School of Social Sciences

CARDIFF UNIVERSITY
PRIFYSGOL CAERDYDD

Working Paper Series
Paper 48

The Relation between Arrangements for Health and Safety and Injury Rates – The Evidence-Based Case Revisited

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June, 2004

ISBN 1-904815-08-1

ABSTRACT

This paper re-examines the most influential analysis of the relation between worker representation and industrial injuries in British manufacturing, the work of Reilly *et al*, which appeared in the *British Journal of Industrial Relations* 33 (3). It argues that although this has been misinterpreted by some who cite it, the reliability of its authors' findings must also be questioned. A step by step replication of their analysis of WIRS90 data is reported, followed by a further examination of data for WERS98. In neither case are the specific claims advanced in the original analysis robust enough to survive scrutiny. Only the more general conclusion that health and safety should not be left to management is adequately supported.

Introduction

The Workplace Industrial/Employment Relations Surveys (WIRS/WERS[1]), which began in 1980, have had the key purpose of providing information on the state of industrial and employment relations. They have provided, amongst other things, cross-sectional data on establishments with 25 or more employees (10 or more in 1998) for all public and private manufacturing and services in England, Wales and Scotland with the exception of some sectors such as deep coalmining, agriculture, forestry and fishing. In 1990, however, the third such survey also included information on industrial injuries. The injury data recorded were not identical to, but were broadly comparable with the then HSE major rate (Nichols and Guy 1993) and since the 1990 survey also collected information about different arrangements for managing health and safety, this meant for the very first time in the UK, or for that matter anywhere else, a national data set had been constructed which permitted the investigation of the determination of injury rates which could take account of both different health and safety arrangements at establishment level and a host of other variables – size of establishment, the proportion of manual workers, the proportion of men and women, the presence of trade unions and so forth.

By far the most influential study to investigate the effectiveness of different health and safety arrangements using the data made available by WIRS 1990 was undertaken by Reilly *et al*, who published the results of their multivariate analysis of private manufacturing in the *BJIR* (Reilly *et al* 1995).

The study had as its main objective the assessment of the role played by union-appointed safety representatives and joint health and safety consultative committees in reducing the frequency of workplace accidents. To this end several independent variables were introduced. These included establishment size, the percentage of manual workers in an establishment, the percentage of female workers and the percentage of the fulltime manual workforce that were trade union members. In addition some 19 industry variables were included from the SIC 80 classification at the two-digit level and a set of 11 regional variables to capture possible industry and regional effects.

The authors assumed that the effects of trade unions on workplace injuries would be mediated through the formal health and safety arrangements in place in establishments and they distinguished eight different sets of arrangements, assigning each establishment to one of these (Table 1).

A great virtue of the WIRS data sets is that, unlike aggregate industry studies, they actually tie information about particular variables, say the percentage of male workers, to the particular establishment for which injury data are also provided. However, the WIRS 90 survey was cross sectional by nature and limited to one point in time. As a consequence of this many establishments, especially smaller ones, recorded zero injuries. In an attempt to cope with the effects of cases where injury rates equalled zero Reilly *et al* calculated weighted least squared estimates using an approach developed by Cox (Reilly *et al* 1995:284; Cox 1970). They then estimated the effects on injury rates of seven different type of joint arrangement for managing health and safety (HS1-HS7) against the arrangement in which health and safety was

managed without any formal arrangement for worker consultation, that is, where it was dealt with exclusively by management (HS8). Estimated log odds effects for industry and region were also made relative to an omitted category in each set, namely the chemical and man-made mineral fibre group and East Anglia.

Reilly *et al's* econometric modelling led them to estimate an injury rate of 10.6 per 1000 in private manufacturing establishments where employers managed health and safety in the absence of any joint arrangements compared with a rate of 5.7 fewer injuries per 1000 where trade unions appointed all the employee members of health and safety committees. It also led them to estimate that in firms with committees but with no union representation injury rates would be 4.9 per 1000 fewer. Indeed in their conclusion, Reilly *et al* use this point to argue a case for legislation to be extended to require joint health and safety committees to be set up in non-unionised establishments.

Reilly *et al* have been widely cited by researchers and specialists on occupational health and safety management in support of participative arrangements and the role of trade unions in improving health and safety performance (see for example, in international reviews, Walters and Frick 2000:47; in the UK Litwin, 2000:2; in Australia Bohle and Quinlan 2000:302).

Their paper has also been used extensively by the HSC and HSE in support of policy statements on the beneficial effects of trade union and worker involvement on health and safety . For example both the HSC *Discussion Document* that outlined the case for new consolidated regulations on worker involvement and the DETR/HSC strategy

statement *Revitalising Health and Safety* cited the research of Reilly *et al* as showing that:

> workplaces with trades union safety representatives and joint health and safety committees have significantly better accident records – over 50% fewer injuries – than those with no consultation mechanism (HSC, 1999:4; DETR/HSC, 2000:29)

More recently, HSC announced a statement of principle on worker involvement and consultation on occupational health and safety that cited Reilly *et al* to the effect:

> Organisations with union safety committees have 50 % lower injury rates per 1000 than average (HSC 2003:10)

In relation to the recently established £3 million Challenge Fund to promote worker involvement and consultation an HSE document again claims:

> Evidence shows that trade unions safety representatives make a substantial contribution to ensuring significant risks to occupational health and safety are properly controlled – injury and ill-health rates are significantly lower for these workers (HSE 2003:3)

There is no doubt at all, then, that Reilly *et al* made an important contribution to debates on official UK OHS strategies. Trades unions have also invoked the study. According to the trade union orientated *Hazards* for example:

> In workplaces with full union recognition and a joint management-union safety committee serious accident rates were less than half those at firms with no union recognition and no joint committee (O'Neill 2002:5)

As we shall see later, claims such as these cannot be justified on the basis of Reilly *et al's* research and Reilly and his colleagues must bear some responsibility for this. They assert for example: 'the strongest reducing effects (excluding the HS5 variable)[2] are reserved for those establishments that operate exclusive joint consultative health and safety committees (albeit with varying degrees of union-nominated worker representation)' Reilly *et al* 1995: 281) and they proceed to make some precise-sounding claims – for example that 'relative to an establishment with a non-consultative management, one possessing a consultative committee containing all union-appointed safety representatives [HS1] has, *ceteris paribus,* 5.7 fewer injuries per 1000 employees; establishments with some (but not all) union representation on the consultative committee (HS2) have, *ceteris paribus,* 3.4 fewer injuries per 1000 employees, and those with no such representatives (HS3: over half of the establishments in this particular category are non-union) have, *ceteris paribus,* 4.9 fewer injuries per 1000 employees'. We shall have cause to revisit some of these claims later on but despite its undoubted influence, the Reilly *et al* study has not been replicated and our primary purpose in this paper is to report such a replication, using first WIRS90 and then WERS98 data. In what follows, we set out our procedures for attempting this and their development step by step.

Replicating the Reilly *et al* study

Our first step in examining the evidence on the relationship between joint work arrangements and injury rates was to attempt to replicate the sample means tabled in Reilly *et al*. In the case of the first set of variables in Table 2 the means were similar with the exception of the variable for the female composition of the workforce, where our mean was somewhat higher than that of Reilly *et al*

In the majority of cases the allocation of establishments to particular types of health and safety arrangement was again straightforward. WIRS provides codes for four main categories of OHS arrangements —

- Establishments with joint committees exclusively for OHS
- Establishments with joint committees that deal with health and safety and other matters
- Establishments with no joint committees but with worker representatives who deal with health and safety (HS7).
- Establishments where health and safety is dealt with by management without formal arrangements for joint consultation (HS8).

For establishments with trade union members present, WIRS provides information on whether all, some, or none of the members of health and safety committees are chosen by trade unions or staff associations. From this information coupled with that above, HS1, HS2, HS4 and HS5 may be entirely derived. Reilly *et al* provide no information on how they allocated establishments to other types of joint OHS arrangements

beyond telling us that they treated HS1-HS8 as binary variables. It was only possible to allocate cases to the categories for joint arrangements that yielded similar sample means to Reilly *et al* after some further steps were taken[3]. After these procedures had been followed we reached a reasonably good approximation of Reilly *et al*'s distribution of cases into categories HS1-HS8. Almost 99 per cent of establishments in our sample had been allocated to the categories used by Reilly *et al*. In seven of the eight HS categories our sample means now corresponded very closely to those of Reilly *et al*.

It is already apparent that a distinctive feature of the Reilly *et al* study is that it includes a large number of variables. Not only does it include eight different variables for the types of health and safety arrangements but 19 two-digit industry variables and 11 regional variables. When added to the other variables for establishment size, composition, and union density this makes a grand total of 42 variables. Of course injury rates may have a large number of possible determinants but these 42 variables have to be seen in the context of a data set that consists of only 432 private manufacturing establishments. Although this is not immediately apparent from the way that Reilly *et al* present their paper, this means that in some cases frequencies were very small indeed. For example, it is not only the case with respect to the HS variables that, as Reilly *et al* tell us, HS5 is restricted to 3 per cent of cases (actually to 13 establishments) so is HS4. The large number of industry variables means that inevitably, some of the industries included in the multivariate analysis have even less cases than this, in one instance, only four establishments being included. To anticipate our findings, this makes for some scepticism about how robust a model constructed on this basis might prove to be.

The fragility of the model became apparent when we attempted to calculate Cox-corrected logistic estimates (Table 3). Like Reilly *et al*, and in keeping with what the existing literature would suggest, we find a significant and negative estimate for the effects on the injury rate of size and the percentage of females in an establishment and a positive relation for the percentage of manual workers. Like them, we find no significant relation between the union percentage and the injury rate. The latter finding is not surprising given the complexity of the relations involved (Nichols 1996:149-51). However, our findings fail to replicate those of Reilly *et al* with respect to the very part of their analysis that is vital to the debate over policy.

As intimated earlier, Reilly *et al*'s results are not as convincing as often thought, even considered on their own terms. Only three of the eight variables they constructed to capture how health and safety is arranged were actually found by them to have a significant relation with the injury rate when compared to the base case, where management deals with health and safety alone, that is without any form of consultation (HS8). These are HS1 (where there is a joint consultative committee exclusively for health and safety matters with all employees chosen by unions), HS3 (where there is a joint consultative committee exclusively for health and safety matters with no employees chosen by unions) and HS5 (where there is a joint consultative committee for health and safety and other matters with some employees chosen by unions). Of these, as we have seen already, Reilly *et al* themselves warn about the validity of HS5. In effect then, their findings come down to two cases (HS1 and HS3), in one of which (HS3) none of the employee representatives on joint committees were chosen by trade unions. Such results do not sit well with the reports

of their findings presented earlier – for example the claim by HSE that 'Organisations with union safety committees have 50 % lower injury rates per 1000 than average.'

In our own attempt to replicate the analysis by Reilly and his colleagues both HS1 and HS3 cease to be significant. HS5 is significant and negatively related to injury rate compared to the situation where management alone decides, but this finding rests on only 12 cases, one less than the 13 that Reilly *et al* themselves warn about.

The upshot is, then, that we have failed to determine any reliable results for the effects of the specific health and safety arrangements distinguished by Reilly *et al*. The general lack of statistical significance in both our results and those of Reilly *et al* can be further seen from that part of the Table that reports estimates for industries and regions. For industries Reilly *et al* had 5 significant results of which only one is confirmed by our attempted replication as being both significant and having the same sign. For regions Reilly *et al* have 5 significant results. Only two of these (North and Yorks and Humberside) are confirmed by our analysis as being both significant and having the same sign.

The estimated injury rates in our study for different health and safety arrangements frequently differ from those of Reilly *et al*. Generally they are of a lower magnitude. For example, our rates under different forms of joint arrangements range from 4.8 per 1,000employees for HS2; 4.5 for HS1 and HS4; 4.4 for HS7; 4.1 for HS3 and HS6 to 2.8 for HS5. Therefore although like Reilly *et al*, we find our estimations of rates for joint arrangements are lower than that for OHS management in the absence of consultation, the difference between them is quite small and nowhere near that

reported by Reilly *et al* for their estimates. The base rate, which Reilly and his colleagues estimated to be 10.6 per 1000 is also much lower in our replication, 5.1 per 1000. This means that, although both our and their estimated rates for all forms of joint arrangements are reasonably close to the average observed rate for manufacturing as a whole (5.3 injuries per 1000), our changes on the base are nowhere near as pronounced as theirs.

Moreover in certain cases there are major differences between our estimates and those of Reilly *et al* for other variables, for example in the case of Timber and Furniture Manufacture, where they estimate an injury rate of 27.5 per 1000, we estimate 12 per 1000 and in Office Machinery, where they estimate 11.3 per 1000, we estimate only 1.5 per 1000. It is most likely that such differences are in the main a result of the very small numbers of cases included in each category.

Further Analysis of the WIRS Data

To try to understand the differences between our initial estimates and those reported in Reilly *et al*, first we developed univariate models that enabled us to consider the relationship between each of the variables used by Reilly *et al* and injuries, in the absence of other variables. In the main we found an expected pattern in which variables such as establishment size and the percentage of the workforce that was female had a negative effect that was significantly estimated, while the percentage of manual workers has a positive effect, also significantly estimated. This is in keeping with the well established findings that injury rates of this type are inversely proportional to establishment size and the percentage of the workforce that are female, while they are directly proportional to the percentage of manual workers present in the establishment.

The relationship between injury rates and trade union density was also negative and the parameter significantly estimated, suggesting that trade union density may also have a beneficial effect on injury rates. All of the categories of joint health and safety arrangements from HS1 to HS6 were negative and significantly estimated but HS7 was positive and not significantly estimated, again suggesting that with the exception of HS7 all of the joint arrangements might relate to improved injury rates. The situation with the 19 two digit industry categories was more mixed with only seven of them significantly estimated and of these five were positive and two negative. All parameters for the regional variables were positive and significantly estimated except East Midlands, which was not significantly estimated.

However, we then undertook a stepwise multivariate analysis in which we were able to observe the progress of the effects of the variables on one another as more were added to our model. This resulted in the situation previously presented in Tables 2 and 3 in which it was observed that although our sample means are broadly comparable with those of Reilly *et al* our co-efficient estimates sometimes differ markedly, in value, direction and significance.

We concluded that the fundamental reason for such differences is to be found in the extremely sensitive nature of the data set in which the behaviour of a total of more than 40 variables is investigated in a study of only 436 cases (432 in Reilly *et al*). This suggests that minor differences in the construction of our sample, which were an unavoidable consequence of the limits of the information provided by Reilly *et al* in the published report of their findings, led to major differences in the results of the two analyses. This leads us to conclude that the findings on the effects of various forms of joint arrangements and especially on the role of trade unions in influencing outcomes in terms of health and safety that are at the heart of the paper by Reilly *et al*, are unreliable and that policy makers should be wary of invoking them to demonstrate the positive role of worker participation in health and safety arrangements.

If the reasons behind our inability to repeat the results obtained in the study by Reilly *et al* were caused by sensitivities related to the effects of such a large number of variables on a comparatively small data set, two possible ways to overcome this would be to increase the size of the data set or to reduce the number of variables involved. In theory the size of the data set might be increased by 'pooling' the data in the WIRS 90 Survey with that in the later 1995 WERS survey. In practice, the

questions asked about health and safety arrangement in 1995 were not strictly comparable with those in 1990 and the actual definition of injury changed. The sample also changed, with establishments of 10 or more employees being included in the later survey. Another possibility, to extend the industries covered in the 1990 dataset beyond manufacturing would have made for other problems, including an increase in the incidence of zero injury rates leading to further major questions concerning the reliability of findings and of course meaning that the chance of replicating the Reilly *et al* analysis, based on manufacturing, would be forfeited. We therefore sought to explore ways of reducing variables in our analysis of WIRS 90 through their combination.

In relation to WIRS 90, we felt that the 19 industrial sector categories could be simplified. Such a simplification could be achieved by utilising SIC codes for private manufacturing at the level above the two digit codes that Reilly *et al* used. This had the effect of reducing the 19 industry categories to three aggregated ones: extraction of minerals, manufacture of metals, mineral products and chemicals; metal goods, engineering and vehicle industries; other manufacturing industries. Similarly, we reasoned that the eight original categories for joint health and safety arrangements may have been graded too finely and we decided to simplify them. For this reason we decided to amalgamate HS1 to HS7 as indicative of joint arrangements and to compare them with HS8 as indicative of OHS management in the absence of formal consultation with workers. Thus, we reduced the eight OHS arrangements variables to two, HS8 and HS17 (including here all the arrangements from HS1-HS7). We believed that by doing so, we could estimate the effects of joint arrangements on injury rates and compare them with the effects of unilateral OHS management

arrangements, while at the same time seeking to account for the effects of independent variables known to influence OHS performance and the industry and regional variables also. Table 4 shows the results we obtained when we introduced these new variables into our Cox zero corrected analysis.

It can be seen from the first set of variables in Table 4 that size of establishment, the percentage of females and the percentage of manual workers are all significantly estimated in this model and that their signs are in the expected direction – larger establishments and higher percentages of females reducing injury rates and a higher percentage of manual workers increasing them. It can be seen that both the coefficient estimates for industries are significant; so, too, most of the regional coefficients; and that HS17 only just misses the conventional five per cent level of significance, joint arrangements being negatively estimated while unilateral management arrangements are estimated positively.

The predicted injury rates for this model are estimated at 3.4 per 1,000 employees for cases where management alone decides health and safety and 2.9 per 1,000 employees for the aggregated category of all other arrangements. This suggests a reduction of 0.5 injuries per 1,000 employees. Therefore, although the reduction is in the same direction as that estimated by Reilly *et al* its magnitude is considerably lower, as are the rates themselves lower than those estimated by Reilly *et al*.

If anything, the simplified 1990 model provides some support for the idea that health and safety is best not entrusted to management alone. The question arises of how

robust even this much less precise finding is when tested against the later WERS 98 data set and indeed, how the original eightfold categorisation of health and safety arrangements fares when tested in the same way. We consider these questions next.

Analysis of the Relationship between Joint Arrangements for Health and Safety and Injuries in a Sample of Establishments from Private Manufacturing in WERS 98

We subjected our data for private manufacturing from WERS 98 to the same analysis as that already reported for WIRS 90. That is, we first obtained a sample similar to that used in Reilly *et al* (1995). Because of differences between the two surveys however, we had to make several further adjustments as well as bear in mind that the definition of injuries used in the WERS 98 survey was somewhat different from that used in WIRS 90 and the establishment size bands are also different (with WERS 98 including establishments with 10 or more employees while WIRS 90 only included those with 25 or more employees). Since categories HS1-HS8 are not directly given in WERS98, we derived them using the appropriate variables identified in the WERS manual[4]

This approach resulted in considerably fewer cases (288, after account had been taken of missing values) than those used either by Reilly *et al* or indeed by our previous analysis of WIRS (Table 5). There was only one case of a joint consultative committee for health and safety and other matters with all employees chosen by unions (HS4) and only two cases of joint consultative committee for health and safety and other matters with some employees chosen by unions (HS5). Our descriptive results also indicate the percentage of unionised establishments is considerably lower in our sample of WERS 98 cases compared with WIRS 90. Further differences include changes in the SIC classifications used in the two data sets, with WERS 98

using SIC 92 in which there are only 14 two digit industry categories as compared with the 19 used in WIRS 90 which is based on the SIC 80 classification.

Table 5 presents mean values of the variables in our data set and Cox zero corrected logistic estimates. As with the previous results, we found the expected negative and significant estimate for size of establishment and a positive and significant relation for the percentage of females and the percentage of manual workers. However, our results for health and safety arrangements show inconsistent and varying effects on injury rates. Given our previous findings and the explanation for them that we have already offered, we don't find these results particularly surprising and we suggest that, as before, they are the unreliable consequence of attempting an analysis in which we have too many variables and too few cases.

The estimated injury rates in our analysis of WERS 98 are strikingly different from those of both our previous analysis of WIRS 90 and that of Reilly *et al*. For joint arrangements they range from 36.7 per 1000 for HS6, to 13.7 per 1000 for HS4; with 18.8 per 1000 derived from the only significant estimate, that for HS7. The base rate for injuries estimated in the absence of joint arrangements was 19.8. However, in WERS 98 generally injury rates are considerably higher than in WIRS 90. For example, the observed rate for manufacturing as a whole was 16 per 1000 (Cully *et al* 1999: 132, Table 6.6). The increase in magnitude we have observed in our own results is in keeping with this inflation. We assume this to be a result of the changes in the definitions of injuries used in the two surveys. In WERS 98 physical injuries resulting from work-related physical assault are included. Probably more significantly in the case of manufacturing, WERS 98 includes any type of burn or loss of consciousness

while, WIRS 90 limits these injuries to those arising from electric shocks[5]. The supporting commentary for the WERS 98 data itself suggests that the differences between the surveys in the definitions and categories of injury used 'may explain why the incidence of injuries is much higher than in 1990' (WIRS Data Set 1998: 31).

Following the logic of our previous analysis we then subjected our cases to further econometric modelling in which we firstly developed univariate models enabling us to consider the relationship of each of our variables and injuries in the absence of other variables. In the main we found a similar pattern to that previously in which as expected, variables such as establishment size and trade union density had a negative effect that were significantly estimated, while the percentage of manual workers has a positive effect, also significantly estimated. All of the categories of joint health and safety arrangements except HS4 were negative and significantly estimated, again suggesting that joint arrangements might relate to improved injury rates. The situation with the 13 two digit industry categories was more mixed with 10 of them significantly estimated, of which two were positive and the rest negative. Seven of the regional variables were significantly estimated and all but one was negative.

In a stepwise multivariate analysis, we again observed the progress of the effects of the variables on one another as more were added to our model, resulting in the situation previously presented in Table 5 in which it was observed that the coefficient estimates fail to demonstrate any consistent effects and differ markedly, in value, direction and significance.

Following our previous argument that the reason for this result may lie in the use of a large number of variables in comparison with the number of cases in the study we then proceeded to collapse the cases by combining them in various ways and as before we reduced the variables for health and safety arrangements into two – either the presence of some form of joint arrangement for health and safety or the situation in which management dealt with health and safety in the absence of joint arrangements. We also used a higher level industry classification thus again reducing the number of industry categories to three.

Our results are shown in Table 6. It can be seen that although in this model the coefficient for the combined health and safety arrangements is negatively estimated, it is not significant and the estimated injury rates suggest a very minor change of 0.7 per 1000 over the base injury rate of 16.3 per 1000.

Reilly *et al*'s findings have not stood up well to our attempts to replicate them either in relation to the WIRS 90 data on which they based their analysis or in relation to our sample of the WERS 98 data on which we have attempted a similar approach. Rather than provide supporting evidence of an effect for joint arrangements on injury rates, the above results confirm the general instability of the statistical modelling on such a data set. There is also reason to suppose, however, that Reilly *et al's* analysis was technically flawed. This brings us to the question of endogeneity.

The relation between trade union presence and injury rate is not a simple one since causality may flow from the latter to the former as well as the other way round. More pertinently for the conclusions of Reilly *et al*, the relation between trade union

presence and type of health and safety arrangement is highly likely to be an endogenous one because at the time of the WIRS90 survey only trade union organised workplaces had the right to call for the establishments of health and safety committees. Despite this Reilly *et al* made no test for the endogeneity of their independent and dependent variables.

We explored this issue in our WERS 98 data. We tested jointly whether or not union density and joint arrangements were endogenous. We used average annual payments as an additional variable in the model because it is necessary that the number of explanatory variables in such auxiliary models must be one more than in the main model. We also tested union density and joint arrangements separately to see if they were endogenous. When tested jointly we found that the suspected variables were both endogenous. When tested separately we found that joint arrangements were still endogenous. This means they cannot be used as explanatory variables and we proceeded to use instrumented ones in our Cox zero corrected model. When we did so using amalgamated groups of variables, as is shown in Table 7 we found that our predicted values for joint arrangements indeed produced a coefficient estimate that was both negative and significant; -0.308 at 0 percent significance level. Such a coefficient estimate would give establishments in manufacturing with joint arrangements a predicted injury rate of 26 per thousand which would be a substantial difference from the base of 36 per thousand, where health and safety is managed in establishments without joint arrangements.

In this particular case then, we arrive at a finding that is compatible with the idea that when management alone deals with health and safety this is likely to be less safe than when, other things being equal, joint arrangements exist. But we have not found this result in all our tests and even though we have done our best to replicate Reilly *et al* we are unable to confirm the particular conclusions that relate to separate OHS categories.

It is rare in social science for studies to be replicated. As far as we know, no other attempt has been made to replicate Reilly *et al*. Nor have other secondary analyses of the WERS 98 data set done anything to support that study's findings. Hillage *et al* (2000) analysed WERS 98 for all industries, not just manufacturing. They followed Reilly *et al* by using the Cox zero correction method and also used the HS1-HS8 categories for health and safety arrangements. Only three of their results were statistically significant. They found cases in category HS4, where there was a general committee for health and safety with all members chosen by the union to have a lower rate than HS8, where management alone dealt with health and safety; but they also found that HS3, where there was a specific health and safety committee with no members chosen by the union, had a *higher* injury rate than HS8, where management alone decided; as did HS6, where there is a general health and safety committee with no members chosen by the union. They report undertaking further analysis based on a similar sample to that used by Reilly *et al* which also produced mixed results and they conclude: 'Our results were not consistent with those of Reilly *et al*' (Hillage *et al* 2000: 120). A study by Robinson and Smallman 2000 also analysed WERS98 for all industries considering both injuries and ill health[6]. They introduced additional variables to those included by Reilly *et al* and suggest their different results might be

because the Reilly *et al* model was prone to omitted variable bias (2000: 9). Whatever the case about that, their results (which do not relate to the HS1-HS8 categories, nor indeed to categories that are mutually exclusive) are decidedly mixed. They suggest for example that general committees with members appointed by trade unions have a significant negative effect on injury rates but that specific committees with members appointed by trade unions have a significant positive effect (2000: 28 Table 7).

A further analysis of WERS98 injury data by Litwin 2000 was pursued in a statistically unconventional manner on only a fraction of the possible cases and also did nothing to add to the reliability of Reilly *et al'*s findings. A further analysis by Fenn and Ashby 2001 again analysed all industries in WERS 98, again treating both injury and ill-health as dependent variables, though this time using count data regression methods to deal with zero observations[7]. Their findings with respect to the effects of trade unions and joint arrangements are essentially the reverse of those of Reilly *et al*: 'the number of reported injuries and illnesses are higher as a consequence of such mechanisms' (2001: 23).

It is clear that these additional studies of WERS 98 do very little to support the widely cited findings of Reilly *et al.* Indeed, when coupled with our own observations they further underline their unreliability.

Discussion

Our analysis of WIRS leads us to conclude that occupational health and safety should not be left to management alone – but that it is not possible to support any more precise conclusions than this about the efficacy of particular joint health and safety arrangements. This has some implications for the likely effects of so-called 'direct consultation'. This form of health and safety consultation, by means of which employers are permitted to discharge their legal responsibilities to consult on health and safety simply by consulting with individual employees and without the assistance of any employee representative (so-called 'indirect consultation') was introduced in the provisions of the Health and Safety (Consultation with Employees) Regulations of 1996. This was too late for WIRS90 and too early for many cases to appear in WERS98. Interestingly, the idea that such direct consultation would be effective itself rested on an uncritical reporting of Reilly *et al*. The *Draft Proposals* for this legislation (HSC 1995) were supported by a cost benefit analysis which in turn invoked their work. It was claimed that where workforces had a representative but no consultative committee this reduced injury rates by 33 per cent and the further assumption was made that direct consultation would make for a similar improvement (Nichols 1996: 208). Since such consultation is in effect at the whim of management we would not expect it to have a beneficial effect on injury rates but this particular matter remains open to empirical verification in future industrial relations surveys.

In the meantime, the fact that we have not been able to arrive at a more precise conclusion than that the arrangements for occupational health and safety should not be left to management alone points to the need for further and more extensive research, both inside and beyond manufacturing. In our view the best way forward would be to

combine both quantitative and qualitative methods, as has been attempted in some North American research by Shannon *et al* (1996) and Lewchuck *et al* (1996). Whatever the way in which such research is conducted, however, it will need to go beyond the analysis of information on formal arrangements for representation (for example, about what proportion of representatives trade unions appoint). It will also need to examine such matters as whether joint committees have financial powers and are recognised as negotiating committees or whether they are, in reality, peripheral to mainstream management, in which case trade union influence may be brought to bear elsewhere in the organisation. There are many other possible indicators of trade union influence which also merit examination, such as agreements that specify support, training provision and facility time for health and safety representatives, as well arrangements for their consultation. Indeed, now that the apparent precision of our knowledge of the effects of health and safety arrangements has been seen to be ill-founded, there is good cause to re-examine a whole number of issues and dynamics that may affect the determination of health and safety. No small reason for doing so is that trade union presence has declined since WIRS90 and that, partly as a consequence of EU directives, there has been increased emphasis on management taking a lead in the development of health and safety systems. For the moment, though, as far as the multivariate analysis of WIRS is concerned, it is a matter of one step back and the hope that new steps forward can now be taken.

TABLES

Table 1
Types of Health and Safety Arrangements

HS1	joint consultative committee exclusively for health and safety matters with all employees chosen by unions
HS2	joint consultative committee exclusively for health and safety matters with some employees chosen by unions
HS3	joint consultative committee exclusively for health and safety matters with no employees chosen by unions
HS4	joint consultative committee for health and safety and other matters with all employees chosen by unions
HS5	joint consultative committee for health and safety and other matters with some employees chosen by unions
HS6	joint consultative committee for health and safety and other matters with no employees chosen by unions
HS7	a workforce representative but no committee
HS8	management deals with health and safety without any form of consultation

Table 2 Comparison of descriptive results from Reilly *et al* (1995) and those from the present study

Variables	*Sample mean in Reilly et.al. (1995)*	*(N)*	*Sample mean in our sample*	*(N)*
Constant	1.000		1.000	
Log(Size)	5.592		5.601	
Percentage union	64.2		63.9	
Percentage female	24.5		19.5	
Percentage manual	69.7		68.7	
Health and safety variables				
HS1	0.264	114	0.255	111
HS2	0.231	100	0.227	99
HS3	0.141	61	0.138	60
HS4	0.030	13	0.030	13
HS5	0.030	13	0.027	12
HS6	0.041	18	0.041	18
HS7	0.107	46	0.112	49
HS8	0.156	67	0.170	74
Two digit industries		432		436
Manufacturing nec	0.032	14	0.002	1
Metal manufacturing	0.044	19	0.048	21
Non-Metallic Minerals	0.051	22	0.048	21
Chemical and Man-Made Fibres	0.067	29	0.073	32
Other Metal Goods	0.060	26	0.061	27
Mechanical Engineering	0.139	60	0.151	66
Office Machinery	0.042	18	0.014	6
Electronic Engineering	0.095	41	0.128	56
Motor Vehicles	0.037	16	0.034	15
Other Transport	0.037	16	0.041	18

Instrument Engineering	0.023	10	0.023	10
Food, Drink and Tobacco	0.099	43	0.099	43
Textiles	0.030	13	0.025	11
Leather Goods	0.002	1	0.002	1
Footwear and Clothing	0.065	28	0.067	29
Paper, Printing etc.	0.079	34	0.080	35
Timber and Furniture	0.032	14	0.039	17
Rubber and Plastics	0.055	24	0.057	25
Other Manufacturing	0.009	4	0.005	2
Regions				
North	0.127	55	0.076	33
North-West	0.104	45	0.138	60
Yorks. And Humberside	0.139	60	0.103	45
West Midlands	0.106	46	0.133	58
East Midlands	0.037	16	0.103	45
East Anglia	0.076	33	0.034	14
South-West	0.132	57	0.076	33
South-East	0.053	23	0.135	59
London	0.049	21	0.056	24
Wales	0.074	32	0.046	20
Scotland	0.102	44	0.103	45
# of establishments	432		436	

Table 3
Parameter estimates.

Variables	*Coefficient estimates (standard errors) of Cox model in Reilly et.al. (1995)*	*Coefficient estimates (standard errors) of Cox model using our sample observations*
Constant	-4.608[c]	-3.747[0]
	(0.521)	(0.442)
Log(Size)	-0.174[c]	-0.305[0]
	(0.059)	(0.044)
Percentage union	0.001	-0.116
	(0.002)	(0.126)
Percentage female	-0.006[c]	-0.591[2]
	(0.004)	(0.245)
Percentage manual	0.016[c]	0.526[5]
	(0.004)	(0.273)
Health and safety variables		
HS1	-0.730[c]	-0.119
	(0.261)	(0.153)
HS2	-0.378	-0.062
	(0.249)	(0.143)
HS3	-0.591[c]	-0.211
	(0.249)	(0.139)
HS4	-0.395	-0.127
	(0.349)	(0.302)
HS5	-1.346[c]	-0.595[5]
	(0.474)	(0.296)
HS6	-0.366	-0.202
	(0.375)	(0.197)
HS7	-0.406	0.151
	(0.279)	(0.110)
HS8	Reference Group	Reference Group
Two digit industries		
Manufacturing nec	-0.529	-0223
	(0.462)	(0.998)
Metal manufacturing	-0.138	-0.149
	(0.307)	(0.248)
Non-Metallic Minerals	-0.320	-0.101
	(0.318)	(0.218)
Chemical and Man-Made Fibres	Reference Group	Reference Group

Other Metal	0.127	0.003
Goods	(0.293)	(0.210)
Mechanical	-0.578[c]	0.265
Engineering	(0.250)	(0.180)
Office	-0.030	-1.184
Machinery	(0.280)	(0.811)
Electronic	-0.359	0.005
Engineering	(0. 257)	(0.203)
Motor Vehicles	-0.465	-0.316
	(0. 298)	(0.301)
Other Transport	-0.910[c]	0.008
	(0. 256)	(0.264)
Instrument	-0.349	0.372
Engineering	(0. 467)	(0.272)
Food, Drink	-0.592[c]	-0.007
and Tobacco	(0. 259)	(0.223)
Textiles	-0.071	0.205
	(0. 390)	(0.252)
Leather Goods	-1.042	-0.272
	(1.770)	(0.961)
Footwear and	-1.145[c]	-0.652[2]
Clothing	(0.434)	(0.286)
Paper, Printing	-0.443	-0.234
etc.	(0.302)	(0.218)
Timber and	-0.933[c]	0.861[0]
Furniture	(0.312)	(0.194)
Rubber and	-0.212	-0.151
Plastics	(0.300)	(0.210)
Other	-0.399	0.346
Manufacturing	(0.775)	(0.541)
Regions		
North	1.250[c]	0.790[2]
	(0.258)	(0.347)
North-West	0.388	0.792[2]
	(0.273)	(0.338)
Yorks. and	0.500[c]	0.725[3]
Humberside	(0.258)	(0.338)
West Midlands	0.200	0.761[2]
	(0.267)	(0.335)
East Midlands	-0.218	0.235
	(0.383)	(0.353)
East Anglia	Reference	Reference
	group	group
South-West	0.321	0.345
	(0.276)	(0.350)
South-East	0.670[c]	0.305
	(0.314)	(0.339)
London	-0.692[c]	0.309
	(0.323)	(0.366)
Wales	0.362	1.103[1]

	(0.263)	(0.347)
Scotland	0.711[c]	0.291
	(0.258)	(0.353)
# of establishments	432	436

Note: c = statistical significance at the 5% level or better using two-tailed tests reported in Reilly *et.al*. (1995).

Table 4
The Simplified 1990 Model

Parameter	Coefficient Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept	-3.9124	0.4178	87.6927	<.0001
lsize	-0.3189	0.0391	66.4684	<.0001
%union	-0.1636	0.1015	2.5981	0.1070
%female	-1.1215	0.1920	34.1244	<.0001
%manual	0.5034	0.2377	4.4841	0.0342
HS17	-0.1651	0.0892	3.4294	0.0640
onedig3	0.2134	0.1066	4.0082	0.0453
onedig4	0.2404	0.1146	4.3991	0.0360
region1	1.1671	0.3344	12.1832	0.0005
region2	1.0674	0.3254	10.7588	0.0010
region3	1.1647	0.3259	12.7709	0.0004
region4	0.9849	0.3243	9.2231	0.0024
region5	0.4277	0.3420	1.5638	0.2111
region7	0.7225	0.3380	4.5699	0.0325
region8	0.5654	0.3292	2.9493	0.0859
region9	0.6091	0.3554	2.9376	0.0865
region10	1.4295	0.3374	17.9525	<.0001
region11	0.6325	0.3416	3.4290	0.0641

Table 5 Descriptive results and parameter estimates from WERS 98 (private manufacturing)

Variables	*Sample mean in our sample*	*(N)*	*Coefficient estimates*	*(standard errors) of Cox model using our sample observations*
Constant	1.000		-2.685[0]	(0. 233)
Log(Size)	5.168		-0.444[0]	(0.030)
Percentage union	33.2		-0.062	(0.138)
Percentage female	27.9		0.361[4]	(0.178)
Percentage manual	65.9		1.486[0]	(0.189)
Health and safety variables				
HS1	0.093		0.448[1]	(0.162)
HS2	0.103		0.473[0]	(0.141)
HS3	0.409		0.361[0]	(0.139)
HS4	0.003		-0.371	(1.099)
HS5	0.007		-0.163	(0.471)
HS6	0.079		0.615 [0]	(0.126)
HS7	0.165		-0.055	(0.113)
HS8	0.141		Reference Group	
Two digit industries				
Food prod. beverages	0.113		-0.167	(0.139)
Textile and text. prod	0.065		-0.938 [0]	(0.183)
Leather and leather prod.	0.038		-0.610 [0]	(0. 187)
Wood and wood prod	0.003		-2.167[11]	(1.350)
Pulp, paper, publishing and printing	0.086		-0.850[1]	(0.162)
Coke, refined petroleum	0.003		-2.291[1]	(0.818)
Chemicals and	0.079		-0.587[0]	(0.155)

chemical prod.			
Rubber and plastic prod.	0.055	0.959[0]	(0.130)
Other non-metallic miner.	0.038	-0.896[0]	(0.234)
Basic metals and fabricated	0.103	0.348[1]	(0.124)
Machinery and equipment	0.079	-0. 235[9]	(0.140)
Electrical and optical equip.	0.165	-0.732[0]	(0.138)
Transport equipment	0.072	-0.038	(0.140)
Manufacturing nec.	0.024	Reference Group	
Regions			
North	0.034	-0.931[0]	(0.149)
North-West	0.096	-0.369[1]	(0.134)
Yorks. and Humberside	0.041	-0.220	(0.220)
West Midlands	0.079	0.351[0]	(0.125)
East Midlands	0.110	-0. 354[1]	(0.131)
East Anglia	0.120	Reference group	
South-West	0.161	-0.274[2]	(0.121)
South-East	0.100	0.285[2]	(0.124)
London	0.048	-1.004[0]	(0.206)
Wales	0.113	-0.571[0]	(0.126)
Scotland	0.093	-0.503[0]	(0.141)
# of establishments	291	291	

Table 6 The Cox Corrected Logistic Estimates for WERS 98 Using Amalgamated Groups of Variables

Analysis of Maximum Likelihood Estimates

Parameter	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept	1	-2.7838	0.2145	168.3794	<.0001
lsize	1	-0.3545	0.0240	218.6723	<.0001
perunio	1	-0.6113	0.1158	27.8843	<.0001
perfema	1	-0.4312	0.1475	8.5419	0.0035
permanu	1	1.6429	0.1777	85.4355	<.0001
HS17	1	-0.0473	0.0828	0.3257	0.5682
onedig3	1	-0.2988	0.0765	15.2591	<.0001
onedig4	1	-0.0755	0.0713	1.1208	0.2897
sreg1	1	-0.7456	0.2447	9.2865	0.0023
sreg2	1	-0.3079	0.1296	5.6440	0.0175
sreg3	1	-0.3202	0.2065	2.4031	0.1211
sreg4	1	0.6277	0.1192	27.7399	<.0001
sreg5	1	-0.1134	0.1276	0.7900	0.3741
sreg7	1	-0.0711	0.1178	0.3645	0.5460
sreg8	1	0.3017	0.1196	6.3615	0.0117
sreg9	1	-0.7956	0.2028	15.3948	<.0001
sreg10	1	-0.1925	0.1179	2.6668	0.1025
sreg11	1	-0.3657	0.1355	7.2855	0.0070

TECHNICAL APPENDIX

This Appendix presents information on the assumptions, definitions and descriptive statistics used in our analysis of the WIRS/WERS data sets.

This Working Paper is largely a replication study and our experience in conducting it has led us to believe that such detail is necessary if we are to open our own work to critical examination.

Section A
Assumptions Made in Obtaining a Sample Similar to the One Used in Reilly et.al. (1995) from WIRS3

The following assumptions were made for the formulation of variables used in Reilly, Paci and Holl (1995).

1. Values equal or greater than 9997 are set equal to missing values for the variables:
- NOI1Y If P3 Any types of injury (1=Yes, 2=No injuries) is greater than 2.
- P4 Taken together, how many of these injuries have occurred at this establishment in the past year?
- MANFTUN Full-time manual workers who are in a union
- TOTEMP Total employment
- TOTEMP1Y Total employment last year
- MANFT Full-time manual workers

2. Values equal to zeroes or equal or greater than 9997 are set equal to zeroes for the variables:
- MANFUSK Female unskilled manual workers
- MANFSSK Female semi-skilled manual workers
- MANFSK Female skilled manual workers
- MANTUSK Total unskilled manual workers
- MANTSSK Total semi-skilled manual workers
- MANTSK Total skilled manual workers

3. If there were injuries in the establishment last year and if last year's total employment numbers are missing then TOTEMP1Y is put equal to TOTEMP.

4. Five values of MANFTUN, which were greater than values of MANFT, are corrected by equalisation.

Deleted observations

All missing values of the variables above are deleted from the data set and there were a total of 467 observations for private manufacturing industry left in the analysis. There were some partial missing values for the series used in the regressions, so the total number of observations in the models decreased to 436.

Allocation of Cases to HS categories
In order to compute the total number of cases in categories HS3 and HS6 (that is for committees where no members were chosen by trade unions), for joint arrangements in establishments where no trade union members were present, we

added cases where there were either committees for health and safety or for health and safety and other matters in these establishments, to cases of such committees in establishments where there were trade union members but where no members of health and safety committees had been chosen by unions. In addition, 10 establishments that were coded as zero in response to the question about how health and safety matters were dealt with were added to HS8 since we assumed that this response was indicative of the absence of joint arrangements. At this point almost 99 per cent of establishments in our sample had been allocated we added the remaining 1 per cent to HS7 in order to bring this mean up to a figure closer to the sample mean for this category in Reilly *et al*.

Section B
Assumptions Made in Obtaining a Sample Similar to the One Used in Reilly et.al. (1995) from WERS 1998.

The following assumptions were made for the formulation of variables used in Reilly, Paci and Holl (1995).

1. if totemp1y=0 then totemp1y=.

2. if perunio=. then perunio=0

2.2. Filtering

Three data files were merged for the analysis. These are mq98fin (2191), wrq98 (918) and region (2191). After merging the files, the following filter was used to choose the observations: if 1<=astatus<=2.

3. Descriptive results and model estimations

The table below reports definitions and descriptive statistics of the variables from WERS 1998 to compare with Reilly et. al. (1995).

Variable	Label
SERNO	Serial number
EST_WT	Establishment weight, based to 2,191 observations
GROSSWT	Establishment weight, based to population of GB workplaces with 10 or more employees
EMP_WT	Employee weight
noi1y	Number of injuries, last year
totemp1y	Total employment, last year
IR	The total number of employees who have sustained a listed injury in the last 12 months divided by total number of establishment employees
lsize	Log (number of employees)
perunio	The percentage of full-time manual workers who are in a union
perfema	The percentage of total establishment employees who are women
permanu	The percentage of total establishment employees who are manual (unskilled, semi-skilled or skilled workers)
ind1	Manufacturing industry
ind2	Electricity gas and water
ind3	Construction industry
ind4	Wholesale and retail trade
ind5	Hotel and restaurant industry
ind6	Transport, storage and communication industry
ind7	Financial intermediation industry
ind8	Real estate, renting and business activities
ind9	Public administration and defense
ind10	Education
ind11	Health and social work
ind12	Other community, social and personal service activities
man1	Manufacture of food products, beverages and tobacco
man2	Manufacture of textiles and textile products
man3	Manufacture of leather and leather products
man4	Manufacture of wood and wood products
man5	Manufacture of pulp, paper products; publishing and printing
man6	Manufacture of coke, refined petroleum products and nuclear fuel
man7	Manufacture of chemicals and chemical products

man8	Manufacture of rubber and plastic products
man9	Manufacture of other non-metallic mineral products
man10	Manufacture of basic metals and fabricated metal products
man11	Manufacture of machinery and equipment not elsewhere classified
man12	Manufacture of electrical and optical equipment
man13	Manufacture of transport equipment
man14	Manufacturing not elsewhere classified
sreg1	North
sreg2	North-West
sreg3	Yorks and Humberside
sreg4	West Midlands
sreg5	East Midlands
sreg6	East Anglia
sreg7	South-West
sreg8	South-East
sreg9	London
sreg10	Wales
sreg11	Scotland
aveanpay	Average annual pay
HS1	Health and Safety Committee 1 as in Reilly et.al (1995)
HS2	Health and Safety Committee 2 as in Reilly et.al (1995)
HS3	Health and Safety Committee 3 as in Reilly et.al (1995)
HS4	Health and Safety Committee 4 as in Reilly et.al (1995)
HS5	Health and Safety Committee 5 as in Reilly et.al (1995)
HS6	Health and Safety Committee 6 as in Reilly et.al (1995)
HS7	Health and Safety Committee 7 as in Reilly et.al (1995)
HS8	Health and Safety Committee 8 as in Reilly et.al (1995)
HS16	Health and Safety Committee HS1-6 as in Reilly et.al (1995)
HS17	Health and Safety Committee HS1-7 as in Reilly et.al (1995)
HS161	Health and Safety Committee HS1,2,4,5 as in Reilly et.al (1995)
HS162	Health and Safety Committee HS3,6 as in Reilly et.al (1995)

Table 1. Variable definitions.

Variable	N	N Miss	Minimum	Mean	Maximum	Std Dev
SERNO	291	0	11003.00	12767.09	14457.00	870.6543771
EST_WT	291	0	0.0717760	1.1400361	18.6862021	2.0119072
GROSSWT	291	0	4.6013343	113.4650287	1197.91	212.0943836
EMP_WT	291	0	0.2218259	1.6600071	31.0842062	2.5874866
noily	291	0	0	3.7869416	200.0000000	14.9883622
totemply	288	3	9.0000000	418.1979167	15471.00	1151.04
IR	288	3	0	0.0144597	0.3174603	0.0366844
lsize	288	3	2.1972246	5.1677972	9.6467226	1.2334339
perunio	291	0	0	0.3318498	0.9803922	0.3357386
perfema	291	0	0	0.2789717	0.9111111	0.2139051
permanu	291	0	0	0.6585386	0.9818182	0.2223360
ind1	291	0	1.0000000	1.0000000	1.0000000	0
ind2	291	0	0	0	0	0
ind3	291	0	0	0	0	0
ind4	291	0	0	0	0	0
ind5	291	0	0	0	0	0
ind6	291	0	0	0	0	0
ind7	291	0	0	0	0	0
ind8	291	0	0	0	0	0
ind9	291	0	0	0	0	0
ind10	291	0	0	0	0	0
ind11	291	0	0	0	0	0
ind12	291	0	0	0	0	0
man1	291	0	0	0.1134021	1.0000000	0.3176299
man2	291	0	0	0.0652921	1.0000000	0.2474661
man3	291	0	0	0.0378007	1.0000000	0.1910424
man4	291	0	0	0.0034364	1.0000000	0.0586210
man5	291	0	0	0.0859107	1.0000000	0.2807148
man6	291	0	0	0.0034364	1.0000000	0.0586210
man7	291	0	0	0.0790378	1.0000000	0.2702625
man8	291	0	0	0.0549828	1.0000000	0.2283394
man9	291	0	0	0.0378007	1.0000000	0.1910424
man10	291	0	0	0.1030928	1.0000000	0.3046038

man11	291	0	0	0.0790378	1.0000000	0.2702625
man12	291	0	0	0.1649485	1.0000000	0.3717734
man13	291	0	0	0.0721649	1.0000000	0.2592066
man14	291	0	0	0.0240550	1.0000000	0.1534839
sreg1	291	0	0	0.0343643	1.0000000	0.1824768
sreg2	291	0	0	0.0962199	1.0000000	0.2954006
sreg3	291	0	0	0.0412371	1.0000000	0.1991807
sreg4	291	0	0	0.0790378	1.0000000	0.2702625
sreg5	291	0	0	0.1099656	1.0000000	0.3133858
sreg6	291	0	0	0.1202749	1.0000000	0.3258431
sreg7	291	0	0	0.1615120	1.0000000	0.3686365
sreg8	291	0	0	0.0996564	1.0000000	0.3000573
sreg9	291	0	0	0.0481100	1.0000000	0.2143672
sreg10	291	0	0	0.1134021	1.0000000	0.3176299
sreg11	291	0	0	0.0927835	1.0000000	0.2906286
aveanpay	291	0	0	0.0656761	3.0239330	0.2158481
HS1	291	0	0	1.0000000	0.0927835	0.2906286
HS2	291	0	0	1.0000000	0.1030928	0.3046038
HS3	291	0	0	1.0000000	0.4089347	0.4924841
HS4	291	0	0	1.0000000	0.0034364	0.0586210
HS5	291	0	0	1.0000000	0.0068729	0.0827596
HS6	291	0	0	1.0000000	0.0790378	0.2702625
HS7	291	0	0	1.0000000	0.1649485	0.3717734
HS8	291	0	0	1.0000000	0.1408935	0.3485110
HS16	291	0	0	1.0000000	0.6941581	0.4615568
HS17	291	0	0	1.0000000	0.8591065	0.3485110
HS161	291	0	0	1.0000000	0.2061856	0.4052622
HS162	291	0	0	1.0000000	0.4879725	0.5007164

Allocation of Cases to HS Categories

We found cases where there are committees specifically for health and safety in which there are no, some or all employee representatives appointed by trade unions, from ICOMMTEE, IJOINT, DWHICH, IREPNUM. We found cases where there are joint consultative committees also dealing with health and safety and other matters with no, some or all employee representatives appointed by trade unions from DJOINT, DAPPOINT and we found cases where there are no health and safety committees but there are worker representatives or where management deals with health and safety in the absence of representatives from ICOMMITEE, IOTHREP.

ACKNOWLEDGEMENT

This paper arises from a wider resraech project into arrangements for worker representation financed by the Health and Safety Executive.

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NOTES

[1] Subsequently WERS in 1998 — Workplace *Employment* Relations Survey

[2] The reservation about HS5 is made on the grounds that only 3 per cent of establishments in their sample fell into this category.

[3] Further detail on the allocation of cases to HS categories for WIRS90 is provided in the Technical Appendix Section B.

[4] Further detail on the allocation of cases to HS categories for WERS98 is provided in the Technical Appendix Section B.

[5] Burns are amongst the most common types of injury recorded in WERS 98 (Hillage et al 2000)

[6] We avoided making any estimations of the possible association between joint arrangements and measures of ill-health in WERS98 for two reasons: our purpose was to replicate the study of Reilly *et al* which concerned injuries only; and we also doubted the adequacy of a cross sectional survey like WERS to take account of latency issues in the relationship between the work environment and health.

[7] In a further exercise, we also used these methods on our WERS 98 data set. In a Poisson regression model we estimated a negative co-efficient for the effect of joint arrangements on injuries that was significant at the 4 per cent level. However, when we used a negative binomial model in order to account for the large total dispersion, although the co-efficient remained negative it was only significant at the 12 per cent level, indicating that the impact of joint arrangements could not be said to be significantly estimated.