1993. In this case the actual accident rate series is relatively volatile reflecting smaller sample sizes in the model. However, the predicted accident rate has remained fairly constant at around 1 percent per annum. Similarly amongst those aged over 55 accident rates have only declined gradually. Actual rates of reportable accidents for this group have decreased from 1.5 to 1.1 percent per annum since 1993. However, the predicted incidence rate has been flat for the past five years and in fact increased slightly since 2001. This reflects the changing role of older workers and the job roles.

6.3.3 Trends in injury rates by region

It is also interesting to compare accident rates by region. Across regions that are strong differences in the composition of employment, in particular with respect to occupational structure. Consequently, average rates of injury tend be higher in regions with a larger manufacturing or industrial base, where demand for labour is biased towards riskier occupations. Table 5.3 shows that accident rates are highest for example in Yorkshire and the north of England lowest in London and the South East. For the purposes of this section of the report we restrict our analysis of trends to three regions to illustrate differences. Figure 6.6 compares actual and predicted injury rates for South Yorkshire (which has the highest rate of accidents amongst the 19 regions), Inner London (which has the lowest rate) and East Anglia (which has the median rate of accidents).

Predicted movements in accidents rates over time were found to be similar by region, as illustrated in Figure 6.6. The actual rates of accidents are more volatile for South Yorkshire than for the other two regions displayed on the diagram, reflected smaller sample sizes in the model. However, the trends in accidents (based on the predicted values of the model) tend to show similar declines in each case, whilst regional differential in accident rates persist. For South Yorkshire the predicted rate has decreased from 2.0 to 1.8 percent per annum since 1993, although there is evidence that predicted and actual rates are increasing again based on 2002-03. In the case of East Anglia the predicted accident rate has decreased from 1.6 to 1.3 percent per annum since 1993, and for Inner London predicted accident rates have fallen from 1.2 to 1.0 percent per annum.

6.3.4 Trends in injury rates by sector

Finally we complete the picture by considering trends in accidents by industrial sector. In this case we remain consistent with analysis of previous chapters and use the ten sectors for which we presented RIDDOR accident rates in chapter 3 of the report. Figure 6.7 compares actual and predicted LFS over-3-day rates by sector. Due to sampling variability, the series of actual injury rates within some sectors exhibited a relatively high degree of volatility. This is the case in particular for sectors AB: Agriculture, Fishing, but also in F: Construction; L: Public Sector and Defence and OPQ: Other Community, Social and Personal Services. This primarily reflects the smaller sample sizes of workers in the model, based on relative employment by sector, but also is an artefact of the unpredictable nature of the sector (for example bad winters are likely to adversely affect accidents in construction). Across most sectors, series of actual and predicted accident rates are relatively stable but exhibiting a slow downward trend. In general the large differences between sectors (for example compare the relatively high rate of accidents in sector F: Construction with the relatively low rate of accidents in sector JK: Financial Intermediation, Real Estate and Business) tend to persist over time, and trends within sectors are broadly of a similar magnitude, reflecting shifts in occupational structure and patterns of working common to all sectors.

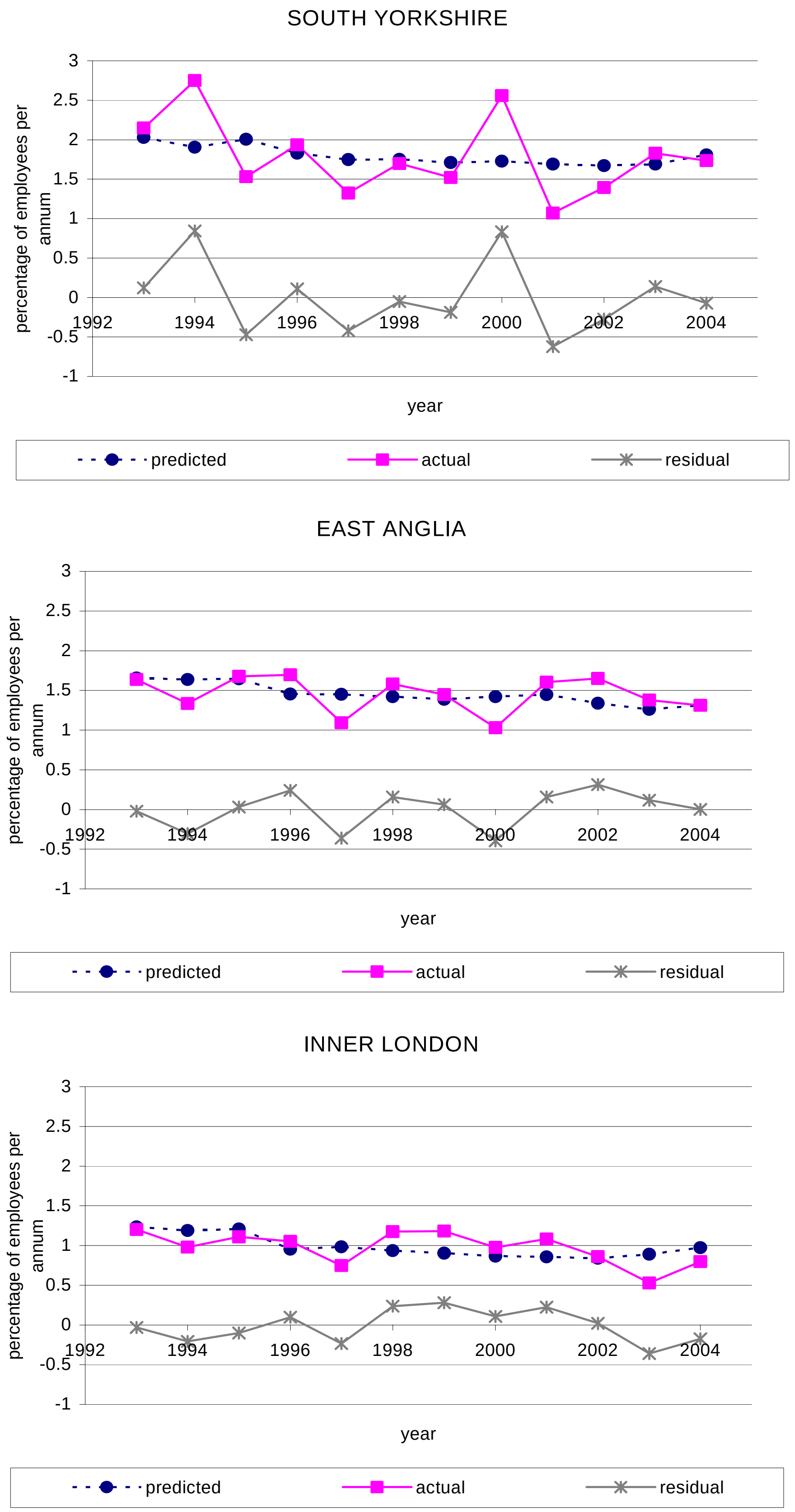


Figure 6.6 Trends in injury rates for selected regions

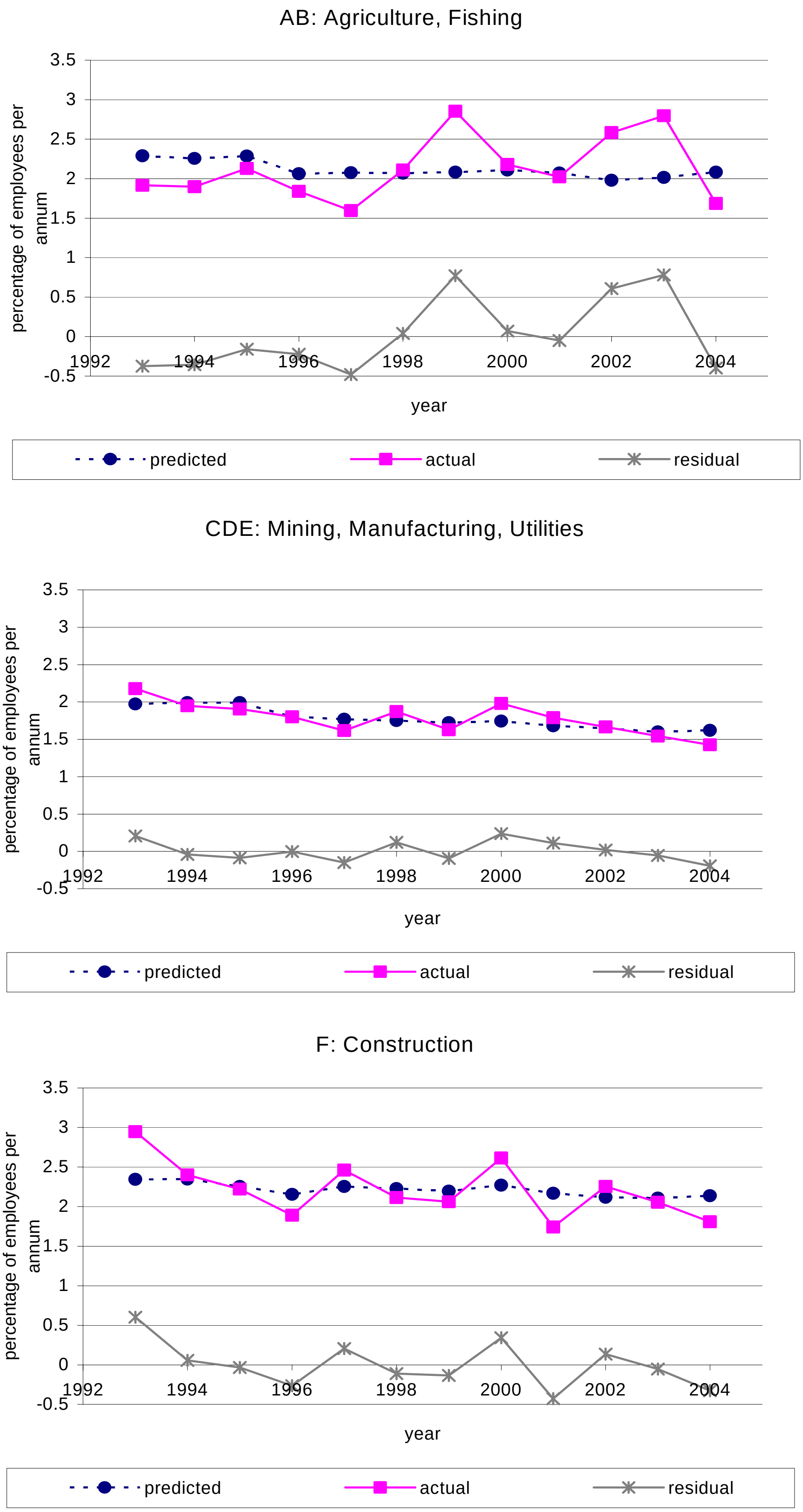
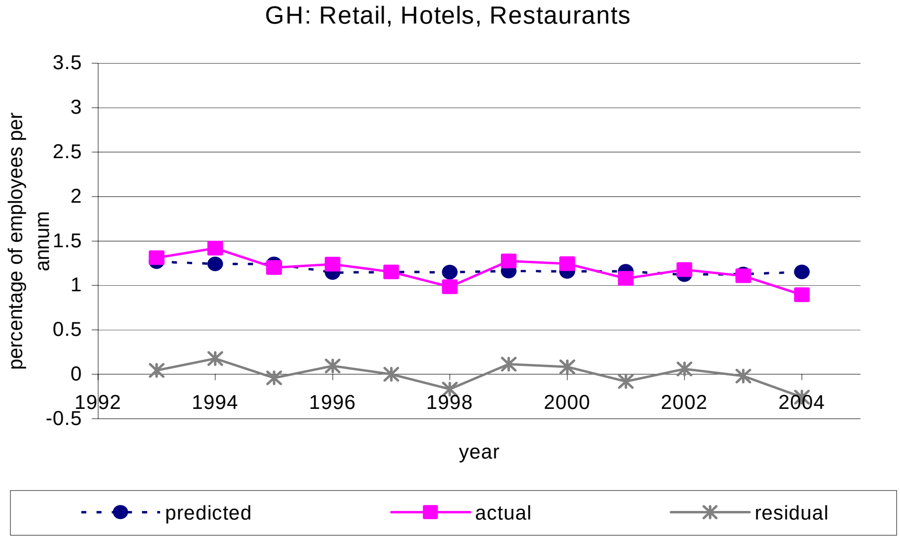
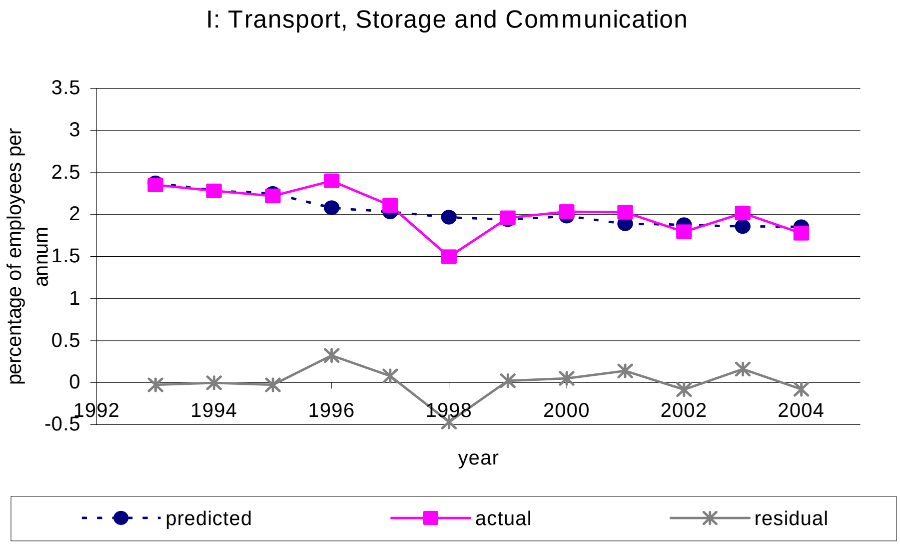


Figure 6.7 Trends in injury rates by sector





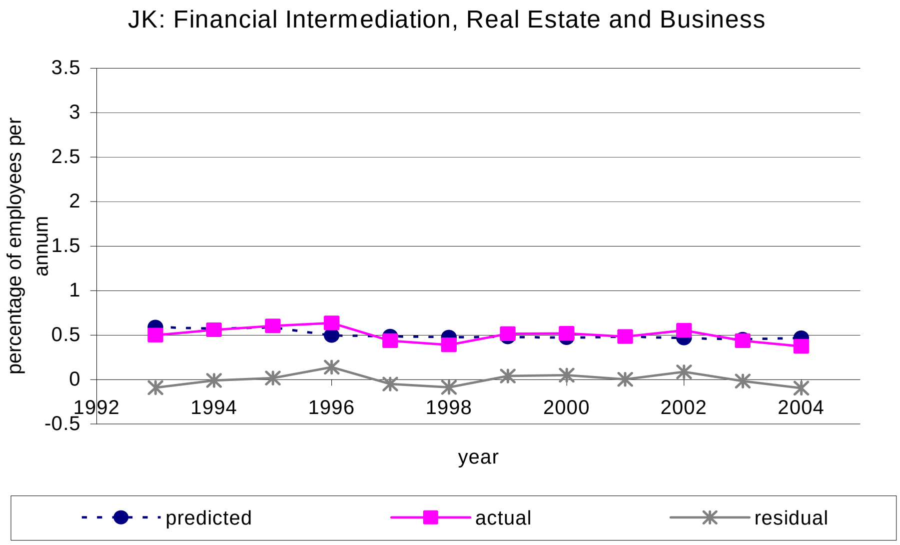


Figure 6.7 (cont) Trends in injury rates by sector

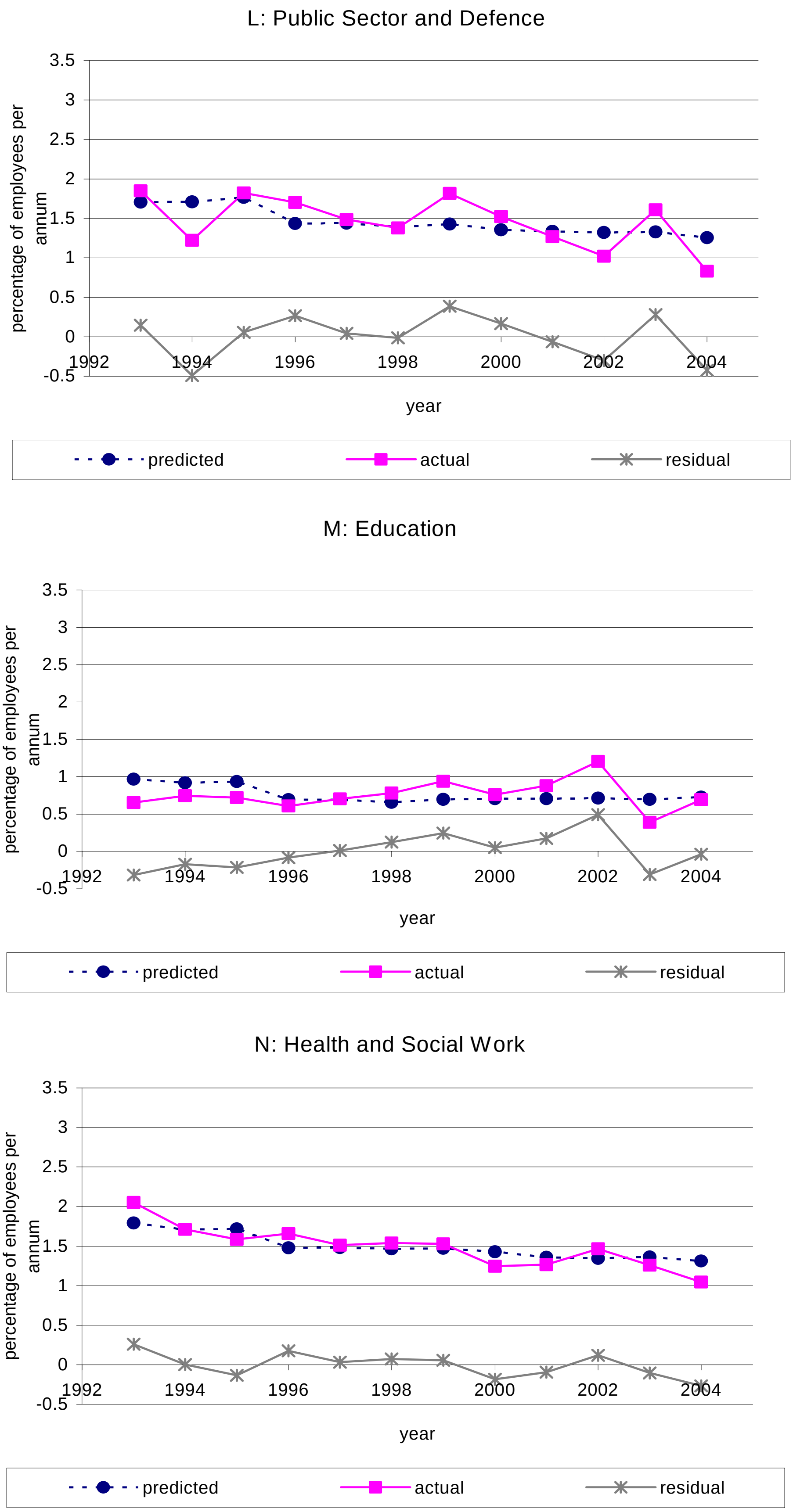


Figure 6.7 (cont) Trends in injury rates by sector

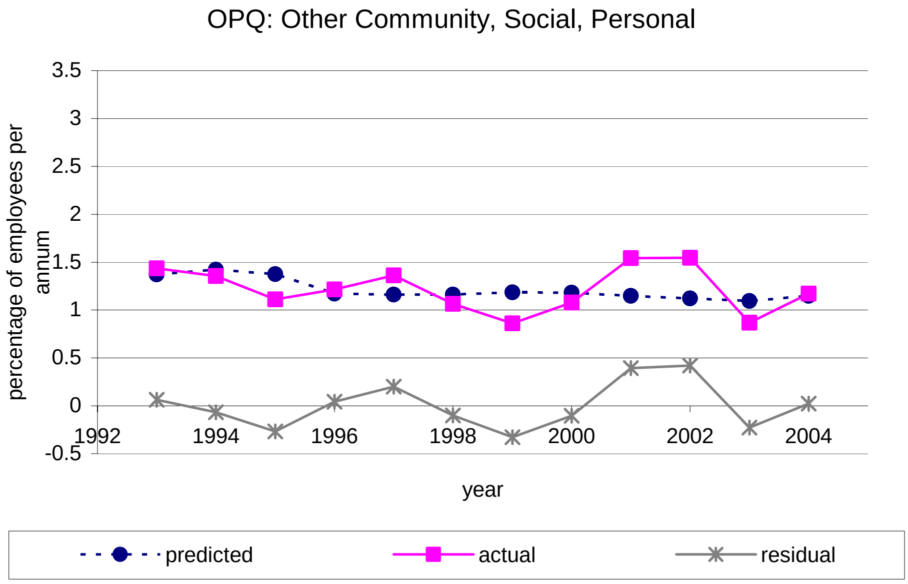


Figure 6.7 (cont) Trends in injury rates by sector

The strongest downward trends in the rate of workplace injury within sectors (based on predicted rates from the model) are in the public sector dominated industries. i.e. L: Public Sector and Defence; M: Education; and N: Health and Social Work. In these sectors average predicted rates of reportable accidents decrease from 1.7 to 1.2 percent per annum, 1.0 to 0.7 percent per annum and 1.8 to 1.3 percent per annum respectively since 1993, although rates actual rates in education show a gradual increase over time prior to 2002 followed by a large decrease since. In contrast, trends in accident rates in the priority sectors of A: Agriculture, Fishing and F: Construction are less strong. In these sectors average rates of reportable accidents, based on the predicted values of the model, decrease from 2.3 to 2.1 percent per annum and 2.0 to 1.6 percent per annum respectively since 1993.

In nearly all cases, it can be seen that the series of predicted injury rates closely follows the series of actual injury rates, indicating that changes in the observable characteristics of individuals can account for movements in workplace injury rates over time. Residual values therefore appear to be randomly distributed around zero rather than trended over time. It is only in the case of Sector AB: Agriculture, Fishing and in Sector M: Education where series of actual injury rates do not closely follow the paths of the predicted injury rate series. Within the agricultural sector, while actual injury rates exhibited an increase of approximately 50 percent between 1993 and 2003, injury rates were predicted to decline by approximately 12% over this period based upon the observable characteristics of those employed in the sector and the nature of the occupations in which they were working. Similarly, within Education sector, while actual injury rates increased by approximately a third before 2003 predicted values suggest that injury rates would have been expected to decline by approximately 25 percent over this same period. However, results suggest that no sector exhibits a decline in its rate of workplace injury beyond that which would have been expected to occur based upon predicted values of workplace injury rates. This reaffirms the predictive power of the model.

In summarizing the findings of this chapter, the calculation of an average 'expected' workplace injury rates for the period 1986 to 2004 through the simple application of occupational specific injury rates to the changing structure of employment over this period reveals that approximately a half of the decrease in accidents from 1986 to 2004 can be attributed to changing occupational structure. This exercise is informative given the importance of occupation in terms of understanding which people are most at risk of suffering a workplace injury. However, occupational composition is not the *only* factor which influences an individual's risk. The residual element that is not accounted for may be due to other compositional changes that could not be considered simultaneously in this one dimensional exercise. However, the contribution of a range of observable factors can be considered in the analysis of reportable injuries based on the LFS, albeit over a shorter period of time from 1993 onwards. The comparison of actual and predicted injury rates reveals that the decline in accident rates over time, especially amongst males, can be explained by changes in personal, establishment and job characteristics.

CHAPTER 7: PROJECTIONS OF WORKPLACE INJURIES: 2004-2012

7.1 INTRODUCTION

Analyses of workplace injury rates derived from RIDDOR data presented in Chapter 3 identified the presence of downward trends in the rate of workplace injury. This was observed both across and within sectors of economic activity. The analysis of movements in aggregate workplace injury rates within the previous chapter revealed changes in workplace injury rates over time could be explained by structural changes in the labour market. Given the wide variation in injury rates that have been shown to exist for different occupations and the importance of occupation in contributing to an individual's risk of suffering a workplace injury, trends in occupational structure are likely to play an important role in the movement of workplace injury rates over time.

It is therefore important to assess how such changes may be expected to effect future changes in workplace injury rates, particularly in the context of HSE targets to reduce the incidence rate of fatal and major injury accidents by 10% by 2010. For example, the effects upon injury rates of real improvements in health and safety at the workplace could be offset by a growth of employment in occupations that are associated with an increased risk of workplace injury. Alternatively, more favourable shifts in the occupational composition of employment could assist the HSE in meeting its injury rate targets. To consider these issues, in this chapter we present projections of workplace injuries estimated by combining information on workplace injury rates with detailed projections of employment for the period 2004 to 2012.

The remainder of this chapter is structured as follows. In section 7.2 we present an overview of available employment projections. Section 7.3 outlines how these projections of employment can be combined within information on workplace injury rates to produce projections of both the number of workplace injuries and workplace injury rates. Section 7.4 outlines the results of the projections exercise utilising workplace injury data derived from the Labour Force Survey. Section 7.5 similarly outlines the results of the projections exercise utilising workplace injury data derived from RIDDOR. Section 7.6 finally considers the robustness of these projections based upon alternative scenarios of economic growth.

7.2 OVERVIEW OF EMPLOYMENT PROJECTIONS

The Institute for Employment Research has recently produced detailed projections of employment as part of a programme of research entitled Working Futures, commissioned jointly by the Sector Skills Development Agency (SSDA) and the Learning and Skills Council (LSC). Separate projections are presented for all years to 2012 through a series of matrices primarily based on classifications of industries (SIC92) and occupational groups (SOC 2000). Projections are also available by gender, employment status (employees, self employed) and distinguish between full time and part time employment. At the most detailed level of occupational classification, projections are presented for at the Sub-Major Group level (2-digit) of SOC2000. At the most detailed level of industrial classification, projections are presented for 67 sectors.

Changes in employment structure are intimately tied up with the development of the economy more generally. The demand for labour is a derived demand and employment levels depend critically on the output of goods and services and the technologies used to produce them. Therefore, in order to assess the prospects for the changing pattern of demand for employment, it is necessary to understand the key economic factors influencing the economy and its structure.

Within the projections exercise this is done in a 2 stage process. Firstly, the macroeconomic factors that produce the demand for labour are modelled to produce estimates of employment demand by industrial sector. This exercise takes into account inter-dependency between sectors, with the outputs of one sector being the inputs of another. Within the second stage, estimates of employment demand by industry are converted to employment demand by occupational sector which are then projected into the future based upon an extrapolation of past trends[19].

For consistency with earlier analyses, we consider projected changes in employment that are expected to occur among employees; i.e. we abstract from the self-employed due to low rates of reporting among this group within the RIDDOR data. Figure 7.1 presents estimates of the projected change in employment by industrial sector. Whilst employment was projected to increase by approximately 1.5 million between 2002 and 2012, it can be seen that there is expected to be variation across industries. The largest employment gains are expected to be within the service sector, continuing the trend of the previous decade. In particular, sectors JK encompassing Financial Intermediation, Real Estate, Renting and Business Activities and sectors GH encompassing Wholesale, Retail and Hotels & Restaurants are expected to generate the most jobs. In terms of employment share, the proportion of employees working in these sectors is expected to increase from 43.9 to 47.1 per cent between 2002 and 2012. At the other end of the spectrum, the manufacturing sector is expected to show a net decrease in the number of workers employed. In terms of employment share, the proportion of employees working in this sector is expected to decrease from 14.8 to 11.9 per cent between 2002 and 2012.

The projected changes in employment demand by occupational group are summarised in Figure 7.2. For ease of exposition, we present changes in the occupational composition of employment in terns of the 9 Major Groups of the Standard Occupational Classification (as noted above, the full projections are available at the Sub-Major group, or 2-digit level, of SOC). It can be seen that in terms of employment share, expanding occupational groups include Managers, Professionals, Associate Professionals, Personal Services and Sales & Customer Service occupations. In contrast, employment demand in other occupations such as Administrative & Secretarial occupations, Skilled Trades, Process and Plant Operatives and other low skilled Elementary occupations are shown to be in structural decline.

While approximately 1.5 million new jobs among employees are expected to be created between 2002 and 2012, this disguises the fact that many of these new jobs will be part time in nature. Figure 7.3 shows that while the number of full time jobs is only expected to increase by around 300 thousand, the number of part time jobs is expected to increase by approximately 1.2 million. This pattern of job creation has important implications for estimating projections of workplace injuries. Increases in the total number of jobs are unlikely to provide an accurate reflection of actual changes in exposure to hazards. For example, without taking into account the increasing incidence of part time employment, workplace injury rates could be artificially deflated without any changes in exposure to workplace hazards having had occurred (e.g. a full time job being replaced by 2 part time jobs). Figure 7.3 therefore also presents employment projections based upon full time equivalents. Taking such changing patterns of work into account, employment on a full time equivalent basis is expected to increase by approximately 1 million between 2002 and 2012.

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[19] *A more detailed description of these employment projections has been published as an IER Bulletin and is available at: http://www2.warwick.ac.uk/fac/soc/ier/publications/bulletins/ier73.pdf*

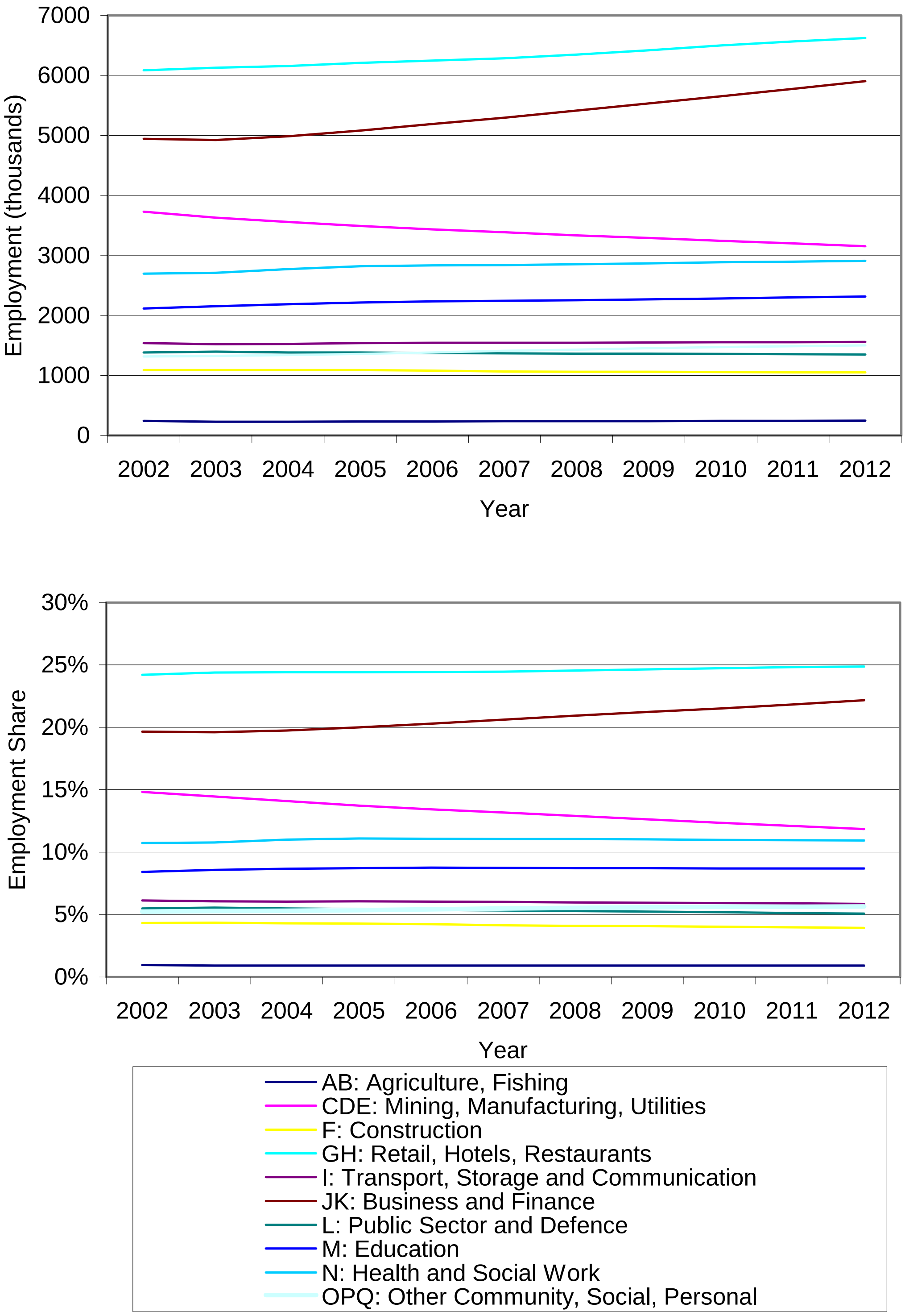

Figure 7.1 Projections of employment by industry

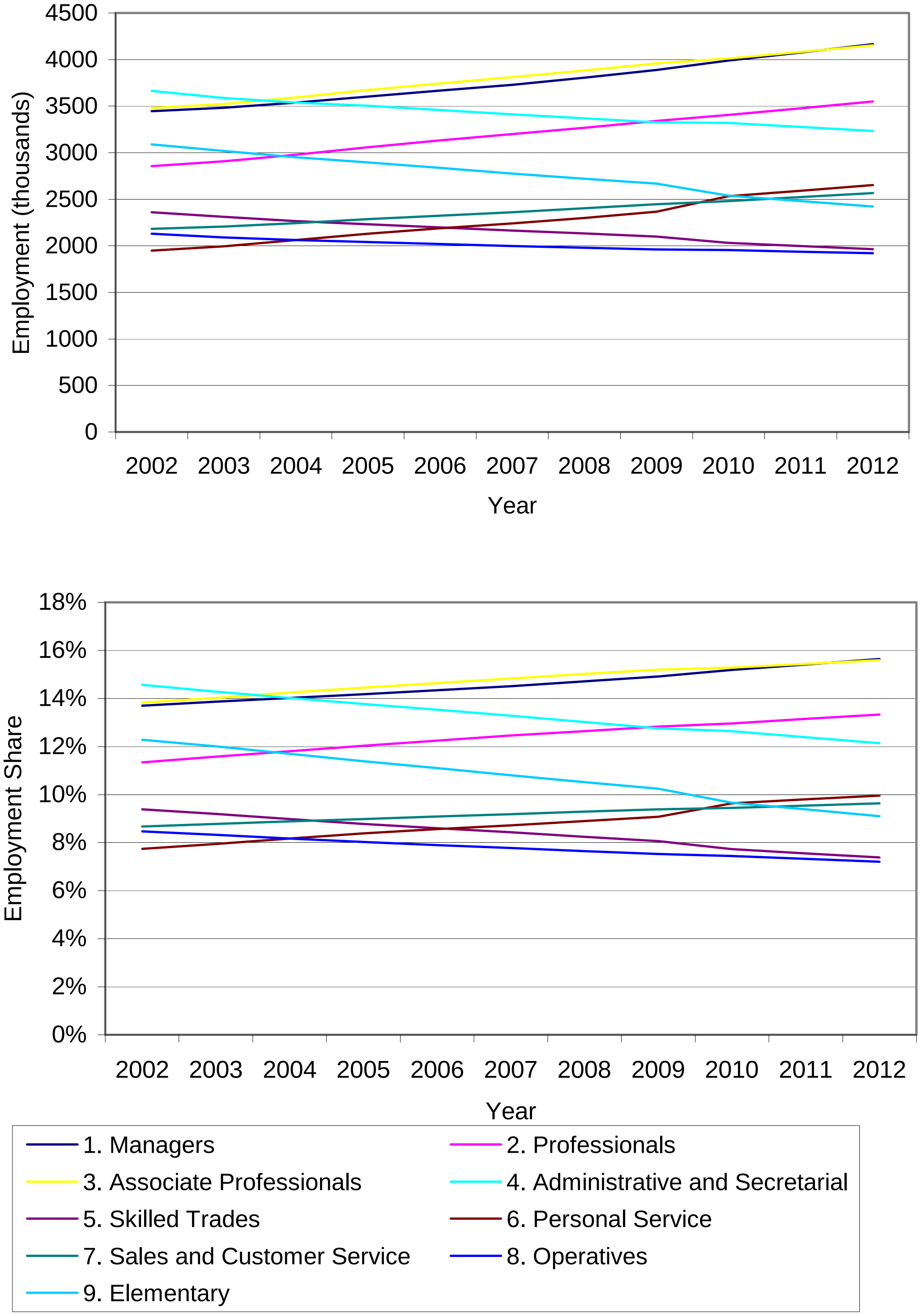

Figure 7.2 Projections of employment by occupation

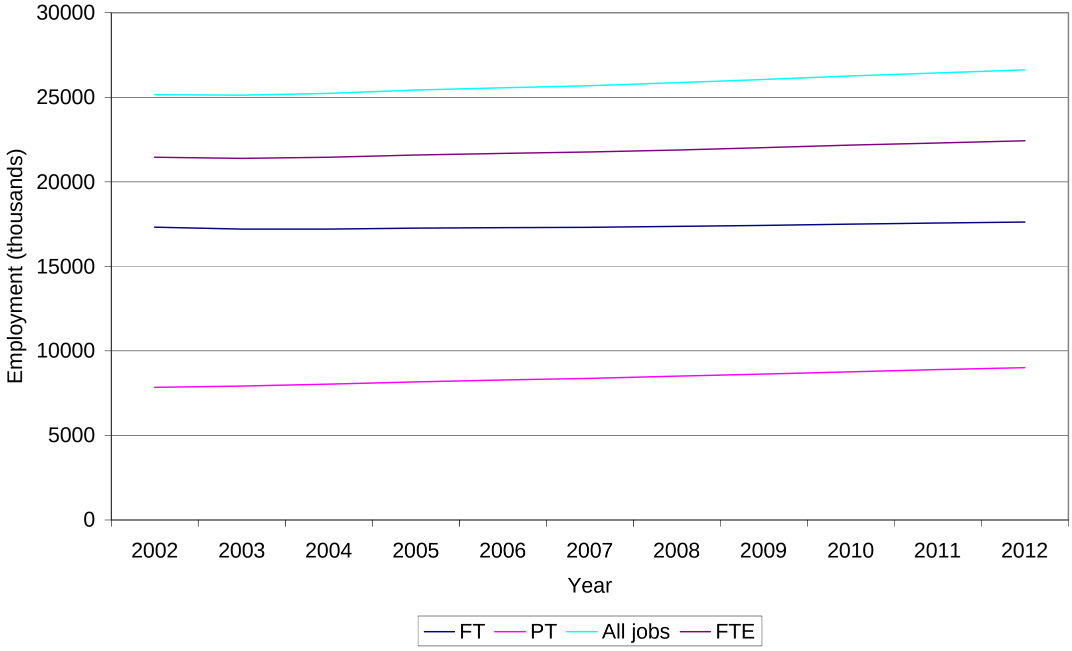

Figure 7.3 Projections of employment by full time/part time status

7.3 FORECASTS OF WORKPLACE INJURIES

Forecasts of both the changing number of reportable workplace injuries and the rate of reportable workplace injuries for the years up to 2012 can be estimated by combining information on workplace injury rates with projections of employment. We present projections of the number of workplace injuries and of workplace injury rates based upon injury rates derived from both the LFS and RIDDOR. As a confidential survey of individuals, we do not expect information from the LFS to suffer problems associated with under-reporting (with the exception of issues relating to recall bias, particularly among proxy respondents). However, the disadvantage of the LFS is that it does not allow us to distinguish between major injuries and over-3-day injuries as defined by RIDDOR. To overcome this problem, accident rates derived from RIDDOR is also used to present projections of workplace injuries separately for major and over-3-day injuries. This is important as structural changes in employment may be expected to have a different effect on the rate of workplace injuries if the relative incidence of major and over-3-day injury varies by occupation.

The projections of workplace injuries requires employment projections and workplace injury rates that are available on a consistent classification of occupations. The occupational dimension of the employment projections is based upon the Sub-Major Groups of SOC2000 (2 digit level). Within the LFS, the coding of occupations to SOC2000 was introduced from spring 2001. At the time of writing, workplace injury data coded to SOC2000 was available for four quarters of the Labour Force Survey; winter 2001/2 to winter 2004/5 inclusive. For the purpose of the projections, employee occupational injury rates derived from the LFS are based upon the average rates across these four quarters. Within RIDDOR, the coding of occupations to SOC2000 was introduced from April 2002. At the time of writing, only accident records made available for the year 2002/3 were coded to SOC2000.[20] Accident records for this year were

[20] *Accident records for 2004 were also made available. However, data for this year was only provisional and may therefore be incomplete.*

aggregated and deflated by an employment base derived from the Labour Force Survey to produce rates of reported workplace injury among employees by SOC Sub-Major Group.

In developing forecasts of workplace injuries we make two assumptions. Firstly, we assume that occupational injury rates remain stable over time. The projections therefore attempt to quantify the effect of projected changes in occupational composition upon workplace injuries, assuming current levels of risk within occupations. Secondly, a number of factors which have also been shown as important in delineating the risk of workplace injury are not explicitly modelled in this forecast. Key in this respect relate to the effects of the business cycle. Future spells of relatively high or low economic growth beyond that assumed within the employment projections may contribute towards actual movements in injury rates deviating away from projected estimates. We shall return to this issue at the end of the chapter. However, it should be noted that the occupational injury rates used within the analysis will implicitly embody information about other risk factors associated with these jobs. For example, changes in occupational composition will also implicitly account for changes in demographic structure of those in employment in so far as particular groups may be concentrated in particular occupational areas.

7.4 PROJECTIONS OF REPORTABLE WORKPLACE INJURIES DERIVED FROM THE LABOUR FORCE SURVEY

Figure 7.4 presents projections of workplace injuries for the period 2004-2012 across all sectors based upon workplace injury rates derived from the Labour Force Survey[21]. The upper panel presents the expected change in employment over the projection period for each of the 9 Major Groups of the Standard Occupational Classification. As described above, employment is expected to increase among Managers, Professional Occupations, Associate Professionals, Personal Service and Sales & Customer Service Occupations. We observe that a significant proportion of the growth in employment within these last 2 occupational groups is expected to be part time in nature. When taking this into account, we observe that the growth in full time equivalent employment is expected to be somewhat lower than the total number of jobs within these occupations. Between 2004 and 2012, it is estimated that net total employment will increase by approximately 1.4 million. When adjusting for full time equivalence, employment is expected to increase by 975 thousand.

In terms of the projected number of injuries, those occupations where employment is expected to increase will be associated with an increased number of reportable workplace injuries. While the risk of workplace injury may be expected to be generally low among Managerial, Professional and Associate Professional Occupations, the simple fact that more people will be working within these occupations contributes to the increased number of accidents that are expected to occur within these areas. The projected decline in employment among skilled trades, operatives and unskilled elementary occupations is expected to result in a reduction in the number of non-fatal workplace injuries of approximately 20,000 when comparing 2012 with 2004. As much of this employment is full time, taking into account full time equivalence does not have a significant effect upon the projections within these occupational areas.

The growth of employment in Personal Service Occupations, combined with the relatively high risks of many occupations classified to this Major Group of SOC contribute to a forecasted increase in reportable injuries within this area. The number of jobs within this area is expected to increase by 600 thousand, with 500 thousand of these jobs occurring within Caring Personal Service Occupations. This occupational area embodies high risk occupations such as low level

[21] *Given that we have information on actual injury rates for the period up to 2003, the projection exercise commences from 2004 onwards.*

nursing occupations and care assistants. It is within this occupational area that taking full time equivalence into account has the largest influence upon projections of workplace injuries. Unadjusted estimates suggest that employment growth in this area will contribute to 10,300 additional injuries. However, much of the employment growth within this area is expected to be part time. Taking into account this reduced exposure to risk, the expected number of additional accidents falls to approximately 7,800.

The final panel of Figure 7.4 shows how these structural changes in terms of the occupational composition of employment contribute to a projected downward trend in the overall rate of non-fatal injuries between 2004 and 2012. Within the LFS, we are able to estimate injury rates for all employees, and then separately for full time and part time employees. This distinction enables us to present projections of unadjusted injury rates and full-time equivalent injury rates. The difference between these two series is essentially one of scaling, with the adjusted injury rates being above the unadjusted series. However, in terms of the rate of decline, both series exhibit a similar downward trend of approximately 6 per cent. A summary of this projection is presented in Table 7.1. For ease of exposition we identify 2 occupational categories, with Major Groups 1 to 4 acting as a proxy for non-manual and Major Groups 5 to 9 acting as a proxy for manual occupations. It can be seen that the projected decline in the number of high risk manual jobs contributes to reduction in the total number of injuries of approximately 5 thousand. This reduction in the number of injuries combined with an increase in employment contributes to a reduction in the full time equivalent injury rate of 6 per cent.

Table 7.1 Overview of LFS based projection

Change in employment, 2004 – 2012	***Total***
Number of Jobs	
SOC 1-4 (Non Manual)	1,452,200
SOC 5-9 (Manual)	-58,800
Total	1,393,400
Full Time Equivalent Employment	
SOC 1-4 (Non Manual)	1,249,500
SOC 5-9 (Manual)	- 274,400
Total	975,100
Rate of reportable accidents per 100,000 FTE (2004 levels)	
SOC 1-4 (Non Manual)	690
SOC 5-9 (Manual)	2390
Change in Number of Reportable Accidents, 2004 – 2012	**-4,800**
Percentage change in Rate of Reportable Accidents, 2004 – 2012	**-5.9**

Finally, Table 7.2 summarizes estimated projections of workplace injuries by industrial sector for 10 sectors. It can be seen that the largest reduction in workplace injury rates are projected to occur within sectors F: Construction and I: Transport, Storage and Communication, with these sectors exhibiting a reduction in workplace injury rates of 7-8%. In contrast, rates of workplace injury are not projected to change significantly within sector JK: Financial Intermediation, Real Estate and Business Activities. Although this sector is expected to exhibit significant employment growth, leading to a large increase in the number of workplace injuries that are expected to occur, a balanced growth in terms of the employment share between manual and non-manual occupations results an injury rate that is projected to remain stable.

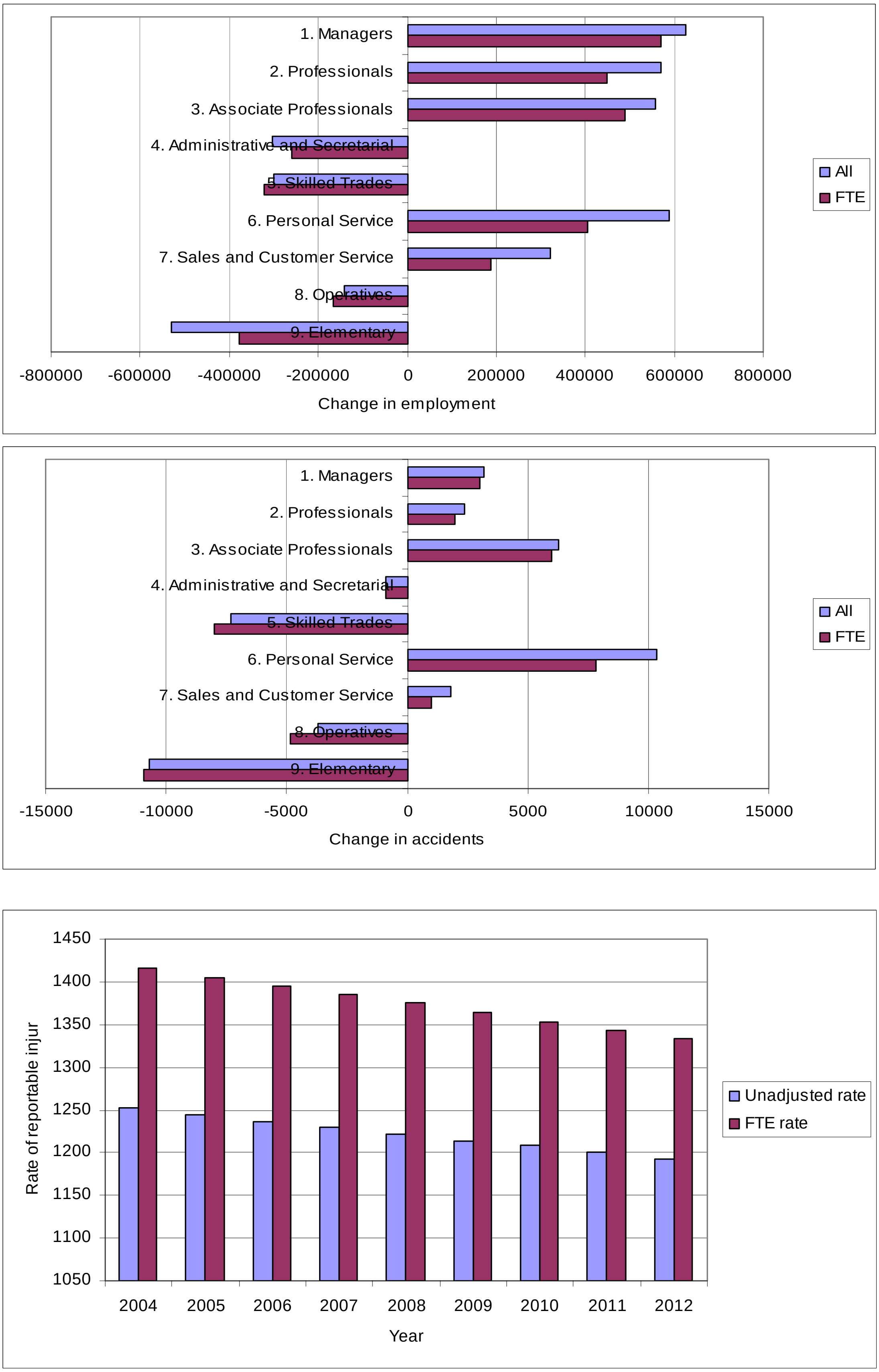

Figure 7.4 Overview of LFS projection

Table 7.2 Summary of projections of LFS reportable workplace injuries by industrial sector

Change in Employment, 2004 – 2012	***AB***	***CDE***	***F***	***GH***	***I***	***JK***	***L***	***M***	***N***	***OPQ***	***Total***
Number of Jobs											
SOC 1-4 (Non Manual)	7,100	- 19,900	49,200	254,400	84,200	732,100	- 7,000	174,500	39,500	138,100	1,452,200
SOC 5-9 (Manual)	9,800	- 380,600	- 87,500	211,900	- 47,500	185,300	- 28,100	- 45,300	98,100	25,100	- 58,800
Total	16,900	- 400,500	- 38,300	466,300	36,700	917,400	- 35,100	129,200	137,600	163,200	1,393,400
Full Time Equivalent Employment											
SOC 1-4 (Non Manual)	5,800	- 27,300	50,300	226,400	80,900	717,500	- 17,700	77,400	34,700	101,600	1,249,600
SOC 5-9 (Manual)	6,700	- 382,200	- 87,500	84,900	- 53,700	170,500	- 33,500	- 21,800	46,000	- 3,900	- 274,500
Total	12,500	- 409,500	- 37,200	311,300	27,200	888,000	- 51,200	55,600	80,700	97,700	975,100
Rate of Accidents per 100,000											
SOC 1-4 (Non Manual)	560	570	530	580	580	590	1,100	650	970	880	698
SOC 5-9 (Manual)	2,920	2,730	2,760	2,090	2,700	2,140	2,480	2,320	2,090	2,340	2292
Change in Number of Accidents, 2004 – 2012	**0**	**- 10,700**	**- 2,100**	**1,400**	**- 1,600**	**8,100**	**- 900**	**- 300**	**800**	**500**	**- 4,800**
Percentage Change in Rate of Accidents, 2004 – 2012	**- 5.3**	**- 5.6**	**- 7.1**	**- 4.2**	**- 8.2**	**- 0.6**	**- 1.2**	**- 4.9**	**- 1.1**	**- 5.4**	**-5.9**

Definitions of industrial sectors: AB: Agriculture, Fishing; CDE: Mining, Manufacturing, Utilities; F: Construction; GH: Retail, Hotels, Restaurants; I: Transport, Storage & Communication; JK: Business & Finance; L: Public Sector & Defence; M: Education; N: Health and Social Work; OPQ: Other Community, Social, Personal.

7.5 PROJECTIONS OF WORKPLACE INJURIES DERIVED FROM RIDDOR

In this section we present projections of reported workplace injuries based upon projections of employment combined with rates of workplace injury derived from RIDDOR data. In contrast to projections based upon the LFS, the advantage of the RIDDOR data is that we are able to present projections of workplace injuries separately for major and over-3-day injuries. If these two types of injury are associated with different types of occupation, then changing occupational composition will have a different influence on projected injury rates. The disadvantage associated with the RIDDOR data is that related to under-reporting. As with actual injury rates, projected injury rates based on this source will be lower than those based upon the Labour Force Survey. However, within the present context, we are interested in the ***change*** in workplace injury rates that result from changing occupational composition rather than the actual ***level*** of workplace injury rates. We therefore do not make any attempt to correct for under-reporting. The projections estimate the number of workplace injuries that are expected to be reported under RIDDOR assuming that occupational reporting rates will remain at 2002/3 levels for the period of the projections[22]. A summary of the injury projections based on the RIDDOR data across all sectors of employment is presented in Table 7.3.

Table 7.3 Overview of RIDDOR based projection

Change in Employment, 2004 – 2012	***Total***
Number of Jobs	
SOC 1-4 (Non Manual)	1,452,200
SOC 5-9 (Manual)	-58,800
Total	1,393,400
Full Time Equivalent Employment	
SOC 1-4 (Non Manual)	1,249,600
SOC 5-9 (Manual)	- 274,500
Total	975,100
Over-3-Day Injuries	
Rate of Accidents per 100,000 FTE (2004 Levels)	
SOC 1-4 (Non Manual)	170
SOC 5-9 (Manual)	820
Change in Number of Accidents, 2004 – 2012	**-3790**
Percentage change in Rate of Accidents, 2004 – 2012	**-8.1**
Major Injuries	
Rate of Accidents per 100,000	
SOC 1-4 (Non Manual)	50
SOC 5-9 (Manual)	170
Change in Number of Accidents, 2004 – 2012	**-740**
Percentage change in Rate of Accidents, 2004 - 2012	**-7.6**

[22] *The projections will however take into account changes in reporting levels that occur as a result of changing occupational structure. For example, if the composition of employment moves towards occupations characterized by relatively high levels of reporting, this will be reflected in the projections of both the number of injuries and of the injury rate.*

It can be seen that in terms of the number of injuries, the increased number of injuries that would be associated with employment growth in within non-manual occupations is offset by the reduction in injuries associated with the decline in manual employment. Overall, the number of over-3-day injuries per annum is expected to decline by 3,790 between 2004 and 2012, while the number of major injuries is expected to decline by 740. This translates into a reduction in the reported rate of over-3-day injuries of 8.1% and a reduction in the rate of major injury of 7.6%[23]. Figures 7.5 and 7.6 provide a more detailed account of which occupational areas the reduction in workplace injuries will occur and how injury rates are expected to decline over time for major and over-3-day injuries respectively[24].

Considering projections of over-3-day and major injury by industry, it can be seen in Table 7.4 that the largest reductions in the rate of over-3-Day injury between 2004 and 2012 are expected to occur within sectors AB: Agriculture (-10.7%), M: Education (-9.7%) and I: Transport Storage and Communication (-9.2%). In terms of major injuries, the largest reductions in injury rates are expected to occur within sectors I: Transport, Storage and Communication (-8.6%) and F: Construction (-7.3%). In terms of the absolute number of injuries reported to HSE, the largest reduction is shown to occur within sector CDE: Manufacturing. In contrast, employment growth within sector JK: Financial Intermediation, Real Estate & Business Activities contributes to an expected increase of 2450 over-3-day injuries and 560 major injuries.

In comparing the industry specific results derived from RIDDOR (Table 7.4) with those derived from the LFS (Table 7.2), we observe that within industries, the projected change in the number of accidents is lower for the projections based upon the RIDDOR data. For example, based upon the LFS projections, it is estimated that the number of reportable workplace injuries within the construction sector is expected to decline by -10,700 between 2004 and 2012. This is compared to a combined (over-3-day injuries and major) reduction of 5,230 injuries based upon the RIDDOR projection. The reason for this is that injury rates based upon the RIDDOR data are lower than those based upon the LFS due to under-reporting. Therefore, within the RIDDOR based projections, any projected change in employment is associated with a smaller projected change in the number of workplace injuries. However, across all sectors, the net effect on the total projected change in the number of workplace injuries is very similar, with the LFS based projection predicting a reduction of 4,800 injuries and the RIDDOR projection predicting a reduction of 4,500 injuries. Within the LFS based projection, larger increases in the numbers of workplace injuries within those sectors that are expected to exhibit high employment growth are simply offset by larger decreases in the number of injuries within those sectors that are expected to exhibit a reduction in employment.

The two sets of projections yield similar results for the estimated changes in injury rates within sectors as these percentage based estimates do not depend upon the projected change in the actual number of workplace injuries. For example, both sets of projections indicate that sector JK: Business and Finance will exhibit the smallest projected change in its injury rate. Therefore, whilst relatively high employment growth will contribute to a large increase in the absolute number of workplace injuries in this sector, the evenness of this growth between manual and non-manual occupations contributes to relatively stable rates of workplace injury over time. In contrast, in those sectors that exhibit a relative movement away from employment within manual occupations such as F: Construction and I: Transport, Storage and Communication, workplace injury rates are projected to exhibit a significant decline.

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[23] *We are not able to make a 'complete' adjustment to the injury rate series for full time equivalence using the RIDDOR data as we are not able to derive injury rates from RIDDOR separately for full time and part time employees. As noted in Figure 7.4, the difference in these series is observed in terms of their levels, with little difference observed in the percentage change in these injury rates over time.*

[24] *Note that these injury rates are annual un-adjusted injury rates and so the actual rates relating to the beginning of the projection period are four times greater than the quarterly rates presented in Chapter 3.*

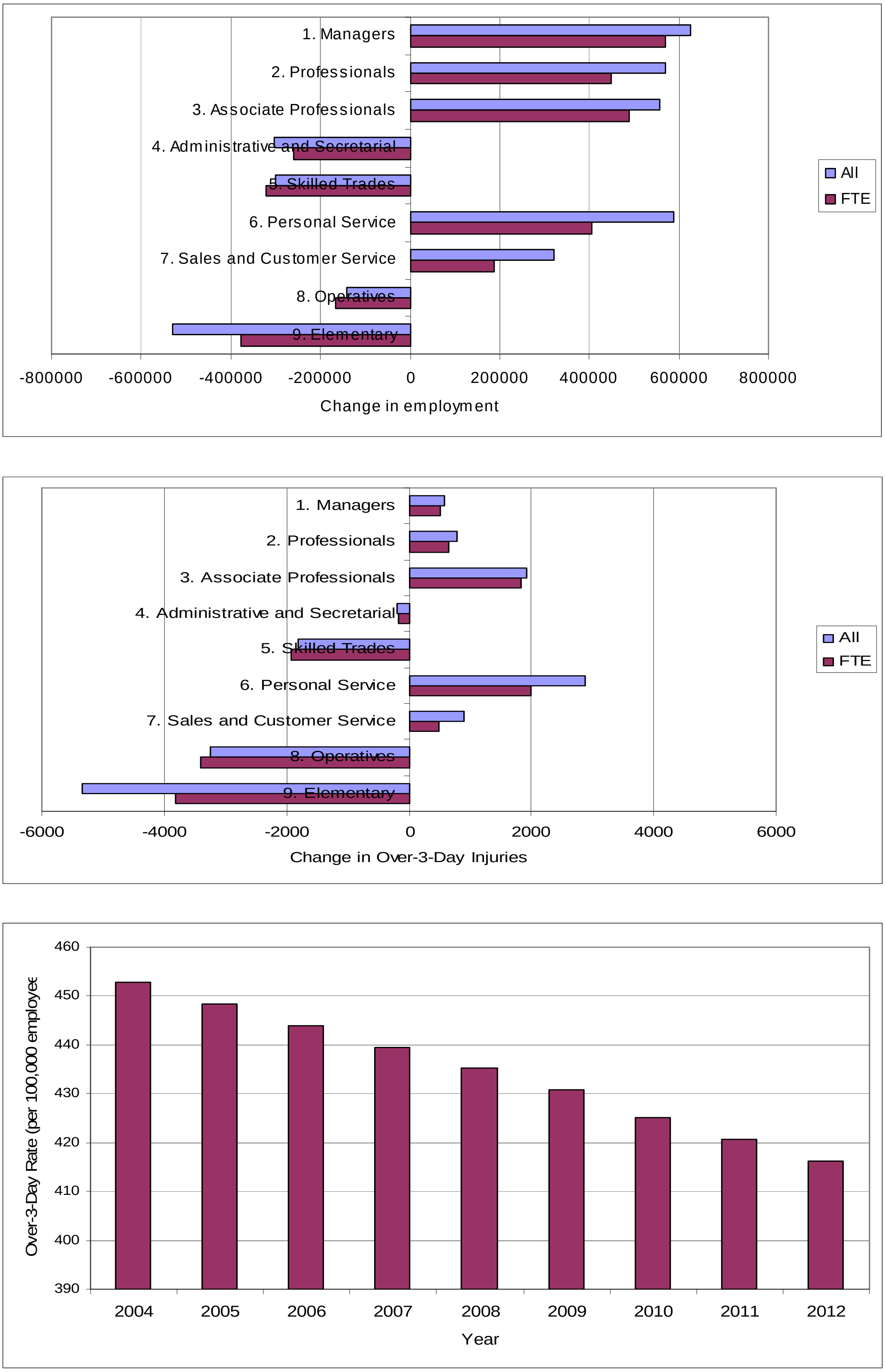
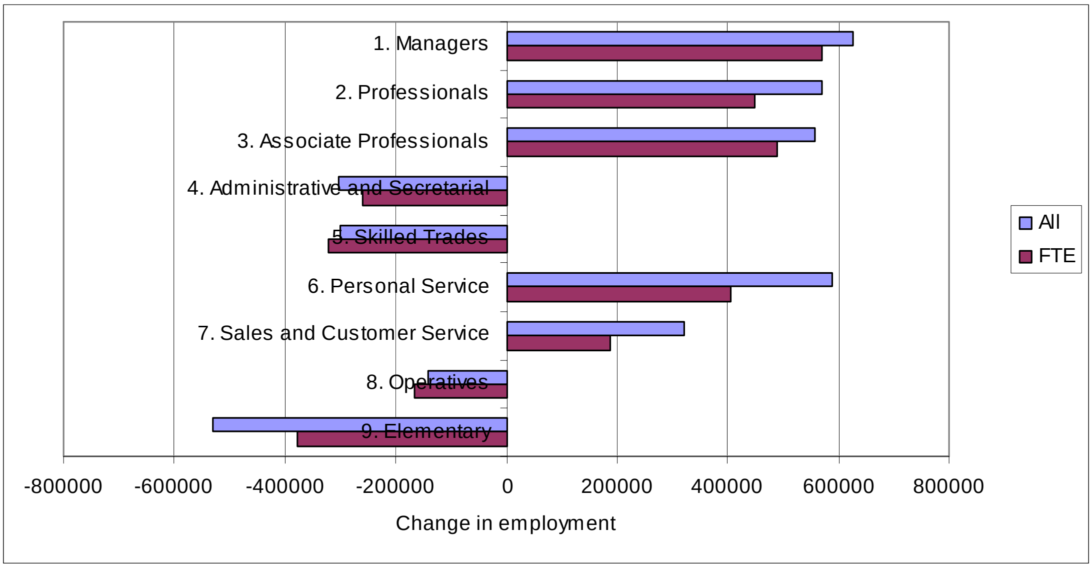
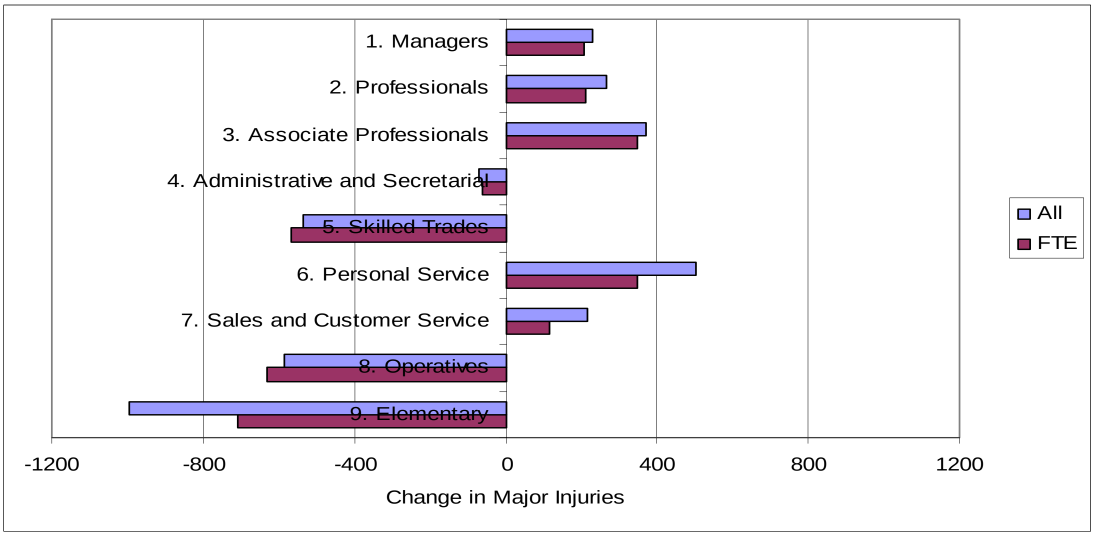


Figure 7.5 Overview of RIDDOR over-3-day injury projection





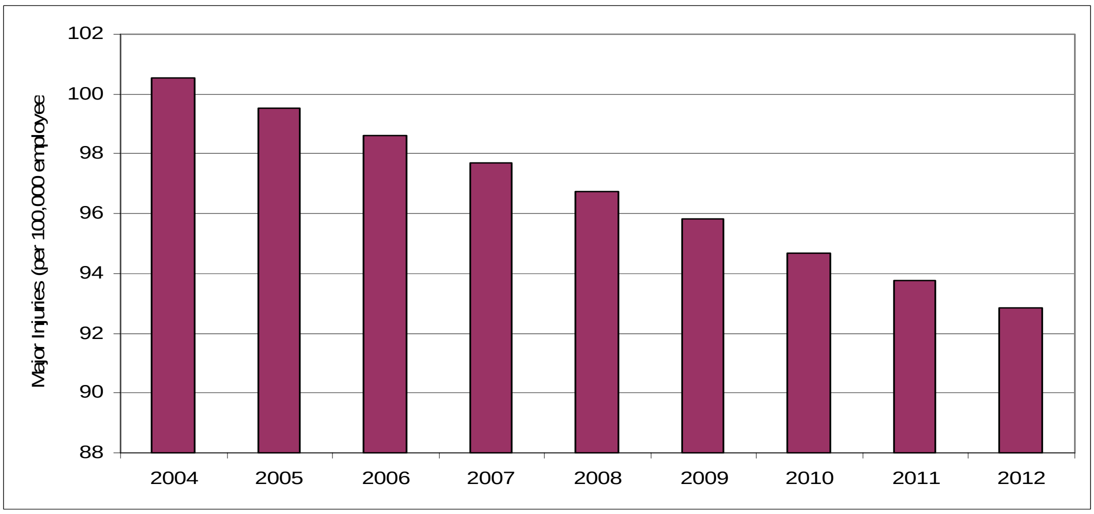


Figure 7.6 Overview of RIDDOR major injury projection

Table 7.4 Summary of projections of workplace injuries reported under RIDDOR by industrial sector

Change in Employment, 2004 –12	*AB*	*CDE*	*F*	*GH*	*I*	*JK*	*L*	*M*	*N*	*OPQ*	*Total*
Number of Jobs											
SOC 1-4 (Non Manual)	7100	-19900	49200	254400	84200	732100	-7000	174500	39500	138100	1452200
SOC 5-9 (Manual)	9800	-380600	-87500	211900	-47500	185300	-28100	-45300	98100	25100	-58800
	16900	-400500	-38300	466300	36700	917400	-35100	129200	137600	163200	1393400
Full Time Equivalent Employment											
SOC 1-4 (Non Manual)	5,800	- 27,300	50,300	226,400	80,900	717,500	- 17,700	77,400	34,700	101,600	1,249,600
SOC 5-9 (Manual)	6,700	- 382,200	- 87,500	84,900	- 53,700	170,500	- 33,500	- 21,800	46,000	- 3,900	- 274,500
Total	12,500	- 409,500	- 37,200	311,300	27,200	888,000	- 51,200	55,600	80,700	97,700	975,100
Over-3-Day Injuries											
Rate of Accidents per 100,000											
SOC 1-4 (Non Manual)	120	150	140	120	160	160	370	120	220	240	170
SOC 5-9 (Manual)	930	1040	910	680	1040	720	860	750	610	770	820
Change in Number of Accidents, 2004 – 2012	**-90**	**-4320**	**-530**	**30**	**-700**	**2450**	**-370**	**-270**	**10**	**0**	**-3790**
Percentage Change in Rate of Accidents, 2004 – 2012	**-10.7**	**-7.6**	**-4.9**	**-6.0**	**-9.2**	**-0.7**	**-2.0**	**-9.7**	**-3.4**	**-8.3**	**-8.1**
Major Injuries											
Rate of Accidents per 100,000											
SOC 1-4 (Non Manual)	40	40	40	40	40	40	80	40	40	60	50
SOC 5-9 (Manual)	190	220	220	150	220	150	170	140	110	160	170
Change in Number of Accidents, 2004 – 2012	**0**	**-910**	**-170**	**40**	**-140**	**560**	**-80**	**-40**	**-10**	**10**	**-740**
Percentage Change in Rate of Accidents, 2004 – 2012	**-6.8**	**-6.5**	**-7.3**	**-5.4**	**-8.6**	**-1.0**	**-2.6**	**-6.9**	**-4.5**	**-7.1**	**-7.6**

Definitions of industrial sectors: AB: Agriculture, Fishing; CDE: Mining, Manufacturing, Utilities; F: Construction; GH: Retail, Hotels, Restaurants; I: Transport, Storage & Communication; JK: Business & Finance; L: Public Sector & Defence; M: Education; N: Health and Social Work; OPQ: Other Community, Social, Personal

7.6 ALTERNATIVE SCENARIOS RELATING TO ECONOMIC GROWTH

By combining information on injury rates with estimates of employment projections, the previous sections have projections of both the number of workplace injuries and workplace injury rates have been produced for the period 2004 to 2012. Estimates based upon workplace injury data from the LFS suggest that the rate of reportable non-fatal injuries would be expected to decline by approximately 6 per cent over this period. Estimates based upon RIDDOR suggest that the rate of reported injuries would be expected to decline by 7-8%. These changes are the effects that are expected to emerge as a result of changes in the occupational composition of employment over time. They do not take into account possible scenarios regarding business cycle effects and assume that real levels of health and safety within occupations remain unchanged. Injury rates may therefore be expected to follow a different path during the course of the projection period if the economy enters a period of relatively high or low economic growth.

In this final section we attempt to present projections of the rate of major injuries reported under RIDDOR based upon two alternative scenarios regarding economic growth. The analysis utilises the results of economic projections produced by the Bank of England in its Quarterly Inflation Report. At the time of writing, the May 2005 report provided projections of GDP growth up until the second quarter of 2008. The Bank's GDP forecast is published in the form of a probability distribution 'fan chart' that reflects the Bank's subjective assessment of GDP growth evolving through time[25]. This method of presenting economic projections emphasises that there is a wide degree of uncertainty surrounding the production of GDP projections.

Table 7.5 shows that average annual GDP growth as estimated by the Bank of England is projected to increase from 2.5% in 2005 to 2.9% by 2008. To provide an indication of how injury rates may vary overtime depending upon the growth path of the economy, we then present alternative scenarios for economic growth. These scenarios are constructed by simply assuming that economic growth was either 10/20% above or below the mean projection. It is noted that the choice of these adjustments is arbitrary. In terms of the likelihood of these growth scenarios actually occurring, our own scenarios relating to +/-10% of expected economic growth will be more likely to occur than those relating to +/-20% of expected economic growth.

Table 7.5 Alternative economic growth scenarios

	Average annual GDP growth[26]			
	2005	***2006***	***2007***	***2008***
Mean Projection (BofE Estimates)	2.53	2.59	2.95	2.93
20% lower than expected growth	2.02	2.07	2.36	2.34
10% lower than expected growth	2.27	2.33	2.65	2.64
10% higher than expected growth	2.78	2.85	3.24	3.22
20% higher than expected growth	3.03	3.11	3.54	3.52

Figure 7.7 demonstrates how these alternative scenarios relating to economic growth would be expected to influence the rate of major injury derived from RIDDOR over time. In Figure 7.6, it was demonstrated that changes in the occupational composition of employment would be expected to reduce the rate of major injuries by approximately 4% between 2004 and 2008. The

25 *See Bank of England Quarterly Bulletin, February 1998, pp30-37.*
26 *Based on simple average of quarterly estimates of annual GDP growth*

injury rate adjustments for alternative economic growth scenarios are based upon the analysis of Chapter 4 which indicated that a 1% increase in GDP above trend was associated with an increase in the rate of major injury of 1.4%. Assuming that the occupational projections are set against a background of average GDP growth reflected by Bank of England estimates, we observe that the estimated decline in the rate of major injuries is lower under the higher growth scenarios. Under the scenario of 20% higher than expected growth, the rate of major injury is estimated to decline by only 1% between 2004 and 2008. Under the alternative scenario of 20% lower than expected economic growth, the rate of major injury is estimated to decline by approximately 7% over this period.

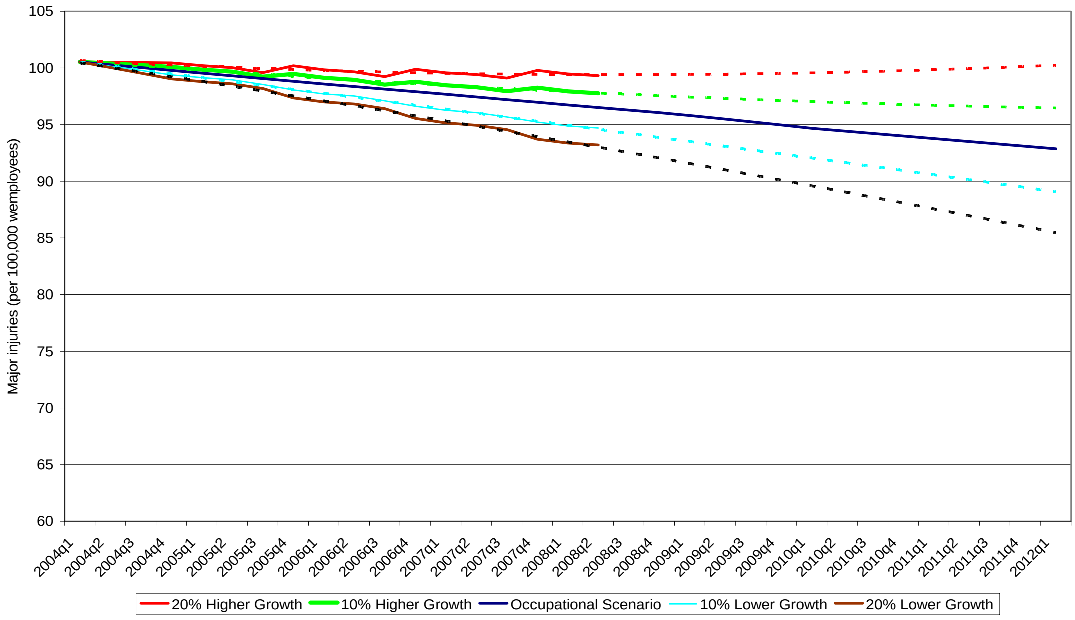


Figure 7.7 Projected annual unadjusted rates of major injury under alternative projections of economic growth

While the projections of injury rates based upon occupational projections are available up until 2012, projections of economic growth are only available until 2008. To consider the effects of upon injury rates of the economy continuing along these alternative paths of economic growth, we extrapolate these economic projections beyond 2008 by extrapolating a trend line fitted through these series. Under the scenario of 20% higher than expected economic growth, the rate of major injury in 2012 is comparable to that during 2004. Under the scenario of 20% lower than expected economic growth, the rate of major injury in 2012 is estimated to be approximately 15% lower than that observed in 2004.

It should be noted that this exercise is undertaken for illustrative purposes. While the exercise clearly demonstrates that the variation in injury rates relating to different economic growth paths increases over time, there are a number of caveats to this approach. Most notably, the projections rate to alternative scenarios of economic growth averaged and extrapolated over a period of almost a decade. These projections do not take into account the possibility of periods of very high or low economic growth around these growth paths. As with economic projections, the level of uncertainty regarding future changes in workplace injury rates increases with the time horizon of the projection period. Finally, we note that a serious attempt to make accurate projections of workplace injury would need to take into account both projected changes in the occupational composition of employment and projections of other labour market variables that relate to the movement of workplace injury rates over time such as the incidence of new hires.

CHAPTER 8: CONCLUDING COMMENTS

8.1 OVERVIEW OF MAIN FINDINGS

Analysis of workplace injury data collected via the reports made to enforcing authorities under RIDDOR indicate that over the period 1986 to 2004, rates of workplace injury have exhibited an overall downward trend. After taking into account improvements in rates of reporting over this period and changes in reporting regulations that accompanied the introduction of the RIDD0R 95 reporting regulations, the general downward movement of injury rates among both males and females have been estimated to account for a reduction in the workplace injury rate of approximately 40% over this 18 year period. Downward trends in injury rates have also been identified within a majority of industrial sectors.

However, this period has been characterised by significant changes in the occupational and industrial composition of employment. There has been a clear shift in employment away from primary industries, utilities and manufacturing towards the service sectors, while the share employment within the service sector has increased. The decline of employment in primary and manufacturing industries has resulted in a reduction in the proportion of individuals employed within occupations traditionally regarded as high risk. This raises the question as to whether downward trends in workplace injury rates actually reflect real improvements in Health and Safety at the workplace or whether these trends can be attributed to structural changes in the workplace. As such, does the setting of over-arching targets for reductions in the rate of workplace injuries as part of the *Revitalising Health and Safety* strategy provide an objective measure of the performance of the regulatory regime?

The aim of this report has therefore been to demonstrate how the broader economic environment and changing labour conditions can affect rates of workplace injury. In terms of identifying the effects of the business cycle upon workplace injury rates, in Chapter 4 we found that:

- Periods of relatively high economic growth are associated with increases in workplace injury rates. Based upon the severity of recent business cycles, moving from a 'recession' to a 'boom' has been estimated to contribute to approximately an 11 to 12% increase in the rate of major injuries among employees.
- Such pro-cyclical relationships were most prevalent in areas of the private sector characterised by a relatively high share of male employment and which have been of traditional importance to the Health and Safety Executive, both in terms of their relative risk and the absolute number of injuries reported. Within the construction sector, moving from a 'recession' to a 'boom' has been estimated to contribute to approximately a 12-14% increase in workplace injury rates among male employees. Within the manufacturing sector, moving from a 'recession' to a 'boom' has been estimated to contribute to approximately a 4-7% increase in workplace injury rates among both male and females employees.
- In terms of the mechanisms that contribute to these pro-cyclical patterns, increased levels of recruitment leading to a higher proportion of 'new hires' has been shown to be correlated with higher rates of workplace injury. There is also some evidence to suggest that increased levels of work effort are correlated with higher injury rates.

In Chapter 5 we investigated what personal, establishment and job characteristics were associated with individuals being at an increased risk of workplace injury. In terms of personal characteristics, we found that:

- Higher rates of workplace injury exhibited by males compared to females can be almost entirely explained by differences in other job and establishment characteristics.
- The strong regional gradient observed in workplace injury rates can be explained by differences in the observable personal and job related characteristics within these regions, there is no 'regional effect'.

In terms of employment characteristics, we found that:

- The dominant influence that contributes to an individual's risk of injury is their occupation. The five most hazardous occupational categories were identified as being Construction Labourers; Metal, Wood and Construction Trades; Vehicle Trades; Agriculture and Animal Care Occupations and Stores/Warehouse Keepers.
- The risk of workplace injury declines rapidly as employment tenure increases. The increased risks associated with tenure a particularly apparent during the first 4 months within a new job.
- In terms of the length of the working day, after correcting for exposure, those working part time hours were most likely to report having had a reportable workplace injury ***per hour worked***. There is no evidence to indicate that those working long hours are more at risk ***per hour worked*** than those working 40-45 hours.
- Among other employment characteristics, we observed that shift working, working in the public sector were associated with individuals being more likely to indicate that they had suffered a reportable workplace injury. Being self-employed and working within small establishments (less than 10 employees) were each associated with a reduced likelihood of individuals reporting that they had suffered a workplace injury.

If the composition of the workforce changes over time, either in terms of the personal characteristics of those employed or the nature of the work tasks undertaken, we would expect workplace injury rates to also vary over time. When using the results from the statistical model to estimate series of predicted injury rates, it was observed that the series of predicted injury rates closely followed the series of actual injury rates, indicating that changes in the observable characteristics of individuals can account for movements in workplace injury rates over time.

8.2 MEETING TARGETS FOR HEALTH AND SAFETY: LOOKING TOWARDS 2010

The results of our analyses indicate that the dominant influence upon an individual's risk of workplace injury is occupation. Therefore, changes in rates of workplace injury over time are likely to be dominated by changes in the occupational composition of employment. To investigate how we may expect injury rates to change in the future, in Chapter 7 we produced projections of workplace injury rates for the period 2004 to 2012 by combining information on injury rates with projections of employment by occupation. Estimates based upon workplace injury data from the LFS suggest that the rate of reportable non-fatal injuries would be expected to decline by approximately 6 per cent over this period. Estimates based upon RIDDOR suggest that the rate of reported injuries would be expected to decline by 7-8%. These changes are the effects that are expected to emerge as a result of changes in the occupational composition of employment over time.

We note that these projections do not aim to provide a detailed assessment of whether RHS targets are either currently being met or are likely to be achieved by 2010. They do not take into account possible scenarios regarding business cycle effects and assume that real levels of health and safety within occupations remain unchanged. As such, the figures should be treated as indicative as opposed to being precise forecasts. Whilst projected changes in the occupational composition of employment appear to be working in favour of HSE, these could be either offset or reinforced depending upon the relative position of the economy within the business cycle.

8.3 WORKPLACE INJURY RATES AS AN OBJECTIVE MEASURE OF PERFORMANCE

The analyses in this report have demonstrated areas where HSE is likely to face particular challenges in the future; both in terms of operational activities and in terms of the presentation of statistical output. The growth in employment within personal service occupations is expected to exert the largest positive effect on the number of workplace injuries. Many of these jobs will be expected to be part time and filled by women. Analysis has demonstrated that those working the shortest hours are most at risk of suffering a workplace injury on ***a per hour*** worked basis. However, an increased incidence of part time employment may lead to a reduction in workplace injury rates as the number of jobs becomes an increasingly less reliable indicator of the level of work done in the economy, particularly among women.

Operational areas of the HSE are generally organised according to different sectors of activity. In terms of operational activities this is appropriate, as the HSE wishes to engage with employers in areas of economic activity that are characterised by particular risk factors. Although these employers will employ non-manual workers in low risk activities, manual workers engaged in higher risk activities will be covered. While industrial sectors are appropriate for the organisation of operational activities, such a dimension is less useful for the presentation of statistical information. The occupational composition of sectors can vary over time (e.g. technological advances that lead to the automation of tasks previously undertaken manually) or across regions (e.g. the nature of agricultural/manufacturing activities and associated risk factors will vary across different geographical areas). Differences in injury rates over time or between regions may therefore not be indicative of differences in real levels of safety at the workplace, but instead simply reflect the different nature of work tasks undertaken.

It is therefore important to ensure that the presentation of injury rate statistics make ‘like with like’ comparisons. As the main determinant of an individual’s risk of workplace injury, most useful in this respect is the presentation of injury rates by occupation, be it within industrial sector, across geographical areas or over time. The Standard Occupational Classification (SOC) provides a national standard for categorising occupational information. Defined as a set of tasks to be carried out by one person, jobs are primarily recognised by their associated job titles. In a majority of cases, accurate occupational coding can be achieved on the basis of job title alone. However, some job titles can be used in a variety of contexts, such as labourer or engineer. Therefore, accurate occupational coding may require additional information about the nature of work tasks undertaken. For example, the Labour Force Survey asks respondents *What was your main job?* and *What did you mainly do in your job?* Without complete information, there is a tendency for those responsible for occupational coding to over-utilise default categories within SOC; groups referred to as *not elsewhere classified* within the structure of the classification. It is observed that the HSE Incident Contact Centre website does not ask information about the nature of work tasks. The WHASS worker questionnaire however does follow the convention of the LFS.

In the context of the RIDDOR data, it is therefore important that the resources are available to ensure the accurate and consistent coding of occupational information if accurate occupational injury rates are to be derived from this source. In essence, if injury data is to be used as the basis of a numerator for injury rates, the occupational coding should be of a comparable standard to that embodied within the employment estimates that serve as the denominator. Recent technical developments in occupational coding include the development of the CASCOT computer program, capable of both occupational and industrial coding[27]. A variant of this software is also being developed on behalf of the Higher Education Statistics Agency to assist in the coding of jobs held by graduates responding to the Destinations of Leavers from Higher Education survey. Accurate occupational coding within RIDDOR can enable the specification of occupational specific injury rates that can form the basis of a more objective measure of health and safety against which to judge the performance of the regulatory regime.

It is important to note that while the analyses in this report point to the importance of changes in structural characteristics within the labour market in determining movements in rates of workplace injury over time, this should not imply that the HSE does not play a positive role in influencing workplace health and safety. As noted in the introductory chapter, a number of studies have been conducted over the last 3 decades that point to a variety of positive impacts of the regulatory regime within Great Britain upon workplace safety. The difficulty in proving a direct link between workplace injury rates and the regulatory activity is being able to identify the *separate* and *additional* contribution of HSE against a background of varying economic conditions and a continually evolving labour market. Analysis of establishment level data which considers the dynamics of workplace injury rates and takes into account the timing of regulatory interventions may be a powerful way of demonstrating whether the HSE can have a positive influence on bottom line measures of workplace safety rather than trying to unpick movements in aggregate rates of workplace injury.

We must finally note the most important caveat to the analyses that are contained in this report. That is, the analyses are conducted within the context of health and safety legislation that has evolved since the 19th Century. It is therefore very difficult to answer the counterfactual question, *what would rates of workplace injury be in the absence of the HSE?*

[27] See http://www2.warwick.ac.uk/fac/soc/ier/publications/software/cascot/

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ANNEX 1: MODELLING CHANGES TO REPORTING LEVELS WITHIN RIDDOR

The results below provide a technical annex which relate to the model of under-reporting of accident rates described in Chapter 3 of the report. The reporting rate is constructed based on the ratio of the number of accidents reported through RIDDOR, combining major and over-3-day injuries, compared to those reported in the LFS, which is taken as the benchmark for “full reporting”. Rates of reporting are calculated by sector and gender on an annual basis from 1993 to 2004, using the winter LFS which contains questions relating to accidents at work.

The aim of the modelling exercise was twofold. Firstly to smooth the reporting rate series, since at the disaggregated level of sector and gender actual rates of reporting were found to be very erratic over time. Secondly, in order to extrapolate rates of reporting by sector and by gender backwards to 1986 so that RIDDOR full time equivalent rates of injuries could be adjusted upwards to their full reporting rate.

The model uses an ordinary least squares regression analysis of reporting rate by sector and gender each year, taking into account systematic differences in reporting rates by gender and by sector and incorporating sector specific trends. The outcome of this exercise is to produce an under-reporting coefficient, by gender and by sector, for each year. These coefficients were then used to adjust the accident rate series to correct for under-reporting, i.e. re-flate the accident rates back to LFS reported levels. The design of the regression model imposes linear trends on reporting rates so that for the intervening period rates of reporting increase or decrease in a linear fashion (for each category). These coefficients capture the sector-specific trends in reporting rates of reporting. The results of the modelling exercise are shown in Table A1.1

Table A1.1 Rate of reporting of accidents by sector and gender

Variable	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
Male	(dropped)					
Female	-.0844796	.0169463	-4.99	0.000	-.1179001	-.0510591
Sector AB	(dropped)					
Sector CDE	23.87846	24.01144	0.99	0.321	-23.4755	71.23242
Sector F	14.58726	24.84804	0.59	0.558	-34.41658	63.5911
Sector GH	14.19158	24.01144	0.59	0.555	-33.16238	61.54554
Sector I	-5.879637	24.01144	-0.24	0.807	-53.23359	41.47432
Sector JK	-33.35746	24.01144	-1.39	0.166	-80.71142	13.99649
Sector L	3.669178	24.01144	0.15	0.879	-43.68478	51.02313
Sector M	45.65368	24.01144	1.90	0.059	-1.700274	93.00764
Sector N	-14.57433	24.01144	-0.61	0.545	-61.92829	32.77962
Sector OPQ	7.940917	24.01144	0.33	0.741	-39.41304	55.29487
Trend AB	.0120116	.0085905	1.40	0.164	-.0049301	.0289533
Trend CDE	.00009	.0084035	0.01	0.991	-.0164828	.0166629
Trend F	.0046725	.0089889	0.52	0.604	-.0130549	.0223999
Trend GH	.0048487	.0084035	0.58	0.565	-.0117242	.0214215
Trend I	.0149904	.0084035	1.78	0.076	-.0015825	.0315632
Trend JK	.0286196	.0084035	3.41	0.001	.0120468	.0451925
Trend L	.0102697	.0084035	1.22	0.223	-.0063031	.0268426
Trend M	-.0108537	.0084035	-1.29	0.198	-.0274265	.0057192
Trend N	.019287	.0084035	2.30	0.023	.0027141	.0358599
Trend OPQ	.0079592	.0084035	0.95	0.345	-.0086136	.0245321
Constant	-23.53199	17.16494	-1.37	0.172	-57.38367	10.31968
Sample Observations	217					
Adjusted R-squared	0.4716					
F Statistic	10.64					
Prob > F	0.0000					

ANNEX 2: UNDERSTANDING CHANGES IN WORKPLACE INJURY RATES: THREE APPROACHES TO THE ANALYSIS OF WORKPLACE INJURIES

Numerous empirical studies have attempted to identify the influence of a variety of factors upon the incidence of workplace injuries. For example, previous analyses have considered the effects on workplace injuries of unions and consultation committees (Beaumont and Harris, 1993, Reilly et al 1995), incentive systems (Nichols and Armstrong, 1973, Beaumont, 1980; Wrench and Lee, 1982; Dwyer and Rafferty, 1991 Hoffmann and Stetzer, 1996) and shift-working (Hood and Milazzo, 1984; Minors et al, 1986). While the emphasis of the empirical analyses varies between studies, most analyses rely upon the specification and estimation of a multivariate statistical model. Such models attempt to quantify the *separate* and *additional* effect of a variety of factors that may be expected to influence the incidence of industrial accidents in order to investigate the effect related to the main hypothesis of the study. For example, after controlling for other influences, does the recognition of trade unions contribute to safer working conditions? In order to control for these other influences, there is consequently a high degree of uniformity in the types of information used within empirical analyses of workplace injuries.

Where these studies differ is in the terms of the types of information used within these analyses. These analyses can be divided into three main areas according to the type of data used; time series analysis, pooled time series analysis and cross sectional analysis. Both time series analysis and pooled time series analysis are based upon the analysis of aggregated injury data in the form of injury rates. Cross sectional analysis focuses upon the analysis of micro-level data; i.e. observations relating to individuals or establishments. Each of these three approaches are utilised within this report.

TIME SERIES ANALYSES

A majority of empirical analyses utilise aggregate injury data, typically specified in terms of rates of workplace injury. A time series analysis of workplace injury rates generally involves the calibration of a statistical model that captures the movement of injury rates over time. These time series analyses are constrained by the availability of a sufficiently lengthy and consistent time series of workplace injury data. The presence of insurance based schemes for the compensation of injured workers in America, Canada and Australasia has contributed to the collection of administrative data relating to workplace accidents over a relatively long period of time. Hillage et al (1998) suggest that interest in the business cycle and occupational safety has been higher in the US due to this greater availability of aggregate time series data. Time-series analysis of annual injury data for US manufacturing industries have been conducted by Robinson (1988) for the period 1946 to 1985 and by Fairris (1998) for fatality data covering the period 1960 to 1985. Wooden (1989) considers annual injury data for South Australia for the period 1960 to 1980. Finally, Nichols (1990) conducts a multivariate analysis of fatalities within British manufacturing industries between 1960 and 1985.

In this report we present the results of a time series analysis of workplace injury rates derived from the aggregated injury data held by the HSE via reports made to enforcing authorities under the Reporting of Injuries, Diseases and Dangerous Occurrences (RIDDOR). HSE supplied individual accident records for the period covered by the RIDDOR 95 regulations; i.e. 1986/7 to 2003/4. Individual accident records could be recompiled into an aggregate quarterly series covering a period of 18 years. The construction of this series is discussed further within Chapter 3.

The time series analysis of workplace injury rates provides the opportunity to examine the movement of workplace injury rates within Great Britain over the longest possible time period. This is important in 2 key respects. Firstly, we are able to examine whether the business cycle (i.e. moving from recession to boom) can be identified to have an influence upon movements in workplace injury rates. This is achieved by demonstrating how rates of workplace injury varies according to whether the economy is experiencing periods of relatively high or low economic growth. Secondly, by observing injury rates over a period of 18 years it is possible to demonstrate the existence and scale of any long term trends in the rate of workplace injuries as reported under RIDDOR. Observing injury rates over a shorter time period would make it difficult to establish the nature of any trends as such movements could simply reflect the position of the economy within the business cycle.

The injury rate series are modelled as shown in the regression equation below. The variables used to model the accident rates are shown on the right hand side of the equation. These include terms to capture:

(1) *Quarterly* variation in the data (Q_1=January-March, Q_2=April-June, etc)

(2) The effect of redefining accidents within RIDDOR 95 after March 1996

(3) Time series effects. A linear time trend term is included.

(4) Business cycle effect based upon a GDP measure.

Regression Model:

$$VERSION\ :1$$
$$\log\left(A_{i,t}\right) = \alpha + \sum_{j=1}^{4} \beta_j Q_j + \mu t + \phi GDP_{i,t} + \delta RIDDOR$$

where:

t = time (quarterly index)

A = accident rate (i= 1,2, 3 representing series)

Q = quarter dummy

GDP = Gross Domestic Product based indicator

RIDDOR = RIDDOR step shift dummy.

The models are specified in logarithms so that coefficients represent relative changes in accident rates (these are converted to percentages where appropriate). Initial estimates using Ordinary Least Squares techniques suffered problems of autocorrelation in the residuals, rendering tests of statistical significance unreliable. To overcome these problems, the models of employee injury rates were run using the Newey-West procedure to correct standard errors for lagged dependencies in the accident rates over time. This procedure provides a statistical treatment of the problems of autocorrelation, enabling an evaluation of the statistical significance of the explanatory variables in the model to be made.

POOLED TIME SERIES ANALYSIS

In order to overcome the problems of data availability associated with longitudinal analyses, a number of studies have conducted multivariate analyses on pooled time series/cross sectional data. These studies still rely on the analysis of aggregated time series rates of workplace accidents or injuries. However, unlike the time series analyses which take a purely longitudinal perspective, the pooled time series analysis incorporates a cross sectional element. The cross sectional unit of analysis is typically defined by industrial sector. For example, Currington (1986) conducts a multivariate analysis of compensated claims for workplace injuries in New York State for the period 1964 to 1976. By aggregating injury records by 2 digit SIC codes, the number of injury rate observations for the 13 year period increases to 234. The pooled time series/cross sectional methodology is also employed by Viscusi (1986): 22 sectors over 10 years, Lanoie (1992): 28 sectors, 5 years, Wooden and Robertson (1997): 16 sectors, 3 years and Barooah et al (1997), 17 sectors, 11 years.

We take this same approach in Chapter 4 to investigate in more detail the nature of the causal mechanisms that contribute to pro-cyclical movements in workplace injury rates derived from RIDDOR. Movements in workplace injury rates over the course of the business cycle are hypothesised to be related to changes in the rate of new hires and variations in levels of work effort. Measures directly related to these causal mechanisms can be derived from the quarterly LFS from 1993 onwards. The benefit of this approach is that we are therefore able to demonstrate whether these mechanisms are actually correlated with movements in injury rates for the period 1993-2004. The cross sectional aspect of the data allows us to take into account different economic and labour market conditions faced by different sectors of the economy, resulting in different pressures on working arrangements. The definition of the industry sectors and the availability of data derived from the LFS is discussed in further detail within Chapter 4.

The object of the modelling exercise is therefore to relate accident rates in sector i at time t (where t is a quarterly index) to a set of explanatory factors, using the cross sectional time series regression model presented in below. The cross sectional aspect of the data allows us to take into account different economic and labour market conditions by sector in our time series model. This approach is appropriate since at any point in time different sectors of the economy may be experiencing different demand conditions, resulting in different pressures on working arrangements. The modelling exercise disentangles these effects and provides a time series model by sector whilst controlling for cross sectional differences in accident rates across sectors. Based upon the availability of 2 measures of worker effort, we estimate the following regression models:

Model 1

$$\log A(i,t) = \alpha(i) + \beta_1 \text{TENURE}(i,t) + \beta_2 \text{OT}(i,t) + \beta_3 \text{MAN}(i,t) + \beta_4 \text{SMALL}(t)$$
$$+ \beta_5 \text{RIDDOR}(t) + \beta_6 \text{QD2}(t) + \beta_7 \text{QD3}(t) + \beta_8 \text{QD4}(t) + e(i,t)$$

Model 2

$$\log A(i,t) = \alpha(i) + \beta_1 \text{TENURE}(i,t) + \beta_2 \text{WI}(i,t) + \beta_3 \text{MAN}(i,t) + \beta_4 \text{SMALL}(t)$$
$$+ \beta_5 \text{RIDDOR}(t) + \beta_6 \text{QD2}(t) + \beta_7 \text{QD3}(t) + \beta_8 \text{QD4}(t) + e(i,t)$$

where:

A (i, t)	=	Accident rates in sector i at time t
TENURE (i, t)	=	Percentage of employees with employment tenure of *less than* 3 months
OT (i, t)	=	Percentage of employees working overtime
WI (i, t)	=	Mean Actual divided by Mean Usual hours worked
MAN (i, t)	=	Percentage of employees in a manual occupation

SMALL (i, t)	=	Percentage of employees working in a firm with less than or equal to 25 employees
RIDDOR (t)	=	Dummy to control for change in definitions in 1996
QD2 (t) - QD4 (t)	=	Quarterly Dummies

The model utilises a **generalised least squares** regression. This specification of the model allows for autocorrelation within the time series data (allowed to vary by sector). This is appropriate when changes in accident rates tend to be persistent over time, so that the regression residual in a standard fixed effects set up will be correlated with the previous error term over time. In simple terms, the model runs a regression *within sector* for each of the sectors concurrently, constraining the parameters to the same value across sectors, whilst allowing for a fixed effect so that mean level accident rates is allowed to vary by sector, as well as incorporating the auto-correlated error structure.

CROSS SECTIONAL ANALYSIS

Cross sectional analysis is undertaken where information on workplace injuries is available for a cross section of agents at a given point in time. Examples from the US include Worral and Butler (1983), who consider individual data from the 1978 US Social Security Survey of Disability and Work which asked respondents about work status, health conditions caused by industrial accidents and various socio-economic characteristics. Reilly, Paci and Holl (1994) and Nichols, Dennis and Guy (1995) both utilise data from the 1990 British Workplace Industrial Relations Survey which provided information on industrial injuries at establishment level, enabling the exploration of relations between a number of establishment variables and injury rates. McKnight *et al* (2001) utilise individual level data from the UK Labour Force Survey which enquires whether or not a respondent has had any accident at work, or in the course of their work, in the preceding year which resulted in injury. This information enables an assessment of the extent to which various characteristics of individuals and their jobs contribute towards the relative risk of workplace injury.

The benefit of analyses based upon cross sectional data is that information relating directly to individuals or establishments are retained within the modelling exercise. Time series analysis or pooled time series analysis involves the aggregation of information about individuals to construct rates of workplace injury. As such, valuable information about individuals who contribute to these rates is lost. Whilst correlations can be established between movements in injury rates and other factors included within these models (e.g. injury rates may be shown to decline as the share of manual employees as a proportion of total employment declines), models based upon micro-level data are better placed to identify the exact nature of factors that contribute to an individuals risk of workplace injury.

The second advantage of analyses based upon micro-level data is that they are generally based upon a larger number of data points. To put this into context, our time analysis of RIDDOR data is based upon 76 quarterly injury rate observations for the period 1986 onwards. Our pooled time series analysis of RIDDOR data is based upon 43 quarterly injury rate observations observed for each of 10 sectors; 430 observations. In Chapter 5, we extend the analysis of McKnight *et al* (2001) to examine individual level data from the Labour Force Survey which tells us whether or not an individual has experienced a workplace injury in the preceding 12 months *and* contains details about the nature of each individual's job and relevant personal characteristics. By merging data from 12 winter quarters of the LFS, our analysis is based on the individual responses of approximately half a million individuals.

We utilise a multivariate statistical technique known as logistic regression to determine the separate ‘contribution’ that each piece of information about an individual’s job or their personal characteristics makes to the observed pattern of workplace injuries. Logistic regression is a statistical method designed to facilitate multivariate analysis of a binary[28] dependent variable, in this case corresponding to whether or not a survey respondent has had a workplace injury at work or during the course of their work during the preceding 12 months. The technique of logistic regression measures the separate contribution to the variation of this variable associated with measured workplace and personal characteristics.

The general specification of such a model has already been developed by McKnight *et al* (2001). By a process of selective modelling, the variables that have been found to be important in explaining the occurrence of workplace injuries have included age, gender, tenure, occupational categories, industry categories and workplace size. The general specification of the logistic regression is as follows:

$$Logit(P_i / 1 - P_i) = \sum_{i=1}^{k} \sum_{j=1}^{n} \beta_{ij} PERS_{ij} + \sum_{i=1}^{k} \sum_{j=1}^{n} \beta_{ij} JOB_{ij} + \sum_{i=1}^{k} \sum_{j=1}^{n} \beta_{ij} ESTAB_{ij} + \mu_i$$

where:

P_i = 0/1 according to whether individual i has had a workplace injury during the previous 12 months;

$PERS_{ij}$ = a range of n personal characteristics relating to individual i;

JOB_{ij} = a range of n job characteristics relating to individual i;

$PERS_{ij}$ = a range of n establishment characteristics relating to individual i.

The results from this analysis are expressed in terms of the impact of a variable on the relative odds of reporting having had a workplace injury, enabling us to consider how personal, job and workplace characteristics contribute to the risk of a workplace injury.

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28 *A variable which takes one of two values, 1 or 0.*

ANNEX 3: DERIVING A CONSISTENT CLASSIFICATION OF OCCUPATIONS

The Standard Occupational Classification (SOC) provides a national standard for categorising occupational information. SOC forms the basis of occupational classification in a variety of national surveys that collect statistical information, including the LFS. Occupation is most often determined by reference to a person's main job at a reference time. Defined as a set of tasks to be carried out by one person, jobs are primarily recognised by their associated job titles. Within SOC, jobs are classified into groups according to their skill level and skill content. The concept of 'skill' is operationalised in terms of the nature and duration of the qualifications, training and work experience required to become competent to perform the associated tasks in a particular job. The occupational groups embodied within SOC are designed to be useful in bringing together occupations that are similar in terms of qualifications, training, skills and experience commonly associated with the competent performance of work tasks.

At the time of writing, workplace injury data is available for twelve quarters of the LFS for the period 1993 to 2003. The ability to merge data across successive quarters of the LFS requires occupational information to be recorded on a consistent basis. However, from the spring quarter (March-May) of 2001, the classification of occupational information contained within the LFS moved from 1990 Standard Occupational Classification (OPCS, 1990) to the 2000 Standard Occupational Classification (ONS, 2000). The last four quarters of LFS data are therefore coded to a different occupational classification compared to the first eight. Though the new classification still has nine major groups at the broadest level of the hierarchical structure, there have been considerable changes in the structure and composition of the classification. There is no direct one-to-one mapping between the constituent occupational groups of SOC90 and SOC2000 in all areas of the classification.

To overcome this problem, we utilized was a special file prepared by the Office for National Statistics from the Winter 1996/7 quarter of the Labour Force Survey which contained dual coded occupational information (SOC2000 and SOC90). This dual coded data set was used to estimate the level of correspondence between the 2 classifications and to derive a 'composite' classification of occupations. Members of the research team were also involved in the development of the 2000 Standard Occupational Classification (see Elias *et al*, 2001) and therefore had access to material that documented the changes that occurred between SOC90 and SOC2000.

The results of the mapping exercise are shown in Table A3.1. The cross classification exercise lead to the construction of 49 composite occupational groups derived from the 77 Minor Groups of SOC90 (2 digit level) and the 81 Minor Groups of SOC2000 (3 digit level). For many Minor Groups, the map between SOC90 and SOC2000 was unambiguous and a straightforward one to one 'best fit' map could be identified. Such a 'best fit' map was identified as occurring when the most populated SOC2000 Minor Group relating to a particular SOC90 Minor Group provided the same map as the most populated SOC90 Minor Group relating to a particular SOC2000 Minor Group. In other occupational areas, changes made between SOC90 and SOC2000 resulted in more complex mappings, with multiple SOC90 and SOC2000 groups being mapped to each other to form a 'composite' occupational group. In each case the occupational group is ascribed as being manual or non-manual, as prescribed by the LFS indicator SOCMANM available on all LFS datasets relating to SOC90 occupational codes.

CAVEATS

There are a number of caveats to the approach taken. Firstly, the LFS is a sample survey so our measures of 'best fit' may themselves be subject to sampling error. Secondly, while the original SOC90 code would have been allocated by the LFS interviewer at the time of the survey, the recoding exercise would have been undertaken by staff at ONS. These different methods of coding could potentially lead to some variation regarding how codes may have been assigned to particular job titles. Thirdly, as the dual coding exercise is based on a single quarter of the LFS, seasonality in occupational composition could have lead to a slightly different set of composite occupational categories if the analysis was conducted on data from a different quarter. Given that information on workplace injuries is also collected within the winter quarters of the LFS, seasonality should not be a problem in the context of the present analysis. Finally, changing occupational structure over time could result in the derivation of a different set of composite occupational groups more recent dual coded LFS data sets (e.g. winter 2001) had been used. The 1996/7 winter quarter was chosen due to its relatively central location in the time period covered by the analysis.

MAPPING TO THE KOS CLASSIFICATION OF OCCUPATIONS

In addition, within Chapter 6 of the report we analyse changes in occupational structure going back to 1986 we undertook a separate exercise to map occupations before 1991 into the SOC structure. The coding of occupations before 1991 is based on the Key Occupations for Statistical Purposes (KOS) coding structure developed during the 1970s. An exercise was therefore undertaken to map KOS codes into the 1990 SOC structure, which were then in turn mapped into the composite structure of 49 occupations. The 1991 annual LFS has details of occupations at an individual level using both KOS and SOC90 coding. Utilising this dataset we performed a similar exercise to the one described above to derive a 'best fit' map of KOS into SOC90 on a category by category basis. We are therefore able to analyse the occupational composition of employment on a consistent basis for the full period covered by the RIDDOR data. Details of the mapping can be found in Table A3.2.

Table A3.1 Derivation of composite categories

Composite Category (M = Manual Occupation)	***SOC90 Minor Groups***					***SOC2000 Minor Groups***			
1: Corporate and Public Service Managers	10	12	13			111	113	115	118
2: Production and Quality Managers	11					112	114		
3: Retail, Distribution and Service Managers	14	17	19			116	122	123	
4: Senior Protective Service Officers	15					117			
5: Farmers and Farm Managers	16	59				121	511	549	
6: Natural Scientists	20					211	232		
7: Engineers	21					212			
8: Health Professionals	22					221			
9: Teaching Professionals	23					231			
10: Legal Professionals	24					241			
11: Business and Financial Professionals	25					242			
12: Architects, Draughtsmen and Surveyors	26	31				243	312		
13: Librarians	27					245			
14: Public Service Professionals	29					244			
15: Scientific Technicians	30					311			
16: ICT Professionals	32					213	313		
17: Ship, Aircraft Officers and Controllers	33					351			
18: Health Associate Professionals	34					321	322		
19: Legal Associate Professionals	35					352			
20: Business, Finance and Public Service Associate Professionals	36	39				353	356		
21: Welfare and Social Care Occupations	37	64				323	611		
22: Artistic and Sports Professionals	38					341	342	343	344
23: Public Service Administrative	40					411			
24: Clerks, Cashiers	41					412			
25: General Administrative Occupations	42	43	49			413	415	721	
26: Stores/Warehouse Keepers *(M)*	44	93				914			
27: Secretaries & Receptionists	45	46				414	421		
28: Metal, Wood and Construction Trades *(M)*	50	53	57			521	531	532	
29: Metal Machining Trades *(M)*	51					522			
30: Electrical Trades *(M)*	52					524			
31: Vehicle Trades *(M)*	54					523			
32: Routine Operatives *(M)*	55	85	86	91	99	541	813	913	
33: Printing Trades *(M)*	56					542			
34: Food Preparation and Service *(M)*	58	62				543	922		
35: Armed Forces and Security Occupations	60	61				331	355	924	
36: Travel Assistants and Personal Services *(M)*	63	69				621	629		
37: Child carers *(M)*	65					612			
38: Hairdressers, Beauticians *(M)*	66					622			
39: Domestic Staff *(M)*	67					623			
40: Sales Agents	70	71	73			354	712		
41: Sales Assistants	72	79				711			
42: Process and Plant Operatives *(M)*	80	81	82	83		811			
43: Construction and Plant Operatives *(M)*	84	89				812	814		
44: Road Transport Operatives *(M)*	87					821			
45: Mobile Machine Drivers *(M)*	88					822			
46: Agriculture and Animal Care Occupations *(M)*	90					613	911		
47: Construction Labourers *(M)*	92					912			
48: Elementary Administration Occupations *(M)*	94					921			
49: Cleaning, Elementary Sales Occupations	95					923	925		

Table A3.2 Mapping of KOS and SOC codes

SOC 1990 minor group	1980 KOS Occupation group
10	7.1-7.2, 8
11	28.6, 34, 35.1-35.2, 36.1
12	2.5, 5.1-5.2, 9.1
13	37.1-37.2, 45.1
14	36.2-36.4
15	41-42, 43.1-43.3
17	9.3, 38.1-38.4, 39.1-39.5, 44.1-44.3
19	9.2, 44.4
20	24.1-24.3
21	25, 26.1-26.2, 27.1-27.2, 28.1-28.5
22	15.1-15.2, 17.1, 18.2
23	10.1-10.2, 11, 12.2, 18.4
24	1
25	2.1-2.2, 4.1, 9.6
26	31.1, 31.3
29	12.3, 13.3, 14
30	30.1-30.2, 33.1-33.3
31	6.2, 29, 31.2
32	4.2
33	32.1-32.3
34	6.1, 16, 17.2-17.6, 18.1
35	9.5
36	2.3-2.7, 3.1-3.2
37	13.1
38	19, 20.1-20.3, 21.1-21.2, 22.1-2.2, 23.1
39	9.4, 9.8, 12.1, 18.3
41	45.4, 46.3
44	45.2, 46.1, 156.1, 157.1
45	9.7, 48.1, 49.2
46	48.3-48.4, 49.1, 51.1-51.3
49	46.2, 48.2, 50
50	101.5, 107.3, 124.5, 124.7, 127.2, 131.5, 132.4, 133.4, 139.2-139.5, 140.1-140.6
51	111.1-111.3, 112.1-112.3, 114.1-114.6, 115, 116.1-116.2, 117, 118.2, 129.1, 130.1
52	120.1-120.7, 121.1-121.3, 122.1-122.2, 123.1-123.2
53	108.3, 108.5, 109.3, 110.2, 124.1-124.6, 125, 126.1-126.2, 127.1, 128
54	114.5, 118.1, 129.3, 131.1
55	84.2-84.4, 85.2-85.3, 86.4-86.8, 87.4-87.8, 101.1-106.1, 102.1-102.3, 103, 107.7-107.8
56	93.2, 93.5, 94.2, 99.1-99.5, 100.1-100.5, 107.9, 129.2, 130.2
57	104.1, 104.2, 104.6, 105.1-105.4, 107.6
58	90.1-90.3, 91, 92.1-92.2
59	76.2-76.3, 78.1-78.2, 95.2-95.3, 95.8, 96.2-96.3, 107.2-107.5, 114.7, 119, 132.1, 132.2-132.3, 133.1-133.3, 144, 145
60	58, 59

Table A3.2 (cont) Mapping of KOS and SOC codes

SOC 1990 minor group	**1980 KOS Occupation group**
61	6.3, 60.1-60.6, 61.1-61.3, 62.1-62.3
62	63.1-63.3, 64, 65.1-65.2
63	67.3, 69.1, 71.3, 75.1
64	67.6-67.7, 70.1-70.2
65	13.2, 67.2, 68.2
66	73, 74
67	67.1, 68.1, 71.1, 72.1, 75.3
69	75.4-75.6
70	5.3-5.4, 57.1
71	57.5-57.6
72	45.5, 47, 54.1-54.2, 55.1, 55.3
73	54.3, 56, 57.2-57.4
79	20.4, 23.2
80	90.4-90.6, 98.2, 98.5-98.7
81	84.1, 85.1, 86.1-86.2, 86.9, 87.1-87.3, 98.4
82	88, 89, 93.1-93.4, 94.1, 94.3, 95.1, 95.4-95.6, 95.9, 96.1, 97.1-97.2, 98.1, 98.8-98.9, 107.1
83	108.1-108.9, 109.1-109.2, 110.1-110.4, 131.2-131.3
84	111.4-111.8, 112.4, 113.1-113.3, 131.8
85	131.6-131.7, 134.1-134.5, 135.1-135.3, 138.1, 138.8-138.9
86	136.1-137.2, 138.2-138.7
87	151.1-151.3, 152.1-152.3, 153.1
88	147, 148, 149.2-149.4, 150.1-150.4, 154.1-154.3, 155.1-155.3, 158.2
89	95.7, 98.3, 99.3, 100.3, 104.5, 106, 120.3, 121.4, 129.4, 131.4, 131.9, 139.1, 142.1-142.2
90	76.1, 76.4-76.6, 77, 79, 80-83
91	159.6-159.7, 160.1-160.7
92	139.6-141.4, 143.1-143.2
93	153.2, 156.2, 156.3, 156.4, 157.2, 157.3, 157.4, 158.1
94	52.1-52.2, 53.1-53.2
95	55.2, 63.4, 66.1-66.2, 67.4-67.5, 68.3, 69.2-69.3, 71.2, 71.4, 72.2, 75.2
99	159.8, 160.8, 161.2

PERFORMANCE OF DERIVED OCCUPATIONAL CLASSIFICATION

Table A3.1 shows how the Minor Groups of SOC90 and SOC2000 map into each of the derived 'composite' occupational categories. An individual can therefore be allocated to the derived classification on the basis of either SOC90 or SOC2000 occupational coding. Therefore, we are able to classify the occupations of individuals from 12 winter quarters of the LFS covering the period 1993 to 2003 on a consistent basis. However, it remains the case that there is no direct map between SOC90 and SOC2000 classifications. Therefore, while the derived classification attempts to provide a 'best fit' between the 2 classifications, inconsistencies in the allocation of individuals to composite categories will still emerge depending upon whether the allocation is made on the basis of SOC90 or SOC2000 Minor Groups.

To investigate the accuracy of this mapping exercise, we utilize the dual coded data from the Winter 96/7 LFS. Within this file, we allocate individuals to the derived composite classification on the basis of both their SOC90 and SOC2000 codes. By cross tabulating these two derivations of the 'composite' categories, we are able to determine the percentage of individuals who are allocated to the same category on the basis of each derivation. The results of this exercise are presented in Table A3.3. Overall, it is estimated that approximately 76% of individuals are allocated on a consistent basis.

Table A3.3 Performance of composite categories

Composite Category	*SOC90*	*SOC2000*	*Rate*
1: Corporate and Public Service Managers	53	68	1.2
2: Production and Quality Managers	70	52	2.6
3: Retail, Distribution and Service Managers	69	76	2.7
4: Senior Protective Service Officers	83	69	4.7
5: Farmers and Farm Managers	72	76	6.1
6: Natural Scientists	74	59	1.7
7: Professional Engineers	55	74	2.2
8: Health Professionals	90	93	2.0
9: Teaching Professionals	95	96	2.4
10: Legal Professionals	95	96	0.8
11: Business and Financial Professionals	68	69	0.7
12: Architects, Draughtsmen and Surveyors	85	80	1.5
13: Librarians	87	59	2.2
14: Public Service Professionals	64	81	3.8
15: Scientific Technicians	61	65	3.8
16: ICT Professionals	88	52	1.0
17: Ship, Aircraft Officers and Controllers	88	66	3.5
18: Health Associate Professionals	90	92	4.1
19: Legal Associate Professionals	76	76	0.6
20: Business and Public Service Associate Professionals	58	53	1.8
21: Welfare and Social Care Occupations	91	87	5.3
22: Artistic and Sports Professionals	89	80	3.0
23: Public Service Administrative	78	55	1.4
24: Clerks, Cashiers	64	81	1.3
25: General Administrative Occupations	64	56	1.4
26: Stores/Warehouse Keepers	69	91	7.0
27: Secretaries & Receptionists	93	84	1.0
28: Metal, Wood and Construction Trades	83	93	7.6
29: Metal Machining Trades	68	77	7.7
30: Electrical Trades	73	80	6.1
31: Vehicle Trades	83	80	8.4
32: Routine Process Occupations	83	80	4.7
33: Printing Trades	65	78	4.6
34: Food Preparation and Service	96	60	4.5
35: Armed Forces and Security Occupations	92	76	8.9
36: Travel Assistants and Personal Services	59	51	3.4
37: Child carers	76	95	2.4
38: Hairdressers, Beauticians	93	70	1.6
39: Domestic Staff	66	83	5.0
40: Sales Agents	70	57	2.4
41: Sales Assistants	87	93	2.5
42: Process and Plant Operatives	80	75	7.3
43: Construction and Plant Operatives	57	48	7.3
44: Road Transport Operatives	95	87	7.4
45: Mobile Machine Drivers	65	84	7.3
46: Agriculture and Animal Care Occupations	75	77	6.6
47: Construction Labourers	71	60	7.8
48: Elementary Administration Occupations	93	70	7.5
49: Cleaning Occupations	63	83	3.8
Overall		**75.8**	

The accuracy of the mapping exercise varies across different areas of the classification depending upon the level of continuity between SOC90 and SOC2000. Two measures of performance are available on an occupational basis. Assuming that SOC90 provides the ‘correct’ derivation, what proportion of individuals would be allocated to the same composite category on the basis of their SOC2000 occupational code. Alternatively, assuming that SOC2000 provides the ‘correct’ derivation, what proportion of individuals would be allocated to the same composite category on the basis of their SOC90 occupational code. Considering the first of these measures, areas of poor performance include 1: Corporate and Public Service Managers, 7: Professional Engineers, 20: Business and Public Service Associate Professionals, 36: Travel Assistants and Personal Services and 43: Construction and Plant Operatives. Within these areas, inconsistently coded individuals are evenly dispersed across a number of composite categories. As such, no obvious candidates for merging groups to improve within group accuracy emerge.

ANNEX 4: REGRESSION RESULTS OF TIME SERIES ANALYSIS

The results below provide a technical annex which relate to findings of the time series analysis reported in section 4.2. The regression model is based on the dependent variable of injury rates based on RIDDOR data, taken as a logarithm per 100,000 employees per quarter. Injury rates relate to over-3-day and major rates of injuries, for both unadjusted and adjusted rates of injuries. Unadjusted rates are based on a denominator of number of employees. Adjusted rates take into account both an adjustment for full time equivalent employment based on a 40 hour week and a rescaling for the estimated effect of under-reporting. Injury rates are treated separately by gender.

The modelling procedure corrects standard errors for the presence of autocorrelation in regression residuals using a Newey-West procedure with a dependent lag structure on model residuals. In the presence of autocorrelation the regression coefficients will be otherwise unbiased, but standard error terms will be biased rendering interval hypothesis testing invalid. The time series sample period is quarterly from 1987q2 – 2004q1 (68 quarters). Note that observations relating to the reporting period 1986q2 – 1987q1 are dropped as the number of reported accidents in the RIDDOR dataset is felt to be unrealistically low compared to subsequent years. In particular there is evidence of very low number of accidents in with some specific industrial sectors, notably GH, JK and OPQ.

The regression model analyses logarithm of accident rate. The model includes a linear time trend indexed by quarter (1987q1 = 1, 1987q2 = 2, etc) and a series of quarterly dummies to capture the seasonal variation around the trend. Note that the observation for quarter 1 is dropped to avoid multicolinearity. The model includes a “RIDDOR 1996” dummy variable which captures the effect of the change of definitions on major and over-3-day reportable accidents. The GDP value refers to the residual percentage above or below long term trend. The model also includes the employment structure by 10 broad industrial sectors. The percentage employment in each sector at each point in time is included. Note that the observation for sector CDE, the largest sector in terms of employment, is dropped to avoid multicolinearity. The results of the analysis are presented in Tables A4.1 to A4.8.

Table A4.1 Male unadjusted over-3-day injury per 100,000 employees

Explanatory Variables	Coef.	Newey-West Std. Err.	t	P>|t|	[95% Conf.	Interval]
Quarter 1	(dropped)					
Quarter 2	-.051971	.0121531	-4.28	0.000	-.076358	-.0275841
Quarter 3	-.0098765	.0132405	-0.75	0.459	-.0364455	.0166925
Quarter 4	-.0732129	.009197	-7.96	0.000	-.0916681	-.0547577
RIDDOR 1996 Effect	-.0355431	.0242563	-1.47	0.149	-.084217	.0131308
Time Trend	-.0105835	.0039027	-2.71	0.009	-.0184149	-.002752
GDP	.0029245	.0053873	0.54	0.590	-.0078858	.0137349
% Empl. Sector AB	-.1275985	.0868997	-1.47	0.148	-.3019755	.0467786
% Empl. Sector CDE	(dropped)					
% Empl. Sector F	.0397691	.0223783	1.78	0.081	-.0051362	.0846744
% Empl. Sector GH	.0342946	.0220808	1.55	0.126	-.0100137	.0786029
% Empl. Sector I	-.0315567	.0381981	-0.83	0.413	-.1082068	.0450934
% Empl. Sector JK	.0664342	.0195766	3.39	0.001	.0271509	.1057175
% Empl. Sector L	.028524	.0203357	1.40	0.167	-.0122826	.0693306
% Empl. Sector M	-.0383796	.0233722	-1.64	0.107	-.0852793	.00852
% Empl. Sector N	.0244195	.029137	0.84	0.406	-.0340483	.0828872
% Empl. Sector OPQ	-.0201155	.0468642	-0.43	0.670	-.1141554	.0739243
Constant	4.376932	.8826849	4.96	0.000	2.605696	6.148169
Sample Observations	68					
Lag Structure	4 quarters					
F Statistic	259.73					
Prob > F	0.0000					

Table A4.2 Male adjusted over-3-day injury per 100,000 employees

Explanatory Variables	Coef.	Newey-West Std. Err.	t	P>|t|	[95% Conf.	Interval]
Quarter 1	(dropped)					
Quarter 2	-.0542968	.0124783	-4.35	0.000	-.0793362	-.0292573
Quarter 3	-.0088195	.0133754	-0.66	0.513	-.0356592	.0180201
Quarter 4	-.0705262	.0092034	-7.66	0.000	-.0889941	-.0520583
RIDDOR 1996 Effect	-.028356	.0213569	-1.33	0.190	-.0712117	.0144997
Time Trend	-.0143896	.0039067	-3.68	0.001	-.0222291	-.0065502
GDP	.0027558	.0049648	0.56	0.581	-.0072067	.0127183
% Empl. Sector AB	-.0613881	.098653	-0.62	0.536	-.2593499	.1365736
% Empl. Sector CDE	(dropped)					
% Empl. Sector F	.0549473	.0206388	2.66	0.010	.0135325	.096362
% Empl. Sector GH	.0318715	.0230375	1.38	0.172	-.0143566	.0780996
% Empl. Sector I	-.0307619	.0362491	-0.85	0.400	-.1035011	.0419774
% Empl. Sector JK	.0574823	.0202398	2.84	0.006	.0168682	.0980965
% Empl. Sector L	.029813	.019181	1.55	0.126	-.0086764	.0683025
% Empl. Sector M	-.0158012	.0213823	-0.74	0.463	-.058708	.0271056
% Empl. Sector N	.0326163	.0262848	1.24	0.220	-.020128	.0853607
% Empl. Sector OPQ	-.0299063	.0470066	-0.64	0.527	-.1242318	.0644193
Constant	5.030942	.887823	5.67	0.000	3.249394	6.812489
Sample Observations	68					
Lag Structure	4 quarters					
F Statistic	694.13					
Prob > F	0.0000					

Table A4.3 Female unadjusted over-3-day injury per 100,000 employees

Explanatory Variables	Coef.	Newey-West Std. Err.	t	P>|t|	[95% Conf.	Interval]
Quarter 1	(dropped)					
Quarter 2	-.0144061	.0130749	-1.10	0.276	-.0406429	.0118306
Quarter 3	-.0036608	.0159976	-0.23	0.820	-.0357624	.0284408
Quarter 4	-.0132639	.0123923	-1.07	0.289	-.0381309	.011603
RIDDOR 1996 Effect	-.0323037	.0452501	-0.71	0.478	-.1231047	.0584974
Time Trend	-.0083137	.0054773	-1.52	0.135	-.0193047	.0026773
GDP	-.0014542	.0082805	-0.18	0.861	-.0180702	.0151619
% Empl. Sector AB	-.2025818	.1031181	-1.96	0.055	-.4095033	.0043397
% Empl. Sector CDE	(dropped)					
% Empl. Sector F	.0140542	.0366259	0.38	0.703	-.059441	.0875495
% Empl. Sector GH	.048949	.0308922	1.58	0.119	-.0130407	.1109388
% Empl. Sector I	-.1323056	.0617199	-2.14	0.037	-.2561556	-.0084555
% Empl. Sector JK	.0891545	.0221677	4.02	0.000	.0446719	.1336372
% Empl. Sector L	.0254222	.0279188	0.91	0.367	-.030601	.0814454
% Empl. Sector M	-.1081621	.0392785	-2.75	0.008	-.1869802	-.029344
% Empl. Sector N	.0675163	.0440066	1.53	0.131	-.0207894	.155822
% Empl. Sector OPQ	.0080375	.0664336	0.12	0.904	-.1252713	.1413463
Constant	3.636332	1.182104	3.08	0.003	1.264266	6.008398
Sample Observations	68					
Lag Structure	4 quarters					
F Statistic	25.93					
Prob > F	0.0000					

Table A4.4 Female adjusted over-3-day injury per 100,000 employees

Explanatory Variables	Coef.	Newey-West Std. Err.	t	P>|t|	[95% Conf.	Interval]
Quarter 1	(dropped)					
Quarter 2	-.0229283	.0133463	-1.72	0.092	-.0497095	.0038529
Quarter 3	-.011912	.0152384	-0.78	0.438	-.0424901	.0186662
Quarter 4	-.0168178	.0123803	-1.36	0.180	-.0416607	.008025
RIDDOR 1996 Effect	-.0054813	.0343943	-0.16	0.874	-.0744985	.0635359
Time Trend	-.0148191	.0053726	-2.76	0.008	-.0256	-.0040383
GDP	-.0039172	.0069747	-0.56	0.577	-.017913	.0100786
% Empl. Sector AB	-.0065854	.1182591	-0.06	0.956	-.2438897	.2307188
% Empl. Sector CDE	(dropped)					
% Empl. Sector F	.0542811	.0311163	1.74	0.087	-.0081583	.1167206
% Empl. Sector GH	.0379137	.0311464	1.22	0.229	-.0245861	.1004135
% Empl. Sector I	-.097149	.055673	-1.74	0.087	-.208865	.014567
% Empl. Sector JK	.0603182	.0215036	2.81	0.007	.0171681	.1034684
% Empl. Sector L	.0164542	.0204949	0.80	0.426	-.0246718	.0575803
% Empl. Sector M	-.0470283	.0327181	-1.44	0.157	-.112682	.0186254
% Empl. Sector N	.0880934	.033612	2.62	0.011	.020646	.1555408
% Empl. Sector OPQ	.0098287	.053812	0.18	0.856	-.0981529	.1178104
Constant	4.412788	1.18433	3.73	0.000	2.036255	6.789321
Sample Observations	68					
Lag Structure	4 quarters					
F Statistic	130.99					
Prob > F	0.0000					

Table A4.5 Male unadjusted major injury per 100,000 employees

Explanatory Variables	Coef.	Newey-West Std. Err.	t	P>|t|	[95% Conf.	Interval]
Quarter 1	(dropped)					
Quarter 2	-.0678197	.0114014	-5.95	0.000	-.0906983	-.0449411
Quarter 3	-.040908	.010291	-3.98	0.000	-.0615583	-.0202576
Quarter 4	-.0451365	.0095478	-4.73	0.000	-.0642955	-.0259775
RIDDOR 1996 Effect	.5666024	.0162709	34.82	0.000	.5339524	.5992524
Time Trend	-.0126017	.0021892	-5.76	0.000	-.0169946	-.0082087
GDP	.0139935	.0042612	3.28	0.002	.0054429	.0225442
% Empl. Sector AB	-.0105337	.0660249	-0.16	0.874	-.1430223	.1219549
% Empl. Sector CDE	(dropped)					
% Empl. Sector F	.075805	.0135717	5.59	0.000	.0485715	.1030386
% Empl. Sector GH	.0346044	.0194433	1.78	0.081	-.0044114	.0736203
% Empl. Sector I	-.0558576	.0398479	-1.40	0.167	-.1358182	.0241031
% Empl. Sector JK	.0315364	.0122918	2.57	0.013	.0068711	.0562016
% Empl. Sector L	.0343197	.0180032	1.91	0.062	-.0018063	.0704457
% Empl. Sector M	.0147835	.016365	0.90	0.370	-.0180552	.0476222
% Empl. Sector N	.1062436	.0232182	4.58	0.000	.0596529	.1528343
% Empl. Sector OPQ	-.0079614	.0289035	-0.28	0.784	-.0659605	.0500377
Constant	1.367945	.6646508	2.06	0.045	.0342254	2.701664
Sample Observations	68					
Lag Structure	4 quarters					
F Statistic	1823.97					
Prob > F	0.0000					

Table A4.6 Male adjusted major injury per 100,000 employees

Explanatory Variables	Coef.	Newey-West Std. Err.	t	P>|t|	[95% Conf.	Interval]
Quarter 1	(dropped)					
Quarter 2	-.070145	.0120293	-5.83	0.000	-.0942835	-.0460065
Quarter 3	-.0398524	.0108749	-3.66	0.001	-.0616745	-.0180302
Quarter 4	-.0424517	.0097567	-4.35	0.000	-.0620299	-.0228735
RIDDOR 1996 Effect	.5737897	.0173015	33.16	0.000	.5390716	.6085077
Time Trend	-.0164081	.0023431	-7.00	0.000	-.0211098	-.0117064
GDP	.0138245	.0043716	3.16	0.003	.0050523	.0225968
% Empl. Sector AB	.0556985	.0765805	0.73	0.470	-.0979716	.2093686
% Empl. Sector CDE	(dropped)					
% Empl. Sector F	.090983	.0127827	7.12	0.000	.0653326	.1166333
% Empl. Sector GH	.0321823	.0198308	1.62	0.111	-.007611	.0719757
% Empl. Sector I	-.0550649	.0388313	-1.42	0.162	-.1329855	.0228557
% Empl. Sector JK	.0225903	.0140656	1.61	0.114	-.0056344	.050815
% Empl. Sector L	.0356116	.0197923	1.80	0.078	-.0041046	.0753279
% Empl. Sector M	.0373676	.017392	2.15	0.036	.0024681	.0722672
% Empl. Sector N	.1144383	.0230779	4.96	0.000	.0681291	.1607475
% Empl. Sector OPQ	-.0177696	.0323431	-0.55	0.585	-.0826707	.0471315
Constant	2.021897	.6218329	3.25	0.002	.774098	3.269696
Sample Observations	68					
Lag Structure	4 quarters					
F Statistic	1208.24					
Prob > F	0.0000					

Table A4.7 Female unadjusted major injury per 100,000 employees

Explanatory Variables	Coef.	Newey-West Std. Err.	t	P>|t|	[95% Conf.	Interval]
Quarter 1	(dropped)					
Quarter 2	-.0967614	.0244223	-3.96	0.000	-.1457683	-.0477545
Quarter 3	-.1182914	.0335688	-3.52	0.001	-.1856521	-.0509307
Quarter 4	.015882	.0267769	0.59	0.556	-.0378497	.0696138
RIDDOR 1996 Effect	.4562808	.0391463	11.66	0.000	.377728	.5348336
Time Trend	-.0189852	.0070775	-2.68	0.010	-.0331874	-.0047831
GDP	.0135315	.007496	1.81	0.077	-.0015104	.0285734
% Empl. Sector AB	.0623709	.2317605	0.27	0.789	-.4026907	.5274324
% Empl. Sector CDE	(dropped)					
% Empl. Sector GH	.0680041	.0315901	2.15	0.036	.004614	.1313942
% Empl. Sector I	.1030704	.0319645	3.22	0.002	.0389289	.1672119
% Empl. Sector JK	-.0436132	.0807888	-0.54	0.592	-.2057278	.1185013
% Empl. Sector L	.0924501	.029399	3.14	0.003	.0334567	.1514435
% Empl. Sector M	.0947785	.0370696	2.56	0.014	.0203928	.1691642
% Empl. Sector N	.0185781	.0490058	0.38	0.706	-.0797593	.1169154
% Empl. Sector OPQ	.18075	.0573642	3.15	0.003	.0656403	.2958598
Constant	-2.54433	1.299193	-1.96	0.056	-5.151351	.0626905
Sample Observations	68					
Lag Structure	4 quarters					
F Statistic	262.21					
Prob > F	0.0000					

Table A4.8 Female adjusted major injury per 100,000 employees

Explanatory Variables	Coef.	Newey-West Std. Err.	t	P>|t|	[95% Conf.	Interval]
Quarter 1	(dropped)					
Quarter 2	-.1052859	.0244999	-4.30	0.000	-.1544485	-.0561233
Quarter 3	-.1265408	.033562	-3.77	0.000	-.1938879	-.0591937
Quarter 4	.0123283	.0256619	0.48	0.633	-.0391661	.0638227
RIDDOR 1996 Effect	.4831057	.0389708	12.40	0.000	.4049052	.5613063
Time Trend	-.0254912	.007404	-3.44	0.001	-.0403485	-.010634
GDP	.0110669	.0084328	1.31	0.195	-.0058547	.0279885
% Empl. Sector AB	.2583677	.2491128	1.04	0.304	-.2415137	.7582491
% Empl. Sector CDE	(dropped)					
% Empl. Sector F	.1082342	.0323992	3.34	0.002	.0432203	.173248
% Empl. Sector GH	.0920341	.0371689	2.48	0.017	.0174492	.1666189
% Empl. Sector I	-.0084541	.082573	-0.10	0.919	-.1741489	.1572408
% Empl. Sector JK	.0636212	.0346032	1.84	0.072	-.0058151	.1330575
% Empl. Sector L	.0858128	.0432784	1.98	0.053	-.0010317	.1726574
% Empl. Sector M	.0797146	.0518471	1.54	0.130	-.0243242	.1837534
% Empl. Sector N	.2013227	.0609129	3.31	0.002	.079092	.3235533
% Empl. Sector OPQ	-.0375666	.1147921	-0.33	0.745	-.2679138	.1927806
Constant	-1.768011	1.415889	-1.25	0.217	-4.6092	1.073178
Sample Observations	68					
Lag Structure	4 quarters					
F Statistic	116.47					
Prob > F	0.0000					

ANNEX 5: REGRESSION RESULTS OF CROSS SECTIONAL TIME SERIES ANALYSIS

The results below provide a technical annex which relates to the cross sectional time series model of RIDDOR major and over-3-day reported accident rates described in section 4 of the report. The object of the modelling exercise is to explain injury rates in sector i at time t against a set of industry and time specific variables. The model is based on 10 sectors and 43 quarters from 1993q3 to 2004q1. The cross sectional aspect of the data, modelled on industrial sector, allows us to take into account different levels of injury rates and differing employment conditions by sector.

The model explains variation in rates of injuries over time within sector. In order to do this the model uses a Feasible Generalized Least Squares (FGLS) procedure which allows for first order autocorrelation of injury rates over time within sectors. This is appropriate when changes in accident rates tend to be persistent over time, so that the regression residual in a standard fixed effects set up will be correlated with the previous error term over time. In simple terms, the model runs a regression within sector for each of the sectors concurrently, constraining the parameters to the same value across sectors, whilst allowing for a fixed effect so that mean level accident rates is allowed to vary by sector, as well as incorporating the auto-correlated error structure.

Based upon the availability of two measures of worker effort, we estimate two types of regression models: first of all on over-time working and secondly on work intensity. The RIDDOR injury data are modelled based on both unadjusted and adjusted rates per 100,000 employees. Results are shown in Table A5.1 – A5.8.

Table A5.1 Overtime cross-sectional time-series model (unadjusted major)

Variable	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Tenure < 3	0.025542	.0048590	5.26	0.000	1.601858	3.506571
Manual	0.027376	.0022689	12.07	0.000	2.29292	3.182313
Overtime	0.005452	.0041180	1.32	0.186	-.2619418	1.35232
Small firm	0.030506	.0021962	1.39	0.165	-.1253957	.7355174
Quarter 1	(dropped)					
Quarter 2	-.0896119	.0135389	-6.62	0.000	-.1161478	-.0630761
Quarter 3	-.1062019	.0142509	-7.45	0.000	-.1341331	-.0782707
Quarter 4	-.0897762	.0138836	-6.47	0.000	-.1169875	-.0625649
RIDDOR 1996	.5598998	.0359705	15.57	0.000	.489399	.6304007
Constant	1.133987	.2226656	5.09	0.000	.69757	1.570403
Sample Observations	430					
Number of groups	10					
Time periods	43					
Wald chi sq	700.02					
Prob > chi sq	0.0000					

Table A5.2 Overtime cross-sectional time-series model (adjusted major)

Variable	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Tenure < 3	0.025311	.0049743	5.09	0.000	1.55618	3.506087
Manual	0.011958	.0017391	6.88	0.000	.8549794	1.536697
Overtime	0.003203	.0036480	0.88	0.380	-.3946213	1.035215
Small firm	0.009329	.0018298	5.10	0.000	.5742189	1.291502
Quarter 1	(dropped)					
Quarter 2	-.077296	.013398	-5.77	0.000	-.1035556	-.0510365
Quarter 3	-.0913663	.0145096	-6.30	0.000	-.1198046	-.062928
Quarter 4	-.0658463	.0140876	-4.67	0.000	-.0934574	-.0382352
RIDDOR 1996	.4690789	.0324789	14.44	0.000	.4054214	.5327363
Constant	2.704392	.1966661	13.75	0.000	2.318933	3.08985
Sample Observations	430					
Number of groups	10					
Time periods	43					
Wald chi sq	688.66					
Prob > chi sq	0.0000					

Table A5.3 Overtime cross-sectional time-series model (unadjusted over-3-day)

Variable	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Tenure < 3	0.012712	.0043812	2.90	0.004	.4125428	2.129939
Manual	0.020141	.0030143	6.68	0.000	1.42334	2.604924
Overtime	0.007241	.0039800	1.82	0.069	-.0559241	1.50421
Small firm	-0.011092	.0028562	-3.88	0.000	-1.669002	-.5493805
Quarter 1	(dropped)					
Quarter 2	-.0807869	.0123973	-6.52	0.000	-.1050852	-.0564886
Quarter 3	-.0449414	.013006	-3.46	0.001	-.0704328	-.0194501
Quarter 4	-.1041225	.0127164	-8.19	0.000	-.1290461	-.0791988
RIDDOR 1996	.0877387	.0359177	2.44	0.015	.0173413	.1581361
Constant	3.992567	.2364644	16.88	0.000	3.529105	4.456028

Sample Observations	430
Number of groups	10
Time periods	43
Wald chi sq	172.35
Prob > chi sq	0.0000

Table A5.4 Overtime cross-sectional time-series model (unadjusted over-3-day)

Variable	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Tenure < 3	0.014570	.0047534	3.07	0.002	.5255217	2.388839
Manual	0.011956	.0022693	5.27	0.000	.7508861	1.64045
Overtime	0.005394	.0038131	1.41	0.157	-.2080036	1.286717
Small firm	-0.008513	.0019609	-4.34	0.000	-1.235593	-.4669527
Quarter 1	(dropped)					
Quarter 2	-.0638499	.0128735	-4.96	0.000	-.0890815	-.0386183
Quarter 3	-.0316674	.0135939	-2.33	0.020	-.058311	-.0050238
Quarter 4	-.0847564	.0135259	-6.27	0.000	-.1112667	-.0582461
RIDDOR 1996	.0302462	.0338696	0.89	0.372	-.0361369	.0966293
Constant	5.207332	.2226887	23.38	0.000	4.770871	5.643794

Sample Observations	430
Number of groups	10
Time periods	43
Wald chi sq	109.70
Prob > chi sq	0.0000

Table A5.5 Work intensity cross-sectional time-series model (unadjusted major)

Variable	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Tenure < 3	0.018807	.0054150	3.47	0.001	.8193637	2.942103
Manual	0.029896	.0015806	18.91	0.000	2.679833	3.299435
WI	0.017162	.0053792	3.19	0.001	.6619044	2.770502
Small firm	0.000244	.0015477	0.16	0.875	-.2789191	.3277841
Quarter 1	(dropped)					
Quarter 2	-.0996028	.0129691	-7.68	0.000	-.1250216	-.0741839
Quarter 3	-.1386676	.0173726	-7.98	0.000	-.1727172	-.104618
Quarter 4	-.1298775	.0193134	-6.72	0.000	-.1677311	-.0920239
RIDDOR 1996	.5578833	.0316311	17.64	0.000	.4958874	.6198792
Constant	-.1699998	.4855937	-0.35	0.726	-1.121746	.7817464
Sample Observations	430					
Number of groups	10					
Time periods	43					
Wald chi sq	1171.72					
Prob > chi sq	0.0000					

Table A5.6 Work intensity cross-sectional time-series model (adjusted major)

Variable	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Tenure < 3	0.016946	.0052663	3.22	0.001	.6620786	2.726438
Manual	0.011467	.0015087	7.60	0.000	.8510067	1.442417
WI	0.020024	.0053621	3.73	0.000	.9514532	3.05336
Small firm	0.008245	.0014041	5.87	0.000	.5493036	1.099717
Quarter 1	(dropped)					
Quarter 2	-.0928207	.0129323	-7.18	0.000	-.1181676	-.0674739
Quarter 3	-.1266267	.0175994	-7.19	0.000	-.1611209	-.0921325
Quarter 4	-.1125234	.0193445	-5.82	0.000	-.1504379	-.0746089
RIDDOR 1996	.468429	.0307506	15.23	0.000	.408159	.5286991
Constant	1.104552	.4830693	2.29	0.022	.1577533	2.05135
Sample Observations	430					
Number of groups	10					
Time periods	43					
Wald chi sq	656.26					
Prob > chi sq	0.0000					

Table A5.7 Work intensity cross-sectional time-series model (unadjusted over-3-day)

Variable	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Tenure < 3	0.004464	.0055890	0.80	0.424	-.6490172	1.541817
Manual	0.025526	.0017413	14.66	0.000	2.21133	2.893918
WI	0.020639	.0055550	3.72	0.000	.9751722	3.152688
Small firm	-0.019495	.0016784	-11.62	0.000	-2.278438	-1.620513
Quarter 1	(dropped)					
Quarter 2	-.0842616	.013945	-6.04	0.000	-.1115933	-.0569299
Quarter 3	-.0772692	.0181221	-4.26	0.000	-.1127879	-.0417504
Quarter 4	-.147384	.0205199	-7.18	0.000	-.1876023	-.1071657
RIDDOR 1996	.0398123	.0274825	1.45	0.147	-.0140523	.093677
Constant	2.61935	.505235	5.18	0.000	1.629108	3.609593
Sample Observations	430					
Number of groups	10					
Time periods	43					
Wald chi sq	317.68					
Prob > chi sq	0.0000					

Table A5.8 Work intensity cross-sectional time-series model (unadjusted over-3-day)

Variable	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Tenure < 3	0.010274	.0053676	1.91	0.056	-.0245915	2.079464
Manual	0.007650	.0020863	3.67	0.000	.356115	1.173927
WI	0.014337	.0052789	2.72	0.007	.3990173	2.468324
Small firm	-0.006838	.0016553	-4.13	0.000	-1.008217	-.3593436
Quarter 1	(dropped)					
Quarter 2	-.0670398	.0129892	-5.16	0.000	-.0924982	-.0415814
Quarter 3	-.0525648	.0171309	-3.07	0.002	-.0861408	-.0189888
Quarter 4	-.1136921	.0190785	-5.96	0.000	-.1510853	-.0762988
RIDDOR 1996	-.0023502	.0333618	-0.07	0.944	-.0677383	.0630378
Constant	4.35835	.4821727	9.04	0.000	3.413309	5.303391
Sample Observations	430					
Number of groups	10					
Time periods	43					
Wald chi sq	82.77					
Prob > chi sq	0.0000					

ANNEX 6: RESULTS OF LOGISTIC REGRESSION ANALYSIS

The results below provide a technical annex which relate to the cross sectional model of LFS over-3-day reported accident rates described in section 5 of the report. The modelling exercise utilises a multivariate statistical technique known as logistic regression to model the probability of an accident occurring based on individual level micro data from the LFS. The occurrence of an accident is recorded as a binary, event zero or one, based on whether or not the individual has had an accident at work during the previous 12 months in their current job which has resulted in over 3 days off work.

The model is able to determine the separate ‘contribution’ that each piece of information about an individual’s job and personal characteristics, with the result expressed as an odds ratio, usually relative to a drop category which has a coefficient of one. The variables included in the model relate to ethnicity, gender, age, region, job tenure, occupational categories, industry categories, sector and employment status, unionisation, shift working and workplace size. The results are shown in Table A6.1.

Table A6.1 Logistic regression model of LFS over-3-day injuries

Variable	Odds Ratio	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Ethnicity						
Not known	.731393	.7381159	-0.31	0.757	.1011871	5.286601
White	(dropped)					
Caribbean	.8893745	.1179092	-0.88	0.377	.6858611	1.153276
African	.9324663	.1714138	-0.38	0.704	.6503664	1.336928
Indian	.6437657	.083932	-3.38	0.001	.4985986	.8311983
Pakistani	.6344654	.1289619	-2.24	0.025	.4259828	.9449826
Bangladeshi	.2227796	.1581868	-2.11	0.034	.0553951	.8959406
Chinese	.8595514	.2748874	-0.47	0.636	.459256	1.608751
Other	.8828592	.1145878	-0.96	0.337	.6845617	1.138598
Sex						
Female	(dropped)					
Male	1.083142	.0383549	2.26	0.024	1.010517	1.160987
Occupation (derived)						
1	.2531379	.037884	-9.18	0.000	.1887854	.3394266
2	.5066527	.0861197	-4.00	0.000	.3630989	.7069616
3	.681527	.090361	-2.89	0.004	.5255639	.8837727
4	.8184726	.231557	-0.71	0.479	.4700972	1.425019
5	2.130199	.3022762	5.33	0.000	1.613	2.813235
6	.3406368	.1101256	-3.33	0.001	.1807607	.6419177
7	.508602	.090197	-3.81	0.000	.359272	.7200004
8	.3069587	.0903654	-4.01	0.000	.1723833	.5465937
9	.5002761	.0699931	-4.95	0.000	.3802936	.658113
10	.1740931	.1029535	-2.96	0.003	.0546268	.5548263
11	.267159	.0783183	-4.50	0.000	.1503966	.4745713
12	.3151811	.0925546	-3.93	0.000	.1772557	.5604282
13	.5989561	.2779626	-1.10	0.269	.2411963	1.487371
14	.7551077	.15163	-1.40	0.162	.5094279	1.11927
15	.8066979	.1402277	-1.24	0.217	.5737823	1.134161
16	.2394043	.0662714	-5.16	0.000	.1391567	.4118698
17	1.330247	.3503357	1.08	0.279	.793887	2.228979
18	.9213917	.125413	-0.60	0.548	.7056429	1.203105
19	.4022193	.237706	-1.54	0.123	.1263033	1.280888
20	.3923259	.0689874	-5.32	0.000	.2779521	.5537633
21	1.913856	.2342391	5.30	0.000	1.50567	2.432702
22	1.116462	.1748916	0.70	0.482	.8213062	1.51769
23	.2497508	.0528615	-6.55	0.000	.164947	.3781548
24	.3834696	.0621118	-5.92	0.000	.2791638	.5267479
25	.3698882	.054556	-6.74	0.000	.2770281	.4938749
26	2.387864	.313167	6.64	0.000	1.84661	3.087765
27	.2814848	.0478846	-7.45	0.000	.2016756	.3928769
28	2.876529	.3693246	8.23	0.000	2.236562	3.699616
29	1.995859	.2696823	5.11	0.000	1.531492	2.601028
30	1.62397	.2233715	3.53	0.000	1.240219	2.126463
31	2.789765	.3964126	7.22	0.000	2.11162	3.685695
32	1.757828	.2261499	4.38	0.000	1.36605	2.261966
33	1.398633	.2673072	1.76	0.079	.9616606	2.034163
34	1.473682	.1929163	2.96	0.003	1.140184	1.904727
35	1.737422	.2341923	4.10	0.000	1.334042	2.262775
36	1.02909	.2012903	0.15	0.883	.7013871	1.509901
37	(dropped)					
38	.5960239	.1664851	-1.85	0.064	.3447471	1.030449
39	1.373842	.2423732	1.80	0.072	.9722271	1.941358
40	.6254726	.1027893	-2.86	0.004	.4532345	.8631646
41	1.179438	.1535977	1.27	0.205	.9137419	1.522393
42	2.254666	.3042696	6.02	0.000	1.73066	2.937331
43	2.094526	.2870062	5.40	0.000	1.60121	2.739827
44	2.377178	.306375	6.72	0.000	1.846534	3.060314

Table A6.1 (cont) Logistic regression model of LFS over-3-day injuries

45	2.172916	.3202879	5.27	0.000	1.627706	2.900749
46	2.73262	.4831416	5.69	0.000	1.932335	3.864348
47	3.313919	.5090558	7.80	0.000	2.452379	4.478124
48	2.023156	.3057098	4.66	0.000	1.504556	2.720511
49	2.061914	.2487865	6.00	0.000	1.627669	2.61201
Not known	.5312511	.382411	-0.88	0.380	.1295921	2.177815
Public / Private Sector						
Not known	.4331141	.1543915	-2.35	0.019	.2153653	.8710215
Private	(dropped)					
Public	1.229543	.0547988	4.64	0.000	1.126696	1.341777
Region						
Tyne & wear	.9781403	.1001156	-0.22	0.829	.8003466	1.19543
Rest of North	(dropped)					
S. Yorks	1.174281	.1062949	1.77	0.076	.9833812	1.402239
W. Yorks	1.1509	.0934487	1.73	0.083	.9815748	1.349435
R.O. Yorks	.9612693	.0859112	-0.44	0.659	.8068093	1.1453
E Midl.	1.007305	.0727359	0.10	0.920	.8743734	1.160445
E Anglia	1.067281	.0869208	0.80	0.424	.9098206	1.251993
Inner London	1.05469	.102104	0.55	0.582	.8724094	1.275056
Outer London	1.125527	.0868213	1.53	0.125	.9676	1.309231
R.O S East	1.001694	.0653954	0.03	0.979	.8813829	1.138428
S West	1.011461	.0718482	0.16	0.873	.8800042	1.162555
W Midl MC	1.084911	.0873695	1.01	0.312	.9265007	1.270406
R.O W Midl	1.011692	.078556	0.15	0.881	.8688684	1.177992
Greater Man	.9746156	.0814389	-0.31	0.758	.8273836	1.148047
Merseyside	1.186668	.1137339	1.79	0.074	.9834386	1.431894
R.O N West	1.103325	.088899	1.22	0.222	.9421479	1.292076
Wales	1.057098	.0819133	0.72	0.474	.9081484	1.230478
Strathclyde	.8973272	.0765963	-1.27	0.204	.7590876	1.060742
R.O. Scotland	.986358	.0746975	-0.18	0.856	.8503008	1.144186
Unionisation						
Not known	1.127288	.0600091	2.25	0.024	1.0156	1.251258
Not in union	(dropped)					
In Union	1.494142	.0456953	13.13	0.000	1.407212	1.586442
Proxy Response						
Personal	(dropped)					
Proxy resp	.7596057	.0199308	-10.48	0.000	.7215296	.7996911
Shift Working						
Not known	1.114009	.0364534	3.30	0.001	1.044805	1.187798
No	(dropped)					
Yes	1.269066	.0403704	7.49	0.000	1.192358	1.350709
Employment Status						
Not known	9.616669	15.32557	1.42	0.156	.4231658	218.544
Employee	(dropped)					
Self Empl	.7248468	.0413072	-5.65	0.000	.6482439	.8105019
Firm Size (Number of employees)						
Not known	1.006687	.2503827	0.03	0.979	.6182781	1.639098
1 – 10	(dropped)					
11 – 19	1.179038	.0655135	2.96	0.003	1.057379	1.314695
20 – 24	1.309239	.0905735	3.89	0.000	1.143227	1.499357
DK under 25	1.063532	.1323486	0.49	0.621	.8333448	1.357301
25 – 49	1.423593	.0696843	7.22	0.000	1.293362	1.566938
DK over 25	1.407131	.1737067	2.77	0.006	1.10473	1.79231
over 50	1.395751	.0579882	8.03	0.000	1.2866	1.514161

Table A6.1 (cont) Logistic regression model of LFS over-3-day injuries

Age Group (years)						
16- 19	1.005701	.0743101	0.08	0.939	.8701106	1.16242
20- 24	1.073704	.0611078	1.25	0.211	.9603732	1.200408
25- 34	1.055861	.0462549	1.24	0.215	.9689863	1.150525
35- 44	1.066402	.0441761	1.55	0.121	.9832397	1.156597
45- 54	1.024541	.0425562	0.58	0.559	.9444371	1.111439
55 and Over	(dropped)					
Job Tenure (in months unless otherwise stated)						
1 or less	.4128378	.0513761	-7.11	0.000	.3234824	.5268757
2	.5426477	.07651	-4.34	0.000	.4116269	.7153724
3	.6965231	.0824714	-3.05	0.002	.5522676	.8784591
4	1.06416	.1071603	0.62	0.537	.8735575	1.296351
5	.9208289	.1040826	-0.73	0.466	.7378472	1.149189
6	.9533041	.1119175	-0.41	0.684	.7573572	1.199947
7	.8279802	.1067008	-1.46	0.143	.6431712	1.065892
8	1.320657	.1446356	2.54	0.011	1.065536	1.636861
9	1.343624	.1492598	2.66	0.008	1.080736	1.670458
10	1.248318	.145122	1.91	0.056	.9939614	1.567764
11	1.277288	.1516356	2.06	0.039	1.012131	1.61191
1-2 years	1.365765	.073919	5.76	0.000	1.228306	1.518606
2-5 years	1.418533	.0661753	7.49	0.000	1.294584	1.554348
5-10 years	1.368005	.0628512	6.82	0.000	1.250202	1.496908
10-20 years	1.177109	.0517649	3.71	0.000	1.079901	1.283067
Over 20 years	(dropped)					
Not known	1.199447	.3895046	0.56	0.575	.6346941	2.266718
Hours Worked						
0-5	.1744965	.0456988	-6.67	0.000	.1044398	.2915462
5-10	.2970818	.0369495	-9.76	0.000	.2328135	.3790914
10-15	.4031024	.0394871	-9.28	0.000	.3326851	.4884245
15-20	.5496886	.041186	-7.99	0.000	.474613	.6366399
20-25	.5919618	.0404952	-7.66	0.000	.5176833	.6768978
25-30	.8922709	.0617104	-1.65	0.099	.7791602	1.021802
30-35	.995234	.0601418	-0.08	0.937	.8840713	1.120374
35-40	.9134596	.0327036	-2.53	0.011	.8515589	.97986
40-45	(dropped)					
45-50	1.061338	.0418502	1.51	0.131	.9824023	1.146616
50-55	1.088479	.0516086	1.79	0.074	.9918862	1.194479
55-60	1.243809	.0768698	3.53	0.000	1.101914	1.403976
Over 60	1.25759	.060497	4.76	0.000	1.144437	1.381932
Not known	1.33817	.7875082	0.49	0.621	.4222621	4.240727
Travel to Work (in minutes)						
Less than 30	(dropped)					
30-59	.994	.0333304	-0.18	0.858	.930774	1.061521
More than 60	.9781902	.0549916	-0.39	0.695	.8761343	1.092134
Not known	1.128582	.0536136	2.55	0.011	1.028245	1.23871
Sector						
Not known	.2213964	.2223125	-1.50	0.133	.0309348	1.584507
AB	1.274251	.1451287	2.13	0.033	1.019316	1.592947
CDE	(dropped)					
F	1.198075	.06688	3.24	0.001	1.073909	1.336598
GH	1.133292	.0563638	2.52	0.012	1.028034	1.249326
I	.9588311	.0559024	-0.72	0.471	.8552928	1.074903
JK	.8176947	.0516358	-3.19	0.001	.7225028	.9254285
L	1.021731	.0827351	0.27	0.791	.8717867	1.197465
M	.8884586	.0823663	-1.28	0.202	.7408407	1.06549
N	1.039474	.07701	0.52	0.601	.8989843	1.20192
OPQ	1.258212	.0856746	3.37	0.001	1.101016	1.437852

Table A6.1 (cont) Logistic regression model of LFS over-3-day injuries

Highest Qualification						
Degree	(dropped)					
Higher Ed	1.692798	.1393688	6.39	0.000	1.44054	1.98923
A level	1.962764	.1420174	9.32	0.000	1.703251	2.261817
GCSE A-C	2.038749	.1505683	9.65	0.000	1.764005	2.356285
Other	2.05482	.1554129	9.52	0.000	1.771718	2.383159
No quals	1.7454	.1393215	6.98	0.000	1.492623	2.040984
Not known	1.846235	.404698	2.80	0.005	1.20144	2.837082

Sample Observations	556,844
Pseudo R-squared	0.0845
Chi squared	6732.55
Prob > chi sq	0.0000

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