Making linked employer-employee data relevant to policy.

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Edited by Alex Bryson, John Forth
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1 The Policy Relevance of Linked Employer-Employee Data

Alex Bryson[1] and John Forth[2]

The role of linked employer-employee data (LEED) in advancing understanding of labour markets is well-established in parts of Northern Europe. Recognising the potential of such data, the United States has devoted considerable resources to constructing LEED from existing administrative sources. In the European Union, there is a similar drive. In the United Kingdom, despite an excellent nationally-representative LEED survey[3] which has helped us understand the contours of industrial relations, and the recent emergence of some administrative LEED sources, the analysis of such data remains in its relative infancy. Furthermore, throughout the world, we believe that insufficient attention has been paid to the ways in which LEED data can make a contribution to policy analysis. This is the challenge to labour economists and other researchers as they seek to persuade national and supranational governments to commit sizeable resources to the production and analysis of these data.

It was in response to this challenge that the Department of Trade and Industry (DTI) and the Policy Studies Institute (PSI) ran a one-day workshop in London on the 16th September 2005, bringing together some of the principal LEED analysts from Europe and the United States. Their papers, brought together in this volume, deal with a variety of substantive issues. But all focus on how LEED have been used to bear down on questions of policy-relevance, and all identify the unique contribution that LEED have made to our understanding of labour markets and firms. They also touch on some of the technical and administrative problems encountered in generating such data, and the difficulties in ensuring that it is available at a time and in a form that can be readily digested by analysts and policy-makers in government and beyond.

The remainder of this introduction discusses the main 'types' of LEED, identifies their potential advantages over other data, illustrates how policy-relevant issues such as productivity can be tackled with LEED, and introduces the papers in this volume.

[1] Policy Studies Institute and Wertheim Fellow, Harvard Law School and NBER.
[2] National Institute of Economic and Social Research.
[3] The Workplace Employment Relations Survey (WERS) 2004. See http://www.dti.gov.uk/er/emar/wers5.htm

1.1 Types of LEED

There are two main 'flavours' or 'types' of LEED: longitudinal and cross-sectional. Longitudinal LEED are usually based on administrative data, while the richest cross-sectional LEED are based on surveys of workplaces and their employees, often conducted face-to-face. We elaborate on their respective advantages and disadvantages in turn.

The role of longitudinal LEED: These data track workers and their firms or workplaces over time. They are particularly suited to linking firm and workplace fortunes (labour productivity, employment growth, survival) to worker flows (entry and exit) and worker progression (tenure and wages) within the firm. One can identify human resource (HR) practices at firm and workplace level using information on entry wages, wage dispersion, wage progression, and rates of entry and exit from the employer, and link these to performance measures over time. Using the time-component of the data one can make causal inferences about the impact of alternative HR regimes, and switches in those regimes, on firm and workplace-level productivity and performance.[4] The construction of similar 'HR proxies' across national data sets would permit comparisons of the impacts of similar practices and procedures across countries, as well as within them. Longitudinal LEED also permit consideration of the extent to which productivity change observed in cross-section is driven by behavioural change within continuing employers, compositional change in employers due to entry and exit, or a combination.

The role of cross-sectional LEED: Cross-sectional survey-based data contain smaller numbers of observations than administratively-based LEED but are richer in covariates. These are usually collected using dedicated survey instruments, often in face-to-face interviews, with HR managers and employees. Nationally representative data of this type are available for the UK (1998 and 2004), Australia (1995), Canada (1999, 2001) and Norway (1989) while in France employer-based surveys (REPONSE 1998 and 2004) have been linked to administrative data on employees. The value of these survey-based LEED lies in the detailed information they contain regarding both policies and practices of workplaces across national economies, coupled with information on employees. In some cases they also contain information on employee attitudes. The available data items permit comparisons of avowed policies, on the one hand, and practices on the other, sometimes distinguishing between the simple incidence of a practice or procedure, and the extent to which it is 'embedded' within an organisation (in terms of coverage and its integration with other policies). The data on employee attitudes to jobs and to the employer also permit us to establish whether the causal mechanisms posited by Human Resource Management (HRM) and other academics do, in fact, obtain and, if so, where and under what conditions.

[4] One of the best and most recent examples of this sort of work is 'The Effect of HRM Practices and R&D Investment on Worker Productivity' by Frederik Anderson et al. (2005), SOLE Conference Paper.

Surveys can be combined with administrative data, as has occurred in countries like Norway, Denmark, Germany and France. This can permit analyses of longer-term impacts of practices and policies on workers and the firm that can be traced in the administrative data, as well as offering opportunities to investigate the antecedents of practice introduction. The combination of survey and administrative information can also be a means of cross-validating the HRM proxy measures generated through wage and other administrative measures and can be used to compare results using subjective and objective measures of productivity and performance, as has been done recently with the 2004 British Workplace Employment Relations Survey (Kersley et al., 2006).

1.2 Unique advantages to LEED

There are four ways in which LEED can offer unique insights into processes within establishments and in the labour market at large:

1. If there is something 'specific' to worker-firm matching which generates both costs and returns to both parties, a proper understanding of labour market dynamics requires observation of that match.

2. Analyses are enriched by data from both the employer and employee side such that otherwise unobserved features of the employment relationship can be accounted for in analyses, overcoming some of the biases inherent in data relying solely on employers or employees.

3. Multiple observations of employees within multiple workplaces permit analyses of the relative contributions to the distribution of pay and other labour market features that are attributable to within- and across-workplace dispersion.

4. Where LEED are longitudinal, one can tackle worker and employer selection processes and the antecedents and consequences of practice/worker adoption, thus permitting a more rigorous assessment of causal processes than might otherwise be the case.

We illustrate some of these points below in the context of research on labour productivity, but most of the points apply to other substantive issues. LEED offer insights into the determinants of labour productivity that are not possible using traditional techniques.

1.3 Illustrations of how LEED can tackle productivity and other policy-relevant issues

There are a number of policy-relevant issues to be addressed with LEED data. Some examples are outlined in a little more detail below, focusing on the substantive issue of labour productivity.

Antecedents of practice introduction: relatively little is known about the antecedents to practice adoption and longevity. This is interesting in its

own right, not least because some of the practices that studies have identified as potentially productivity-enhancing have not been widely adopted by firms. It may be that adopters are those who benefit most from such policies, either because there are heterogeneous returns to practices or because differences in the cost of adoption generate different net returns. A better understanding of the conditions under which particular policies are adopted, or abandoned, will help us better understand this issue, including the potential endogeneity of particular practices. LEED can make a particular contribution where they contain information on worker flows into and out of plants at moments of technological adoption, and when they measure employee reactions to technological innovation.

Heterogeneous impacts: the returns to particular practices may be heterogeneous, in which case one would expect differences in estimated effects of treatment-on-the-treated and treatment-on-the-non-treated. Current theories and studies suggest this heterogeneity would manifest itself along dimensions such as firm size and the nature of product market competition. With longitudinal LEED one might be able to identify which firms benefit from which policies, and under what conditions. Analyses of this sort could address whether there are 'best practices' that, if adopted, can work for 'all', or whether firms must seek a 'fit' between their policies and the external environment they find themselves in. Where data are available on the employees at the firm the analyst is better able to establish what practices should 'fit' given the composition and orientations of the workforce. Answering these questions is a prerequisite to engaging with policy questions regarding practice transfers across firms and countries.

Within and across firm variance in productivity: Little is known about the contributions of within and across-firm variance in productivity to variance at economy-level. One might establish how 'bunched' firms are in terms of their productivity levels and growth, and compare across countries. There will be particular interest in the tails of the productivity distribution, that is, high and low performers, and why it is that the UK seems to have a particularly long low-productivity tail. This raises a fundamental question: if firms can survive with low productivity, what are they managing to maximise in order to survive? Equally important is the degree to which workers' productivity differs within and across the workplaces in a firm. Where data sets contain firm-level identifiers one can explore the degree to which within-firm variance in productivity and growth are related to policies and practices.

Roles of compositional and within-firm change in productivity dynamics: Whereas something is known about time-series trends in productivity across countries, little is known as to whether they are driven by compositional change in firms or by behavioural change in continuing workplaces. Links between productivity and labour turnover – including job shedding and job creation – are also best tackled with longitudinal LEED.

1.4 Practical difficulties in using LEED

If the compilation and analysis of LEED data were straightforward, it would probably have become widespread in Britain already. In practice, there are a number of practical problems that need to be overcome before one can undertake this sort of research. First, the data need to be collected. This can be expensive, requiring government departments and others to devote considerable resources to the issue. Longitudinal data require investments to track units over time and to minimise attrition, while rich survey-based cross-sectional data are expensive to collect. In some cases, changes in rules and regulations are required to join up existing data sets.

Second, the data need to be made available to researchers for analysis. This is often very difficult, especially where the data were collected from employers or employees as part of statutory obligations. In such circumstances, the conditions under which data can be passed to third parties is very limited, and may require researchers to be employees of government agencies, or conduct analyses in secure environments on government premises. Confidentiality issues can arise even where data are anonymised. Even where it is practically possible to link different data sets with unique identifiers, there are a range of reasons why this may not be possible, including refusals by one or other arm of government to share its data with others, even if legally entitled to do so.

Third, data must be in a format allowing researchers to manipulate and analyse them. This can prove very challenging, especially when data collection is primarily motivated for non-research reasons. Even when analysts are permitted to manipulate data, they may follow different protocols from one another, making it difficult to compare results across analysts: this is a particular problem when comparing data over time or across countries. All of this can take time, so that a particular problem can be the timeliness of any analyses conducted. For LEED to have an impact on policy formation and execution, it needs to be available for analysis soon after collection.

1.5 The papers presented

Eight papers were presented at the September 2005 DTI-PSI workshop[5]. This publication contains shortened versions of seven of them. These are briefly summarised below.

Ed Lazear and **Kathryn Shaw**'s seminal paper uses LEED from eight countries to explore firm wage structures and promotion, hiring and mobility patterns. The main finding is that countries are remarkably similar in their wage structures and wage changes. Most wage variation is within firm. Although there is a good bit of variation between firms in every country, firms have a large range of the wage distribution within. With respect to wage growth, although firms differ with respect to the

[5] They can be downloaded at: http://www.psi.org.uk/events/event.asp?event_id=91

average raises they give in a particular year, the standard deviation of raises within firm is between 10 per cent and 20 per cent, even when average raises are close to zero. This is most consistent with the view that firms respond to outside pressure (either market or governmental) to raise workers' wages commensurate with some occupational or skill standard. Mobility levels differ across countries but, on the whole, high wage firms have lower mobility than low wage firms and entry and exit rates are positively correlated, with entry rates being somewhat larger than exit rates in most country years.

David Margolis, using data for France, shows that takeovers have important consequences for employment that are only visible in LEED. Characterising acquired and acquiring firms in terms of their compensation policies and human resource management practices, he shows that firms behave essentially as predicted by economic theory concerning mergers and acquisitions. Some takeovers seem to be driven by ex-ante perceptible differences in firm characteristics, most notably compensation policy, that could be perceived as sources of inefficiency to be improved upon after the takeover occurs. Acquired firms tend to be significantly more indebted but with significantly higher returns on assets than the firms that acquire them, consistent with the idea that mature firms "buy in" opportunities for growth while young firms obtain their necessary financing by being integrated into a larger entity. Analysis of post-transaction continued employment shows that workforce reorganisations performed by the new entity target similar types of workers in the acquired and acquiring firms, suggesting that acquiring firms may use the takeover event as a justification for undertaking a broader restructuring, integrating the acquired firm's employees into the new entity and keeping only the most appropriate workers from both firms. Workers who leave the firm after takeover tend to have low job tenure, white-collar skills and unobserved characteristics that give them low market value. For the most part, these are the workers who find it easiest to get new jobs following a mass layoff, which means that employment services may not need to be directed as intensely to employees laid off after a takeover since these workers are likely to be able to find new jobs relatively easily even in the absence of additional assistance.

Harald Dale-Olsen's paper for Norway indicates that fringe benefits can be important in managing firms' human resources since workers' quit behaviour is very sensitive to the offering of fringe benefits. Establishments also achieve higher productivity by offering more fringe benefits, although it is not clear whether this is caused by workers providing more effort or if it is caused by saving recruitment costs, and they also have higher survival rates than other establishments. This is as expected, since a strategy that yields improved productivity for the establishment should imply a higher survival rate.

From a policy point of view this article thus advocates the use of fringe benefits as part of the compensation policies offered to workers by employers.

Nabanita Datta Gupta and **Tor Eriksson's** paper uses Danish LEED to investigate the effect of new workplace practices on the gender wage gap. The theory as to whether or not these new work practices can be the *great equaliser* when it comes to the persistent pay gap that exists between men and women is ambiguous. Empirical evidence presented in the paper indicates that wage gains from the introduction of new workplace practices (such as self-managed teams, project organisation and job rotation schemes) seem to accrue mainly to salaried males, and in fact, wage losses accrue to females so that the gender gap in pay widens at the level of the firm. In most instances male wages increase and female wages are reduced in firms that offer these practices. When both groups get increases, then males obtain a relatively larger increase. The positive effects on male wages are not a result of worker sorting. Nor do they seem to be due to women having fewer possibilities to exploit potential gains from the practices because of family responsibilities.

The paper by **John Addison, Lutz Bellmann, Thorsten Schank, and Paulino Teixeira** explores demand for different types of labour using German panel LEED, uncovering evidence that is not in accord with most studies to date. Within manufacturing, unskilled workers appear to be substitutes for more skilled workers whereas, in services, there is little evidence that unskilled and skilled workers are affected by each other's wage. Increased trade does not appear to have adverse consequences for any skill group. Perhaps most at odds with previous research is that they find no support for skill-biased technical change: neither upgrading to state-of-the-art equipment nor investing in information technology has negative consequences for any skill categories. The authors suggest that if, as is often argued, rigid wages lie at the heart of the German employment problem, the evidence suggests some value in subsidising unskilled work.

Using British WERS98 LEED, **Mark Bryan** shows that workplace-level hours 'policies' or norms are strong drivers of the hours that employees end up working. Overall, they account for nearly a third of the variation in hours explained by the analysis, and they have an especially large effect in the private services sector. Hours' variation within workplaces accounts for over a third of the explained variance, with skill and occupation as well as family characteristics all affecting hours within workplaces. Just over a quarter of the variation in hours is explained by a sorting process of workers to firms. Workers in occupations that entail long hours also tend to be in workplaces where, on average, everyone works longer hours.

Finally, in their paper **Alexander Hijzen, Peter Wright** and **Richard Upward** ask: what happens to workers' earnings when their employer goes out of business? They provide the first analysis that explicitly estimates the earnings losses due to enterprise closure in the UK using data from the New Earnings Survey Panel. They show earnings losses are primarily associated with periods of non-employment rather than with falls in wages for those who are re-employed. This is in sharp contrast to findings

from the US, but consistent with the only other UK study on worker displacement. Second, earnings losses do not appear to be particularly long-lived. After controlling for observable characteristics displaced workers earnings are not lower than non-displaced workers five years after displacement.

2 Wage Structure, Raises and Mobility

Edward P. Lazear and Kathryn L. Shaw[6]

2.1 Introduction

This paper uses linked employer-employee data from a number of different countries in an attempt to generalise about firm wage structures and promotion, hiring and mobility patterns. This is principally done by examining wage heterogeneity within and across firms, and also across countries. The relationships with national income distributions, worker mobility and productivity are also examined. Through this analysis, the paper aims to address a number of specific questions:

1. What is the structure of wages within firms and how does that structure compare to the structure of wages for the country as a whole? Specifically, is the distribution of wages within firms less diffuse than that for the country as a whole and how much variation is there in the average wage between firms?
2. Is there much within-firm variation in wage growth rates? Does "a rising tide lift all ships?" When a firm experiences a good year and average wages rise considerably, do all workers share in the prosperity?
3. To what extent is there heterogeneity in wage raises between firms?
4. How does the extent of heterogeneity in wage levels and raises affect worker mobility and productivity?

Until very recently, it would have been impossible to answer these questions because they require data to be available on all of the workers in a firm, for a large number of firms. But now, the required data are available from a number of different countries. These data sets, from many European countries and from the US, contain information on all workers in those countries (or at least on a large subset of those workers). As a result, it is possible to examine the worker in the context of his or her entire firm.

This is not the first time such questions have been asked. However, existing studies (Lazear, 1992; Baker, Gibbs, and Holmstrom, 1994a, b) have made use of data on single firms. The advantage of these studies is that they examine the entire firm, thereby analysing promotion paths, determinants and consequences, as well as wage determination and structure. The disadvantage is that because the studies each cover single

[6] Stanford Graduate School of Business.

firms, it is difficult to generalise the results. This problem is accentuated because not all of the results are consistent across the various studies. Panel datasets that use the individual as the unit of analysis and sample randomly from a large population are also inadequate, as they typically have very few observations from the same firm. As a consequence, neither a firm's wage structure nor its hiring and promotion patterns can be gleaned from traditional data. In contrast, the data presented in this paper cover all workers in a large number of firms.

2.2 Wage structures, mobility and productivity

The implications of wage structures for income inequality, worker mobility and productivity can be illustrated by means of examples.

Consider first the possibility that every firm is a microcosm of the overall economy. All firms share the same distribution of income within the firm as does the entire economy. In this case, the firm in which a worker finds himself may be of little consequence, because all incomes and presumably opportunities are represented. Alternatively (and equally implausibly), all firms have but one wage. All workers within the firm earn the same amount and the way by which a non-degenerate income distribution is generated is that firms differ in the single wage that they pay. If the latter characterises the labour market, then the only way for a worker to change his earning situation is to change firms. Were mobility limited, the consequence of initial firm assignment for income inequality could be much more significant.

Different hiring and pay policies may also lead to different levels of productivity. For example, it may be that firms with too compressed a wage policy may experience lower productivity, because in the presence of strict job-based wage setting, a worker wanting a higher wage must move to another firm. Firms with compressed wage policies may therefore see competitors stealing away their best workers, which might lower productivity for the firm and perhaps even for the country as a whole.

Theory implies different patterns in wage heterogeneity within and across firms. The theory of human capital states in its most basic form that workers are paid on the basis of their general skills. Were human capital the only determinant of wages, it would not matter at all in which firm a worker finds himself. The competitive labour market would require that all firms pay the worker exactly the same amount, irrespective of the firm in which he works. Otherwise, other firms could easily steal him away by paying a slightly higher wage and capturing the profits. This is most easily described as a spot market view of the labour market, where competition forces workers to be paid on the basis of the productivity, which is in turn reflected perfectly in measurable skills. Nevertheless, a complication to human capital theory was introduced even in Becker's (1962) early paper on human capital, where he defines 'firm-specific' human capital. This is

skill that affects productivity in the worker's current firm, but not in other firms in the economy. It is important to distinguish between general and firm-specific human capital. The latter creates an immediate reason why wages might differ from firm to firm, even for the same worker. For example, a worker who had a great deal of firm-specific human capital and who encountered an unanticipated job loss, say because his plant closed, would suffer a wage reduction in moving to another firm because the skills used at the first firm would not all be transferable to the new firm.

A purely institutional theory of wage determination has the same implication as the basic theory of human capital, namely, that a worker's wage is independent of the firm in which he is employed. Suppose that wages were set by a central authority and the authority set the wage based on the worker's occupational title, years of schooling or years of experience, perhaps for reasons of equity. Each of these may be independent of the worker's level of productivity within the firm. There are, however, other theories that imply heterogeneity across firms. Tournament models[7], for example, which are most applicable to white collar workers, suggest that wage structures within firms serve incentive purposes and that it is the structure, rather than the current wage that determines the strength of the incentive. In tournament theories, workers at higher levels of the firm's hierarchy receive pay that has impacts on those below them. Lower level workers want to become higher level workers and their desire to climb the internal job ladder depends on the raise that workers receive when they are promoted (non-monetary as well as monetary). Since the optimal size of the raise depends on internal conditions like the riskiness of the activity and the shape of the firm's hierarchy, tournament theory suggests that workers will be treated differently in different firms, even though they have the same basic characteristics. Bargaining theories, where the outside alternatives affect the actual wage level as well as the worker's value to the firm, also create a separation between the wage that a particular firm pays and the 'market', which is less well defined, once contracting and bargaining are taken into account.

The types of data that are available in the new data sets allow researchers to get a good start at examining these various issues.

2.3 The data

The data come from all of the Scandinavian countries (Denmark, Finland, Norway, Sweden) and from Belgium, France, Germany, and Italy. The sampling frames are different across countries, but with the exception of Italy, each country provides a substantial number of observations coming from a given firm across a large number of firms. In some countries, e.g. Denmark and Norway, every worker in the entire country is represented. There are two data sets for Sweden. One (Oyer 2006) covers only a subset of the country but provides rich data on jobs. The other data set (Edin,

[7] Lazear and Rosen (1981)

Holmlund, and Skans, 2006) is more comprehensive, but does not have the same detail on some variables that are of interest.

Key to using the data is that there is substantial information on a cross section of workers within each firm across many firms to draw inferences about wage structure, worker mobility, and promotion and hiring patterns. Only Italy falls short on this score, but the Italian authors provide information on synthetic firms by taking data from similar industries and locations and blending them into cells, which they treat as firms. The French data are a 1/25 sample, but this allows computation of wage distributions at least for the larger firms.

2.4 Wage levels

If all firms were alike, then their wage distributions would be identical to the distribution for the country as a whole as shown in Figure 2.1a. At the other extreme, firms might treat their workers very similarly, and the variation in wages throughout the country could be accounted for by differences in the mean value of wages between firms, as shown in Figure 2.1b.

Figure 2.1a: Within firm variation; no between firm variation PDF for country, PDF for median and extreme firms all identical

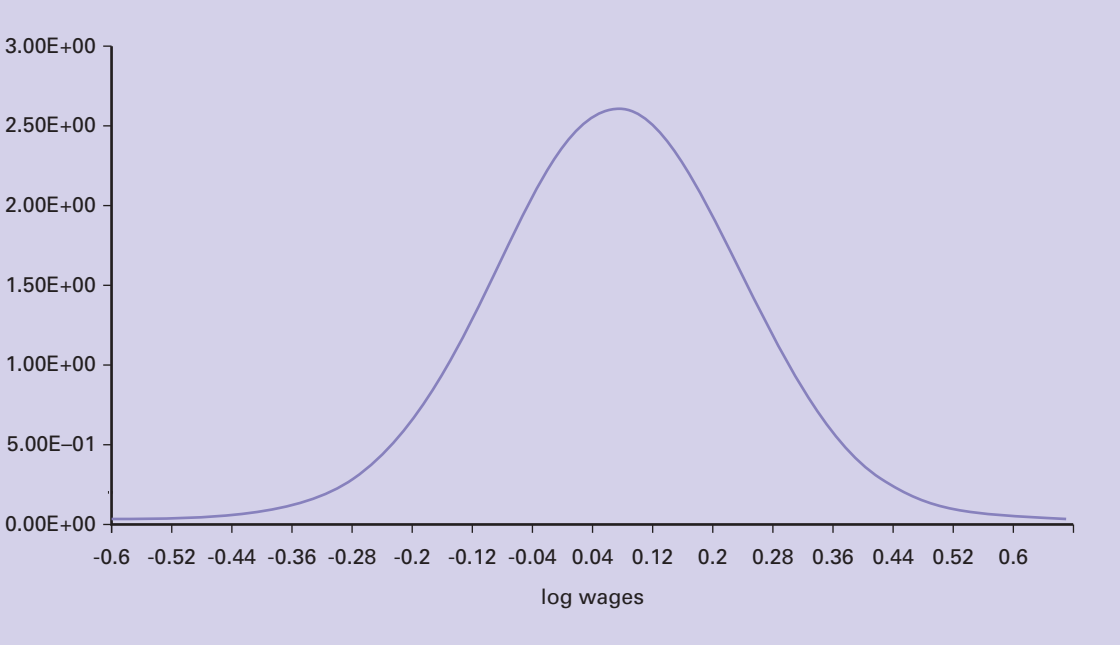


Figure 2.1b: Within-firm similar; between firms different

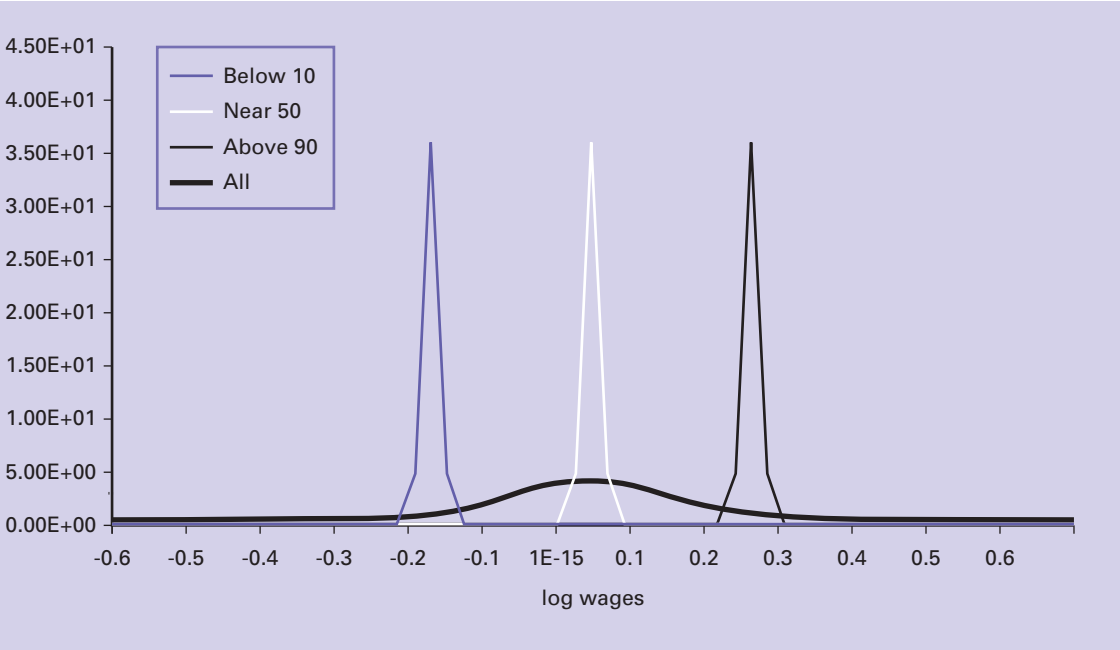


Figure 2.1c: Norway 1997

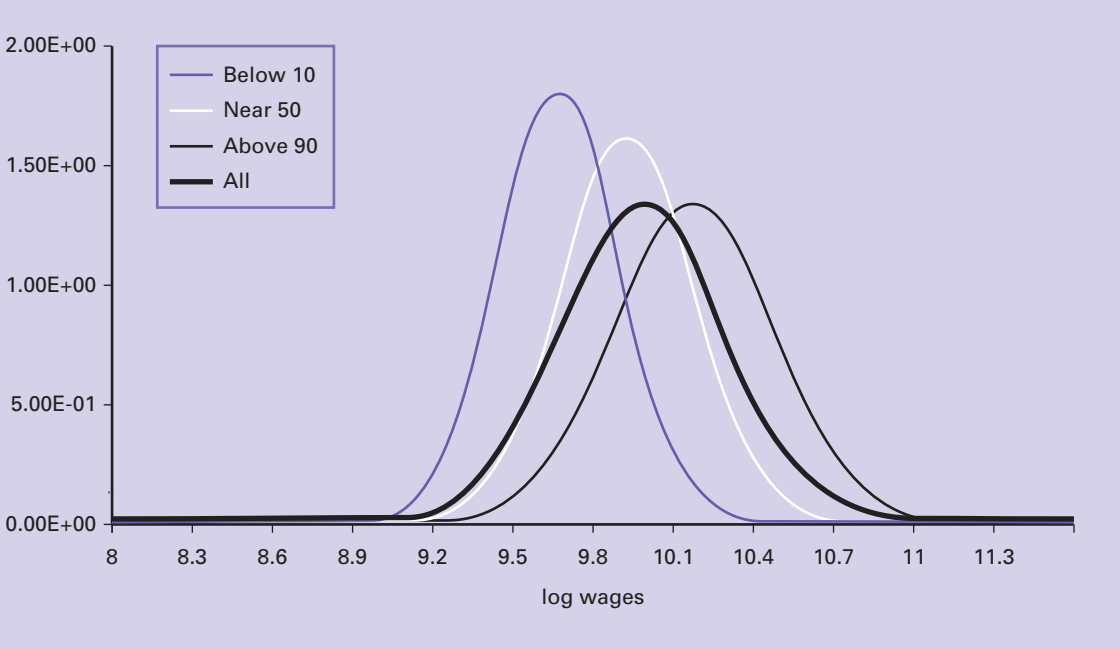
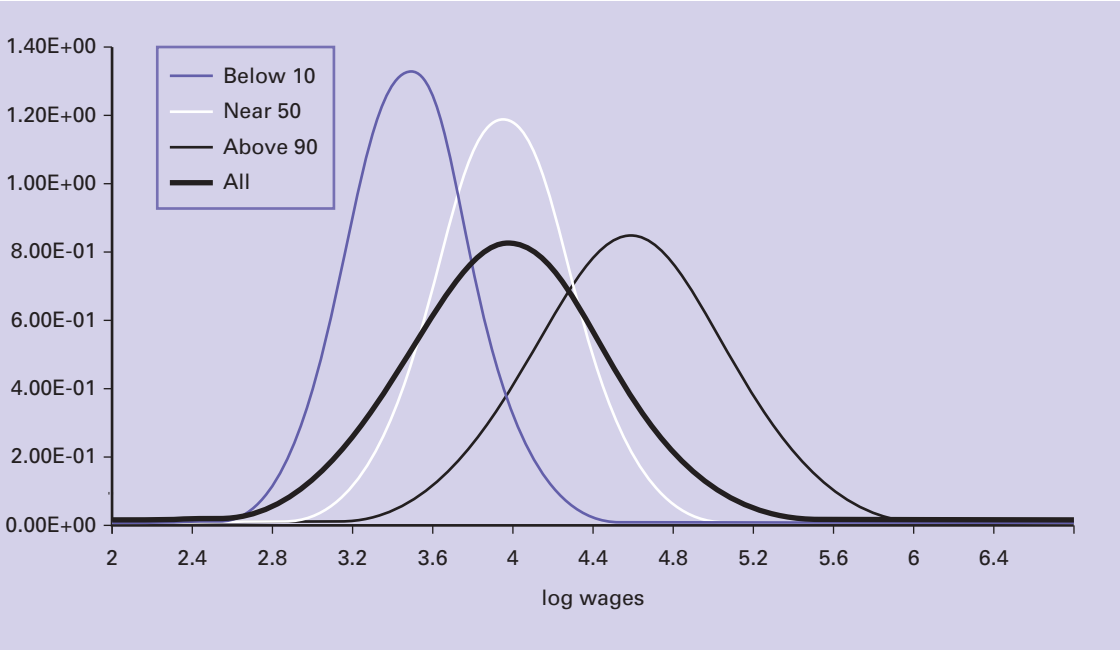


Figure 2.1d: France 1996



Most countries, with the significant exception of France, have similar patterns. The coefficient of variation in individual wages within most countries is around 0.3 (Figure 2.2). Also, whilst the mean wages of firms are almost as high as the population mean wage, the variance of wages within firms is about 60 to 80 per cent of the variance of wages for the population. (Figure 2.3 compares standard deviations). The fact that the within firm wage variance is smaller than the variance for the overall distribution suggests firms make up parts of the overall distribution as shown in Figure 2.1b. But there is also considerable variation within firms.

The typical pattern is illustrated by Figure 2.1c, for Norway. Norway's situation is a compromise between Figure 2.1a and Figure 2.1b, but leaning more to Figure 2.1a than to Figure 2.1b. The overall distribution for the country as a whole is much more dispersed than that for the typical firm. The actual distribution for the typical firm that is below the 10th percentile is considerably tighter than that for the country as a whole. The same is true for the typical firm around the median and for the typical firm with mean wages in the top 10 per cent of firms.[8] Although there is some overlap, the wage distributions of high wage and low wage firms are by and large disjoint. Still, firms have considerable dispersion within. The typical firm is not the almost spiked distribution as shown in Figure 2.1b.

[8] The typical firm was constructed by averaging the mean and standard deviation of log wages for firms in the 0-10th percentile, the 45-55th percentile and the 90th and above percentile. The distributions were constructed assuming that wages are distributed log normally.

Figure 2.2: Country coefficient of variation (individual data)

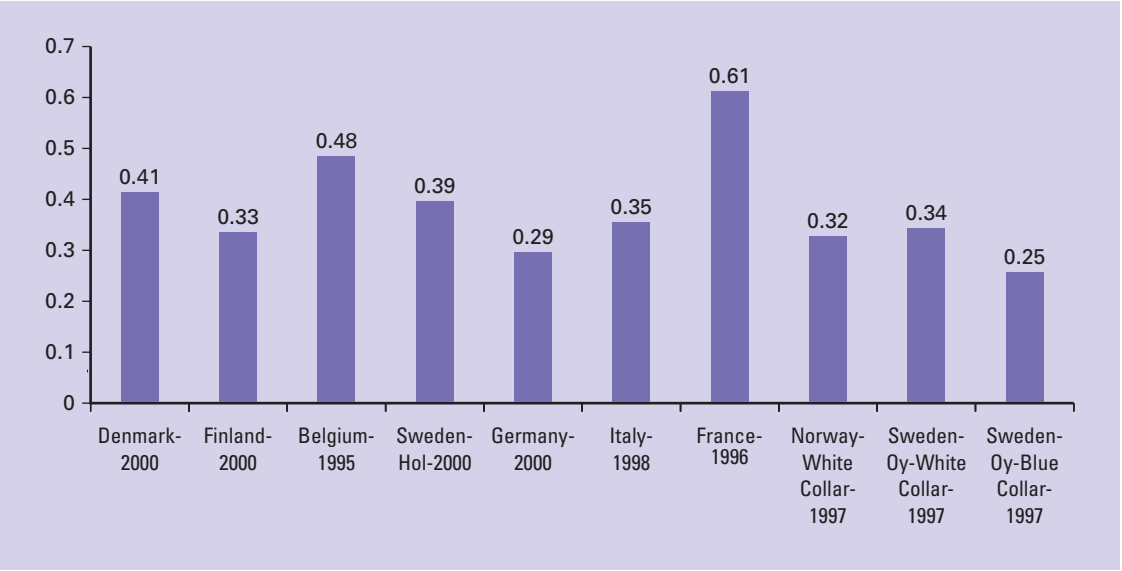


Figure 2.3: Ratio of average within firm standard deviation to country standard deviation

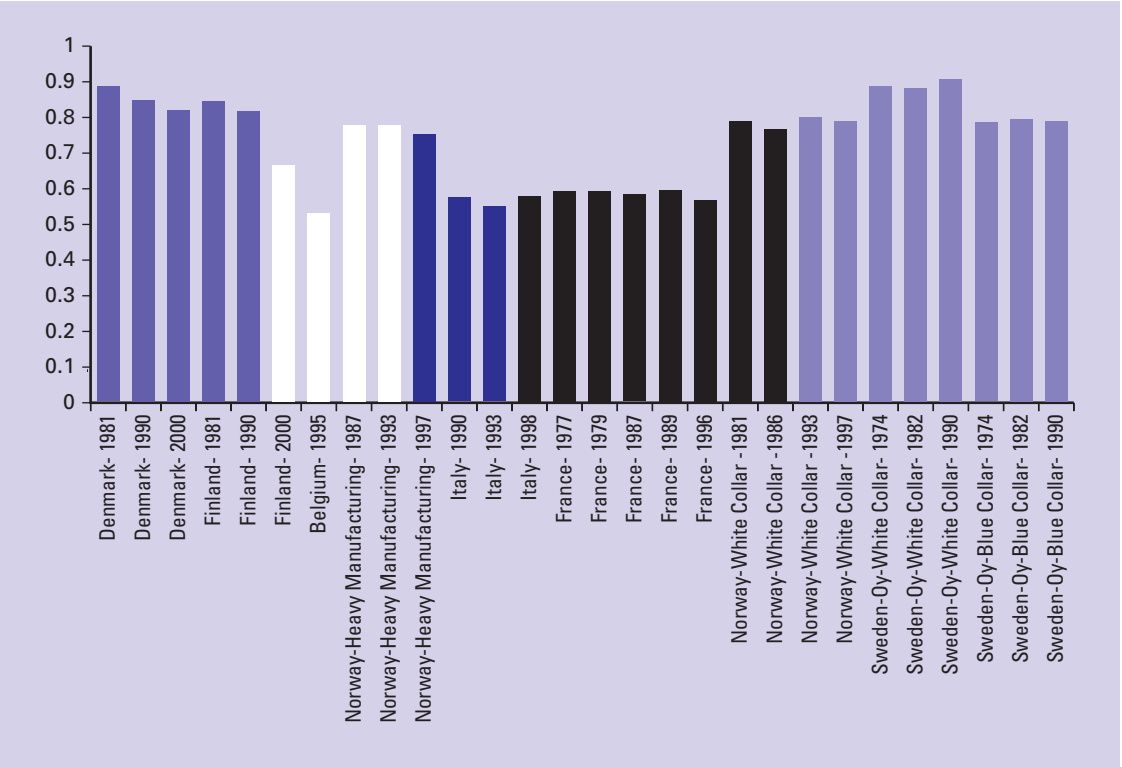
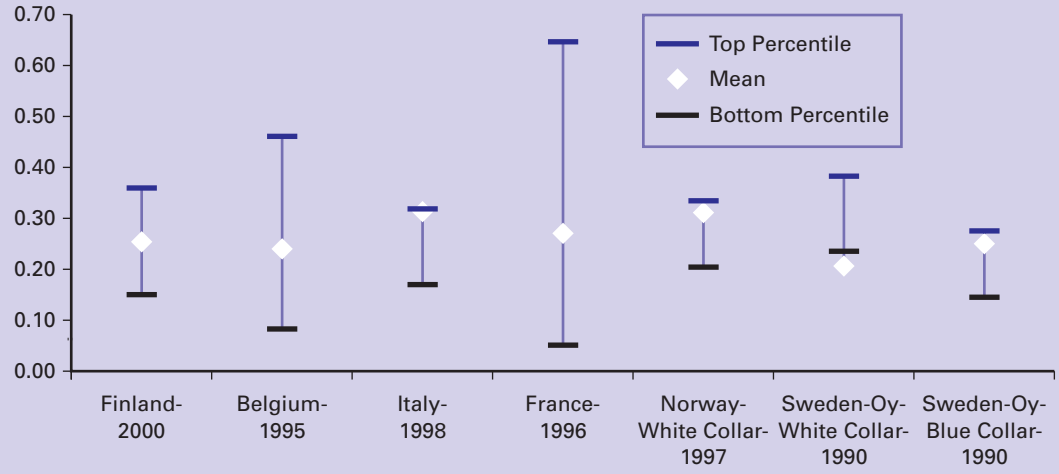


Figure 2.4: The distribution of the coefficient of variation of wages within firms 90/10 percentiles



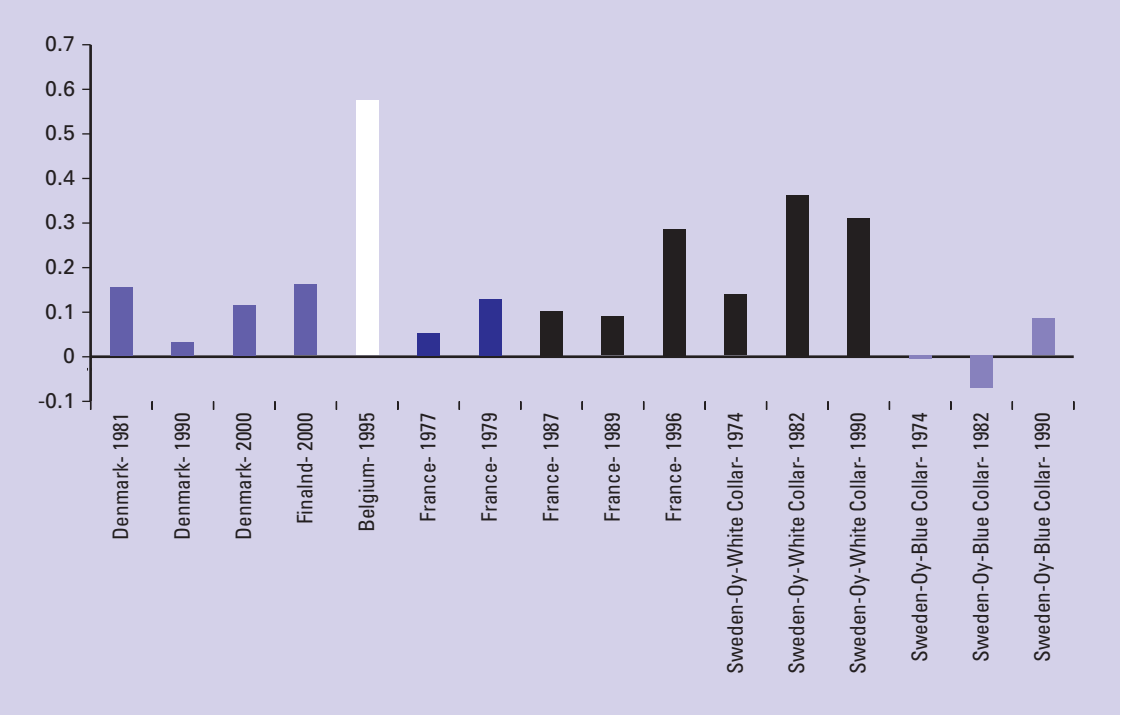
Constructed using firm-specific averages: The mean of the (within-firm coefficient of variation), and the 90th and 10th percentile of the within-firm CV (row 30;row32;row33)

Indeed, the amount of within-firm variation is striking. There are a number of interpretations of the fact that firms exhibit much, if not all, of the variation in wages that is seen at the country level. One likely possibility is that the skill mix that is necessary to operate a company does not vary all that much by company. All firms must have high level managers, production workers of some sort, and a basic clerical staff. Another interpretation is that firms use the same kinds of incentive structures to motivate their workers. Still another is that wages are set according to seniority and the demographic distribution of workers, although different among firms, displays the same underlying pattern.

Figures 2.1c for Norway and 2.1d for France also indicate that the dispersion varies with the overall level of wages, with high wage firms having more dispersion than low wage firms. So not only is the mean wage different among firms, but the amount of within firm variation is different as well. Figure 2.3 shows that countries are remarkably similar with respect to within-firm wage variance relative to country wage variance. Figure 2.4 shows the distribution of the variance of wages within firms. Figure 2.5 provides further evidence that the correlation between log wage and spread is positive for five of the six data sets in which it is reported (covering five countries). There are at least three ways of interpreting this correlation. It may be that high within-firm variance pushes up mean wages, if firms that allow disparate wage treatment also reap the benefit through incentive and selection effects of higher productivity. Firms that compress wages may drive out their best workers and stifle incentives to produce. Alternatively, it may be that high wage firms necessarily also have high spreads, because there is more heterogeneity in high wage firms than in low wage ones. Law firms must

have receptionists, but telephone call centres need not have lawyers. A third possible explanation is purely statistical. Suppose that the underlying distribution of wages reflects worker heterogeneity and competitive wage setting. Suppose further that there is significant positive skew in worker ability. Finally, suppose that firms are partitions of the overall income distribution. A positive correlation between the average and standard deviation of wages would result. For example, suppose that there were only two firms and that the bottom 50 per cent of wage earners worked for one whereas the top 50 per cent worked for the other. The high wage firm would have higher variance. Since it is well known that income distributions are approximately log normal and therefore have positive skew, the statistical argument remains a possibility.

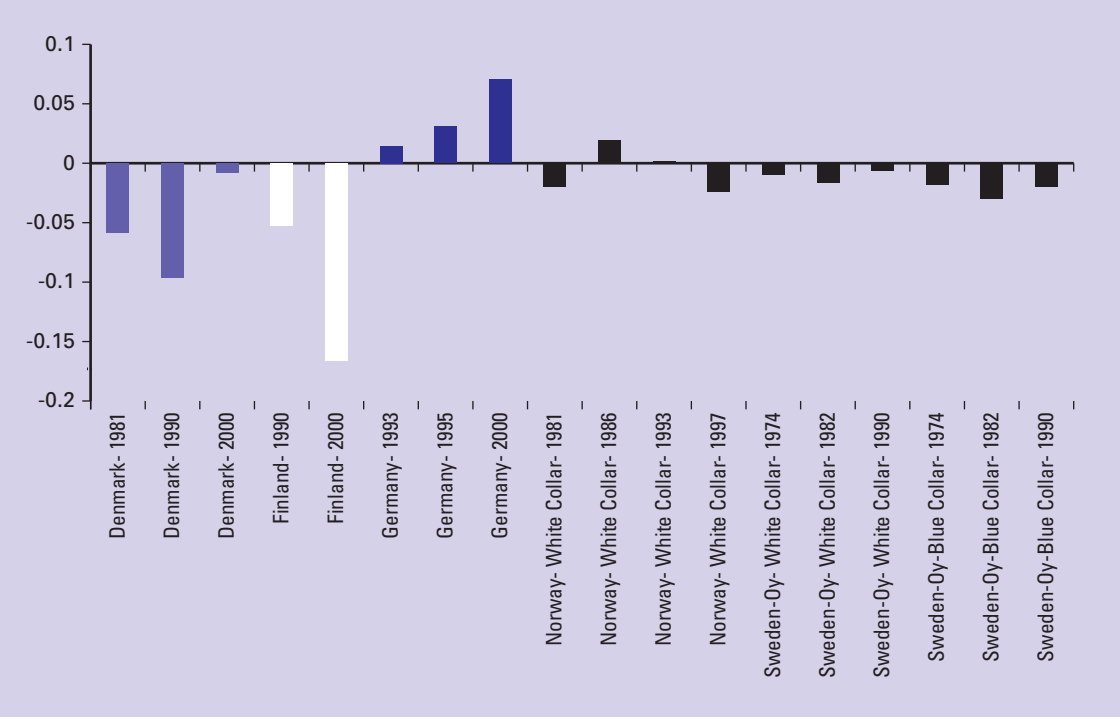
Figure 2.5: Correlation: log wage standard deviation and log wage



The fact that there is considerable wage variation within-firm means that, at least potentially, workers are not locked into a particular wage slot as a function of their first job assignment. To test this hypothesis, one needs to examine the degree of residual wage variation after controlling for person effects. If all of the variation in wages within firm were accounted for by person effects, then there would be constancy over time in a worker's position, given his initial position. Workers care that their position can improve in the firm as a result of experience and promotion. If there is no within-firm residual variation, then the only way for a worker to improve his relative position is to move. So if residual variance is low, then worker mobility is expected to be high.

The pattern of mobility can help determine whether within-firm wage variation reflects underlying worker characteristics or wage policy. For example, consider a firm that has a small standard deviation of the log of wages. This could reflect a policy of pay compression or it could reflect a homogeneous work force. If it is pay compression that hurts the top relative to the bottom, then the top workers should be more likely to leave the firm than the bottom workers. If we find a pattern where firms with tight wage distributions also have disproportionate exit of the highest paid workers, then the inference that we would draw is that the pay compression is policy. Conversely, if low wage workers have their pay increased relative to the market in such firms, then they should be less likely to leave. There would be no reason for top workers to leave disproportionately or for bottom workers to stay disproportionately if all were paid their competitive wage.

Figure 2.6: Difference between exit rates of top workers compressed minus non-compressed



For the few countries where we have the data to test these propositions it seems that, if anything, for most countries the more compressed wage firms have less mobility among top workers than firms with less compressed wages (Figure 2.6). If these findings hold up elsewhere, they would suggest that the pattern observed reflects worker heterogeneity more than it does wage policy. In other words, they would suggest that firms which are more compressed have a more homogeneous work force and that, within that group, there is less difference between the top workers and the median workers. As a result, top workers are less likely to

be underpaid in that environment. What might explain this? Three candidate explanations are:

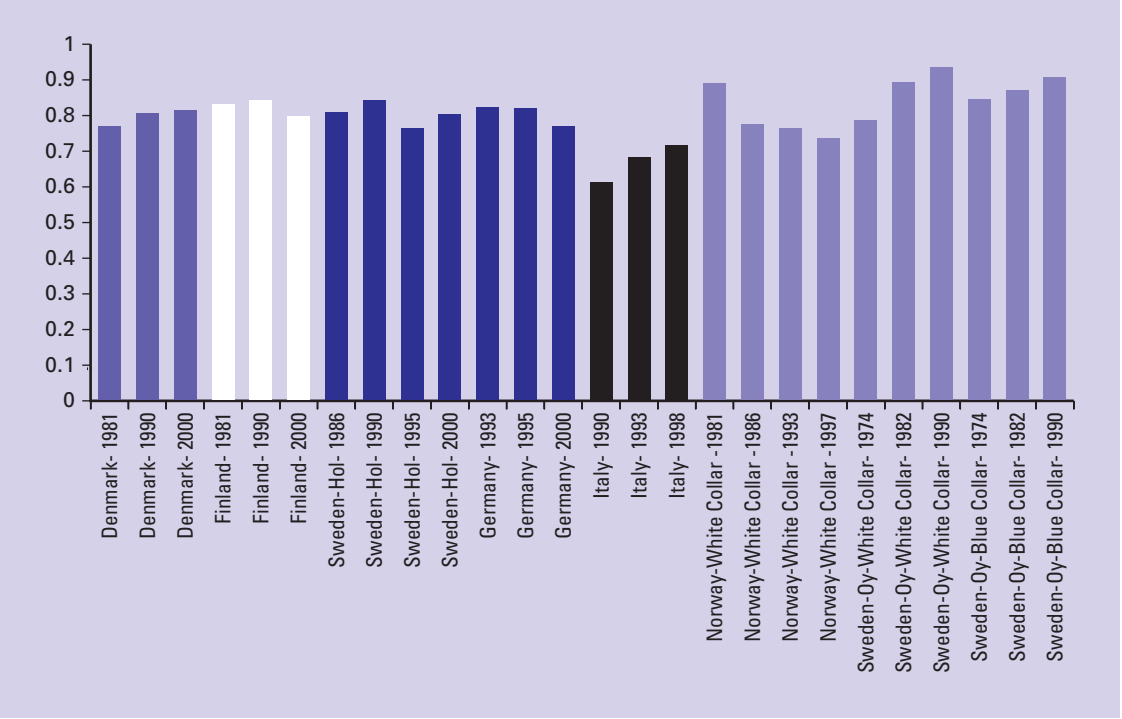
1 Firm size – Wage compression and mobility (at all parts of the wage distribution) might be correlated with firm size.

2 Selection when entering the firm. If a firm has a compressed top, the best people may shy away from those firms. Then those who are there may have already been sorted. This would explain a zero correlation, but it is unlikely to explain a negative correlation.

3 Unions or other institutional factors. Unions tend both to compress and raise wages. If all workers earn rents in compressed wage firms, then there would be low labour mobility for all workers in these firms.

Figure 2.7 presents some data with respect to possible explanation number (1). The ratio of mobility in the larger firms (>100 workers) is compared to overall mobility. The ratio is almost always below one, meaning that larger firms have lower mobility levels. If larger firms also have more compressed wage structures because of their bureaucratic nature, then the relatively low mobility of top workers in compressed wage firms might simply be picking up firm size.

Figure 2.7: Exit rates of big firms/exit rates of average firms



Obtaining information on mobility of different wage workers in compressed versus non-compressed wage firms would address (1) and (3). Examining the observable characteristics of workers in compressed and non-compressed wage firms would speak to (2). Holding constant

unionisation and other institutional factors would shed light on (3). Such evidence is not available for this paper.

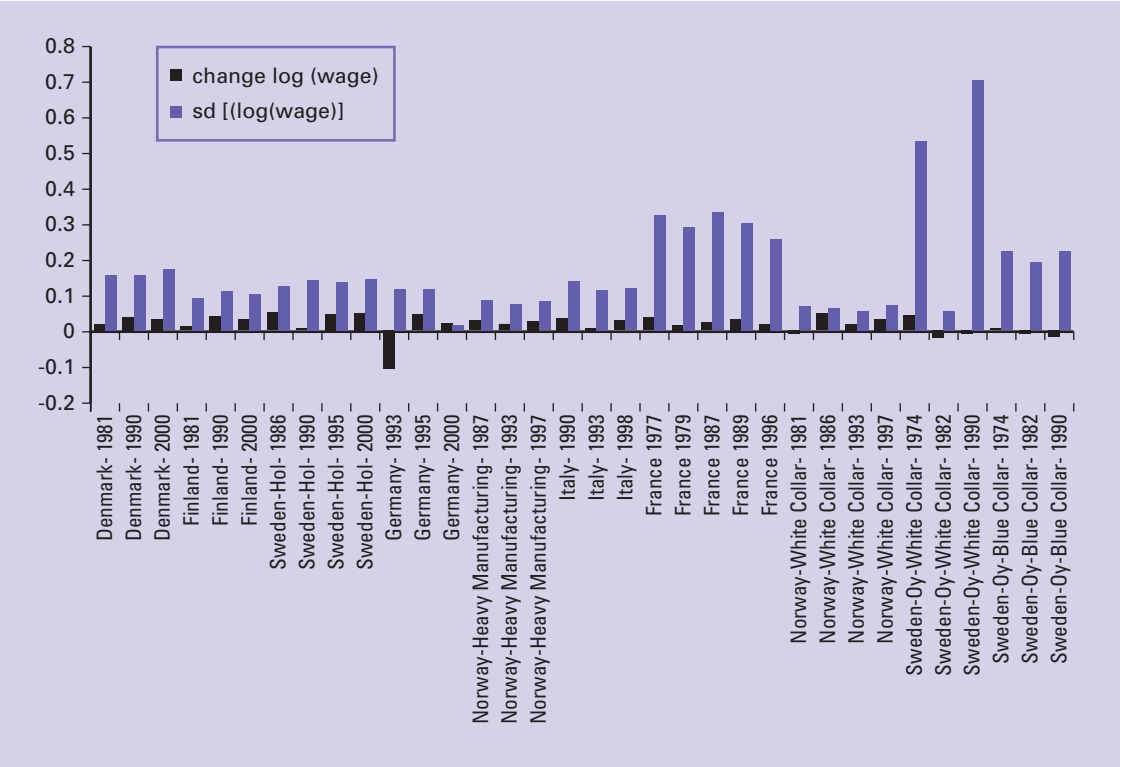
The general conclusion from this section is that there is considerable within-firm variance in wages in all countries. Although firms differ considerably within a country, both in terms of average wage and in terms of wage spread, there is a significant amount of variation within each firm. Some of this reflects differences in workers within each firm, but some may reflect wage policy. At this point it is difficult to distinguish, but the wage compression evidence points more to heterogeneity than to policy, at least in Norway, Denmark Finland and Sweden.

2.5 Wage growth

The common person's view of business cycles and economic growth is that when things are good for some, they are good for all. There is a parallel with firms and their employment and wage conditions. One extreme view is that firms move in tandem. When the economy is good, wages grow for the economy as a whole and every firm experiences the same increase in wage growth. At an even more micro level, every worker within every firm experiences the same percentage increase in wage growth. During bad times, the reverse occurs with all firms and all of their workers experiencing the same decline in wages. Obviously, this cannot be true, but is it a reasonable approximation of the truth?

Figure 2.8 provides some evidence on this. While hardly surprising, the standard deviation of the change in log wages is much larger than the average level of wage growth for most countries. When wages are rising at a fast rate, there are plenty of workers who are left behind and when average wages are falling, many workers are still experiencing substantial wage increases. Even when wages were not growing that rapidly on average, some workers experienced very high wage increases. The economy hardly moves in a synchronised fashion. The same is true for virtually all years and all other countries. This is an interesting fact, and one that could have been learned from standard panel data sources. The advantage of the new data is they enable us to look at the firm.

Figure 2.8: Mean change in log wage; std dev (change in log wage)



The same is true within firms. The within-firm standard deviation in wage increases is always larger than the mean wage change and in many countries, very much larger. For example, in Denmark, in 2000, average wage growth for the firm was 3.4 per cent. The within-firm standard deviation of growth rates was 8 per cent.

One way to get directly at these questions is to determine how much of wage variation is accounted for by firm and year effects. A regression could be run for each country year of the form

$$\gamma ln\ Wage_{ij} = a_0 + a_1\ (Firm\ Dummies)$$

where $\gamma ln\ Wage_{ij}$ is the change in log wages of worker i in firm j. The estimation would reveal how much of the variation is accounted for by firm effects. Then years could be stacked to see whether high raise firms remain high raise firms for substantial periods. That is, are the firm effects robust only within the year or are they fixed over substantial periods of time so that high wage increase firms, say, in 1985 are also high wage increase firms in 1990? At least at some time interval, the firm effects should vanish or some firms would have wage structures that are far out of line with the average for their industry or occupation.

It is also interesting to examine whether a wage policy where firms give all workers the same raise results in more turnover. One possibility is that homogeneous wage increases breed discontent, particularly among the high ability workers who are not rewarded appropriately in their own eyes.

Is there a negative correlation between turnover rate and within firm standard deviation in wage growth (within firm coefficient of variation in wage growth)? This is discussed below in the section entitled "Worker Mobility."

Why does this matter? If workers' fate is determined primarily by the fate of their individual firm, then wealth can be affected by factors that are largely beyond a worker's control. If instead, most of the wage growth is idiosyncratic and specific to the worker, then individuals may have the ability to take actions that affect their wealth levels. In addition, if wage growth is mostly determined by the firm, but this tends to even out over time, say because wage growth is negatively serially correlated (high growth firms in one period are low growth firms in the next period), there would be little persistence to worry about and inter-firm mobility would not be required to remove long term discrepancies in wages. But if the firm effects are persistent, then movement by some workers is necessary to keep on track with others in the same occupation. All of these questions can be investigated using the linked data.

2.6 Wage growth and tenure

The standard finding in the literature on human capital is that wage growth is more rapid during the early years of career than during the latter years. This can come about through a variety of mechanisms. One is that young workers move more than old workers – something we show below. The other is that within firms, there is a policy to give larger wage increases to young workers than to older ones.

Figure 2.9 provides evidence on average wage increases for low and high tenure individuals within the firm, averaged across firms in the economy. The difference is almost always positive, and in some country-years, it is large. Of course, this is wage growth for those who stay in the firm. Much of the difference in wage growth at the individual level that occurs over the life cycle may work through mobility. What is clear, though, is that firms have a policy of allowing the wages of at least some young workers to grow more rapidly than the wages of the best treated senior workers. The notion of skewness in wage growth as a policy is a new finding that warrants further investigation and conceptualisation.

Figure 2.9: Difference in wage growth by tenure group low tenure growth rate – high tenure growth rate

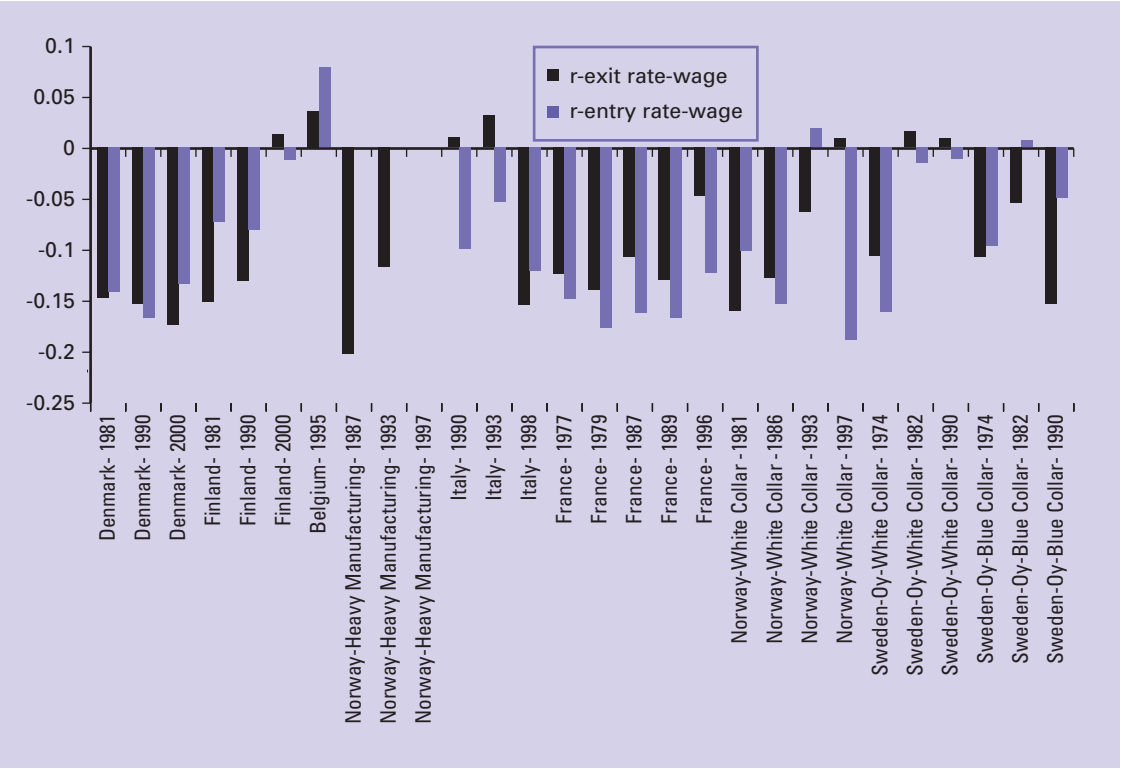
2.7 Worker mobility

Exit rates vary substantially across firms and countries. The typical firm's exit rate varies from lows of around 15 per cent in Norway, Sweden, Finland and early observations for Germany, to highs of 35 per cent in France. As expected, entry rates and exit rates are highly correlated. In countries where exit rates are high, entry rates are high. This must be true in equilibrium where approximately the same number of workers is employed over time. There are some notable exceptions, however. During the early 1990s Germany had exit rates that far exceeded entry rates. This reflects the re-unification and fundamental changes in the labour market that occurred during that period.

2.8 Mobility and wage levels

There is a negative correlation between both exit and entry rates and wage levels – see Figure 2.10. High wage firms are also low turnover firms. This could reflect one of two phenomena. First, high wage firms may pay above the market rate. Workers queue for jobs in those firms. When they finally land a job in a high wage firm, they keep it because their alternatives are rarely better. An alternative explanation is that high wage firms have more skilled workers and the turnover rates for the less skilled are higher than those for the more highly skilled.

Figure 2.10: Correlation of entry and exit rates with wage



2.9 Mobility and firm size

Gibrat's Law contends that growth rates are independent of firm size. Figure 2.11 speaks to this by looking at the net entry rate (entry – exit rates) and then taking the difference between all firms and big firms. There is no consistent pattern. This neither supports nor rejects Gibrat's law. In some country years, there is a pattern of growth being lower in large firms. In other country years the reverse is true. But the difference is rarely zero, which would be the prediction of Gibrat's Law. Apparently other factors are important in determining the size distribution of growth rates and the statement that growth is independent of firm size seems to be inaccurate. A more accurate statement is that growth rates vary with firm size across time and location. The causal nature remains unknown at least for this study.

Figure 2.11: Net entry all minus big

The determinants of firm turnover rates (industry, occupation, wage, skill, average tenure, etc.) could be investigated. Although we present no evidence on those factors here, it is possible to perform an analysis of this sort using the country-wide datasets discussed in this paper.

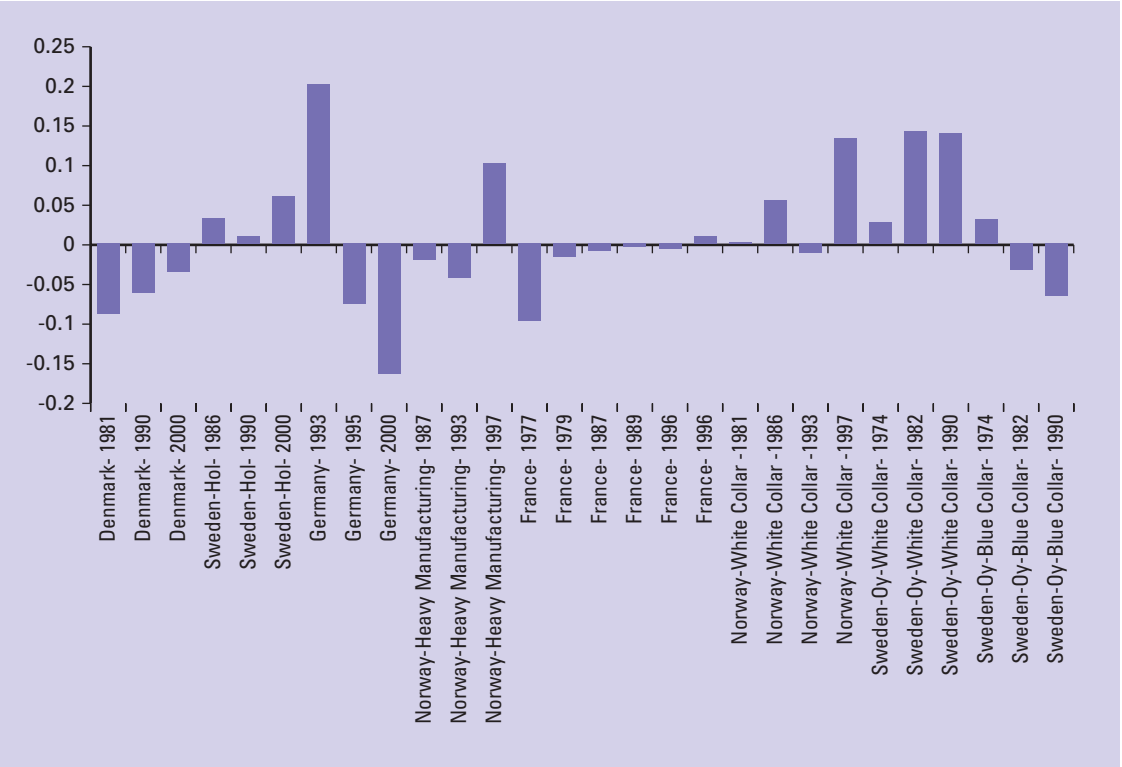
2.10 Mobility and wage growth

If the typical labour market allows for some rent sharing between capital and labor, worker wages should rise when firm profits rise. Firms that are profitable are also likely to be doing more net hiring than firms that are unprofitable. As a result, good times might be accompanied by super-normal wage growth and also by super-normal employment growth. The cross-country data provide evidence on the correlation and we believe that this is the first evidence of this sort that cuts across many firms.

The correlation between wage change and entry rates tends to be positive in a given country-year. But firms that are raising wages do not consistently (across country-years) have lower exit rates (Figure 2.12). In the most open countries, like Denmark, the finding is strong. High wage growth and low exit rates move together. But in Sweden, the results are weak and in the opposite direction. This might reflect the 'Dot.com Boom' phenomenon. Programmers and other skilled technical workers moved from firm to firm frequently, as demand shifted to reflect the fortunes of one company or another. Firms with rapidly growing wages hired many workers, but also lost them to other firms with rapidly growing wages because of the nature of industrial structure. Turnover rates were lower,

and wages were increasing less rapidly, in more traditional parts of the economy where the situation was closer to stable. So exit rates and high wage growth might go together if they characterise firms that are in industries undergoing rapid change. Again, this is a question that requires additional evidence, obtainable in these data sets, but not presented here.

Figure 2.12: Correlation exit rate and within firm wage change (within country)



2.11 Summary

Linked employer-employee data from a number of different countries are used to provide evidence on firm wage structures and promotion, hiring and mobility patterns. The main finding is that countries are remarkably similar in their wage structures and wage changes. Most wage variation is within firm. Although there is a good bit of variation between firms in every country, firms have a large range of the wage distribution within.

Furthermore, with respect to wage growth, there are consistent patterns. Although firms differ with respect to the average raises they give in a particular year, firms do not tie all workers to the same raise. The standard deviation of raises within firm is between 10 per cent and 20 per cent, even when average raises are close to zero. This is most consistent with the view that firms respond to outside pressure (either market or governmental) to raise workers' wages commensurate with some occupational or skill standard.

Mobility levels differ across countries, but even here, mobility patterns seem relatively consistent. High wage firms have lower mobility than low wage firms and entry and exit rates are positively correlated, with entry rates being somewhat larger than exit rates in most country years.

2.12 References

Baker, G., Gibbs, M. and Holmstrom, B. (1994a) 'The Internal Economics of the Firm: Evidence from Personnel Data.' *Quarterly Journal of Economics* 109, 4, pp. 598-614

Baker, G., Gibbs, M. and Holmstrom, B. (1994b)'The Wage Policy of a Firm.' *Quarterly Journal of Economics* 109,4 pp. 921-55

Becker, Gary S. (1962) 'Investment in Human Capital: A Theoretical Analysis.' *Journal of Political Economy* 70 pp. 9-49

Edin, P-A., Holmlund, B. and Nordstrom Skans, O., (2006) 'Wage Dispersion Between and Within Plants: Sweden 1985-2000,' in *The Structure of Wages within Firms – Europe and the United States*, Edward Lazear and Kathryn Shaw, ed., forthcoming.

Lazear, E. (1992) 'The Job as a Concept.' In *Performance Measurement, Evaluation, and Incentives*, ed. Bruns, Jr, W.J. (Boston: Harvard Business School Press), pp. 183-215

Lazear, E. and Rosen, S. (1981) 'Rank-Order Tournaments as Optimum Labor Contracts,' *Journal of Political Economy* 89:5 pp. 841-64

Oyer, P. (2006) 'Wage Structure and Labor Mobility In Sweden, 1970-1990,' in *The Structure Of Wages within Firms – Europe and the United States*, Lazear, E. and Shaw, K., ed., forthcoming.

3 Compensation Policy, Human Resource Management Practices and Takeovers

David N. Margolis[9]

ABSTRACT

Our analysis allows us to draw several policy conclusions. First, there may a justification for subsidising loans to high growth potential, highly indebted firms since profitable yet indebted firms seem to look to other firms for financing of their growth opportunities. Second, although predator and target firms are similar to each other, they differ from non-takeover firms in observable ways, and thus employment services may be able to prepare for future layoffs by focusing on these firms. Finally, the types of workers laid off after a takeover seem to be the ones with the best chances of finding new jobs, so there may not be a need for additional resources to help the placement of these workers after a takeover.

3.1 Introduction

In order to grow, firms (and economies) need capital to invest and projects in which to invest it. The capital that firms need can be drawn from many different sources, including bank financing, stock issues, direct issuance of corporate debt, receipt of equity or cash injections from other firms. Different sources of financing come with different constraints for the firm, but in every case the entity that provides the financing hopes for a return on its investment derived from the operations of the firm.

The projects are also of different sorts, depending on the sector(s) of the economy in which the firm operates. The project can either involve expanding existing capacities or acquiring new ones. Both sorts of goals can be achieved by "organic" growth, with the firm creating opportunities

[9] This paper originated in a joint project started with Andrew Hildreth (U.C. Berkeley), to whom the author is thankful for several discussions. The author would also like to thank Denis Fougère, Robert Gary-Bobo, Francis Kramarz, Jérôme Philippe, Antoine Terracol, Jan van Ours and the participants in seminars at CREST, Tilburg University, the University of Aberdeen, the Joint UCD-Queen's Belfast Economic Seminar and the TEAM internal workshop for useful comments. All remaining errors are mine.
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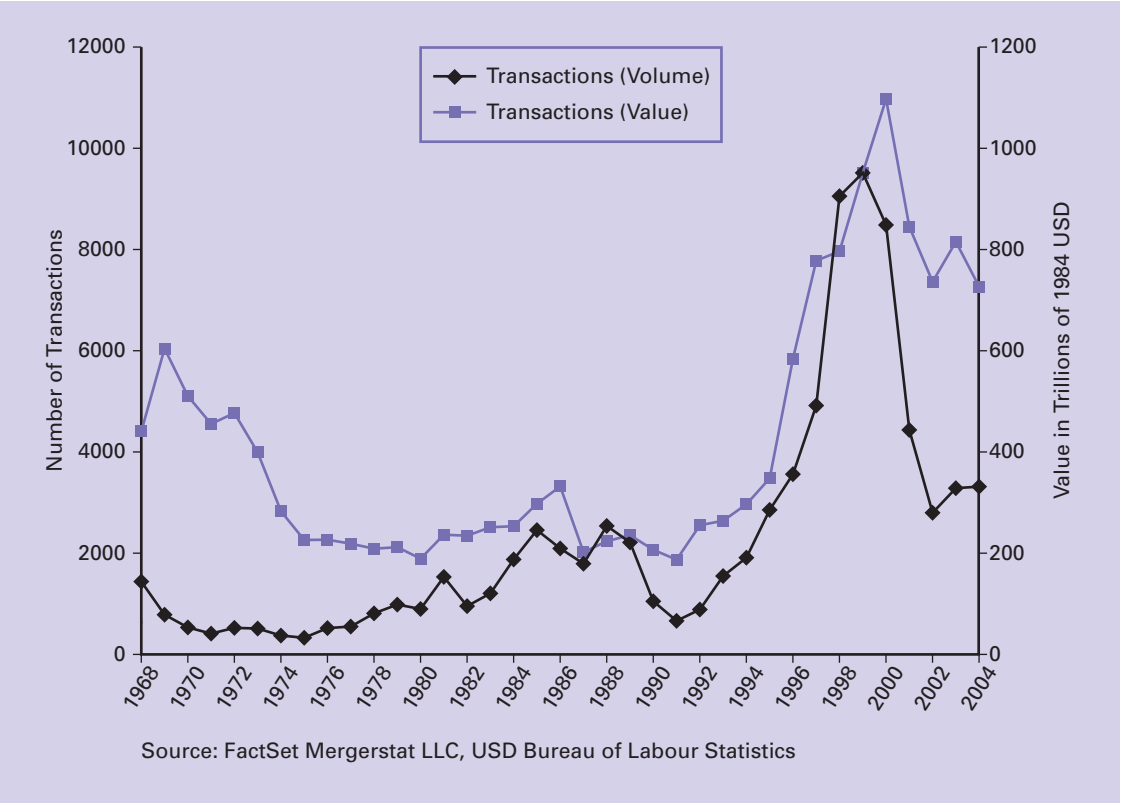
by itself, via joint ventures with other firms or by acquisition of another firm that possesses the capacities, market share, products, distribution networks or whatever the firm needs in order to grow.

Companies have been exploiting this last possibility for many years. Figure 3.1 shows that even in the late 1960s (when the earliest consistent data are available), several thousand mergers and acquisitions were undertaken each year in the United States, and these transactions, although varying over time and increasing substantially in value, have remained economically important.

Figure 3.1: U.S. & U.S. Cross-Border Mergers and Acquisitions



Source: FactSet Mergerstat LLC, USD Bureau of Labour Statistics

Since an acquiring firm must pay the market price for its target (plus the additional costs associated with undertaking the transaction), its choice of target becomes critical. If the acquiring firm cannot improve the profitability of the newly created entity by more than the costs associated with creating it, then the transaction will not take place. Clearly, one of the means by which profits can be increased is to reduce costs, namely through firing workers seen as overpaid, poorly adapted or simply superfluous to the needs of the new entity. Thus the compensation structure and human resource management policies of the target firm become an object of interest for predators, and post-transaction layoffs can reflect the acquiring firm's efforts to improve the profitability of the newly created entity.

Such considerations explain why mergers and acquisitions are often portrayed in the media in terms of their perceived negative consequences for labour as opposed to their positive consequences for growth. Press releases that accompany mergers often stress the potential for "rationalising" or "downsising", talking of possible "synergies" resulting from consolidating existing structures. All of these policies imply workforce reductions, and although they are sometimes implemented through early retirements or non-replacement of workers who quit, they also correspond in many cases to mass layoffs.

This paper addresses the merger and acquisition process from the pre-transaction period (when the predator firm chooses its target) to the post-transaction period (when restructuring actually takes place). The primary focus is on compensation and employment, although consideration is also given to other elements of the process. In particular, using a unique linked employer-employee data set from France, we begin by exploring the differences between predator and target firms along several dimensions, including compensation and employment. This allows us to characterise which sorts of firms are more likely to be targeted for takeovers and which ones are more likely to undertake them. We then look at the post-transaction reorganisation period and try to establish whether workers from the acquired firm are more or less at risk of a layoff, which sorts of workers are more likely to be laid off and which sorts of firms are more likely to undertake large adjustments in their work forces post-takeover.

From a policy perspective, all of these issues are important. When considering ways to foster economic growth, it may be useful to see what sorts of firms are the ones that undertake the acquisitions, as these are the ones that are aggressively seeking growth opportunities and may be worthy of additional attention. Conversely, if one can identify the sorts of firms that are most likely to be acquired, one can prepare for the risk of layoffs in the areas where such firms are located. In particular, by analysing which workers stay and which workers go after a takeover, employment services can better structure their preparation for assisting these workers when they become laid off. Employment services can also direct resources to geographic areas where particularly vulnerable firms are established in anticipation of the post-takeover layoffs and make plans for helping the types of workers who are most likely to appear in search of assistance.

3.2 How Economists Perceive Mergers and Acquisitions

The vast majority of the attention among economists concerning mergers and acquisitions has focused on the reasons why one firm might acquire another. Several main explanations have arisen:

Controlling the actions of incumbent management:[10] When the management team of a firm takes poor decisions that result in the firm's stock being priced below its potential, an outside firm can acquire the underperforming firm, change the management team, reverse the poor decisions and reap the gains from the improved efficiency. If these gains are sufficient to offset the costs, the transaction will take place. The literature[11] has pointed to compensation policy and human resource management practices as two areas in which an existing management team, perhaps in the hopes of buying peaceful labour relations or of trying to create a paternalistic environment, often makes "poor" decisions that can render a firm a takeover target.

Costly capital and the lack of investment opportunities: As a firm matures, the return on its remaining opportunities for organic growth decreases (it exploits the best opportunities first and works its way down the list). However, it may build up a capital structure and a debt history that renders its cost of acquiring additional capital relatively low. Conversely, a newly created firm which may have had to borrow extensively to finance its starting up may be unable to find additional sources of capital to exploit its (relatively high return) investment opportunities. In such a situation, the mature firm may acquire the potentially fast-growing firm, whose stock price will not incorporate the returns on investments it is unable to finance on its own, in order to have access to these higher-return opportunities for investment while taking advantage of its relatively advantageous credit terms for financing the additional investments.

Attaining a critical mass:[12] A firm may have access to a production technology which is particularly efficient at high volumes of output, but it is unable to generate enough demand on its own. As a result, it may attempt to acquire additional distribution outlets or access to additional markets in order to exploit the cost advantages of large scale production inherent in its technology.

Increasing market share:[13] When a firm has a substantial degree of market power, even without going as far as a monopoly, it can often exercise a certain degree of control over market prices and output levels and thereby improve profitability. In order to attain sufficient market share, firms may attempt to buy competitors. Of course, such strategies are frowned upon by competition authorities and are thus rarely presented to the media under this angle.

Enforcement of a threat under tacit collusion:[14] In the absence of an explicit motive to gain market share, firms may partake in pricing and production practices that represent collusive behavior. However, since these implicit

[10] Some examples of this appraoch include Manne (1965), Jensen and Meckling (1976) and Jensen (1984, 1986, 1988).
[11] See, for example, Bertrand and Mullainathan (2003), Brown and Medoff (1988) and Gokhale, Groshen and Neumark (1995).
[12] See, for example, Bradley, Desai and Kim (1983).
[13] See, for example, Eckbo (1983) and Borenstein (1990).
[14] See, for example, Compte, Jenny and Rey (2002).

arrangements are subject to undercutting by a member of the cartel, other members may use the threat of takeover to enforce the arrangements and may occasionally need to act on this threat in order to maintain their credibility.

Insuring against market-specific risks:[15] If a firm is in a sector that is subject to important demand or input price fluctuations, it may seek to insure its share price against these fluctuations by diversifying into other, more stable, sectors or sectors with counterbalancing risks. This conglomeration approach, popular in the 1980s, has gradually been abandoned by firms focusing on their "core competences" while letting investors insure themselves privately by mixing shares within their own investment portfolios.

3.3 How Do Linked Employer-Employee Data Help?

Since the objective of this paper is to study the employment and compensation dimensions of the takeover process, one obviously needs information on employment and compensation in firms involved in takeovers. This information can come from a variety of sources on either the employer or the employee side, or from linked employer-employee data.

Data coming from employer-side sources include the aggregate statistics published by various statistical agencies and investment banks, corporate tax returns, corporate accounts published by firms listed on stock markets or employer surveys. Each of these sources has its disadvantages. The aggregate data are clearly inadequate since it is impossible to know if a sector that undergoes significant restructuring through takeovers and also loses significant numbers of workers is losing the workers because of the takeovers or responding to some external negative demand shock by laying off workers and simultaneously consolidating. Furthermore, there is no way of knowing whether or not the firms that are laying off workers are also the firms involved in the takeover activity.

Tax returns and corporate account data are more promising, in that one can identify particular firms and measure total employment and total compensation costs. However, there is significant work associated with identifying which firms are involved in takeover activity; this information is made available by consulting firms, investment banks and occasionally statistical institutes, but it is not easy to merge accurately with the accounts information. Furthermore, although one can now identify which firms are involved in the takeover activity, one cannot tell which workers are let go, nor whether a firm with, for example, a high compensation cost per worker is really overpaying its workers or whether it has a genuinely more productive workforce that it needs to compensate appropriately.

[15] See, for example, Matsusaka (1993).

Employer-side surveys come even closer to the ideal, since one can ask detailed questions about the structure of the workforce and compensation by type of worker. But once again, the problem lies in interpreting the figures: if a firm's employment remains stable after a takeover yet its wage bill falls, have its workers taken a pay cut or were the more expensive ones fired and replaced with less expensive workers doing the same jobs? An additional issue lies in how representative the data is; the only employer-side survey-based studies in the literature are restricted to narrow sectors in specific geographic areas, and it is hard to generalise about what might happen on a nationwide scale on the basis of such analyses.

Employee-side data analyses are much rarer, in that the majority of employee-side data do not ask whether a person's employer has been involved in takeover activity. Some of the literature on mass layoffs tries to consider whether the layoffs occurred as a result of a plant's closing or while a plant remained open, but to this date they have not explicitly considered takeovers as a reason for the layoff. This is due to the absence of data on the question: neither the United States' Displaced Workers Supplement to the Current Population Survey nor Canada's COEP data, the two main sources used in the literature on mass layoffs, ask if the firm underwent a takeover. Furthermore, even if such information were available, workers typically do not possess detailed knowledge of their employer's financial accounts (and are never asked about it in surveys), meaning that one could not control for alternative explanations of takeovers when analysing takeovers with this sort of data.

Linked employer-employee data, such as those exploited in this paper, can solve all of these problems. Since the data include information on the firm side, such as data on corporate accounts and identification of which firms are involved in takeover activity (and their role in the takeover), one can control for various explanations of takeovers other than just compensation and employment issues and one can cleanly identify the acquiring, acquired and control (non-takeover) firms. Since the data also include information from the worker side, one can also cleanly identify whether the in-place workforce is "overpaid", inappropriately structured (e.g. too many high skilled-workers for the production technology) or too numerous relative to other comparable firms. Since the data are also longitudinal, meaning that individual firms and workers can be followed over time, one can also see which workers stay and which workers go after a takeover.

In fact, the linked employer-employee data that are used in this paper are drawn from several sources. The first source is a longitudinal data set of firm accounts (FUTE) established by INSEE, France's National Institute for Statistics and Economic Studies, that draws on corporate account data filed for tax purposes and from supplementary surveys. This data, of which we use the 1993-1999 information, covers all sectors of the economy and firms of all sizes, and allows one to control for explanations of takeovers that are related to a firm's financial situation, revenues or

sector of activity. A second source is the little-exploited data in the Modification of Structure (MDST) database, also compiled by INSEE. This data, available from 1993-1999, covers all asset transfers over a minimum size (8 million French Francs) between firms and classifies them by type. Among the types of asset transfers covered are mergers (several firms transfer all of their assets to a newly created entity) and acquisitions (the acquired firm transfers all of its assets to the acquiring firm). Both of these data sets use the standard identification code for French firms (the SIREN) which allows the data to be combined easily and reliably.

On the individual side, this paper exploits two other data sets, the Annual Declarations of Social Data (DADS) and the Permanent Demographic Sample (EDP). The DADS is a longitudinal data set available from 1976-1999 which provides information on every job held in the private, state-owned, local government and non-profit sectors by every worker in France. The longitudinal version of this data covers roughly 1/25 of the French population (people born in October of even-numbered years) and contains both an individual's national identification number (NNI) and the SIREN code of the employer, in addition to information on earnings, occupation, hours worked during the year and a rather limited set of individual characteristics (age, sex, place of birth and place of work). The EDP data, which are drawn from census records, birth, death and marriage certificates and other administrative sources for individuals born in the first 4 days of October, allow us to add additional individual-specific characteristics such as education to the DADS data, due to their use of the individual's NNI as an identifier.

The DADS data are the key linked employer-employee data source, and due to the presence of both the NNI and the SIREN in these data, all four data sets can be brought together in one combined database for analysis. This allows us to resolve all of the problems associated with having only employer-side or only employee-side data, and as Table 3.1 below shows, one can thus characterise firms by their status (acquired, acquiring or control) according to firm- or worker-side characteristics. However, since dating an individual's employment status relative to the takeover date is complicated when considering firms that have engaged in multiple takeovers, the analysis undertaken here only considers French firms that were either involved in no takeovers at all during the 1993-1999 period (Non-MDST Firms) or involved in only one takeover during this period (Acquired and Acquiring Firms).

Table 3.1 shows that there are differences between target and predator firms along all of the dimensions considered: compensation policy, human resource management policy and firm accounts. In particular, on average, firms that are acquired pay above the rates paid by acquiring and control firms, although they do not increase pay with seniority as much as acquiring firms. The target firms also tend to employ slightly less educated and younger workers, who do not remain employed for as long as in the other sorts of firms. The target firms are also smaller, more indebted, have

higher returns on assets and are more productive than predator firms on average. The simple fact that different sorts of firms can be classified along all three sorts of dimensions is a testament to the usefulness of linked employer-employee data.

Table 3.1: Descriptive Statistics of Firms by Takeover Status

Variable	Multiple Takeover	Taken Over	Taking Over	No Takeover
Compensation Policy				
Firm-Specific Fixed Effect	-0.4987	-0.2558	-0.3724	-0.3686
Firm-Specific Seniority Returns (per Year of Job Seniority)	3.86%	3.07%	3.43%	2.99%
Human Resource Management Policy				
Male	62.98%	64.64%	63.30%	63.08%
Potential Experience (Current Age – School-Leaving Age)	36.76	29.14	39.72	34.84
Years of Job Seniority	6.13	4.78	7.49	5.88
Skilled Blue Collar	16.25%	21.70%	19.68%	21.97%
Unskilled Blue Collar	17.20%	26.84%	20.74%	25.57%
No Education	27.84%	29.27%	28.08%	29.13%
Baccalauréat (High School Diploma)	6.64%	6.44%	6.50%	6.43%
Advanced Tertiary Education	3.34%	2.81%	3.03%	2.86%
Firm Accounts				
Total Employment	6314.57	835.92	18869.65	8201.16
Fixed Assets Net of Depreciation and Amortisation (MFFr 1990)	9.4257E+06	1.2086E+06	9.2926E+07	1.4519E+07
Pct. Increase in Value of Fixed Assets (t-1 to t)	2423.56	134.93	705.04	209.01
Total Debt/Total Assets	67.33%	73.58%	69.23%	72.22%
Return on Assets	2.78%	3.87%	3.11%	3.56%
Value Added per Worker (MFFr 1990)	1426.01	352.13	282.31	311.58
Number of Observations	357392	287043	543601	3142435

Sources: MDST, FUTE, DADS and EDP data and Authors Calculatio ns.

Notes: The excluded educational categories are only primary education, pre-high school level vocation or technical education, pre-high school level general education, high school level technical or professional education and 2 year post-high school education. The excluded occupation is white collar.

3.4 Identifying the Significant Differences Between Acquired and Acquiring Firms

The descriptive statistics presented in Table 3.1 only provide a general picture of the sorts of firms that are involved in takeovers, and as such they are not sufficient to distinguish the characteristics that really differentiate between predator firms and their targets, since some variables may tend to vary together. For example, if a firm is to remain competitive on the labour market it may have to match average compensation in other firms. If it pays a lower initial wage, it may have to pay higher returns to job seniority to attract workers. This situation is consistent with the average figures in Table 3.1 when comparing predator firms to target firms, but a question remains unresolved: is it really the same firms that pay less on average that pay more for seniority, or do these firms pay less overall (base pay and seniority returns) while other firms pay more both on average and for job seniority, with the relative differences in the two subgroups offsetting each other?

Using econometric techniques for analysing qualitative data (logit models), one can control for such correlation between variables and distinguish which variables really increase the likelihood that a given firm will be the target of a takeover or become an acquirer of other firms. For details, the reader is referred to Margolis (2005), but the main results are presented here and in Table 3.2.

First, in terms of compensation policy, there is basically nothing that distinguishes target firms from predators, although they both pay better for seniority (while target firms pay worse starting wages) than firms in the control group. One consequence of the target firms' lower return to seniority relative to control firms is that target firms also have workforces with lower job seniority than control firms, while no significant differences in average seniority are apparent between target and predator firms. Since the literature on mass layoffs suggests that high-seniority workers have a harder time finding jobs post-layoff, this is somewhat encouraging news if the majority of workforce reductions post takeover occur in the acquired firm.

On the human resource management side, almost nothing significantly distinguishes target firms from predators. However, both sorts of firms employ relatively fewer senior workers and more men than control firms. Again, this is encouraging news since the mass layoffs literature has also noted that less senior and male workers tend to find new jobs faster than more senior or blue collar workers.[16]

With respect to the information available in the firm's accounts, the econometric results suggest that the investment opportunities explanation for takeover is particularly relevant in France. Acquired firms, in addition to being significantly smaller than their purchasers, have (insignificantly) higher debt-to-asset ratios while maintaining higher rates of return on their assets. Thus it may indeed be the case that firms with healthier balance sheets but more limited investment opportunities use takeovers as a means of gaining access to new avenues of growth.

[16] See Fallick (1996) for a (somewhat dated) survey of the North American literature. Kuhn (2002) provides an international perspective on displaced workers and Margolis (2002) provides an in-depth look at the determinants of new job finding for displaced workers in France.

Table 3.2: Logit Regressions: Characterisation of Firms Relative to Takeover Activity (Coefficients with Standard Errors in Parentheses)

Probability Modeled Comparison Group	P(Acquired) Acquiring Firms	P(Acquired) Control Firms	P(Acquiring) Control Firms
Human Resource Management			
Male	-0.0460 (0.0858)	0.1591*** (0.0365)	0.1917*** (0.0521)
Age	-0.0221 (0.0159)	0.0094 (0.0089)	0.0064 (0.0090)
Job Seniority	-0.0055 (0.0048)	-0.0198*** (0.0022)	-0.0224*** (0.0030)
Skilled Blue Collar	-0.1784** (0.0803)	-0.1999*** (0.0352)	-0.0661 (0.0493)
Unskilled Blue Collar	-0.0256 (0.0776)	-0.0547 (0.0336)	-0.0556 (0.0482)
Return to Fixed Unobservable Individual-Specific Characterisitcs	1.57E-06 (5.300E-05)	1.900E-05 (2.100E-05)	1.230E-06 (2.500E-05)
Returns to Education	7.00E-06 (1.170E-04)	-3.000E-05 (4.800E-05)	8.593E-06 (7.000E-05)
Returns to Observable (Time-Varying) Individual-Specific Characterisitcs	-5.700E-04 (6.620E-04)	-3.600E-04 (2.500E-04)	1.280E-04 (4.010E-04)
Compensation Policy			
Firm-Specific Fixed Effect	-0.1015 (0.0682)	-0.0709** (0.0277)	-0.0030 (0.0399)
Firm-Specific Seniority Returns	-0.2344 (0.2370)	0.2887** (0.1165)	0.6306*** (0.1672)
Residual from Earnings Decomposition	-0.1331** (0.0669)	-0.0818*** (0.0269)	0.0218 (0.0392)
Firm Accounts			
Log (Total Employment)	0.4589 (0.4410)	0.0804 (0.2079)	-0.0125 (0.2893)
Log (Value of Fixed Assets Net of Depreciation and Amortisation)	-0.7321* (0.4411)	0.1637 (0.2077)	0.4069 (0.2892)
Percent Increase in the Value of Fixed Assets Net of Depreciation and Amortisation	-3.580E-07 (1.780E-06)	6.621E-08 (1.045E-06)	2.247E-07 (3.101E-07)
Log (Total Debt/Total Assets)	0.0181 (0.0437)	0.0249 (0.0209)	0.0282 (0.0257)
Log (Return on Assets)	0.0517*** (0.0151)	0.0453*** (0.0072)	0.0064 (0.0094)
Log (Value Added per Worker)	-0.0588 (0.0495)	0.0830*** (0.0237)	0.1408*** (0.0301)
Log Likelihood	-3897.1845	-15352.8675	-8191.83
Number of Dependent Variable = 1 Firm	4536	4536	2210
Number of Firms	6746	74807	72481

Sources: MDST, FUTE, DADS and EDP data and Author's Calculations.

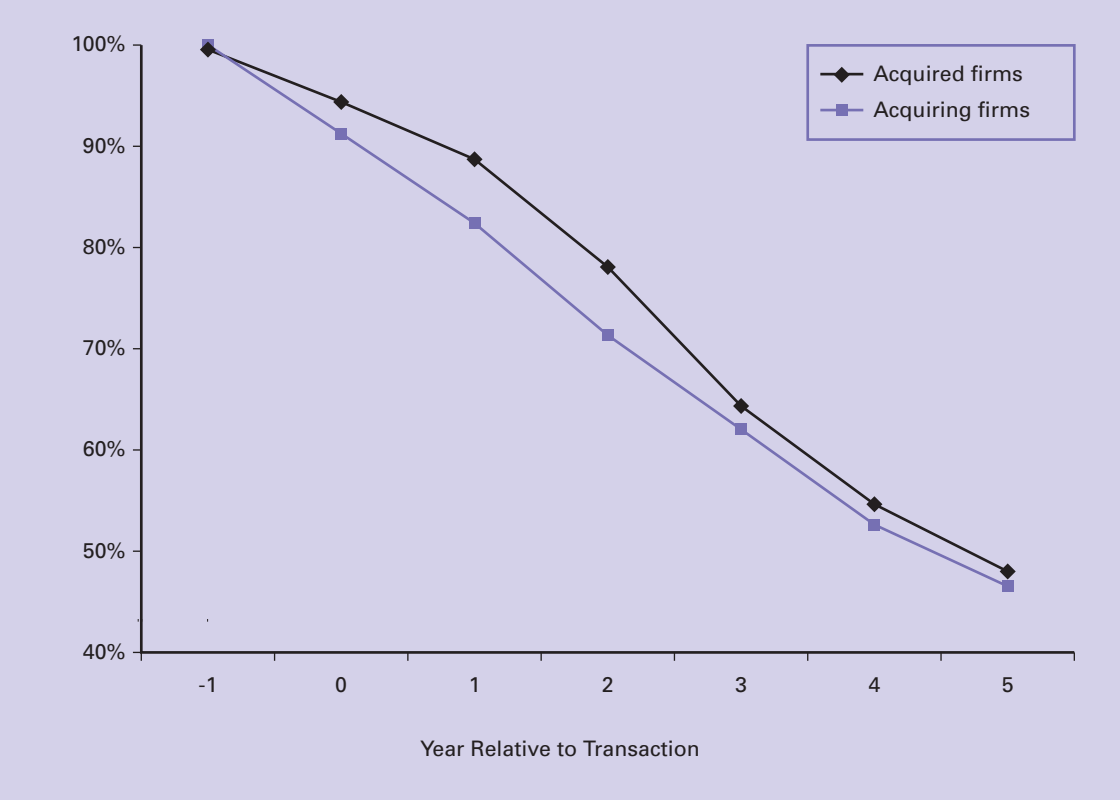
Notes: All models also include controls for 9 observation years, 10 sectors, Paris region, 8 educational categories, age2, age3 and age4, Log (capital-labour ratio), Log (sales/worker) and the interation of seniority with returns to seniority.
*** indicates a coefficient significant at the 1% level, ** at the 5% level and * at the 10% level.
One observation per firm, representing averages over the sample period, is used for the analysis.

3.5 Who Stays and Who Leaves After a Takeover?

Once one has characterised which firms are more or less likely to be involved in takeover activity, one can turn one's attention to which workers in those firms are more or less likely to stay on with the new entity after the transaction. The longitudinal linked employer-employee data used here allow one to consider workers who were employed by acquired and acquiring firms in the year before the takeover and follow them in the years after the takeover to see which workers stay and which leave, either through layoffs or by quitting (the data do not provide information on the reason for the separation).

The first step is to look at overall workforce retention in acquired and acquiring firms. Figure 3.2 shows the probability of continued employment in acquired and acquiring firms. While it seems clear that more layoffs occur in the target firm in the short term than in the predator firm (the difference is significant for the first 2 years), such differences in separation behaviour tend to disappear in the medium term.

Figure 3.2: Probability of Continued Employment by Takeover Status



When looking in detail at which workers stay with their firms (see table 3.3), however, it becomes clear that the layoffs are not evenly distributed across the existing work force. This simple observation is actually quite informative given that almost no workforce characteristics distinguished acquiring firms from their targets. It implies that a predator firm does not base its takeover decision on the composition of its target's workforce, as might be expected if the takeover is hostile and the acquiring firm has no access to the target firm's personnel records. Thus human resource management policies do not form the basis of the takeover decision, whereas compensation policies may enter into account. On the other hand, once the transaction is completed, the acquiring firm obtains access to the acquired firm's personnel records and can selectively organise its layoffs to maximise the cost savings while minimising production losses due to having fewer workers.

Table 3.3: Logit Regressions: Probability of Continued Employment (Coefficients with Standard Errors in Parentheses)

	Acquired Firms			Acquiring Firms		
Variable	**1 year after**	**2 years after**	**5 years after**	**1 year after**	**2 years after**	**5 years after**
Human Resource Management						
Male	0.6230**	0.8024*	1.3165	0.4441	0.3413	2.7088***
	(0.3135)	(0.4421)	(1.0012)	(0.3186)	(0.3917)	(1.0475)
Age	0.3728*	0.6409**	1.3074**	0.4639**	0.1450	0.7694
	(0.1973)	(0.2943)	(0.6578)	(0.2017)	(0.2634)	(0.6555)
Job Seniority	0.0209***	0.0156***	0.0043	0.0093***	0.0250***	0.0445***
	(0.0021)	(0.0026)	(0.0057)	(0.0020)	(0.0025)	(0.0058)
Skilled Blue Collar	0.0890**	0.2114***	0.2917***	-0.0436	0.0335	0.2335**
	(0.0377)	(0.0453)	(0.0937)	(0.0346)	(0.0435)	(0.0946)
Unskilled Blue Collar	0.0292	0.0734	0.0970	-0.1301***	-0.0688	-0.1905*
	(0.0407)	(0.0502)	(0.1069)	(0.0387)	(0.0482)	(0.1115)
Return to Fixed Unobservable Individual-Specific Characteristics	0.1631***	0.3404***	0.3854***	0.1947***	0.1719***	0.2128**
	(0.0299)	(0.0408)	(0.0969)	(0.0310)	(0.0386)	(0.0960)
Returns to Education	0.1634***	0.3402***	0.3851***	0.1948***	0.1721***	0.2130**
	(0.0299)	(0.0408)	(0.0969)	(0.0310)	(0.0386)	(0.0960)
Returns to Observable (Time-Varying) Individual-Specific Characteristics	-1.0999	-3.5280**	-5.4494	-1.3130	-0.8246	-8.2198**
	(1.0975)	(1.5513)	(3.4497)	(1.1180)	(1.3845)	(3.5221)
Compensation Policy						
Firm-Specific Fixed Effect	0.2252***	0.2776***	0.8409***	0.2626***	0.1019	0.9212***
	(0.0330)	(0.0446)	(0.1116)	(0.0457)	(0.0664)	(0.1652)
Firm-Specific Seniority Returns	0.1753	0.3932***	0.6705***	-1.9967***	-2.2268***	0.9989
	(0.1073)	(0.1366)	(0.2075)	(0.2799)	(0.3805)	(0.9479)
Residual from Earnings Decomposition	0.0343	0.1156***	0.0580	0.0198	0.0636*	0.0358
	(0.0226)	(0.0325)	(0.0848)	(0.0250)	(0.0349)	(0.0856)

Table 3.3 *(continued)*: **Logit Regressions: Probability of Continued Employment** (Coefficients with Standard Errors in Parentheses)

	Acquired Firms			Acquiring Firms		
Variable	**1 year after**	**2 years after**	**5 years after**	**1 year after**	**2 years after**	**5 years after**
Firm Accounts						
Log (Total Employment)	0.0094	0.0258***	0.0909***	0.0542***	0.0508***	0.0088
	(0.0064)	(0.0081)	(0.0177)	(0.0065)	(0.0075)	(0.0209)
Log (Value of Fixed Assets Net of Depreciation and Amortisation	-0.1070***	-0.2732***	-0.3048***	-0.2583***	-0.0971***	-0.2618***
	(0.0112)	(0.0140)	(0.0300)	(0.0100)	(0.0126)	(0.0340)
Percent Increase in the Value of Fixed Assets Net of Depreciation and Amortisation	-5.400E-04**	1.730E-03***	-0.0022***	-8.100E-04**	4.200E-05	-0.0265***
	(2.450E-04)	(2.570E-04)	(0.0004)	(3.560E-04)	(1.180E-04)	(0.0094)
Log (Total Debt/Total Assets)	0.2613***	0.2736***	0.0217	0.2196***	0.3438***	-0.7780***
	(0.0408)	(0.0496)	(0.1097)	(0.0444)	(0.0503)	(0.1399)
Log (Return on Assets)	0.0313***	0.0952***	0.0780**	0.0630***	-0.0737***	0.0528
	(0.0115)	(0.0143)	(0.0309)	(0.0101)	(0.0115)	(0.0373)
Log (Value Added per Worker)	0.3777***	-0.1227**	-0.9281***	0.3617***	0.5152***	-0.1804
	(0.0488)	(0.0599)	(0.1495)	(0.0536)	(0.0673)	(0.1992)
Log Likelihood	-5851.0055	-3919.493	-893.785	-6703.903	-4397.9905	-914.871
Number of Individuals Still Employed	2982	1906	385	6256	4209	888
Number of Eligible Individuals	17114	14363	8702	17706	13287	7488

Sources: MDST, FUTE, DADS and EDP data and Author's Calculations.

Notes: See notes to Table 3.2. Each individual employed in the relevant firm in the year preceding the takeover year is potentially eligible, although the number of logit models in which an individual participates depends on the takeover date relative to the end of sample date (1999).

Looking first at the employees of the acquired firm, those who were employed by firms that paid particularly below market wages or rewarded seniority particularly poorly are least likely to stay with the new entity post takeover. This is consistent with the idea that the new owners are likely to impose a corporate culture where employees are expected to exert effort (and will be compensated for it), and that those employees who were used to a corporate culture in which people were not paid much but little was expected of them in terms of effort (the literature often considers returns to job seniority as providing a mechanism for inciting individuals to exert effort on the job) are more likely to quit when their firm is absorbed.

In terms of worker characteristics, senior workers are most likely to stay with the new entity post-takeover, as are men, older workers, skilled blue collar workers and workers whose market value, both in terms of education and other unobservable characteristics, is relatively high. The results concerning the market value of workers may reflect the fact that it is costly to find such high-value workers, and the predator firm takes advantage of the fact that the target firm has already paid these costs. The results concerning job seniority are likely to reflect collective bargaining

agreement conditions and legislation concerning layoffs that protect longer-tenure workers over recent hires. It is worth noting, however, that low-seniority workers and white collar workers (the difference with unskilled blue collar workers is insignificant) are the most likely to separate from their employers post-takeover and that these workers are, at least in some dimensions, the workers that the literature on mass layoffs suggests find new employment more easily.

When looking at firm accounts, it appears that an employee of a large firm (measured by assets) has a significantly higher chance of leaving the new entity than an employee of a smaller firm. On the other hand, employees of firms that were more indebted yet more profitable prior to the transaction are more likely to stay on with the newly created entity post-takeover. Perhaps surprisingly, the effect of average employee productivity changes over time, with the workers of more productive acquired firms initially staying with a higher probability than those of less productive acquired firms and the relation reversing two years after the takeover.[17] When considering acquiring firms, a similar inversion takes place, although it is statistically insignificant and takes place at a much longer distance from the actual takeover event.

The results concerning continued employment in firms that acquire other firms are very similar to the results for employee retention in acquired firms, in terms of which workers are more likely to stay or leave, although unskilled blue collar workers in acquired firms do tend to separate with a significantly higher probability than skilled blue collar workers or white collar workers in these firms. This observation provides partial validation for the idea that the acquiring firm's management team has an "ideal" workforce structure in mind and uses the occasion of the takeover to proceed with "necessary" reorganisations both in house and with its newly acquired staff. Since firms involved in takeovers are similar to each other ex-ante in terms of the structure of their workforces (and different from firms that do not undergo a merger or acquisition), it is perhaps unsurprising that the same sorts of workers from both acquired and acquiring firms stay with the newly created entity post transaction. However, since these sorts of firms can be distinguished from non-takeover firms according to the characteristics of their workforces, such similar post-transaction behavior should ease the task of employment agencies somewhat as they can prepare to accommodate similar types of workers in a similar manner in areas where "typical" firms are found without having to worry about which side of the transaction the firm will be on.

[17] The fact that the coefficient changes sign over the duration of the employment spell implies that simple duration econometric models would be misspecified when analysing this model. This is the primary reason why we chose to analyse the continued employment duration through a series of logit models.

3.6 Conclusion: Takeovers Have Important Consequences for Employment that Are Only Visible in Linked Employer-Employee Data

The analysis undertaken in this paper represents a step forward with respect to existing knowledge about takeovers along several dimensions. Acquired and acquiring firms were characterised in terms of their compensation policies and human resource management practices, as opposed to simply balance sheet data. Detailed analyses of which workers are most at risk of separating from their employer post takeover were also carried out, and the distribution of layoffs between acquired and acquiring firms was investigated. None of these additional steps could have been undertaken without the detailed linked employer-employee data that served as the basis for the analysis.

French firms have been shown to behave essentially as predicted by economic theory concerning mergers and acquisitions. Some takeovers seem to be driven by ex-ante perceptible differences in firm characteristics, most notably compensation policy, that could be perceived as sources of inefficiency to be improved upon after the takeover occurs. Analysis of post-transaction employment shows that workforce reorganisations performed by the new entity target similar types of workers in the acquired and acquiring firms, suggesting that acquiring firms may use the takeover event as a justification for undertaking a broader restructuring, integrating the acquired firm's employees into the new entity and keeping only the most appropriate workers from both firms.

French firms also seem to follow the investment opportunities model of takeovers, in that acquired firms tend to be more indebted but with significantly higher returns on assets than the firms that acquire them. Such takeovers may indeed correspond to mature firms "buying in" opportunities for growth while young firms obtain their necessary financing by being integrated into a larger entity.

The workers who leave the post-transaction entity can be characterised by their observable characteristics as well as their "market value" (a measure of unobservable characteristics). They tend to be younger, female and white-collar workers with low job tenure and characteristics (both education-related and unmeasured in the data) that give them low market value. For the most part, these characteristics describe the workers who also find it easiest to get new jobs following a mass layoff, which means that employment services may not need to be directed as intensely to employees laid off after a takeover since these workers are likely to be able to find new jobs relatively easily even in the absence of additional assistance.

As a final note, it is worth highlighting the manner in which the results shown here can be used to inform policy. First, it seems that some smaller firms disappear due to their inability to access affordable capital, even though they have promising investment opportunities. This suggests that

capital markets should be investigated for failures and that there may be an additional justification for subsidising fast-growing firms: not only do they seem unable to access capital markets adequately, but they are more likely to be acquired by other firms and such acquisitions tend to lead to (proportionally) large reductions in employment.

Second, acquired firms do indeed lay off workers more than acquiring firms but only in the short term, while the workers who end up laid off may not be as much in need of reemployment assistance as might previously have been thought. Both acquired and acquiring firms differ from non-takeover firms in observable ways, and similar sorts of workers are laid off from both types of firms after a takeover, so employment agencies may be able to do some planning for layoffs before they occur by focusing on firms that are more likely to be involved in takeover activity. But the planning may not need much in terms of additional resources (with the exception of women, those workers whose educational or otherwise unobservable characteristics make them less desirable to the labour market and unskilled blue-collar workers from the predator firms) since the workers most likely to be laid off are also those who can find new jobs the quickest after a layoff.

In sum, mergers and acquisitions are intimately related to the compensation policies and human resource management practices of the firms involved. One can use linked employer-employee data to target policy initiatives along several dimensions related to takeover activity, and an analysis of the employment implications of takeovers may lead to different policy recommendations than might have be preconceived in the absence of such detailed microeconometric evidence.

3.7 References

Bertrand, M. and Mullainathan, S. (2003) 'Enjoying the Quiet Life? Corporate Governance and Managerial Preferences,' *Journal of Political Economy*, October, pp. 1043-1075

Borenstein, S. (1990) 'Airline Mergers, Airport Dominance and Market Power,' *American Economic Review*, 80:2, May, pp. 400-404

Bradley, M., Desai, A. and Han Kim, E. (1983) 'The Rationale Behind Interfirm Tender Offers: Information or Synergy?' *Journal of Financial Economics*, 11, April, pp. 183-206

Brown, C. and Medoff, J.L. (1988). 'The Impact of Firm Acquisitions on Labor,' in A. Auerbach, Corporate Takeovers: Causes and Consequences, (Chicago: NBER, University of Chicago Press)

Compte, O., Jenny, F. and Rey, P (2002), 'Capacity Constraints, Mergers and Collusion,' *European Economic Review*, 46:1, January, pp. 1-29

Eckbo, B.E. (1983) 'Horizontal Mergers, Collusion and Stockholder

Wealth,' *Journal of Financial Economics*, 11, April, pp. 241-273

Fallick, B.C. (1996) 'A Review of the Recent Empirical Literature on Displaced Workers,' *Industrial and Labor Relations Review*, 50:1, October, pp. 5-16

Gokhale, J., Groshen, E. and Neumark, D. (1995) 'Do Hostile Takeovers Reduce Extramarginal Wage Payments?' *Review of Economics and Statistics*, 77, pp. 470-485

Jensen, M. (1984) 'Takeovers: Folklore and Science,' *Harvard Business Review*, 84, pp. 109-121

Jensen, M. (1986) 'Agency Costs of Free Cash Flow, Corporate Finance and Takeovers,' *American Economic Review*, 76, pp. 323-329

Jensen, M. (1988) 'Takeovers: Their Causes and Consequences,' *Journal of Economic Perspectives*, 2, pp. 21-48

Jensen, M. and Meckling, W. (1976) 'Theory of the Firm: Managerial Behavior, Agency Costs and Ownership Structure,' *Journal of Financial Economics*, 3:4, October, pp. 305-360

Kuhn, P.J. (ed.) (2002) Losing work, moving on: International perspectives on worker displacement, (Kalamazoo, Mich.: W. E. Upjohn Institute for Employment Research)

Manne, H. (1965) 'Mergers and the Market for Corporate Control,' *Journal of Political Economy*, 73, pp. 110-120

Margolis, D.N. (2002) 'Licenciements collectifs et durée entre deux emplois,' *Economie et Statistique*, Number 351, pp. 65-85

Margolis, D.N. (2005) 'Mergers, Acquisitions and Employment,' TEAM – Université Paris 1 Panthéon-Sorbonne mimeo, December

Matsusaka, J.G. (1993) 'Takeover Motives during the Conglomerate Merger Wave,' *Rand Journal of Economics*, 24:3, Autumn, pp. 357-379

4 Using Linked Employer-Employee Data to Analyse Fringe Benefits Policies: Norwegian Experiences

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ABSTRACT

Over 50 per cent of firms in Norway offer fringe benefits as part of their compensation package for workers, but their incentives for doing so are not well understood. Using linked employer-employee data provided by Statistics Norway and surveys of managers, this paper investigates the relationship between fringe benefits, worker retention and firm performance. The findings indicate that fringe benefits can play an important role in human resource management, as workers' quit behaviour is very sensitive to their existence. Establishments also achieve higher productivity by offering more fringe benefits, although it is not clear whether this is due to workers making greater efforts, or to lower recruitment costs. Finally, firms with more generous benefits have higher survival rates than other establishments.

4.1 Introduction

Policy analysts and academics often equate labour costs with wages, when, in fact, non-wage labour costs account for between 15 and 40 per cent of total labour costs in major OECD countries.[19] Non-wage elements are becoming increasingly important. From the 1960s to the 1990s in the United States, fringe benefits increased from 4.9 per cent of total compensation to over 10 per cent.[20] This begs the question: what do

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[19] Hart et al. (1988) report figures for France, Germany, Italy, Norway, Sweden, UK, USA and Japan from 1965 to 1983. To my knowledge, comprehensive comparative surveys with more recent figures have yet to be published.

[20] Woodbury (1983) reports total compensation comprises 4.9 per cent benefits in 1966 using BLS-data. Benefits comprise employer payments to pension, health and life insurance, and other agreed-upon items. While indexing the 1966-figure as 100, Hashimoto (2000) reports that the index in 1995 has increased to 174.1 and 212.45 for legally required and voluntary benefits, respectively. In economic research, several contributions have studied the relationship between fringe benefits and worker behaviour. In 2002, Journal of Labor Economics ran a special issue on compensation strategies, where fringe benefits were the focus of two articles.

employers hope to gain from these benefits? Perhaps fringe benefits are a tax-efficient form of remuneration, or permit the targeting of incentives to valued workers without distorting pay structure? Maybe fringe benefits are excluded from the bargaining process in countries where wages are set by centralised bargaining, thus providing employers with ways to recruit new workers and to retain old workers?

In this article we report findings from recent studies of firms' fringe benefits policies using Norwegian data. Norway differs from most west-European countries in certain respects. Norway is not part of European Union, it has a sizeable petroleum sector and it provides its citizens access to a generous welfare state. At the same time, Norway is among the most highly centralised wage bargaining countries in the world (Wallerstein, 1999). Employer and worker unions bargain centrally over wages. But this does not mean that all wages are set centrally: not all sectors participate in the bargaining process, and in many sectors local and/or individual-level bargaining supplement the central bargaining process.

Do workers and employers bargain over fringe benefits? The answer is clearly yes, but not always for all kinds of fringe benefits. Important fringe benefits such as pension schemes, health insurance and holidays are clearly subjects for bargaining. Fringe benefits of lesser value are less often a bargaining objective for unions, at least when bargaining centrally, but even low valued benefits may be objects for local and individual bargaining.

What constitutes a fringe benefit? This clearly varies between countries. In the literature, one usually considers pension schemes, health and life insurance as fringe benefits. But in the USA for example, sickness and maternity leave and paid holidays are also considered fringe benefits, while these benefits are statutory rights in the majority of OECD countries (OECD, 2002). In Norway public pensions, sickness and maternity leave and basic holidays are determined by governmental legislation and agreements between employer and worker unions on a central level. They are usually not considered as fringe benefits. Private pension schemes may however be considered as fringe benefits. For tax purposes, many fringe benefits must be reported to the tax authorities. Among these are stock options, free cars and free housing (see Section 4.3 for a more comprehensive list). Lower valued fringe benefits and those of a more spurious character (for example free coffee and fruit) are usually not reportable. Fringe benefits that are considered reportable and taxable change over the years. Employers introduce new kinds of fringe benefits that are not reportable and taxable, which then are made reportable and taxable by the tax authorities. Finally, one should be aware that even those fringe benefits that should be reported are not always reported. There is reason to believe that this is particularly true for small amounts, less well-established employment relationships and for less well-regulated industries.

In many ways, we have seen increased emphasis on fringe benefits in Norway during the last decade. In Norwegian newspapers and media we have seen an increased number of articles focussing on the positive aspects of fringe benefits. Along other dimensions the change is not that obvious. Consider Table 4.1, which reports statistics on the value of fringe benefits as they are reported to the tax authorities during the period 1995 to 2002. Column 3 shows that the percentage of establishments offering fringe benefits has increased, although due to business cycle effects the trend is not linear. But, as columns 4 and 5 show, throughout the period the value of fringe benefits as they are reported to the tax authorities only accounted for a small percentage of total compensation.

If the value of fringe benefits is so small on average, why do fringe benefits merit attention? First, even small values can have large impacts on certain outcomes. Second, although the average values are small, for specific groups the fringe benefits payments may be larger and may show a stronger trend. Consider for instance Figure 4.1. This figure depicts the value of fringe benefits reported to the tax authorities as a share of the total compensation for five groups of educational qualifications: oil-well drillers and miners, welders, lawyers, economists with a university degree, and economists with an MBA. While for most of the groups we observe only small changes during the period 1995-2002, the development for the MBAs is striking. During the period of observation, the fringe benefits' share has become close to five times as large as at the outset. Is this change just a reflection of how the MBAs' employers have altered the fringe benefits policy, regardless of their employees' educational qualifications? In 1995, the MBAs' establishments provided on average fringe benefits valued at 2.6 per cent of total compensation (not shown on the graph). In 2002 this had only increased to 3.8 per cent, so MBAs experience a stronger movement towards a compensation comprising more of fringe benefits and less of wages than the average worker.

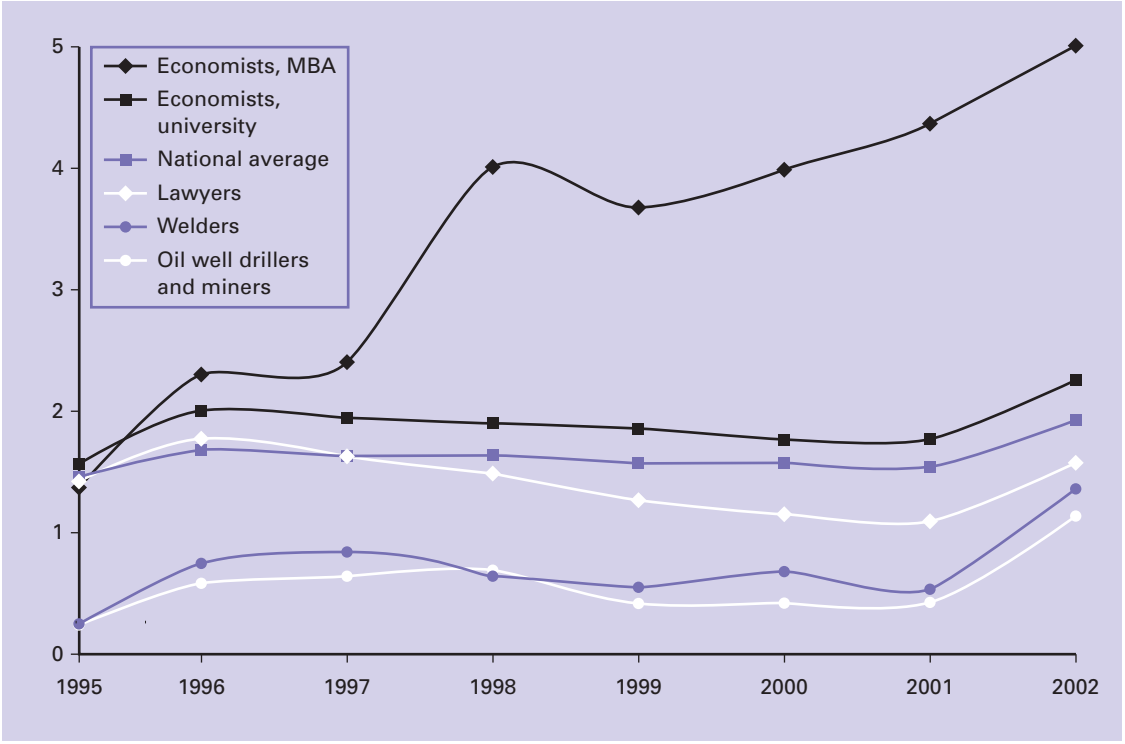
Furthermore, this development is not caused by these MBAs being employed within telecom and IT (narrow industries with preferences for fringes such as stock options). Telecom and IT have experienced a strong growth in the provision of fringe benefits, but so have wholesale trade and production of food and beverages. When asked, employers in the two former industries stress that employees prefer fringe benefits to wages, but also that they are important for recruitment purposes. Fringe benefits are important for recruitment purposes in the two latter industries as well, but the producers of food and beverages rarely reply that employees prefer them to wages. So while the growth in fringe benefits for MBAs is partly caused by the developments in Telecom and IT, we are still left to explain why MBAs in other industries experience this growth.

Table 4.1: The use of fringe benefits 1995-2002

Year	Number of establishments	Percentage of establishments offering fringes	Fringes as share of total compensation (%)	
			All establishments	Fringe offering
1995	141169 (29564)	29.4 (55.6)	1.4 (0.9)	4.6 (1.6)
1996	144223 (30338)	43.9 (81.5)	1.7 (1.2)	3.5 (1.5)
1997	148380 (32571)	46.9 (83.6)	1.6 (1.2)	3.3 (1.4)
1998	150598 (34591)	48.4 (84.3)	1.6 (1.1)	3.2 (1.4)
1999	150965 (35518)	39.0 (67.3)	1.6 (1.0)	3.8 (1.5)
2000	150064 (36194)	38.5 (65.4)	1.6 (1.0)	3.9 (1.5)
2001	149092 (36551)	39.3 (65.1)	1.5 (0.9)	3.8 (1.4)
2002	148125 (36968)	57.9 (89.6)	1.9 (1.4)	3.2 (1.5)

Note: Population: All Norwegian establishments and workers during the period 1995-2002. The figures in parentheses are based on establishments with more than 10 employees. Total compensation comprises wages and the value of fringe benefits as they are reported to the tax authorities.

Figure 4.1: Fringe benefits expressed as share of total compensation (%-points) during 1995-2002 for five educational qualifications



In the next sections, we summarise recent research on fringe benefits which implies that the use of fringe benefits is beneficial for both workers and firms. These studies mainly use Norwegian linked employer-employee data (LEED) supplemented by survey questionnaire data. Two questions are particularly important in this research: 1) Can fringe benefits be important as devices to control worker turnover; 2) How do fringe benefits policies affect establishment performance?

Performance is not a well-defined target. The literature focuses on total factor productivity and establishment survival probability as measures reflecting performance. These measures are quite different, and one should not necessarily expect fringe benefits to have the same impact on these. All else equal, more productive establishments should survive longer. But theory also implies that establishment survival will only be ensured as long as the sum of the discounted future revenue stream generated by continued operation is at least as large as the revenue generated from the sale of all equipment and hardware today. If, for example, employers discount differently, this variation may be correlated with their provision of fringe benefits in such a way that fringe benefits increase productivity, but appear to reduce establishment survival. In the data section, we discuss some of the merits of LEEDs, but also point out some potential drawbacks.

4.2 Some theoretical thoughts – why offer fringe benefits?

Fringe benefits can be understood from two different perspectives – as equivalent to money wages or as non-pecuniary goods. If fringe benefits are equivalent to money wages, why are they offered? The wage is the price for labour, which provides consumption opportunities for the worker. If fringe benefits are offered instead, this may imply that the prices for fringe benefits are lower than money wages or that they provide the worker with better consumption opportunities. There are several reasons why fringe benefits can be cheaper than wages. For workers and firms, tax legislation often treats fringe benefits more favourably. A wage of one pound seldom yields consumption opportunities of one pound for the worker and labour costs of one pound for the employer. Employers may save pay-roll tax, and workers may save earnings tax. In addition, due to market power firms may achieve fringe benefits at favourable prices compared to what is available for workers. Furthermore, in some cases the fringe benefits are produced by the firm itself, and the mark-up saved by avoiding expensive third-party sellers may provide the employers with a significant leverage in providing employees with attractive fringe benefits.

Fringe benefits may also be understood as non-pecuniary goods. Fringe benefits are seldom accepted as a medium of exchange. They are not readily used as payment for goods and services. Thus the real value of fringe benefits for both the provider and the recipient can be difficult to surmise. Fringe benefits may, however, give the workers strong

satisfaction. They may have strong preferences and fondness for a particular holiday cottage. An offer of free child care may take care of workers' organisational problems at home. The point is that fringe benefits are singled out from the basic wage, thus worker evaluation is influenced by endowment and framing effects (Thaler, 1980, Tversky and Kahneman, 1986; Kahneman, Knetsch and Thaler, 1990) and biases of judgement (Rabin, 1998).

Regardless of these two perspectives, fringe benefits allow employers to design or structure the remuneration package offered to workers so that it differentiates between workers (Elliot, 1991), and so they have an element of "wage discrimination" attached. Fringe benefits allow employers to target particularly attractive workers or groups of workers, and offer them benefits which they desire. From this perspective, we see that fringe benefits may be particularly attractive for employers in centralised wage bargaining economies. Certain fringe benefits can also be understood as a form of deferred compensation, which may achieve efficiency gains by increased worker commitment, but also "lock" workers to firms. Fringe benefits may act as a motivational device through the gift-exchange mechanism of Akerlof (1982) and other efficiency wage mechanisms, and they may act as important incentive devices.[21] Finally, it was noted as early as the 1980s that unionism and collective bargaining cause total compensation to comprise relatively more fringe benefits and less money wages (Freeman, 1981; Woodbury, 1983).[22] Thus a typical fringe benefits policy would be to offer the management stocks and stock options, while the workforce in general is offered a pension scheme.

In Dale-Olsen (2005a, 2005b), fringe benefits are primarily treated as non-pecuniary goods, i.e., fringe benefits are not treated as equivalent to money wages. This allows us to interpret fringe benefits in a framework which explicitly acknowledges that firms pay different job bundles (wages and different non-pecuniary goods), workers – as unemployed or as employed – search for jobs, but search frictions cause delays to the match between workers and firms.[23] In this framework, firms find that workers quit due exogenous reasons. However, workers also search continuously for better jobs, and they quit when they receive a better job offer. Firms offer job bundles comprising of wages and non-wage amenities (e.g., fringe benefits) to attract workers and to retain employees. Large firms offer job bundles providing more utility to workers than small firms, since this strategy reduces worker turnover rate, and makes it easier to attract replacement hires. This is a necessity just to keep a large workforce. The optimality of this strategy follows from the theoretical model's matching assumptions, that workers and firms are homogenous and the notion that

[21] Stocks/stock options are counted as fringes in Norway, making the link to the CEO incentive literature clear.
[22] Union policies are strongly influenced by the median voter, and the median voter is often an older, tenured worker. He or she will often prefer fringes as health insurance and pension plans to money wages.
[23] This framework is the equilibrium search (or dynamic monopsony) framework with hedonic wages as presented by Hwang, Mortensen and Reed (1998).

the economy is in equilibrium (for example, firms do not shrink or expand their workforce). Thus it does not imply that achieving a low quit rate is an optimum strategy in all cases.

Finally, one should note that there are several reasons why the fringe benefits policies of firms should depend on size. Large firms have more market power than small firms. Large firms are more likely to produce items or goods that may be considered fringe benefits to workers. Large firms are more likely than small firms to have designed and established wage and recruitment policies – large firms "lose" workers all the time, while workers quit small firms more unevenly.[24] Clearly large firms, more often than small firms, offer their employees access to internal labour markets. Thus, while it is well known that there exists a firm-size wage premium, such a premium should also exist when it comes to fringe benefits.

4.3 Data

Linked employer-employee data (LEED) provide the perfect background for analysing workforce policies regarding, for example, payment issues- but also more externally designed social reforms. LEED datasets give a researcher the opportunity to follow workers over time, to see how they react to work environment changes. Longitudinal LEED datasets, such as those used in this paper, often provide researchers with information on whole populations. A small LEED dataset could comprise all the employees of a firm. Large ones are often based on public administrative registers, thus comprising the whole populations of workers and establishments in a country. Since the access cost to these registers is less related to the number of subjects (or records), the researcher may find it more cost effective to access the complete population than to focus on a sample. Several research issues can for all practical purposes only be addressed using large comprehensive LEED datasets. A typical issue could be the identification of high wage and low wage firms and the study of how they are matched to high wage and low wage workers.

However, LEED datasets are not without drawbacks. Since they are originally constructed for administrative purposes, the information they include is often more limited. The researcher is limited to the information that already exists. The unit of the population is already pre-defined, and especially for LEED datasets based on administrative registers, the legislation for the register governs changes to this population. Thus questionnaires can be much more targeted and designed to shed light on special issues, but at the price of having to be based on samples only.

[24] Consider, for example, two groups of establishments in 2000. In group A, each establishment employs 3 workers, of which at least two workers quit. In group B, each establishment employs 500 workers, of which at least two workers quit. Average duration between each quit in group A is close to 84 days, with a variance of 3392. Average duration between each quit in group B is 9 days, with a variance of 58. Even the variance relative to the mean is much smaller for group B than for group A, implying more uneven quits from group A than from group B.

For social scientists the well-regulated social democracies of the Nordic countries provide relatively easy access to LEED datasets.[25] The LEED datasets are mostly managed by the public authorities. The countries have implemented different systems or regimes for how researchers are to access these databases. The systems are designed to take into consideration individuals' privacy issues and the possibility of misuse and exploitation. Thus one regime is that the micro data never leave the central statistical agency, and all analyses have to be conducted on the premises of this agency. This does not imply that the researcher physically has to be on the same premises, since she may remotely submit programs. Another regime is to accept that data leave the public authorities after approval from statistical agencies and governmental bodies. In this case all identifying numbers are usually encrypted. Often the data are to be kept in a secure environment (not accessible over the internet).

Statistics Norway provides researchers with access to very large comprehensive Norwegian LEED datasets. The research referred to in this article uses information mainly from a LEED dataset based on public administrative registers, and comprises all employers and their employees in Norway 1995–2003 employed on May 15th each year. A crucial and important aspect making the construction of Norwegian LEEDs possible (or at least easier) is that in Norway separate identifying numbers exist for each citizen, each establishment and each enterprise. The PIN-code of the workers makes it possible to track workers through time, even while employed by different employers and during periods of unemployment. Similarly, the identifying number of the establishments makes it possible to follow an establishment from creation to closure. In our LEED dataset the identifying numbers are encrypted, but otherwise all aspects of the number series are kept.

How do the Norwegian administrative registers treat closures? The classical closure of an establishment – a plant is completely disbanded, dismantled and then disappears – is seen as the disappearance of the establishment from the registers. In many cases, some sort of continued operation occurs, but the establishment's identifying number changes and thus implies an establishment closure in the records. From 1995 the main principle for designating a new identifying number and new date of birth to an establishment in such cases is that at least two of three characteristics have to change: 1) new owner; 2) new main product (change of industry); and 3) new location (change of municipality). If the workforce remains identical, all three characteristics have to change for it to be considered a death of an "old" establishment and a "birth" of a new one. This means that establishment closures due to purely administrative reasons should not occur. Important characteristics of the establishment have to change for the establishment to get a new identity.

[25] By relatively ease, I mean that in these countries large comprehensive LEEDs actually do exist, and researchers get access to them.

It is a matter of concern that a change of ownership results in what appears as a birth of a new establishment. As pointed out above, enterprises (owners of establishments) and establishments have separate identifying number series. Purely legal ownership changes result in a new identifying number for the enterprise, but otherwise no changes for the establishment. Note also that these criteria are identical for single-establishment and multiple-establishment enterprises. Reallocation of resources between establishments within the same enterprise may result in what appears as more frequent establishment closures among multiple-establishment enterprises, but one may equally well observe the opposite, since multiple-establishment enterprises have available more resources and financial reserves (these enterprises are usually larger than single-establishment enterprises).

This linked employer-employee data set provides information on workers (gender, education), jobs (for example earnings, daily wage, hourly wages in 2002-2003, the value of fringe benefits as they are reported to the tax authorities, weekly working hours, seniority) and establishment-characteristics such as industry (5-digit NACE), sector and municipality. The data are very comprehensive, thus it is possible to derive information on the establishments' local labour market (at the municipality level) and at a detailed industry level (3-digit NACE).

Among fringe benefits reported to the tax authorities are, for example, loans provided by employers at low interest rates, and free or subsidised telephones/mobile phones, cars, newspapers, work clothing, public holidays, gifts, food (lunch/dinner), free child care (including kindergartens), free accident insurance, retirement insurance, stocks available at below market price, free housing, free memberships in private medical services, paid parking spaces, and benefits from borrowing computer equipment from employers.

This LEED dataset faces a typical drawback – it does not comprise all the desired information. Although our data are very comprehensive, it would have been of benefit to have information on the *value* reported to the tax authorities of specific fringe benefits (for example company car, free housing, stocks or loans lower than market price/interest rate). And even more important, not all fringe benefits are reported to the tax authorities. The information is also much more limited when it comes to information on establishments (not aggregated from worker characteristics). For a sample of the establishments we have access to information on value added, capital (insurance values), pay-roll tax and investments, but only for establishments that are part of the manufacturing statistics (and a few mining, construction and trade establishments).

In the research reviewed in this article, information from two LEED datasets are linked to the information from two questionnaires – FLEXI97 and ABU2003 – conducted in 1997 and January-March 2003, respectively. Each questionnaire was answered by the daily leader or personnel manager of more than 2300 Norwegian establishments and covered topics such as new work practices and organisation issues, wage determination, health and pension issues. These establishments were sampled from establishments with more than 10 employees, but the sample was constructed so that large establishments were over-sampled (stratified). For example, all establishments with more than 300 establishments were included in the samples. Both survey samples were drawn by Statistics Norway using stratified sampling from Statistics Norway's registers of establishments and enterprises. Statistics Norway has access to most identifying numbers in Norway (e.g., citizen, worker, establishment, enterprise). The identifying establishment and enterprise numbers are then replaced by the encrypted ones, so these surveys are easily linked to our LEED datasets.

While FLEXI97 and ABU2003 comprise questionnaire information on new work practices, ABU2003 focuses especially on fringe benefits issues. What kinds of fringe benefits are offered? What are the employers' motivations for offering fringe benefits? By answering these questions, the questionnaire provides the information the LEED datasets lack. This article focuses principally on ABU2003, but returns to Flexi97 in the final section.

4.4 What characterises establishments offering fringe benefits?

In this section, a rough picture is provided of the non-public administration sector establishments that offer fringe benefits in Norway 2002. In the ABU2003 questionnaire the employers are asked about the provision of eight specific fringe benefits: pension schemes, allowed leave due to self-reported sickness in excess of collective agreements (from here on called extended sickness absence), private physicians, gym membership, child care, cleaning assistance, holiday homes (cottage/flat), and vacation longer than collective agreements (from here on called extended vacation). It is possible for an employer to provide more than one fringe benefit.

Tables 4.2 and 4.3 describe wages, fringe benefits (from the questionnaire and LEED), and show the distribution of the provision of fringe benefits in Norway 2002. On average close to 80 per cent of Norwegian employers offer at least one fringe benefit. Pension schemes and gym membership are the most common. Child care and cleaning assistance are seldom offered. Table 4.3 also reveals that the distribution of the number

of fringe benefits offered is skewed. Most employers offer one or two benefits, while a small minority (10 per cent) offers more than three. The distribution of the value of fringe benefits is equally skewed. Most employers offer benefits of a low reported value, but maximum reported establishment average value is over 1500 NoK (8NoK≈1€).[26]

Table 4.4 looks closer at the clustering or groups of fringe benefits offered. It shows that pension schemes are the central fringe benefit. As employers increase the number of fringe benefits provided, they also combine extended sickness absence, gym membership and holiday home. Only employers providing six or seven fringe benefits offer child care or cleaning assistance.

Table 4.5 reveals that there exist distinct industry differences, regardless whether one considers the fringe benefits reported to the tax authorities or the fringe benefits reported in the questionnaire.

Table 4.2: Provision of fringe benefits. 2002

	Average in economy
Daily wages incl. fringes (NoK)	739.5
Fringe benefits as % of compensation	1.7
Norwegian employers offering:	
At least one fringe benefit (%)	78.4
Pension scheme (%)	54.4
Extended sickness absence (%)	26.5
Private physician (%)	15.3
Gym (%)	33.4
Child care (%)	2.9
Cleaning assistance (%)	0.4
Holiday home (%)	14.9
Extended vacation (%)	21.7

Note: Questionnaire information is linked to register information for 2002. 1387 observations. They are weighted to be representative for the population of establishments employing at least 11 employees. This population employs 956177 workers. Average establishment size is 38.5 employees. 8NoK≈1€.

[26] During the period 1995-2003 1 $ has varied between 6 and 10 NoK, while the variation between the Norwegian Krone and Euro has been much smaller. Thus in the following sections, we only show the conversion to Euro.

Table 4.3: Distribution of fringe benefits 2002

Reported daily fringe value Interval of the distribution over reported fringe benefits		Number of fringe benefits Interval of the distribution over the number of benefits provided	
Min	0	Min	0
1%	0	1%	0
5%	0	5%	0
10%	0	10%	0
25%	1.1	25%	1
50%	5.5	50%	1
75%	17.1	75%	3
90%	39.7	90%	4
95%	68.3	95%	4
99%	160.2	99%	5
Max	1672.6	Max	7

Note: See Table 3.2

From the questionnaire data, manufacturing, services and transport are high fringe benefit industries, while trade and primary are low fringe benefit industries. From the tax authority data, we see that primary industries are among the higher ranked. This reflects differences in fringe benefits reported to the tax authorities and those reported in the questionnaire.

Table 4.4: Clustering of fringe benefits 2002

The number of fringe benefits offered	Frequency category	Fringe benefits	within group percent
1	1	Pension scheme (PS)	54.4
	2	Extended sickness absence (ESA)/gym (G). These are tied.	13.4
2	1	PS, ESA	28.0
	2	PS, G	21.3
3	1	PS, G, holiday home (HH)	18.0
	2	PS, ESA, HH	15.2
4	1	PS, ESA, HH, G	29.3
	2	PS, HH, G, extended vacation (EV)	19.2
5	1	PS, ESA, HH, G, EV	31.8
	2	PS, ESA, HH, G, private physician (PP)	26.1
6	1	PS, ESA, HH, G, EV, PP	35.7
	2	PS, ESA, HH, G, EV, child care (CC)	21.4
7	1	PS, ESA, HH, G, EV, PP, CC	60.0
	2	PS, ESA, HH, G, EV, CC, cleaning assistance	20.0

Note: Questionnaire information is linked to register information for 2002. 1387 observations. They are weighted to be representative for the population of establishments employing at least 11 employees. Frequency category 1 is the most frequent fringe benefit or combination of fringe benefits within the groups defined by the number of fringes offered. Frequency category 2 is the second most frequent fringe benefit or combination of fringe benefits within the groups defined by the number of fringes offered.

For example, low reported values of fringe benefits in the hotel and restaurant industries are not surprising, since these are less well-regulated industries and well-established employment relationships are less common. Insurance, vehicles, housing and food are relevant fringes in the primary sector, but are only reported to the tax authorities. The manufacturing, service and primary industries are high-wage; hotels and trade are low-wage. Thus it appears that industries paying high wages also offer more fringe benefits than low-wage industries.

The next table – Table 4.6 – addresses this issue in more detail: Do establishments paying high wages also offer more fringe benefits? From a compensating wage differential perspective, we would expect high wage firms to pay low fringe benefits, and vice versa. Introducing on-the-job search and search friction may yield a positive correlation between wages and benefits.

To shed light on this issue, in Dale-Olsen (2005b) the establishments are ranked by their position in the wage distribution, and grouped into six groups depending on rank. The first group comprises establishments positioned at the bottom of the wage distribution, from the 0th percentile to the 10th percentile. The last group comprises establishments positioned at the top of the wage distribution, from 91st percentile to the 100th percentile. For each of these groups, Dale-Olsen (2005b) studies average

size, average wage, and average percentage fringe benefit value of the total compensation. Table 4.6 reports these figures for three separate populations: for all establishments 1995-2002, for all establishments employing at least 10 workers, and establishments in the ABU2003-sample (a sample from establishments with more than 10 workers).

In all three populations there is a very similar picture, as revealed in Table 4.6. The higher in the wage distribution the establishment is positioned, the larger is the establishment and the larger the part of total compensation comprised of fringe benefits. The slight deviation for all establishments' workforce size (when comparing columns five and six in row one) is caused by the high average wage level of some very small establishments, but then again these averages rest on a few observations only. At the top of the wage distribution, the value of the fringe benefits is 4-5 per cent of the total compensation

Table 4.5: Wages, fringe benefits and industry 2002

	Total	Primary	Manuf.	Construction	Trade	Hotel	Transport	Service
Total number of workers	956177	9088	334150	60901	155218	50231	91723	194288
Establishment size	38.5	25.8	57.5	29.7	24.5	29.2	41.0	44.2
Daily wages incl. fringes	739.5	856.0	819.1	803.5	661.9	391.0	780.5	897.7
Fringe benefits (%)	1.7	2.7	1.7	1.1	2.5	0.9	1.2	1.9
Fringe benefits								
Pension scheme	54.4	57.4	55.0	20.8	46.3	22.8	76.8	63.7
Extended sickness absence (%)	26.5	0	35.0	24.0	14.8	17.8	41.1	28.5
Private physician (%)	15.3	18.3	19.0	12.0	13.3	17.3	13.9	15.0
Gym (%)	33.3	6.7	32.9	24.0	23.2	46.0	39.1	47.7
Child care (%)	2.9	0	2.0	0	0.4	0	0.1	5.1
Cleaning assistance (%)	0.4	0	0.3	0	0	0	0.1	1.9
Holiday home (%)	14.9	0	23.3	10.7	8.7	1.4	24.3	16.9
Extended vacation (%)	21.7	1.0	14.2	20.8	18.8	31.5	23.5	30.0

Note: Establishment size expresses the number of employees. Daily wages incl. fringes (in NoK, 8NoK≈1€) expresses the establishments' average daily wages inclusive the value of fringes reported to the tax authorities. Fringe benefits (%) express the share (in percentage points) fringes contribute to total wages. The industries reported in the column head are aggregated as follows: Primary (NACE 01-05), Manufacturing (inclusive mining and power, NACE 10-45), Construction (NACE 45-49), Trade (NACE 50-54), Hotel (inclusive restaurants, NACE 55-59), Transport (inclusive communication, NACE 60-64), Service (inclusive finance, insurance, real estate and personal services, NACE 65-74, 90-93). Questionnaire information is linked to register information for 2002. 1387 observations. They are weighted to be representative for the population of establishments employing at least 11 employees.

Table 4.6: Establishment size, wages and reported fringe benefits

	Interval of the distribution over average establishment wages					
	0-10%	11-25%	26-50%	51-75%	76-90%	91-100%
All establishments and their workers 1995-2002						
Number of employees	5.8	11.7	16.6	18.2	18.6	15.8
Average daily wage	254.3	519.6	689.3	856.5	1063.2	1597.1
Fringe benefits (%-points)	1.2	1.1	1.7	2.8	4.1	5.0
Establishments with more than 10 employees and their workers 1995-2002						
Number of employees	29.7	34.9	45.5	56.3	60.4	69.9
Average daily wage	324.7	527.7	692.4	859.4	1068.1	1556.3
Fringe benefits (%-points)	0.6	0.6	1.2	2.3	3.2	4.5
ABU-sample of establishments with more than 10 employees and their workers 2002						
Number of employees	32.9	36.3	41.4	49.1	59.4	89.3
Average daily wage	334.2	530.5	701.7	857.5	1076.9	1565.5
Fringe benefits (%-points)	0.6	0.6	0.9	2.1	3.8	4.3

Average daily wage (in NoK, 8NoK≈1€) expresses establishment-specific average of daily wages less the reported values of fringes. Fringe benefits are reported as share of total compensation (in percentage points). Total compensation comprises the reported values of fringes and wages (reported to the tax authorities). Source: Dale-Olsen (2005b).

The observed wage distribution is a reflection of the establishments' wage policies and their workforces' qualifications. Establishments at the top may pay high wage premiums (above average market wages) compared to other establishments, for example to achieve a larger workforce size (even given equally productive workers). However, establishments may also be located at the top because they have a highly qualified workforce.

Dale-Olsen (2005b) derives separate distributions for the wage premiums and workforce qualifications from the wage distribution, and then studies these separately. The study concludes that fringe benefits are more extensively used among establishments that are higher up in the wage premium distribution and among workforces of higher quality. Child care though, is offered primarily to less skilled workforces. This reflects these establishments' workforce gender composition, being dominated by female occupations. Cleaning assistance is primarily offered by establishments at the very top of the wage premium distribution.

Finally, Table 4.5 revealed that wages vary between industries. How do the above findings change if one considers the relationship between fringe benefits and the wage distribution conditional upon industry? It turns out that the high wage establishments still offer more benefits and they are still large, but one also finds that very low wage establishments offer more benefits and these are also large. Thus in this case we observe a convex relationship between fringe benefits and workforce size.

4.5 Employers' motivations for offering fringe benefits

We start by providing a brief look at employers' motivations for providing fringe benefits. In the questionnaire the employers were asked why they offer fringe benefits. They were given four alternative answers to choose from: i) employees prefer fringe benefits to wages, ii) it is important to recruit/retain workers, iii) it saves pay-roll tax, and iv) employers obtain goods and services at lower prices than workers. The categories of motivation are not mutually exclusive. Employers may choose more than one reason or none (29.4 per cent answer none).

Table 4.7, reproduced from Dale-Olsen (2005b), shows that the main reason for employers to offer fringe benefits is because they are (thought) to be important for recruitment and retention of workers. More than fifty per cent of the employers answer that this is the reason for offering them. 25 per cent answer that employees prefer fringe benefits to wages or that employers achieve lower prices than workers. Very few answer that fringe benefits are offered to save pay-roll tax (but this may be because it is not socially acceptable to say so).

These reasons are also clustered. Employers who only provide one reason usually motivate fringe benefits by "recruit/retain workers" (74.8 per cent). If they provide two reasons, a majority say "recruit/retain workers" and "since employees prefer fringes to wages" (54.6 per cent). However, several employers answer "recruit/retain workers" and that they "achieve lower prices than workers" (41.2 per cent). If the employers provide three reasons, then 87.9 per cent answers "recruit/retain workers", "employees prefer fringe benefits to wages" and "employers obtain lower prices than workers".

Since some workers employed by larger firms are likely to quit each period, recruitment and training of new workers are costly issues that occur regularly, at least for larger firms, and have to be addressed in an organised way. Thus larger firms are more likely to have personnel departments and well-developed recruitment and wage policies, and they are more likely to answer that fringe benefits are important for recruitment. Larger firms are also more likely to obtain lower prices than employees. Table 4.7 also reveals that the fringe benefits on offer vary according to the employers' motivation. Those saving pay-roll tax offer private physicians, child care and cleaning assistance – the latter two being typical informal economy occupations. Employers motivated by 'employees prefer fringe benefits to wages' offer private physicians and extended vacations, but they are less likely to offer a holiday home.

Table 4.7: Why do establishments use fringe benefits?

	Motivation for using fringe benefits as part of total compensation			
	Employees prefer fringes to wages	**Important for recruit/ retain workers**	**Achieve lower prices than workers**	**Saves pay-roll tax**
Mean (%)	25.5	55.0	24.1	2.0
Pearson correlation coefficients (Fisher's z-transformation). In per cent.				
Number of employees	-2.0	8.1**	7.1**	-1.5
Pension scheme	3.7**	8.1**	13.1***	7.0**
Extended sickness absence	2.7	6.2*	2.6	8.0**
Private physician	10.0***	6.9*	3.3	12.8***
Gym membership	1.6	8.9**	16.1***	3.0
Child care	0.0	4.6	-3.7	8.5**
Cleaning assistance	7.0*	3.3	-1.3	15.7***
Holiday home	-8.4**	9.0**	13.0***	-3.8
Extended vacation	24.1***	12.9***	-8.8**	-10.0***

Note: Weighted. Figures based on the response from 847 establishments offering at least one fringe benefit in excess of pension scheme. The categories of motivation are not mutually exclusive. ***, **, and * denote 1, 5, and 10 per cent level of significance, respectively. Source: Dale-Olsen (2005b)

4.6 The impact of wages and fringe benefits on workers' quit behaviour

In this section we study in more detail how workers' quit behaviour is affected by wages and fringe benefits. In Dale-Olsen (2005b), the results from several duration regression models are presented. A duration regression model explicitly models the time in a particular state – in this case the employment spell. The models are estimated using the observations on the nearly 200,000 workers employed by the non-public administration establishments of the ABU2003-sample.

This article focuses on the results from two of the duration regression estimations.[27] Observed heterogeneity is controlled by the variables: education (years and field dummies), experience (years), gender, union member, municipality mean and variance log wages, industry mean and variance log wages, industry and county dummies. Table 4.8 presents two regression results regarding wages and fringe benefits. Regression 1 includes hourly wage and dummies for different fringe benefits. Regression 2 includes hourly wage and the percentage of total compensation comprised by fringe benefits. For ease of interpretation, the estimated parameters are presented as showing the impacts on the quit rate in per cent. The average quit rate is 20.6 per cent.

[27] The estimations are of so-called Weibull-duration regression models where unobserved heterogeneity (variation) is controlled for by a Gamma distributed term.

Regression 1 of Table 4.8 shows that higher wages and some of the fringe benefits (child care, holiday home, extended sickness absence leave) strongly reduce worker turnover. Establishments offering child care experience a 40 per cent lower quit rate than other establishments. In addition, the results of Regression 2 imply that as the relative value of the fringe benefits increase, the quit rate drops. More fringe benefits, given the total level of compensation, reduces worker turnover.

Table 4.8: The impact of wages and fringe benefits on workers' probability of quitting

	Hourly wage (1NoK)	Pension scheme	Extended sickness absence	Private physician	Gym membership	Child care	Cleaning assistance	Holiday home	Extended vacation	Fringe benefits (1%-point)
1:Impact (%)	-0.27***	-5.7	-20.5***	8.0	-4.8	-40.0***	-16.2	-15.7**	7.3	
2:Impact (%)	-0.26***									-3.0***

Note: Table elements are calculated from estimates of two Weibull (with Gamma heterogeneity) duration models. Dependent variable is the workers seniority in years. See text for further details. Average hourly wage is roughly 200 NoK (8NoK≈1€). ***, **, and * denote 1, 5, and 10 per cent level of significance, respectively. Source: Table elements based on figures presented in Dale-Olsen (2005b).

The results of regressions 1 and 2 are very robust. Dale-Olsen (2005b) reports the results from several other specifications (different controls, different distributional assumptions, bootstrap), and these are quite similar. For example, in one specification the total reported value of the fringe benefits was included in addition to the variables mentioned above. This specification controls for the fact that the fringe benefits dummies do not indicate the amount of fringe benefits offered and that those reported to the tax authorities and those reported in the questionnaire may not coincide. This causes only minor changes, and the parameters associated with the fringe benefit dummies are basically unchanged.

To give a visual impression of the importance of fringe benefits for the quit rate, the parameter estimates are used to calculate the hazard function and the cumulative hazard function. The hazard function is interpreted as the probability that the worker quits next period contingent on the worker being employed in this period. The cumulative hazard then gives a picture of the total quit probability as the years of seniority increase.

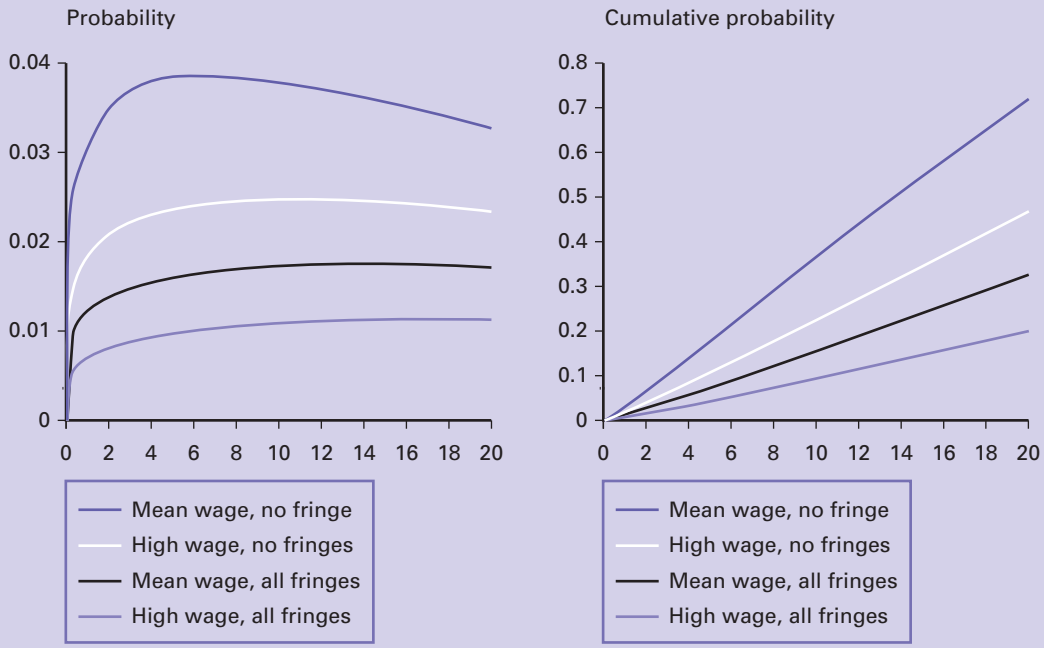
In Figure 4.2 four cases are considered: mean wage/no fringes, mean wage/all fringes, high wage/no fringes and high wage/all fringes. These are extreme cases, but they reveal the differences between the policies. The mean wage in this sample of workers is roughly 200 NoK (8NoK≈1€), while high wage is defined as twice the mean wage. 'All fringes' implies that all eight fringes are provided. Figure 4.2 shows that the probability is roughly twice as large for mean wage/no fringes compared to mean

wage/all fringes. More importantly, though, paying high wages/no fringes yields a probability that is larger than paying mean wages/all fringes. Thus with respect to worker turnover at least, offering fringe benefits may totally compensate for lower wages.

The estimated figures in Dale-Olsen (2005b) indicate extremely strong preferences for some of the fringe benefits. These estimates can be used to calculate workers' marginal willingness to pay (MWP) for fringe benefits. Table 4.9 presents these MWP-figures. The method is basically to use the quit behaviour as a key to provide an MWP-estimate. How much is the probability of quitting reduced by increasing wages? How much is it reduced by offering fringe benefits? The relative relationship then provides an MWP-estimate. Of course, this method rests on very strong simplifying assumptions, for example regarding utility functions.

The significant MWP-figures reported in Table 4.9 are extremely high. One reason for this result is that the utility function does not take into consideration the necessity of wages, but treat wages and fringe benefits equally. Wages provide workers with consumption opportunities today. Certain fringe benefits act as deferred compensation. They are non-transferable and provide consumption opportunities in the future.

Figure 4.2: Wage and fringe benefits policies and workers' probabilities of quitting: four cases



Note: The probability rates are calculated from the estimates of a Weibull duration model (with Gamma heterogeneity) reported in Dale-Olsen (2005b). See text for details.

Table 4.9: The marginal willingness to pay (MWP) for fringe benefits (in Norwegian Krone)

	Pension scheme	Extended sickness absence	Private physician	Gym membership	Child care	Cleaning assistance	Holiday home	Extended vacation	Fringe benefits (1%-point)
MWP	20.9	84.7**	-29.6	17.7	188.0**	59.9	63.1**	-26.8	11.0***

Note: The MWP-figures are based on Table 4, and are expressed in Norwegian krone (£1≈11-12 NoK, 1€≈8 NoK). ***, **, and * denote 1, 5, and 10 per cent level of significance, respectively.
Source: Dale-Olsen (2005b).

Some fringe benefits provide utility today, but are non-transferable, non-divisible, lack readily available markets, and thus they provide fewer consumption opportunities than wages.

Another reason may be the fact that the fringe benefits are modelled by the use of dummies on the establishment-level, and the associated parameter estimates may catch the importance of other non-observed benefits. But also the MWP for an extra 1 percentage point of fringe benefits (reported on the individual level) as part of total compensation is strong.

These workers are on average on the margin willing to pay 11 NoK (8NoK≈1€) for 1 percentage point more fringes as part of total compensation. On average, an extra 1 percentage point of fringe benefits implies an extra 2 NoK of fringe benefits. Thus the workers are willing to pay 11 NoK to get a value of 2 NoK in fringe benefits.

The results referred to here can be criticised for not taking into account the fact that employers design their wage and fringe benefits policy to achieve a desired level of worker turnover. For example, very few employers attempt to achieve zero worker turnover. Employers have thus determined the profit-maximising combination of wages, fringe benefits and worker turnover. If this is the case, then the regressions above may be affected by endogeneity bias. To address this, Dale-Olsen (2005b) also runs establishment-level quit regressions, utilising the panel characteristics of the data. This allows one to estimate quit regressions using the GMM-method of Arellano and Bond (1991) incorporated in STATA. This still identifies strong significant negative impacts from both fringe benefits and wages on worker turnover.

4.7 Do establishments offering fringe benefits achieve higher productivity?

The next issue is whether or not establishments offering fringe benefits achieve measurable productivity gains from their fringe benefits policies. The main employer argument for offering fringe benefits was that fringes

were necessary to recruit and to retain workers. Worker turnover, and the consequent recruitment and training are costly, so fringes may offset turnover. A properly designed fringe benefits policy also acts as an incentive device, i.e., these establishments may achieve a more efficient workforce compared to establishments not offering fringe benefits. To shed some light on this issue, Table 4.10 presents descriptive statistics on value addition and fringe benefits for 164 manufacturing establishments in the ABU2003-sample. The first column provides statistics across all establishments. The next columns provide statistics for four groups of establishments, where group membership is determined by fringe benefits' share of total workforce compensation. The first group comprises of the 10 per cent establishments with the smallest share. The next group comprises of the next 11-50 per cent establishments, and so on.

Although the relationships are slightly weaker for the top group, Table 4.10 shows that establishments paying relatively more fringe benefits are larger overall, employ more highly educated workers, are more capital intensive, pay higher wages, pay more pay-roll taxes, and produce more than other firms. While value addition increases as the share of fringes increases, no causal impact of fringe benefits on productivity is identified. But this topic is elaborated in Dale-Olsen (2005b) by estimating several Cobb-Douglas production functions. Using an estimation method called system-GMM (Blundell and Bond, 1998) to address endogeneity issues, a positive impact of fringe benefits on value addition is identified. Establishments paying more fringe benefits relative to total compensation experience higher total factor productivity than establishments paying little fringe benefits. This productivity effect is not caused by saving pay-roll tax, since it persists even after controlling for pay-roll tax differences.

Table 4.10: Productivity, wage and fringe benefits policies. Average 1995-2002

		Interval of the fringe benefits distribution			
	Total	**1-10%**	**10-50%**	**51-90%**	**90-100%**
Number of employees	239.9	103.4 (98.6)	237.9 (218.4)	281.8 (247.3)	216.5 (192.2)
High educated employees	61.2	8.1 (8.7)	45.6 (70.4)	85.7 (113.3)	72.5 (76.0)
Log capital	12.0	11.2 (1.5)	12.1 (1.7)	12.2 (1.5)	11.5 (1.5)
Log value added	11.2	10.2 (1.1)	11.1 (1.3)	11.5 (1.4)	11.3 (1.4)
Daily wage	760.0	640.3 (116.2)	709.4 (151.4)	812.8 (189.9)	812.8 (189.9)
Fringe benefits (%-points)	1.4	0.02 (0.02)	0.5 (0.2)	1.7 (0.6)	5.7 (2.6)
Pay-roll tax rate (%-points)	11.2	10.6 (2.4)	10.8 (2.4)	11.5 (2.5)	12.5 (1.5)
Number of observations	1168	116	468	467	117

Note: Table elements express mean and standard deviations (in parentheses). Capital, value added and daily wage are reported in NoK. Population: 164 manufacturing ABU2003-establishments with valid observations on capital and pay-roll tax.

4.8 The impact of new work practices, fringe benefits policies and wages on establishment survival

In this section, we turn to the final issue – how do fringe benefits policies affect establishment survival? In the previous sections, we have seen that fringe benefits can be used to manage the worker turnover of an establishment. Furthermore, manufacturing establishments offering higher valued fringe benefits achieve productivity gains compared to establishments offering lower valued benefits. All things equal one should then expect that establishments offering relatively more fringe benefits should be better able to survive in a competitive economy than those establishments offering relatively fewer fringe benefits.

A problem with evaluating the impact of fringe benefits and wages on establishment survival is that if one considers the population of establishments existing at one point in time, and then studies which establishments survive, the original population is also a product of a 'natural selection' process. Some establishments are very old – survivors – while others are brand new – whereof some may become survivors as time goes by. This problem is aggravated by the fact that in our data we only can identify the time of entry for establishments participating in the questionnaires (Flexi97 and ABU2003) or for establishments established during 1996-2003.

During the period 1995-2003, we can focus on a specific cohort or cohorts of establishments. Dale-Olsen (2005c) selected the cohorts of 1996-2000, and then followed them until 2003. For example, the 1996-cohort comprises 10,383 establishments with more than one employee (single-person establishments are discarded from the data, since the role of these compared to self-employed individuals is unclear). Table A4.1 in the appendix provides descriptive statistics of all establishments and the entry establishments in the Norwegian economy in 1996. The entry establishments are usually smaller than the incumbent establishments. The entry rate is highest in the hotel, post-telecom (where a major reorganisation occurs) and IT industries, and smallest in manufacturing and primary industries. The entry establishments pay lower wages than the incumbents, but slightly more fringe benefits. These findings are quite robust across the cohorts.

Our main focus in this section, however, is on establishment closure. Table 4.11 shows the average exit rate of the 1996-, 1997- and 2000-cohort of establishments during the periods 1996-2003, 1997-2003 and 2000-2003, respectively[28]. The table presents figures for all establishments and for establishments with more than 10 employees separately. For all three cohorts the quit rates drop with workforce size, so it appears that larger

[28] The figures express the average closure rate during the period of observation, and they do not provide information on the cumulative probability of establishment survival during this period. The closure probability drops strongly as the establishment grows older. This is clearly seen if one focuses on the 1996-cohort. In 2003 only 55 per cent of the cohort is still active. Of the 45 per cent closures, more than 10 percentage points can be related to closures during the first year. To save space, the table does not present statistics on the 1998- and 1999-cohort.

size ensures survival. Establishments in multiple-establishment organisations have on average lower exit rates than establishments in single-establishment organisations (which may reflect multiple-establishments' larger sizes).

The table reveals clear differences between cohorts, populations (size) and industries. The 2000-cohort has the highest closure rate – 8.9 per cent – as expected (the shakeout or selection process is strongest among the young establishments), but the closure rate for the 1996-cohort is actually quite similar. 1997-cohort clearly has lower closure rates. Hotel-, IT- and post-telecom-sectors rank at the top when it comes to high exit rates, but these rankings are less clear when one focuses on establishments with more than 10 employees.

Table 4.11 also reports "rough" correlations between the total fringe benefit value as a share of total compensation, workforce size and establishment closure for the different cohorts, populations and industries. They demonstrate the strong heterogeneity that exists.

The correlations are qualitatively dependent on cohorts, populations and industries. At the aggregate level one gets the impression that fringe benefits correlate positively with closures (particularly for 1996), but no strong pattern can be seen between benefits and size. It is, however, clear that the construction-, service-, post-telecom and IT-sectors are the driving forces behind the positive correlations between fringes and closures. If one turns to the manufacturing establishments, having more fringe benefits is associated with fewer closures. This is particularly interesting since the previously referred productivity results were based on observations of manufacturing establishments.

Table 4.11: The closure rates of establishments (per cent), size and fringe benefits. 1996-, 1997- and 2000-cohorts

	1996-cohort		1997-cohort		2000-cohort	
	All	+10 employees	All	+10 employees	All	+10 employees
Total	8.5	4.9	6.9	5.6	8.9	6.0
Total – Only multisite	8.2	2.2	3.9	2.2	4.6	2.9
Primary	9.6	1.7	12.3	5.6	12.0	5.4
Manufacturing	8.3	5.1	8.7	7.1	8.8	3.9
Construction	7.3	4.5	9.6	8.8	9.4	6.0
Trade	7.4	3.8	8.1	3.8	8.4	3.0
Hotel	10.0	6.4	12.6	7.0	14.6	6.6
Transport	9.1	7.6	8.6	5.4	9.1	5.4
Post-telecom	20.6	3.9	11.5	9.0	11.5	8.0
Service	8.0	5.7	6.9	4.1	10.1	7.1
IT	9.5	9.3	10.6	5.4	15.8	15.2
Correlation between workforce size and the value of fringe benefits as share of total compensation.						
Total	-0.9**	-1.5	0.1	3.9***	0.1	2.1
Primary	1.6	0.5	3.4	-5.1	12.9**	8.3
Manufacturing	-1.7	-1.1	-0.9	-2.9	-0.4	1.1
Construction	-3.3**	-2.9	0.2	3.2	1.3	-6.2
Trade	0.1	1.5	5.1***	18.1***	-1.5	4.8
Hotel	-1.8	-0.9	0.2	6.1	4.0	4.0
Transport	1.0	-4.0	4.2**	7.6	-0.2	-8.0
Post-telecom	-7.0***	-8.4***	-0.8	3.4	-9.5	-6.9
Service	-2.7**	-1.8	-2.4**	4.4**	0.1	8.7**
IT	-2.6	22.6***	-5.8*	4.0	6.5*	17.7**
Correlation between the exit of establishments and the value of fringe benefits as share of total compensation.						
Total	1.3***	4.4***	0.2	1.1	0.9	3.7*
Primary	-1.9	-6.9	-0.9	34.7***	-8.4*	-12.6
Manufacturing	-1.4	-3.3	-3.5*	-7.7**	-3.4	-2.1
Construction	2.8*	18.5***	3.4**	11.3***	-0.4	-1.6
Trade	-1.7*	5.5**	0.3	5.8**	1.6	13.6**
Hotel	-4.3**	-6.0**	-3.8*	-8.1***	-3.1	-5.1
Transport	-2.4	-9.5*	0.8	0.1	-3.9	-7.3
Post-telecom	4.0***	13.3***	-1.5	-3.9	14.2**	-9.4
Service	1.1	9.4***	1.1	1.0	2.3	-3.0
IT	2.1	2.6	4.6	-3.8	6.1	20.2***

Note: Population: all entry Norwegian establishments in 1996, 1997 or 2000 (cohort 1996, cohort 1997, cohort 2000) excluding public administration and one-man establishments. All reported figures of correlations are Pearson correlation coefficients (Fisher's z-transformation) measured in per cent. ***, **, and * denote 1, 5, and 10 per cent level of significance, respectively. Source: Dale-Olsen (2005c).

To study the relationship between establishment survival and fringe benefit policies in more detail, Dale-Olsen (2005c) estimates duration regression models on observations of the 1996-2000 cohorts of establishments. The models control for log daily wages, fringe benefits (%), a dummy for being part of a multiple-establishment organisation (yes=1), log number of employees, the proportion of the workforce that is unionised, average years of education in the workforce, the number of educational qualifications in the workforce, the proportion of workforce on part-time contracts, average municipality wages, cohort-dummies and industry dummies (NACE, 2-digit).[29] All variables except for the dummies are treated as time-varying covariates.

Table 4.12 reports the results – probability ratios – from four of the regressions.[30] The first two columns present the results for two different duration models based on all observations. The next two columns report the results from similar regressions on observations of the manufacturing establishments only, thus enabling comparison to the findings of Section 4.7's productivity analysis. Table 4.12 shows that the results are quite robust to the choice of duration model – a nice feature which lends credibility to the findings. With the exception of the impact caused by municipality wages, we observe qualitatively similar effects for the other significant covariates. Furthermore, we see that for most covariates – the municipality wage level is once more an exception – the results are equally robust to the choice of population.

[29] Regressions are based on the Weibull-model and the semi-parametric Cox proportional hazard model, with time-varying covariates. To avoid making the analyses sensitive to characteristics of a specific cohort, the regressions are conducted on pooled observations from the five cohorts. The legislation regulating entries and closures in the administrative registers was introduced in 1995, and thus the quality of the data is improved for the later cohorts.

[30] Note that these ratios are actually hazard ratios. A hazard ratio associated with a covariate is to be interpreted as how much higher/lower is the hazard caused by this covariate relative to the baseline hazard (reference). In Table 4.12, consider the parameter associated with multiple-establishment organisation (MEO): 0.761. Being member of a MEO then implies 0.761 – 1 = –0.239, i.e., 23.9 per cent lower than the baseline hazard. See also the interpretation of the hazard function in Section 4.6.

Table 4.12: The impact of fringe benefits policies on establishment probability of closure. Probability ratios

	All establishments		Manufacturing establishments	
	Cox	Weibull	Cox	Weibull
Log workforce size	0.802***	0.522***	0.855***	0.677***
Multiple-establishment organisation	0.761***	0.879***	0.702***	0.797*
Log daily wages	0.926***	0.672***	0.909***	0.633***
Fringe benefits (%)	0.998***	0.991***	0.993***	0.977***
Women (in per cent of workforce)	0.996	0.897***	0.979	0.991
Average years of education	0.998	0.994	0.997	1.003
Number of educational qualifications	1.014***	1.040**	1.010***	1.024**
Part-time workers (in per cent of workforce)	0.931***	0.635***	0.868***	0.504***
Union workers (in per cent of workforce)	1.066**	1.001	1.167**	1.493***
Average municipality wage	1.001***	0.998***	1.001*	0.998***
Industry and cohort dummies	YES	YES	YES	YES

Note: Observations: All: 185586 observations, 44978 establishments, 14751 closures; Manufacturing: 11182 observations/2991 establishments, 1019 closures. ***, **, and * denote 1, 5, and 10 percent level of significance, respectively. Source: Table elements based on figures presented in Dale-Olsen (2005c).

A higher share of fringe benefits in total compensation significantly reduces the exit probability. The impact is not strong, but one should not expect a huge impact. Increasing the share of fringe benefits by one percentage point implies a 0.2-0.9 per cent lower exit probability (for all establishments). For manufacturing establishments the impact is slightly stronger – a 0.7-2.3 per cent lower probability of closure. Thus these regressions support the productivity results of Section 4.7.

Wages turn out to affect the probability of closure negatively, i.e., paying higher wages delays closure. At first this may seem surprising, but one has to remember that wages reflect productivity – more productive firms pay higher wages. Since more productive firms survive longer (everything else equal), a positive correlation exists between wages and survival. Controlling for productivity, a higher wage level should imply earlier closure, but in these regressions without controls for productivity we actually observe what should be expected. In general, doubling the wage implies a 7.4-32.8 per cent lower probability of closure (Cox and Weibull, respectively).

Although not the main focus of this section, Table 4.12 reveals interesting findings regarding the impact of workforce size, unionisation, multiple-establishment organisations and human resources on establishment closures. Workforce size matters for survival – being large ensures survival. For example, in these data average manufacturing size is 13 employees. The probability of closure drops by 14.5 per cent (Cox) when

the size doubles. Unionisation is associated with shorter lifespan. This can be interpreted as evidence that unions lower efficiency and ultimately cause closure, but this is probably a too simple explanation. Unionisation will reflect these establishments' ex ante lower survival probability – workers become members for protection. Being part of a multiple-establishment organisation lowers the probability of closure, which may indicate a positive network influence. And while the level of the workforce's educational qualifications has little or no importance for closure, the number of educational qualifications in the workplace clearly matters. A more diverse workforce implies higher closure probabilities. An explanation is that difficulties of managing a workforce increase with diversity – in principle not unlike Kremer's ideas regarding the O-ring of production (Kremer, 1993).

The final issue in this section is to provide evidence on whether fringe benefits are primarily adopted by employers also advocating certain management practices, and whether these management practices really determine survival. To shed some light on this issue, Dale-Olsen (2005c) estimate four duration regressions on the combined LEED-FLEXI97-questionnaire data, using 488 observations from the manufacturing sectors only.[31] All establishments are active in 1997, but during the next 8 years nearly 20 per cent close. All covariates in the regressions are measured earlier than or at the time of the questionnaire (1996 or early 1997). Three derived variables measuring total factor productivity (TFP), an index for new work practices (NWP) and an index for competition issues (CI) are incorporated in the analyses.[32] These are clearly very rough measures, and this combined with the fact that the regressions rest on rather few observations, imply that some care should be taken so that one does not draw too strong conclusions. Table 4.13 presents the results of these regressions.

[31] It is, with few exceptions, only for these industries that we have information on capital and value added. Unfortunately this means that the regressions rest on few observations, which clearly limits the number of controls. The regressions – Cox and Weibull – are weighted appropriately to take into account the stratified sampling of the data.

[32] TFP is measured by the average of the residuals from the estimation of simple Cobb-Douglas production functions separately on 1995- and 1996-data. An index of NWP is derived by simply adding 13 dummies of for the following characteristics: i) having a non-centralised wage determination and providing incentive wages, ii) offering worker autonomy and self-control, and having previously reorganised so employees got more responsibility, iii) letting low-level employees conduct quality control, control the final result and be responsible for purchases, iv) letting employees work at home, in work groups and use job rotation, v) employing temporary workers and short-term recruits from other firms. Maximum of the index is 12 and mean 5.6. An index of DC is constructed by similarly adding 5 dummies for i) international market most important, ii) competition become stronger, iii) temporary laid-off workers, iv) permanently laid-off workers, v) recruiting problems. Maximum is 5 and mean 1.6.

The basic model, Model A, controls for log total labour cost per employee, fringe benefits (%), log number of employees, a dummy for being part of a multiple-establishment organisation (yes=1), number of employees, union workers (in per cent of workforce), the workforce average years of education, and average municipality wages. Model B then adds TFP, NWP, NWP squared, CI, and the pay-roll tax rate.

Table 4.13: The impact of new work practices and productivity on establishment closure. Probability ratios

	Model A		Model B	
	Cox	Weibull	Cox	Weibull
Log workforce size	0.644***	0.660***	0.533***	0.581***
Multiple-establishment organisation	1.367	1.351	1.327	1.410
Log total labour costs per employee	0.734**	0.709**	13.187***	12.158**
Fringe benefits (%)	0.948	0.938	0.888	0.895
Women (in per cent of workforce)	1.065	0.905	1.443	1.280
Average years of education	0.621**	0.627**	0.675*	0.688*
Union workers (in per cent of workforce)	1.435	1.434	1.352	1.217
Average municipality wage	4.766	7.411	4.497	1.856
Total factor productivity (TFP)			0.382***	0.389***
Log capital			0.808***	0.803***
Pay-roll tax rate			1.139**	1.140
Index for new work practices			0.302***	0.312***
Index for new work practices squared			1.108***	1.104***
Index for competition issues			2.071***	2.000***

Note: 488 observations, representing 2698 establishments, 505 closures. ***, **, and * denote 1, 5, and 10 per cent level of significance, respectively. Source: Table elements based on figures presented in Dale-Olsen (2005c).

Model A of Table 4.13 reveals qualitatively similar results compared to Table 4.12, although the lack of observations makes it more difficult to get strong results. Significant impacts are only found concerning workforce size, log total labour costs per employee and workforce's years of education, which still correlate negatively with the probability of closure. However, the point estimate related to fringe benefits indicates that relatively more benefits reduce the probability of closure.

The inclusion of TFP, NWP, NWP squared, CI, and the pay-roll tax rate presented in the columns under the heading Model B then changes the impact of labour costs. Controlling for the level of productivity, higher labour costs increase the probability of closure. Similarly, controlling for the level of productivity, a higher level of pay-roll tax increases labour costs and consequently raise the probability of closure. Being a more productive establishment, controlling for costs, then yields a lower

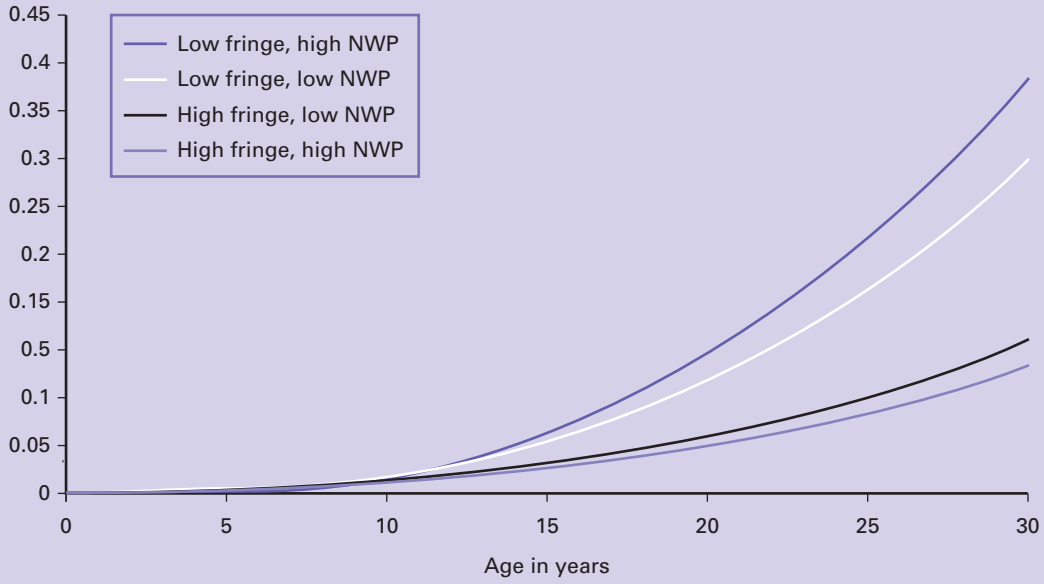
probability. When it comes to fringe benefits, however, the impact remains insignificant although the point estimate indicates a negative impact.

On the other hand, the index of new work practices strongly correlates with survival. The estimates of Table 4.13 indicate a convex relationship. For very low values of the index the probabilities of closure decrease, but establishments achieving high values on index experience increased probabilities compared to non NWP-establishments.

Using the parameter estimates, it is possible to calculate the cumulative exit probability. Figure 4.4 shows the cumulative exit probability for four groups defined by fringe benefits policy (1 and 10 per cent of total compensation, respectively) and NWP-status (index value of 2 and 10, respectively). These four groups are defined as: (low fringe, low NWP), (high fringe, low NWP), (low fringe, high NWP), and (high fringe, high NWP). As seen in Figure 4.4, scoring high on the index of NWP is clearly detrimental to survival, while more fringe benefits yield the opposite conclusion.

Why are NWP associated with reduced survival rates compared to establishments adopting more traditional management? Originally one would surmise that NWP-establishments having a flexible workforce, paying incentive wages, and delegating responsibility to the workers should be better suited for competitive markets. In the regressions referred to above, differences in establishment productivity and capital are controlled for. A speculative explanation could therefore be that the owners of NWP-establishments operate with a different set of targets (for example, a preference for returns today rather than later) than non-NWP-establishments. For instance, if the owners of NWP-establishments demand higher returns to their investments than other owners, then they may disband their establishments sooner than non-NWP-establishment owners.

Figure 4.3: The impact of new work practices (NWP) on the probability of establishment closure. Flexi-sample



Note: The figure shows the cumulative exit probability (hazard) for four groups of establishments. See text for details. Source: Calculated using estimates presented in Dale-Olsen (2005c).

4.9 Conclusion

This article has summarised recent research on fringe benefits policies. This research shows that workers' quit behaviour is very sensitive to the offering of fringe benefits. Fringe benefits can thus be important devices for managing firms' workforces. Paying high wages is one strategy to reduce the worker turnover, offering attractive fringe benefits is another. The research also indicates that establishments achieve higher productivity by offering more fringe benefits, although it is not clear whether this is due to workers making more effort or if it is due to reduced recruitment costs. Finally, we have seen how establishments offering more fringe benefits experience higher survival rates than other establishments. This is as expected, since a strategy that yields improved productivity for the establishment should imply a higher survival rate.

From a policy point of view this article thus advocates the use of fringe benefits as part of the compensation policies offered to workers by employers. Care should be taken when designing the fringe benefits policies. Fringe benefits, as seen in Section 4.6, are not equally appreciated by different groups of workers. Furthermore, a few reservations are needed. While the research reveals positive impacts of fringe benefits on productivity, this rests on observations from manufacturing firms only. Manufacturing has traditionally been more conservative concerning the provision of benefits, while other industries (IT and telecom) have practiced generous provision. This research does

not discuss whether fringe benefits in non-manufacturing industries have had the desired effect. Neither is it determined whether the impact that we observe is related to the introduction of fringe benefits as new elements in the remuneration package. During 1996 to 2002 the provision of fringes increased by 23 and 76 per cent in manufacturing and telecom, respectively. Fringe benefits may very well lose their attraction if/when they become common.

The article has shown how linked employer-employee data (LEED) make it possible to shed light on an issue from different angles, thus making the findings more robust. Furthermore, it has presented results using analyses which for all practical purposes are not possible to do except on LEED datasets. But while the benefits of using LEED in social science are great, they do come at a price. While questionnaires can target specific questions, the LEED surveys are often constructed for non-research purposes. The article discusses this, and advocates the use of LEED datasets combined with information from other questionnaires.

4.10 References

Akerlof, G.A. (1982) 'Labor Constracts as a Partial Gift Exchange', *Quarterly Journal of Economics,* 97, pp. 543-69

Alpert, W.A. and. Woodbury, S.A (2000) *Employee Benefits and Labor Markets in Canada and the United States.* Michigan: W.E. Upjohn Institute for Employment Research

Arellano, M. and Bond, S. (1991) 'Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations.'*The Review of Economic Studies,* 58, pp. 277-97

Blundell, R. and Bond, S. (1998) 'Initial conditions and moment restrictions in dynamic panel data models.' *Journal of Econometrics,* 87, pp. 115-43

Dale-Olsen, H. (2005a) 'Wages, Fringe Benefits and Worker Turnover.' *Labour Economics* (forthcoming)

Dale-Olsen, H. (2005b) Fringe Attraction. Compensation Policies, Worker Turnover and Establishment Performance. Paper to be presented at DTI/PSI Workshop on Making Linked Employer-Employee Data Relevant to Policy Analysts

Elliot, R.F. (1991) *Labour Economics: A Comparative Text*. Macgraw-Hill Book Company, London

Freeman R.B. (1981) 'How much has de-unionization contributed to the rise in male earning equality?' National Bureau of Economics Research, Working Paper 3826. Cambridge, Mass.

Dale-Olsen, H. (2005c) The Impact of Wages, Fringe Benefits and New Work Practices on Establishment Survival. Manuscript

Hart, R.A., Bell, D.N.F., Frees, R., Kawasaki, S., Woodbury, S. (1988) Recent Trends in Non-Wage Labour Costs and Their Effects on Employment: Japan, United Kingdom, United States and West Germany. Brussels: Commission of the European Communities

Hashimoto, M. (2000) 'Fringe Benefits and Employment' In: *Employee Benefits and Labor Markets in Canada and the United States*, Alpert, W. A. and S. A. Woodbury (eds.). Michigan: W.E. Upjohn Institute for Employment Research, pp. 229-261

Hwang, H., Mortensen, D.T. and Reed, W.R. (1998) 'Hedonic Wages and Labor Market Search' *Journal of Labor Economics,* 16, pp. 815–847

Kahneman, D., Knetsch, J.L. and Thaler, R.H. (1990) 'Experimental Tests of the Endowment Effects and the Coase Theorem.' *Journal of Political Economy* 98, pp. 1325-48

Kremer, M. (1993) 'The O-Ring Theory of Economic Development.' *Quarterly Journal of Economics* 108, pp. 551-75

OECD (2002) 'Taking the measure of temporary employment.' *OECD Employment Outlook,* July 2002, pp. 127-186

Rabin, M. (1998) 'Psychology and Economics.' *Journal of Economic Literature,* 36, pp. 11-46

Thaler, R. H. (1980) 'Toward a Positive Theory of Consumer Choice.' *Journal of Economic Behaviour and Organisation,* 1, pp. 39-60

Tversky, A. and Kahneman, D. (1986) 'Rational Choice and the Framing of Decisions.' *Journal of Business,* 59, pp. S251-S278

Wallerstein, M. (1999) 'Wage-Setting Institutions and Pay Inequality in Advanced Industrial Societies.' *American Journal of Political Science,* 43, pp. 649-680

Woodbury, S. A. (1983) 'Substitution Between Wage and Nonwage Benefits.' *American Economic Review,* 73, pp. 166-182

Appendix A4.1: The entry of establishments, wage and fringe benefits policies. 1996.

		Establishment size group				
	Total	**1-5**	**6-10**	**11-25**	**26-100**	**Over 100**
Total number of workers	1592580	161400	154916	262566	435915	577783
Total number of establishments	100180	51864	20395	16419	9276	2226
Workers in new establishments (%)	5.2	12.5	8.7	6.7	3.9	2.6
New establishments (%)	10.2	13.3	8.7	6.5	4.3	3.5
Industries – all workers (% new entry workers)						
Primary	29012 (3.9)	6798 (7.1)	3113 (6.2)	3990 (3.6)	7371 (1.6)	7740 (2.5)
Manufacturing	326237 (2.4)	12362 (11.5)	16525 (5.2)	37586 (8.3)	86824 (2.3)	172940 (1.3)
Construction	92471 (4.2)	14268 (12.8)	14048 (5.4)	21538 (2.7)	24415 (1.7)	18202 (1.4)
Trade	264082 (4.8)	52344 (10.0)	55477 (4.7)	75028 (3.3)	58783 (2.6)	22450 (2.9)
Hotel and restaurants	59205 (11.0)	5597 (20.2)	8043 (14.7)	15524(11.4)	19812 (6.9)	10229 (10.4)
Transport	128465 (2.3)	13054 (9.9)	10012 (4.8)	17342 (2.6)	31933 (1.0)	56124 (0.8)
Post-telecom	37979 (44.1)	2251 (90.5)	3139 (88.5)	5062 (75.1)	7530 (46.7)	19997 (23.0)
Service	174015 (5.5)	33129 (10.9)	22380 (7.2)	30482 (4.8)	39312 (3.0)	48712 (3.4)
IT	13037 (10.4)	1171 (24.3)	1013 (13.7)	1982 (12.7)	3464 (10.2)	5407 (6.0)
Average establishment characteristics – old establishments (new establishments)						
Number of employees	16.8 (8.0)	3.1 (2.9)	7.6 (7.6)	16.0 (15.6)	47.2 (42.1)	262.1 (189.0)
Daily wage	458.0 (414.3)	418.8 (398.3)	467.5 (422.1)	496.5 (460.2)	536.7 (493.0)	581.1 (557.4)
Fringe benefits (%-points)	1.5 (1.7)	1.8 (1.7)	1.4 (1.7)	1.3 (1.5)	1.2 (1.3)	1.1 (1.1)

Note: Population: all Norwegian establishments in 1996 excluding public administration and one-man establishments. Figures in parentheses describe the entry population. The industries reported in the row head are aggregated as follows: Primary (NACE 01-05), Manufacturing (including mining and power, NACE 10-44), Construction (NACE 45-49), Trade (NACE 50-54), Hotel (including restaurants, NACE 55-59), Transport (NACE 60-65 except 64), Post-telecom (NACE 64), Service (including finance, insurance, real estate and personal services, NACE 65-74 except 72 and 90-93), IT (NACE 72). The daily wage is reported in NoK (8NoK≈1€).

5 New Workplace Practices and the Gender Wage Gap: Can the New Economy be the Great Equaliser?

Nabanita Datta Gupta[33] and Tor Eriksson[34]

ABSTRACT

We estimate the effect of introducing new workplace practices on the gender gap in wages in the manufacturing sector. We use a unique 1999 survey on work and compensation practices of Danish private sector firms merged to a large matched employer-employee database. Self-managed teams, project organisation and job rotation schemes are the most widely implemented work practices. Our estimates from a differences-in-differences model of wages and work practices show that the wage gains from adopting new workplace practices accrue mainly to salaried males and typically increase the gender gap in pay at the level of the firm. Considering practices individually, however, a few exceptions are seen: the gender wage gap among salaried workers is significantly reduced in firms which offer project organisation while the gap in pay among workers paid by the hour is significantly reduced with the use of quality control circles. All in all, however, the new economy is not the great equaliser.

5.1 Introduction

A growing area of research focuses on the reorganisation of work taking place in the modern-day organisation, away from a task-specialised structure towards a more task-integrated organisational structure (Lindbeck and Snower, 2000). The new organisational structure has introduced work practices such as job rotation and learning across tasks, teamwork, decentralisation of responsibility and worker participation in decision making. The adoption of new work practices has led to a breakdown of traditional occupational barriers and the

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establishment of flatter organisational structures. Moreover, high-performance work practices are usually accompanied and sustained by performance-based pay, giving rise to new payment schemes.

In terms of their adoption, such practices diffused slowly in the decade of the 1970s and 1980s but began to be widely adopted starting from the early 1990s, and by 1997, approximately 71 per cent of U.S. firms had adopted some form of innovative human resource management practices (Osterman, 1994; 2000). In Europe considerably fewer employers have implemented these practices, see OECD (1999). However, in Scandinavia, including Denmark, the new practices have been adopted more frequently than in the rest of Europe.

A great deal of the previous research in this area has focussed on the effect of new workplace practices on establishment level outcomes such as total labour costs, and firm productivity; see Ichniowski and Shaw (2003) for a recent survey. Relatively less is known about their effects on workers' wages, and in particular, whether these practices affect groups of workers differently. This is largely due to a lack of micro data on workers matched to firm-level data on the adoption of high-performance work practices. Even when wage outcomes are considered, previous studies have assumed that the returns to these practices do not vary by gender, race or other group characteristics, the typical outcome under study being total labour compensation or average establishment level earnings; exceptions are Bauer and Bender (2003) and Black and Lynch (2004). In this paper, we consider the effects of new work practices separately on men's and women's wages within a firm. Our aim is to investigate whether the new economy can act as the *great equaliser* – that is, whether the introduction of innovative human resource management practices can reduce the gender gap in wages among men and women working within the same firm.

There are several channels through which new workplace practices may *lower* the gender wage gap. First, the breakdown of traditional occupational lines or barriers due to the introduction of quality control circles or job rotation gives women an entry into the design and production side, traditionally men's domain, and allows for skill accumulation in tasks that are more remunerative than traditionally female tasks. Second, decentralisation of supervisory authority and increased worker participation in decision-making give women greater bargaining power and control over wages and working conditions compared to hierarchical organisational structures in which supervisory positions are mostly held by men.

Another mechanism could be that incentive-based pay systems that accompany high-performance work practices allow for transparency in pay, as wages are based on known, objective and quantifiable performance criteria. This may make it easier for women to bargain for matching increases or to seek legal recourse in situations where wage discrimination may be present. Further, some of the new practices impart

flexibility in workers' schedules, allowing women to balance home and work responsibilities more effectively, thereby raising their productivity at the workplace. Finally, a recent line of experimental enquiry within cognitive and social psychology explores whether women have an enhanced ability to multitask or superior communicative and collaborative skills (Williams et al., 1991; Rubenstein et al., 2001; Hannah and Murachver, 1999; Underwood et al., 1990; 1994). Possessing a relative advantage in such skills could make women better matched to meet the demands of the modern workplace and thereby raise their relative value to employers.

There exist a few channels through which the introduction of new workplace practices could serve to *increase* the gender gap in pay. Because of family responsibilities, women may find it difficult to make the needed investments to take full advantage of the new practices. Also, decentralisation of pay negotiation and incentive-based pay remove centrally-determined wage floors which have effectively increased women's wages relative to men's. Yet another factor that can boost men's wages in this context is if (mostly male) supervisors in firms which adopt new working practices are given pay increases by management in exchange for their cooperation in supporting and disseminating these practices within their units (Black and Lynch, 2004), i.e. acting as *facilitators*.

The overall effect on the wage gap is theoretically inconclusive and can only be determined by empirical means. Our purpose is therefore to quantify the effect of these practices on the within-firm gender wage gap, controlling for all other observable firm characteristics that can affect wages.

By combining a unique 1999 survey of employers in Denmark to register data on their employees, we match data on a total of 224,262 workers working in 1,387 of the firms that were surveyed. The firms that were surveyed were asked to provide information on the adoption of innovative work practices as well as new incentive-based pay practices. This allows us to estimate the wage impacts of new workplace practices on groups of male and female workers and on the gender wage gap within private sector organisations in Denmark. As new work practices have been implemented on a larger scale and rather differently in the manufacturing sector, we restrict our analysis to the manufacturing sector only. This gives us a sample of 691 firms employing on average 194,838 workers per year and 282 employees per firm. This focus also makes our results comparable to previous studies in the literature (Black and Lynch, 2001, 2004 for example).

In spite of the Danish gender wage gap being one of the lowest among industrialised countries, the female-male wage ratio in Denmark has shown signs of stagnation in the 1980s and 1990s at a more or less constant level of 80-88 per cent, depending on whether straight wages or total compensation are used as a measure (see for example Pedersen and

Deding, 2002). A number of previous studies have linked women's relatively lower pay to their over-representation in the public sector, which has experienced slower wage growth than the private sector in recent decades (Rosholm and Smith, 1996; Datta Gupta et al., 2000). A few recent studies which have had access to matched data have turned their attention to the private sector, where the raw male-female gap in pay is considerably larger than the national average, even when considering full-time workers only. Further, in the private sector, even within narrowly defined industry and occupation groupings, Datta Gupta and Rothstein (2005) and Deding and Wong (2004) find that a significant unexplained gap exists even after controlling for standard human capital characteristics. Thus, the question is whether implementation of new workplace practices and new forms of work organisation can be a way to eliminate the persistent wage differences that seem to exist among men and women of identical characteristics even within narrowly defined job types.

The rest of the paper is organised as follows. Section 5.2 yields a brief review of the earlier literature. In the next two sections we discuss some methodological issues and describe the data at our disposal. The fifth and the sixth sections give the empirical model and the empirical estimates, respectively. Section 5.7 concludes.

5.2 Previous research

Only a few previous studies have had access to data on work practices at the individual or firm level. A study on the impact of work practices on productivity by Black and Lynch (2001) estimates production functions using both GMM and within estimator techniques on a representative panel data set of businesses over the period 1987-1993. They find that it is not so much the type of work practice but rather how it is implemented that matters for productivity. For example, productivity is higher in unionised establishments which adopt work practices giving workers greater decision-making authority together with pay practices such as incentive-based pay schemes, than in non-union establishments with the same practices.

Another study on the relationship between workplace innovations and wages by Black and Lynch (2004) matches plant level practices with plant-level productivity and average establishment wages, and estimates production functions and wage functions using both cross-sectional and longitudinal data drawn from surveys of U.S. manufacturing-sector establishments from 1993 and 1996. This study finds that the reorganisation of workplaces to incorporate high performance work practices leads to an increase in average establishment wages of about 6 per cent. But, at the same time, profit sharing and/or stock options lead to lower regular pay for workers, particularly technical and clerical/sales workers. Their study is based on a sample size of 766 establishments in 1996 (cross-section) and 193 establishments in the panel (1993-1996).

Cappelli and Neumark (2001) use a national probability sample of establishments that includes comparable measures of performance and work practices across organisations. By virtue of the sample's longitudinal design, they are able to incorporate data from a period preceding the introduction of these practices. This allows them to purge their estimates for firm- or establishment-level heterogeneity that may arise due to high-performing firms having a greater ability to adopt such practices ("best practices"). Their findings point to increased employee compensation and therefore higher labour costs per employee from adopting these practices, but weak productivity effects. The overall effect on profitability is inconclusive.

Caroli and van Reenen (2001) study organisational changes, which imply a reduction of hierarchy within work organisations in two separate panels of French and British firms. They find that these changes had a positive impact on productivity. In addition, they find negative effects on unskilled manual workers' employment share and wage sum. Thus, their study indicates that the new work practices were biased against unskilled labour. Bauer and Bender (2003) utilise matched employer-employee data from Germany to study effects of organisational changes and focus in particular on the new practices' effects on firms' wage structures. They find that flattened hierarchies and especially the introduction of teamwork increase wage inequality within firms, due to the wage gains being concentrated at the higher end of the firms' wage distributions.

A paper by Bailey, Berg and Sandy (2001) examines the relationship between high performance work systems (HPWS) and the earnings of 4,000 management employees in 45 establishments in the steel, apparel and medical electronics and imaging industries in the period 1995-97. They find that, except in the case of medical electronics, management workers employed in workplaces in industries that have more high-performance practices do earn more than those in traditional workplaces, after controlling for gender, race, education, experience and tenure. The lack of an effect in the medical industries probably reflects the importance of formal qualifications and education for pay in that industry.

Eriksson (2003) makes use of the same data source as the current paper and examines the effects of introduction of new work practices in Danish firms on firms' average wages and productivity. He distinguishes between practices adopted for salaried employees and those paid by the hour and investigates how their impact differs between early and late adopters as well as between the short- and the medium-term. The study shows that it is crucial to control for the skill structure of firms' workforces. Otherwise the returns to practice adoption are substantially overestimated. Late adopters benefit less while for early adopters the short-run (2-3 years) gains seem to be quite persistent.

We are aware of only one micro study that examines the question of whether workplace practices can explain a significant part of the gender wage gap.[35] Drolet (2002) uses matched employer-employee data on 24,302 workers from the 1999 Canadian Workplace and Employee Survey to find that – not controlling for industry and occupation – workplace characteristics account for 27.9 per cent and worker characteristics for 10.8 per cent of the pay gap. However, the largest contributor among workplace characteristics is the workplace part-time rate, which alone accounts for 17.7 per cent of the pay gap. In terms of measures of high-performance workplace practices, Drolet (2002) has access to two measures, which are (a) whether or not the worker participates in self-directed workgroups and (b) whether or not the worker receives performance-based pay. These two variables account for 2.5 per cent and 2.3 per cent of the pay gap when occupation and industry are not included, and 2.1 per cent and 2.2 per cent when they are included. When occupation and industry are included, respectively, in worker and workplace characteristics the part of the pay gap explained by these components increases to 18.6 per cent and 42.6 per cent. Thus, while overall 61.2 per cent of the gender wage gap is explained in this study, the contribution of the two new workplace practice measures is minor and the largest single contributing factor explaining gender differences in pay in Canada appears to be industry.

Two recent papers by Garcia et al. (2002) and Lausten (2001) investigate the impact of the degree of worker autonomy and level of authority in explaining gender wage differences among Spanish employees and Danish executives, respectively. None of these previous studies has, however, been able to examine the effect of a wide array of high performance work practices on men's and women's wages for an adequately large sample of establishments spanning a relatively long period. By having access to an unique survey of the extent of adoption of new work practices among firms in Denmark, matched to a large employer-employee data base, ours is the first study to be able to quantify the impact of a number of practices on the wages of male and female employees within firms in the manufacturing sector, controlling for other firm-level characteristics.

5.3 Methodological issues

A few methodological issues present themselves in the estimation of wage models accounting for new workplace practices. First, more productive workers may self-select into jobs characterised by high-performance work practices or where pay is tied to performance (see for example Parent, 1999; Lazear, 2000). The question is, how to disentangle this "sorting" effect from real productivity effects of work and pay

[35] In Altonji and Blank's (1999) Handbook of Labor Economics chapter on labour market gender differentials, not one of the studies is concerned with the impact of differences and changes in work organisations. The same is also true for new pay practices; for an exception, see Heywood and Jirjahn (2002).

practices? This issue cannot be resolved easily in our data set-up. This is because it is difficult to find unique instruments that can explain workers' choices of firms but do not also affect their wages.

The other selection issue is that firms that face the threat of closure may be the ones most likely to adopt such practices. Thus, there is a need to measure performance before these practices are introduced (see for example Cappelli and Neumark, 2001). As the sample period in the current analysis spans the period 1992 to 2000, and as only a fifth of the firms had adopted a practice already in the 1980s, a relatively large number of firms in the sample are observed before the adoption of such practices, allowing us to control for this type of heterogeneity.

As the model we will estimate is in essence a difference-in-differences (DID) estimation, another potentially serious concern is that of serial correlation. This is because, firstly, the panel is fairly long, secondly, wages, the dependent variable, may be serially correlated and thirdly, the treatment variable (introduction of new work practices) may not change much over time. Bertrand, Duflo and Mullainathan (2004) suggest a technique that can eliminate this problem which works well as long as there is an adequate count of the unit of observation (firms, in our case) in the data. We apply this method to our data in Section 5.6.

5.4 Data description

The analysis uses a data set on Danish private sector firms with more than 20 employees, which has been constructed by merging information from two sources. The first source is a questionnaire directed at firms, that contains information about their work and compensation practices. The other is a longitudinal employer-employee data set[36] that provides information about firm characteristics and performance as well as about the firms' employees.

The survey was administered by Statistics Denmark as a mail questionnaire survey in May and June 1999, which was sent out to 3,200 private sector firms with more than 20 employees. The firms were chosen from a random sample, stratified according to size (as measured by the number of full time employees) and industry. The survey over-sampled large and medium-sized firms: all firms with 50 employees or more were included, and 35 per cent of firms in the 20-49 employees range. The response rate was 51 per cent, which is relatively high for the rather long and detailed questionnaire of the type that was used.[37]

The survey represents a unique source of information on Danish firms' internal labour markets and changes therein. In addition to some background information about the firm, each firm was asked about its

[36] See the Om Centre for Corporate Performance, Aarhus School of Business (http://www.ccp.asb.dk) for a more detailed description.

[37] The response rates for the size and one-digit industry cells vary only little: between 47 and 53 per cent. Thus, the representativeness of the sample is of no major concern.

work organisation, compensation systems, recruitment, internal training practices and how it evaluated its employees. For the questions concerning work design and practices, the firms were asked to differentiate between salaried employees and those paid by the hour. A brief description of the questionnaire and the main results are available (in Danish) in Eriksson (2001).

For the analysis in the present paper we use data from the manufacturing sector only. This is motivated by the fact that the practices may have been implemented quite differently in the services and the manufacturing sectors. The sample we study thus consists of 691 firms and on average 194,838 employees per year. It should be noted that two thirds of male workers are in blue collar jobs compared to about 60 per cent of female workers, but the difference is not large. Thus, as we distinguish between salaried employees and those paid by the hour, we are not simultaneously distinguishing between the genders.

Using unique firm identification numbers from Statistics Denmark, the survey data were supplemented with information about the firms as well as about their workforces. This information is taken from a large employer-employee linked database, which covers all private sector firms and all the employees who worked in them (in Denmark) in any year during the period 1980 to 2000.[38] The panel contains detailed information about employee characteristics[39] (and hence, firms' workforces in any year) and about their labour earnings and other income. In addition, the panel has economic information about firms with 20 or more full-time equivalent employees, for the years 1992 to 2000.

Firms' use of work (and pay) practices can be measured along several dimensions. The measure adopted in the survey questionnaire is whether a firm has implemented one of six work designs:

(i) *Self-managed teams*. An organisation with self-managed teams gives its members authority over how to perform tasks, or even which tasks to perform. Important aspects of team working are pooling of skills and skills development of individual workers.

(ii*) Job rotation*. Job rotation is a system where the workers are explicitly required to rotate between different jobs. This increases the variety of tasks to be performed by the employee and is also likely to enhance the employee's understanding of the operation.

(iii) *Quality circles*. Groups of workers who meet regularly to solve problems concerning productivity and people and to discuss aspects of performance and quality.

[38] The important feature of the panel is the link between firms and employees, which is consistent over time. The data originate from two separate registers maintained by Statistics Denmark: the integrated database for labour market research (IDA) and the business statistics database (BSD).

[39] Worker characteristics at the person-year level include gender, age, ongoing tenure, and level and years of education.

(iv) *Total quality management* (TQM). An important element of TQM programmes, of which ISO9000 probably is the best known, is that they include employee involvement.

(v) *Benchmarking.* Benchmarking is a formal system of learning about practices in other firms and organisations.

(vi) *Project organisation*. Groups of workers are organised in projects with defined targets, timetables, budgets and frequently considerable authority with respect to how to perform tasks.

It is important to note that the firms were also asked when each work practice (if any) was adopted. However, one important piece of information we do not have regarding the implementation of the practices is the proportion of employees affected by the particular work designs.[40] Nor were the respondents asked to rank the practices according to some notion of their importance.

The firms were also asked a corresponding question regarding the implementation of performance related pay (PRP) practices. More precisely the firms were asked whether they had adopted one of four PRP methods – team bonus, individual bonus, stock and stock options and profit sharing – for four different categories of employees: top managers, middle-management, other white collar workers and blue collar workers; see Eriksson (2001), for details. In contrast to the work practices, the firms were unfortunately not asked about when they had implemented the different pay practices. The questionnaire only asked the firms whether they had made considerable changes in their payment systems in recent years, without being more specific as to when or to which payment system.

Table 5.1 gives some information on manufacturing firms' adoption of each work practice as of 1998. Table 5.2 provides corresponding information regarding new pay practices. From Table 5.1 we may note that the most widely implemented new work practices are self-managed teams, project organisation and job rotation schemes. Corresponding shares of employees working in firms that have or have not introduced the practices are found in Table 5.3. As larger firms are substantially more likely to have adopted new work or pay practices (see Eriksson, 2001), the proportion of workers in firms with them is larger than the share of firms that have them.

[40] If seems plausible to assume that the higher the number of practices used, the larger is the proportion of workers in the firm involved in some of the new work practices. Thus, the number of practices implemented can serve as a proxy for coverage.

Table 5.1: Some characteristics of adopters and non-adopters of new work practices.

Work practice:	Teams		Job rotation		Quality circles	
Has adopted:	NO	YES	NO	YES	NO	YES
Prop. of firms	82.2	17.8	84.95	15.05	97.5	2.5
Prop. of women in firm	31.6	31.8	30.7	36.7	31.6	34.4
Av. Wage women	117.32	116.46	117.34	116.21	117.12	119.27
Av. Wage men	149.93	149.07	150.36	146.49	149.70	152.76
Raw gender gap	32.60	32.62	33.02	30.28	32.58	33.49

Work practice:	TQM		Proj. org.		Benchmark	
Has adopted:	NO	YES	NO	YES	NO	YES
Prop. of firms	95.8	4.2	86.5	13.5	97.8	2.2
Prop. of women in firm	31.5	34.7	31.9	30.1	31.6	34.5
Av. Wage women	117.21	116.23	117.05	117.96	117.05	112.30
Av. Wage men	149.94	145.98	148.95	155.03	149.65	155.29
Raw gender gap	32.73	29.75	31.91	32.61	32.60	32.99

Table 5.2: Some characteristics of adopters and non-adopters of new pay practices.

Pay practice:	Team bonus		Indiv bonus		Stock option	
Has adopted:	NO	YES	NO	YES	NO	YES
Prop. of firms	65.1	34.9	59.0	41.0	90.8	9.2
Prop. of women in firm	31.6	31.7	32.0	31.1	31.3	34.6
Av. Wage women	116.92	117.63	116.15	118.63	116.37	125.05
Av. Wage men	149.95	149.68	147.80	152.61	148.16	162.75
Raw gender gap	32.76	32.32	31.65	33.98	31.79	40.70

Pay practice:	Profit sharing		Qualific Pay	
Has adopted:	NO	YES	NO	YES
Prop. of firms	83.0	17.0	47.0	53.0
Prop. of women in firm	31.6	31.8	31.8	31.5
Av. Wage women	117.68	114.69	117.70	116.69
Av. Wage men	150.29	147.27	150.91	148.77
Raw gender gap	32.61	32.59	33.20	32.08

Table 5.3: The share of male and female employees working in firms with new work and pay practices, by practice.

Percentage of employees in firms with:	Female	Male
NWPs:		
Teams	21.8	19.5
Job rotation	29.5	24.1
Quality circles	9.6	7.8
TQM	10.4	9.4
Benchmarking	7.8	6.6
Project organisation	16.6	17.0
NPPs:		
Team bonus	47.9	41.9
Individual bonus	53.8	51.9
Profit sharing	16.6	15.9
Stock, stock options	22.8	15.2
Qualification pay	60.6	58.9

Since the questionnaire was only sent out to private sector firms with 20 or more full-time employees, the (unweighted) average proportion of women in the firms – 31.2 per cent – is considerably lower than in the whole Danish labour force, in which women make up about fifty per cent. It can, moreover, be seen that firms that have adopted new working practices have on average a larger proportion of female employees than other firms.

So, female employees are more likely to work in a firm with one or more of the new work practices. The average firm wage for women is, however, higher in firms which have not adopted the new practices, save firms with quality circles and project organisations where hourly wages are respectively higher and roughly the same as in those without them. For male workers there is a similar pattern, except for firms with and without project organisation and benchmarking, where men are on average paid more in the former. The "raw" firm level gender gap is clearly smaller in firms that have introduced job rotation and TQM schemes than in those that have not.

Turning to Table 5.2, every second firm has the so called qualification pay system – a formalised wage setting system, where extra pay is given to an employee based on her qualifications such as education, experience of a certain job or tasks, skills acquired through on-the-job training, etc. – and 35-40 per cent have team or individual bonuses. We notice that the proportion of women is the same in firms with and without the performance related pay systems, save stock and stock options where there are somewhat more women working in firms that have them. For both genders we observe the following pattern: with the exception of

qualification pay and profit sharing, the average wage is higher in firms with the new pay practices than in those which have not introduced them, and the differences are typically quite large. As for the firm gender gaps, they are larger in firms with individualised pay, like individual bonus systems and stock and stock option schemes.

Of course, all the wage differences in Tables 5.1 and 5.2 may be due to differences in the composition and skills structures of the workforces in firms with and without the new work and pay schemes. In particular, the differentials between adopters and non-adopters of new pay practices may reflect the sorting effect mentioned earlier (see Lazear, 2000) that pay systems rewarding good performance attract the best workers. The similarity of patterns for both genders also suggests that there are a number of factors we have not yet considered that give rise to differences in pay between adopters and non-adopters of different work and pay practices. In the following section we will, therefore, carry out analyses that aim at controlling for these differences as well as accounting for when and which of the different work practices were implemented in the firms.

5.5 Empirical model

The dependent variable in the analysis is the log of hourly wages, where wages are deflated by the consumer price index. More specifically, we compute for each firm and year, (i) the average hourly wage separately for women and men, and (ii) the gender wage differential. Differences in the average firm wages reflect of course differences in the composition of the firms' workforces with respect to age, education and other human capital variables. As the firms' workforce structures typically change only slowly, we do not enter these as explanatory variables in the estimations but capture them by using firm fixed effects and a time trend.

Thus, log hourly wages for sex group i in firm j at time t is given by:

$$LogW_{ijt} = \alpha_1 S_i + \alpha_{2j} F_j + \beta_{1j}(S_i \times F_j) + \beta_2(S_i \times T_t) + \delta_i NWP_{jt} + \varepsilon_{ijt} \quad (1)$$

where S_i indicates sex group i, F_j is an indicator for the firm, T indicates the time period and NWP_{jt} is an indicator for new workplace practices. Note that the NWP indicator which we will operationalise in alternative ways is a time-varying variable. Thus, the indicator captures the effect of introducing a specific or one additional new work practice in the firm. An advantage of observing firms before they introduce NWP is that we can purge the estimates for some firm-level heterogeneity that arises because of the "best practices" effect.

The gender gap in wages can be written as

$$LogW_{mjt} - LogW_{fjt} = \alpha_1(S_m - S_f) + \beta_{1j}(S_m - S_f)F_j + \beta_2(S_m - S_f)T_t + (\delta_m - \delta_f)NWP_{jt} + \varepsilon_{mjt} - \varepsilon_{fjt} \quad (2)$$

or,

$$\Delta LogW_{jt} = a + b_{1j}F_j + b_2 T_t + dNWP_{jt} + \varepsilon_{jt} \quad (3)$$

The NWP indicator is entered in three different ways. First, we use a simple dummy for whether or not the firm has adopted at least one of the new work practices. This is of course a very crude measure. Our second measure is the number of new work practices, which informs us about the marginal effect of additional work practices. This measure allows for synergies arising from bundling practices together, without either arbitrarily grouping practices *ex ante* or selecting those groupings that best fit the data *ex post*. The third operationalisation is entering the work practices individually. We run the equations separately for women's wages, men's wages and the gender differential. A small number of the firms have either very few (less than 5) male or female employees, and for these observations the firm gender wage gap measure is rather meaningless. We have therefore, omitted the firms with less than five male or female employees from the estimation sample.

In the estimations we implement when possible the correction for serial correlation mentioned in Section 5.3. Following Bertrand, Duflo and Mullainathan (2001), we first regress wages on firm fixed effects and a time trend. Second, the residuals for only the treated firms (those that implemented the practices) are divided into pre and post-treatment periods, reducing the data set to a two-period panel. Then, a simple fixed effects regression of work practices on wages is run on the transformed data, yielding the serial-correlation corrected estimate and standard error.[41]

5.6 Estimation results

We bagin by considering the simplest version of the NWP indicator: at least one practice, the estimates of which are collected in Table 5.4. We can see that there are positive (1.5-2 per cent) and significant estimates for men, especially those in salaried employment. For women, the estimates are negative. As the wage gains are of opposite signs, the gender differential is affected, and to the disadvantage of female employees, by the introduction of new work practices, measured in this admittedly very crude manner.

Table 5.4: The impact of the number of new workplace practices on men's and women's wages, with correction for serial correlation[a]

Dependent variable: log hourly wage (in gender gap regressions: difference in log hourly wage)									
	Men	Women	Gender gap	Men hourly paid	Women hourly paid	Gender gap hourly paid	Men salaried	Women salaried	Gender gap salaried
At least one NWP	0.011**	-0.011**	0.022***	0.007	-0.006	0.014*	0.012	0.008	0.004
	(0.005)	(0.005)	(0.005)	(0.006)	(0.008)	(0.008)	(0.008)	(0.007)	(0.010)

[a] Firm fixed effects and a time trend were included as additional controls

[41] We also estimated the models without corrections for serial correlation. The estimates did not differ much from those reported in the text.

Turning next to Table 5.5, where the number of practices is used as the NWP indicator, we may observe that the firm average wage for all (hourly paid) men is positively affected by the first two (three) practices, after which most of the estimates do not differ significantly from zero. It should be noted that the estimates for five practices, some of which carry large coefficients, are based on very few observations. The wage of female workers is significantly lower in firms that have implemented one to four new work practices. However, when separating between salaried female employees and those paid by the hour, almost all coefficients lose their statistical significance. The firm-level gender gap estimates are positive for the first 3-4 practices adopted, and this seems to be due chiefly to the increase in the gender gap among the hourly workers.

Table 5.5: The impact of the number of new work practices on firm average wage by gender and the gender gap[a]

Number of practices	Men	Women	Gender gap	Men hourly paid	Women hourly paid	Gender gap hourly paid	Men salaried	Women salaried	Gender gap salaried
One	0.015**	-0.015**	0.031***	0.012*	-0.011	0.023**	0.021**	0.009	0.013
	(0.006)	(0.007)	(0.007)	(0.007)	(0.010)	(0.011)	(0.011)	(0.011)	(0.014)
Two	0.015*	-0.019**	0.034***	-0.003	-0.004	0.001	0.006	0.013	-0.007
	(0.008)	(0.009)	(0.010)	(0.009)	(0.014)	(0.014)	(0.014)	(0.014)	(0.018)
Three	0.015	-0.012	0.027**	0.044***	-0.007	0.051***	0.013	0.033*	-0.020
	(0.011)	(0.013)	(0.013)	(0.013)	(0.019)	(0.020)	(0.019)	(0.019)	(0.025)
Four	0.019	-0.041**	0.060***	0.022	0.017	0.005	0.034	0.003	0.031
	(0.017)	(0.020)	(0.021)	(0.020)	(0.030)	(0.031)	(0.030)	(0.030)	(0.039)
Five	-0.081*	-0.181***	0.101*	0.132**	0.035	0.097	-0.238***	-0.218***	-0.020
	(0.048)	(0.055)	(0.059)	(0.057)	(0.083)	(0.086)	(0.085)	(0.084)	(0.110)
Six	0.017	-0.095	0.113	0.042	-0.030	0.072	-0.003	-0.014	0.010
	(0.057)	(0.066)	(0.070)	(0.068)	(0.099)	(0.104)	(0.102)	(0.101)	(0.132)

[a] Firm fixed effects and a time trend were included as additional controls

Note, however, that in addition to the rent sharing interpretation, it is also possible to interpret the results in Table 5.4 (and subsequent tables) as a market outcome. If female employees have a stronger preference for the new, less hierarchical, work organisations allowing for more collaboration than men, then the gender gap observed could be due to compensating wage differentials: women pay for the flatter more cooperative workplaces (whilst men are compensated for it).

Table 5.6 gathers the results from regressions with all the individual practices included. For women the estimates are either insignificant (for the salaried, all practices) or with one exception – a large positive coefficient attached to quality circles for employees paid by the hour – negative. For men, there are more coefficients that differ from zero. These are positive, save job rotation for men paid by the hour and project organisation for salaried men. Hence in many cases the "net effect" on the

firm level gender wage gap is positive, that is, the work practice is associated with a large gender wage differential. For the salaried employees the impact of the practices on the gender gap is small and differs from zero only for project organisation. In all cases where the gender gap is significantly larger in firms that have adopted a work practice, the coefficient for the practice in question in the wage equations for women is always significantly (or not so far from significantly) negative.

Table 5.6: The impact of work practices considered jointly on firm average wage by gender and the gender gap[a]

	Men	Women	Gender gap	Men hourly paid	Women hourly paid	Gender gap hourly paid	Men salaried	Women salaried	Gender gap salaried
Teams	0.017***	-0.013*	0.030***	0.021***	-0.009	0.030**	0.022*	-0.001	0.023
	(0.006)	(0.008)	(0.008)	(0.008)	(0.011)	(0.012)	(0.012)	(0.011)	(0.015)
Job rotation	-0.001	-0.020**	0.019**	-0.027***	-0.025*	-0.002	0.031**	0.021	0.011
	(0.007)	(0.009)	(0.009)	(0.009)	(0.013)	(0.013)	(0.013)	(0.013)	(0.017)
Quality circles	0.001	0.017	-0.016	0.037*	0.167***	-0.130***	-0.007	-0.023	0.015
	(0.018)	(0.021)	(0.022)	(0.021)	(0.031)	(0.033)	(0.032)	(0.032)	(0.042)
TQM	-0.035***	-0.007	-0.028*	0.014	0.021	-0.007	-0.014	-0.006	-0.008
	(0.013)	(0.016)	(0.017)	(0.016)	(0.023)	(0.024)	(0.024)	(0.024)	(0.031)
Benchmarking	0.000	-0.011	0.011	0.010	-0.030	0.039*	0.007	0.012	-0.006
	(0.013)	(0.015)	(0.016)	(0.015)	(0.022)	(0.023)	(0.023)	(0.022)	(0.029)
Project Org.	0.012	0.007	0.006	0.021**	0.011	0.010	-0.052***	0.000	-0.053***
	(0.008)	(0.009)	(0.010)	(0.010)	(0.014)	(0.015)	(0.014)	(0.014)	(0.019)

[a] Firm fixed effects and a time trend were included as additional controls

Thus, we find very little, and mixed, evidence that new work practices improve women's access to skill acquisition. For women paid by the hour, quality circles are associated with a large wage premium and a small gender gap, but on the other hand job rotation schemes leave their wage unchanged both in absolute terms and relative to men. Nor is there much to suggest that the new practices improve female employees' bargaining power. TQM and project organisations (for salaried workers) are associated with a smaller gender gap, but this is due to men obtaining lower pay in firms which have these practices.

In Tables A5.1 to A5.3 in the appendix, we present the results from regressions in which individual practices are entered one by one. Because the results for the number of practices indicate that bundles matter, we might expect the results to differ from those in Table 5.6. But they do not. In fact they are very similar regarding significance and do not differ markedly when it comes to magnitudes, either. Thus, the estimates from including the practices separately one at a time into equation (1) yield

some additional support to our earlier findings, insofar as the introduction of new work practices in firms widens the gender wage gap for workers paid by the hour, but leaves it largely unchanged for salaried workers.

Assuming the gender pay differential associated with the new work practices is not merely due to compensating wage differentials, where does it come from? One possibility is that it could be due to differential sorting. Because of the lack of a counterfactual, we can unfortunately not apply the DID analysis to newcomers and incumbents, respectively, which otherwise would be the obvious way to investigate the role of sorting. Instead we have estimated wage growth equations for the employees in firms that implemented a new work practice during years 1990-95 distinguishing between newcomers and incumbents.[42] The observations of the individuals' wage growth are from two and more years after the practice was adopted. Controlling for the employees' age, education and job level and the size and industry of the firm, we find that neither male nor female newcomers receive significantly higher wages. This we interpret as implying that the quality of the new workers joining firms after they introduced the new work practice did not increase.

Another possibility is that the increased gap reflects real differences in productivity due to women having fewer possibilities to exploit the advantages of the new work organisations because of family responsibilities. In order to shed some light on this we computed average firm wages for the genders by presence of children under the age of 7 and 18, respectively. We found only small differences; the gender gap for all employees was 32.61 Danish Kroner (about 4.40 Euros), and 33.49 (4.50 Euros) and 33.09 (4.45 Euros) for those with children under the age of 7 and 18, respectively. Thus, family responsibilities do not seem to be a prime candidate for explaining the larger gender gap associated with the new work practices. Still another explanation could be the facilitator hypothesis mentioned by Black and Lynch (2004): male supervisors are rewarded for supporting and implementing the new practices in their workplaces. The data do not speak in the favour of this hypothesis, either. First, the proportion of men in the middle management positions is roughly the same in firm with and without new work practices: 14.1 and 16.2 per cent, respectively. Second, as we have seen above, the gender gap for salaried workers is not larger in firms that have adopted the new practices.

5.7 Conclusions

This paper investigates the effect of new workplace practices on the gender wage gap by combining information on the adoption of an array of workplace practices obtained from a unique survey on firms matched to panel data on the population of workers within these firms. Thus, this is one of few studies to explore whether such practices impact groups of workers within firms differently, in contrast to the previous literature that is largely focused on establishment-wide earnings outcomes. Our question

[42] To save space these are not reported here, but are available from the authors upon request.

is whether or not new work practices can be the *great equaliser* when it comes to the persistent pay gap that exists between men and women who have the same characteristics and who work in the same firms.

The descriptive evidence shows that the most widely implemented work practices among manufacturing firms in the private sector in Denmark are self-managed teams, project organisation and job rotation schemes. Estimation of a DID model of wages and work practices controlling for all observed firm-specific factors shows that wage gains from the introduction of new workplace practices seem to accrue mainly to salaried men, and in fact, wage losses accrue to women so that so that the gender gap in pay widens at the level of the firm.

When considering individual work practices, essentially the same findings obtain despite the 'unbundling' of practices that presumably belong together: the pay gap widens significantly for workers paid by the hour, particularly in firms which introduce teamwork and benchmarking. It is only reduced in the case of quality circles. For salaried employees the pay gap remains unchanged in most cases, although it is reduced significantly through project organisation. These findings may indicate that female salaried employees benefit particularly from the greater control over task definition and planning implied by project organisation and female workers paid by the hour are able to learn across tasks by participating in quality control circles, and these factors raise their relative wages. But these represent the exception rather than the rule. All in all, in most instances men's wages increase and women's wages are reduced in firms that offer these practices. When both groups get increases, then men obtain a relatively larger increase. Bias due to serial correlation does not move the results as nearly identical estimates are obtained after correcting for this problem.

Some additional analyses of the data indicate that the positive effects on men's wages are not a result of worker sorting. Nor do they seem to be due to women having fewer possibilities to exploit potential gains from the practices because of family responsibilities. Whatever the interpretation however, we find that the new economy is not the great equaliser – new workplace practices in most cases benefit men and not women.

5.8 References

Altonji, J.G., and Blank, R.M. (1999) 'Race and Gender in the Labor Market', in Ashenfelter, O. and Card, D., eds., *Handbook of in Labor Economics,* Volume 3. Amsterdam: Elsevier, pp. 3143-3259

Bailey, T., Berg, P. and Sandy, C. (2001) 'The Effect of High-Performance Work Practices on Employee Earnings in the Steel, Apparel and Medical Electronics and Imaging Industries.' *Industrial and Labor Relations Review,* 54, pp. 525-543.

Bauer, T. and Bender, S. (2003) Flexible Work Systems and the Structure of Wages: Evidence from Matched Employer-Employee Data. IZA discussion paper No. 353

Bertrand, M., Duflo, E. and Mullainathan, S. (2004) How Much Should We Trust Differences-in-Differences Estimates? *Quarterly Journal of Economics,* 119(1), pp. 249-75

Black, S.E. and Lynch, L. (2001) 'How to Compete: the Impact of Workplace Practices and Information Technology on Productivity', *Review of Economics and Statistics,* Vol. 83, pp. 434-445

Black, S.E. and Lynch, L. (2004) 'What's Driving the New Economy: The Benefits of Workplace Innovation', *Economic Journal,* Volume 114, pp. F97-F116

Cappelli, P. and Neumark, D. (2001) 'Do "High-Performance" Work Practices Improve Establishment-level Outcomes', *Industrial and Labor Relations Review,* 2001, 54, pp. 737-775

Caroli, E. and van Reenen, J. (2001) 'Skill Biased Organizational Change? Evidence from a Panel of British and French Establishments', *Quarterly Journal of Economics,* 116, pp. 1449-1492

Datta Gupta, N. and Rothstein, D.S. (2005) 'The Impact of Worker and Establishment-level Characteristics on Male – Female Wage Differentials: Evidence from Danish matched Employee-Employer Data', *Labour,* CEIS, 19(1), pp. 1-34

Datta Gupta, N., Oaxaca, R.L. and Smith, N. (2000) 'The Danish Gender Wage Gap and Wage Determination in the Public and Private Sectors', in Gustafsson, S. and Meulders, D., (eds.), Gender and the Labour Market: Econometric Evidence on Obstacles in Achieving Gender Equality, AEA Macmillan Series, pp. 53-74

Datta Gupta, N., Oaxaca, R.L. and Smith, N. (2005) 'Swimming Upstream, Floating Downstream: Comparing Women's Relative Wage Progress in the U.S. and Denmark', CLS working paper 01-06, forthcoming, Industrial and Labor Relations Review

Deding, M. and Wong, K. (2004) 'Mænds og kvinders løn – En analyse af løngabet 1997-2001', the Danish National Institute of Social Research report 04:10

Drolet, M. (2002) Can the Workplace Explain Canadian Gender Pay Differentials? Paper presented at the NZ Conference on Database Integration and Linked Employer-Employee Data in Wellington

Eriksson, T. (2001) 'How Common Are the New Compensation and Work Practices and Who Adopts Them?', Working Paper 01-8, Aarhus School of Business

Eriksson, T. (2003) 'The Effects of New Work Practices: Evidence from Employer-Employee Data.' in Kato, T. and Pliskin, J., eds., The Determinants of the Incidence and the Effects of Participatory Organizations. Advances in the Economic Analysis of Participatory and Labor-Managed Firms, Vol. 7. Amsterdam: Elsevier, pp. 3-30

Garcia, J., Hernández, P.J. and López, A. (2002) 'An Investigation of the Relationship between Job Characteristics and the Gender Wage Gap', unpublished working paper, May 2002

Hannah, A. and Murachver, T. (1999) 'Gender and Conversational Style as predictors of Conversational Behavior', *Journal of Language and Social Psychology*, 18, pp.153-175

Heywood, J. and Jirjahn, U. (2002) 'Payment Schemes and Gender in Germany', *Industrial and Labor relations Review,* 56 (1), pp. 44-64

Ichinowski, C. and Shaw, K. (2003) 'Beyond Incentive Pay: Insiders' Estimates of the Value of Complementary Human Resource Management Practices', *Journal of Economic Perspectives,* 17 (1), pp. 155-178

Lausten, M. (2001) Gender Differences in Managerial Compensation – Evidences from Denmark. Aarhus School of Business Department of Economics working paper no 01-4

Lazear, E. (2000) 'Performance Pay and Productivity', *American Economic Review,* 90, pp. 1346-1361

Lindbeck, A. and Snower, D.J. (2000) 'Multi-task Learning and Reorganization of Work: From Tayloristic to Holistic Organization', *Journal of Labor Economics,* 18, Number 3, 2000, pp. 353-376

OECD (1999) 'Employment Outlook' (OECD, Paris)

Osterman, P. (1994) 'How Common is Workplace Transformation and Who Adopts It?', *Industrial and Labor Relations Review,* 47, pp. 173-188

Osterman, P. (2000) 'Work Reorganization in an Era of Restructuring: Diffusion and Effects on Employee Welfare', *Industrial and Labor Relations Review,* 53, pp. 179-96

Parent, D. (1999) 'Methods of Pay and Earnings: A Longitudinal Analysis', *Industrial and Labor Relations Review,* 53, pp. 71-86

Pedersen, L. and Deding, M. (2002) 'Wage Differentials between Women and Men in Denmark', the Danish National Institute of Social Research, Working Paper 15:2002

Rosholm, M. and Smith, N. (1996) 'The Danish Gender Wage Gap in the 1980s: A Panel Data Study', *Oxford Economic Papers*, 48, pp. 254-279

Rubenstein, J., Meyer, D. E. and Evans, J. E. (2001) 'Executive Control in Cognitive Processes in Task Switching', *Journal of Experimental Psychology – Human Perception and Performance,* 27, pp. 763-797

Underwood, C., Jindal, N. and Underwood, J. (1994) 'Gender differences and effects of co-operation in a computer-based task.' *Educational Research,* 36, pp. 63-74

Underwood, C., McCaffrey, M. and Underwood, J. (1990) 'Gender differences in a cooperative computer-based task', *Educational Research,* 32, pp. 44-49

Williams, C.L., and Meck, W.H. (1991) 'Organizational effects of gonadal steroids on sexually dimorphic spatial ability', *Psychoneuroendocrinology*, 16, pp. 157-177

Appendix A5.1: The impact of individual practices on firm average wage, corrected for serial correlation

Dep. var.:									
	log male wage[a]								
	log female wage[a]								
	gender wage gap[a]								
Teams	0.012**								
	(0.006)								
	-0.012*								
	(0.006)								
	0.024***								
	(0.006)								
Job rotation		0.002							
		(0.005)							
		-0.018***							
		(0.006)							
		0.020***							
		(0.006)							
Quality circles			-0.001						
			(0.012)						
			0.008						
			(0.021)						
			-0.009						
			(0.019)						
Total quality management				-0.023***					
				(0.009)					
				-0.010					
				(0.012)					
				-0.013					
				(0.010)					
Benchmarking					0.004				
					(0.008)				
					-0.015				
					(0.009)				
					0.019**				
					(0.008)				
Project organisation						0.010			
						(0.008)			
						-0.001			
						(0.009)			
						0.012			
						(0.008)			

[a] Firm fixed effects and a time trend were included as additional controls.

Appendix A5.2: The impact of individual practices on firm average wage, corrected for serial correlation

Dep. var.:									
	log male wage[a]								
	log female wage[a]								
	gender wage gap[a]								
Teams	0.016**								
	(0.006)								
	-0.007								
	(0.009)								
	0.022***								
	(0.008)								
Job rotation		-0.013**							
		(0.006)							
		-0.016							
		(0.010)							
		0.003							
		(0.010)							
Quality circles			0.031**						
			(0.013)						
			0.134***						
			(0.039)						
			-0.103***						
			(0.039)						
Total quality management				0.020					
				(0.015)					
				0.024					
				(0.018)					
				-0.004					
				(0.019)					
Benchmarking					0.011				
					(0.008)				
					-0.023				
					(0.015)				
					0.033**				
					(0.013)				
Project organisation								0.018*	
								(0.010)	
								0.005	
								(0.012)	
								0.013	
								(0.012)	

[a] Firm fixed effects and a time trend were included as additional controls.

Appendix A5.3: The impact of individual practices on firm average wage, corrected for serial correlation

Dep. var.:						
	log male wage[a]					
	log female wage[a]					
	gender wage gap[a]					
Teams	0.014					
	(0.010)					
	0.002					
	(0.009)					
	0.012					
	(0.011)					
Job rotation		0.021**				
		(0.009)				
		0.016*				
		(0.009)				
		0.006				
		(0.011)				
Quality circles			-0.003			
			(0.029)			
			-0.014			
			(0.030)			
			0.012			
			(0.032)			
Total quality management				-0.011		
				(0.016)		
				-0.004		
				(0.014)		
				-0.008		
				(0.017)		
Benchmarking					0.009	
					(0.012)	
					0.014	
					(0.012)	
					-0.005	
					(0.016)	
Project organisation						-0.032***
						(0.011)
						0.003
						(0.012)
						-0.036***
						(0.012)

[a] Firm fixed effects and a time trend were included as additional controls.

6 The Determinants of the Employment Structure: Wages, Trade, Technology, and Organisational Change

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ABSTRACT

This paper uses matched employee-employer LIAB data to provide panel estimates of the structure of labour demand in Germany, 1993-2002, distinguishing between highly skilled, skilled, and unskilled labour and between the manufacturing and service sectors. Reflecting current preoccupations, our demand analysis seeks also to accommodate the impact of technology and trade in addition to wages. The bottom-line interests are to provide elasticities of the demand for unskilled (and other) labour that should assist in short-run policy design and to identify the extent of skill biases or otherwise in trade and technology.

6.1 Introduction

For several decades now, the demand for unskilled labour in Germany as elsewhere has been declining. There is no shortage of explanations for this phenomenon: skill-biased technological change (Falk and Seim, 1999), increased international trade (Fitzenberger, 1999a) and, latterly, organisational change (Lindbeck and Snower, 2000; Fitzenberger, 1999b). (A related preoccupation is of course the extent to which declining demand for the unskilled has been exacerbated by a rigid wage structure.)

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In the present treatment, using information on 1,171 manufacturing plants employing on average 360,000 employees, and on 174 service sector establishments covering some 49,000 employees, we seek to address these various influences using a flexible cost function framework to derive the demand for heterogeneous labour. It is precisely this latter complication that involves the use of linked employee-employer data because only the latter contain detailed wage information. We estimate. the own-wage elasticity of unskilled and skilled (and highly skilled) labour as well as the elasticities of the various labour categories with respect to trade, technology, and organisational change measures. We disaggregate by manufacturing and services both because of sectoral differences in the role of trade and by reason of occupational composition.

To anticipate our findings, which are somewhat at odds with the literature, we report that the own-wage elasticity of unskilled labour in manufacturing, although well determined, is smaller in absolute value than that of skilled workers (if not the most highly skilled). We also find that trade and technology are not unfavourable to unskilled worker employment, while organisational change often presumed to be destructive of unskilled jobs also appears to have a positive effect. To explain why unskilled worker employment has shrunk, we would therefore rely on (excessive) unskilled worker wage levels in a rigid wage system, even if the actual decline in employment over the decade long sample period is muted.

6.2 Data

Our data are taken from ten waves of the LIAB, 1993-2002. The LIAB combines Federal Employment Agency (*Bundesagentur für Arbeit*) employment statistics with plant-level data from the Institute for Employment Research (*Institut für Arbeitsmarkt- und Berufsforschung*) or IAB Establishment Panel. The distinctive feature of the LIAB is the combination of information on individuals and details concerning the firms – strictly establishments – that employ them. The employment statistics are drawn from the German employment register, which contains information on all employees and trainees subject to social security taxes (see Bender, Haas, and Klose, 2000). In 1995, for example, the employment statistics covered 79.4 (86.2) per cent of all employed persons in Western (Eastern) Germany. Those excluded, in addition to the

self employed, include civil servants, family workers, students enrolled in higher education, and workers in marginal employment. The employment register was established in 1973 to integrate the notification procedures for social security (pensions, health insurance, and unemployment insurance). Information is recorded at the start and end of the individual's employment within a firm and in annual end-year reports. The employment statistics contain data on the individual's three-digit occupation, daily gross wage up to the earnings ceiling for social security contributions,[47] gender, year of birth, nationality, marital status, number of children, and schooling/training. Each individual record also contains the establishment identifier, as well as the size and industry affiliation of that establishment, although unfortunately one cannot match establishments belonging to a single enterprise.

The plant-level component of the LIAB, the IAB Establishment Panel,[48] was initiated in 1993 (Kölling, 2000). It is based on a stratified random sample – strata for 16 industries and 10 employment size classes – from the population of all establishments. (Although larger plants are over-sampled, within each cell the sampling is random). In 1993 the sample comprised 4,265 plants, accounting for 0.27 per cent of all plants in West Germany and 11 per cent of total employment (29 million employees). Subsequently in 1996 the former GDR was administered the Panel survey, with 4,313 establishments (or 1.1 per cent of all plants) and 11 per cent of total employment (6 million). Since then the number of plants sampled has steadily increased to facilitate analysis at *Länder* level; for example, in 2003 the unified sample contained some 15,857 plants.

For its part, the IAB Establishment Panel was created to meet the need of the Federal Employment Agency to provide further and detailed information on the demand side of the labour market. Accordingly, information on the workforce, its decomposition, and development through time are central elements of the Panel questionnaire. Further questions concern establishment sales, exports, and investment, technological status, age, corporate form and legal status, as well as the size of the overall wage bill, training provision, working time, reorganisation measures, and aspects of collective bargaining. Most such questions are asked annually. One exception is organisational change. The question pertaining to those organisational changes introduced in the last two years was included in four surveys only, namely, 1995, 1998, 2000, and

[47] We shall impute wages above the ceiling (see below).
[48] The Panel survey is based on the employment statistics via the establishment identifier; as a result, the panel only includes establishments with at least one employee covered by social security.

2001.[49] Other examples cover topics such as innovations, profit sharing/share ownership, further training, and labour flexibility.

In summary, the LIAB is created by linking the employment statistics of the Federal Labour Agency with the IAB Establishment panel via the plant identifier available in both data sets. This matched data set currently comprises the years 1993 to 2002. For the purposes of the present inquiry and in the interests of panel estimation we use information on all ten years and thus exclude Eastern Germany. The basis of the initial sample is all establishments in the manufacturing sector, while for services we exclude banking and insurance where output is not measured by sales (being reported in balance-sheet terms for the former and in premiums for the latter) plus three clearly not-for-profit service subsectors (e.g. public administration). We then proceeded to weed out further nonprofit organisations in services by exploiting (two) other questions in the Establishment Panel so as to obtain our preferred services (sub)sample.[50]

6.3 The model

Workers were notionally classified into six skill categories: three blue-collar and three white-collar groups. So as to avoid having too few workers in the individual skill categories for our two sectors, we formally classified workers into four categories per sector – as well as imposing a minimum requirement of two workers per skill group. For manufacturing this meant three blue-collar skill categories (unskilled, skilled, and highly skilled [i.e. master craftsmen]) and one composite white-collar group, based on employer definitions. For services this meant three white-collar skill categories (unskilled, skilled, and highly skilled, now defined on the basis of education level and qualifications) and a composite blue-collar entity.[51]

Given this representation of the structure of the workforce, we wanted the substitution possibilities between the various types of labour to be as unrestricted as possible. To this end, we used a flexible cost function – specifically, the Generalised Leontief Function – in which the elasticity of substitution between any pair of factors can assume any (positive) value. Further, we treat capital as a quasi-fixed factor, meaning that we are only concerned with the optimal choice of the set of variable labour inputs (using the capital stock as a regressor in our heterogenous labour demand

[49] In a subset of estimates using this variable (see Table 6.5 below), since the Establishment Panel measures organisational change over a two-year interval we chose to use data from 1995 to impute values for the years 1993 and 1994 (thus dropping 1995), data from 1998 to impute values for 1996 and 1997, data from 2000 to impute values for 1998 and 1999, and finally data from 2001 to impute a value for 2000 (dropping 2001). In other words, for specifications using the organisational change argument we lose three years of data, including 2002 for which there was no organisational change question in the Establishment Panel.

[50] The questions concern the legal form of the firm and the definition of business volume. We excluded two such legal forms {'Körperschaft des öffentlichen Rechts' and 'Sonstige Rechtsform (z.B. Verein, Genossenschaft)'} as well as those units that defined their business volume in terms of budget rather than sales.

[51] Following Bauer and Bender (2004), we also experimented with an occupational-based representation of the blue-collar and white-collar skill structure, in which workers were classified into just three categories – unskilled, skilled, and highly skilled – notwithstanding their white- or blue-collar status. The results of this exercise are briefly reported on in section VI below.

functions rather than its user cost). We supplement our measure of capital with a number of technological variables available in the Panel (see below) and, in one specification, a measure of organisational change.

From the cost function, we are able to estimate the conditional demand functions for the four types of labour.[52] These *four* demand functions – each giving the quantity of labour employed at establishment level as a function of wage and non-wage variables – are estimated jointly. (Technically, they are estimated in a system of seemingly unrelated regressions to allow for the possibility that the error terms in each are contemporaneously correlated, as when unexpected shocks affect them in a systematic way). We can then obtain the *own-wage* and *cross-wage elasticities*, as well as the labour demand elasticities with respect to the all other explanatory variables. The own wage elasticity for a particular category of labour is defined as the percentage change in its employment caused by a one per cent increase in its wage (and since the cost function is concave, the own wage has a non-positive impact on the demand for each category of labour). The cross-wage elasticity of labour category *i* with respect to the price of category *j* is measured as the percentage change in the demand for *i* brought about by a one per cent change in the price of input *j*; the two groups being substitutes (complements) if the cross-wage elasticity is positive (negative). Similarly, the labour demand elasticity with respect to output (capital) is defined as the percentage change in employment of a given labour category resulting from a one per cent change in output (the capital stock). For the dichotomous technology variables, note that we report the respective labour demand semi-elasticities, giving the percentage change in labour demand caused by a unit change in the corresponding technological indicator. (The reader is referred to the Appendix A6.1 for technical details).

We anticipate that the own-wage elasticities should not only be negative but also decrease (in absolute value) with the skill content of the labour input, because high-skill workers are more difficult to replace in production than those with lesser skills. The capital stock is expected to evince greater complementarity with highly skilled workers as well. We also anticipate that technological and organisational change might impact labour, and in particular unskilled labour, unfavourably and (for manufacturing) that any adverse trade effects would likely be confined to unskilled workers.

[52] Courtesy of Shephard's lemma, the partial derivatives of the cost function give the conditional labour demand.

6.4 Empirical specification

As was noted in section III, we estimate the four factor demand functions (per sector) by the Seemingly Unrelated Regression (SUR) method. We do not present the eight regressions here – they are available from the authors on request – instead electing to summarise them in the form of the wage and other elasticities.

We have already described the basis of construction of the four labour inputs in each of our two sectors, manufacturing and services. Also taken from the employment statistics are input prices since the establishment panel only contains information on the *overall wage bill*. It will be recalled that the earnings variable in the administrative data is censored at the maximum earnings taxable under social security. In manufacturing (services), 7.75 (8.56) per cent of the wage observations were censored. We therefore used a Tobit-type estimator to impute daily earnings values for those with right-censored earnings for each skill group separately, estimating eight wage equations using pooled data and time dummies.[53] Predicted wages together with the corresponding actual (below-ceiling) wages were used in the calculation of mean wages per skill group per plant per year. For manufacturing, the total number of observations were as follows (with the censored values in parentheses): blue-collar unskilled, 2,626,147 (6,848); blue-collar skilled, 2,296,841 (18,763); blue-collar, highly skilled 185,083 (31,856); white-collar composite, 2,330,451 (519,904). For services, the corresponding totals were: white-collar unskilled, 99,296 (2,642); white-collar skilled, 1,729,792 (117,505); white-collar highly skilled, 454,763 (140,556); blue-collar composite, 796,786 (2,964). The variables included in our conventional earnings function are detailed in Appendix A6.2 and the fitted equations are available from the authors upon request. Not mentioned in the table is our imposition of a *monthly* wage cutoff of DM 1,000, although as a practical matter this restriction resulted in the loss of few observations because of the 'prior' exclusion of part-time workers.

These plant specific wage measures, together with the corresponding number of employees,[54] are added to the establishment panel, which contains the other information needed to estimate the system of input-output ratios from which our elasticities are derived. Our measure of output is sales volume. It would have been preferable to use a value-added measure of output, obtained by subtracting the cost of materials from

[53] We selected the cluster option of the intreg-estimator provided in Stata. Our imputation procedure, based on the predicted wage plus an error term, also guarantees that the imputed wage is never below the ceiling. Results are available from the authors on request. Alternative imputation methods did not fundamentally alter the results reported below.

[54] We should note that there are disparities between the sum of employees obtained from the employment statistics and the total given in the establishment panel. Where these amounted to 20 per cent or more we chose to exclude the plant from the sample, treating the establishment identifier as flawed.

sales. Although the establishment panel allows us to construct a value-added measure[55] – and a number of recent studies have deployed this measure (see, for example Wolf and Zwick, 2002) – inspection of the raw data reveals that the materials cost estimates are little more than informed guesstimates. No less important, panel survey respondents often fail to answer the materials cost question, so that use of a value-added measure involves a large reduction in the number of observations: around one-third of all plants have missing values for these intermediate inputs.

The next variable taken from the establishment panel is our measure of the capital stock. This argument is approximated by the sum of investment expenditures in the last two years and, like the output measure, is also calculated in DM million. In other work, two of the present authors have used replacement investment since this variable is more clearly expected to be proportional to the capital stock (see Addison, Schank, Schnabel, and Wagner, 2003). In the present paper, however, our sample period begins in 1993 and data on replacement investment is only available after 1996.

The penultimate four arguments are dummy variables and provide more information on the nature of the capital stock. Three investment dummies signify whether a plant has, in the previous year, invested in property and buildings, in production units, and in information and communication technology. Supplementing the last measure as a proxy for the use of new technologies in the plant is a separate dummy variable set equal to one if the plant uses either state-of-the art or at least up-to-date equipment to produce goods and services.[56] For manufacturing alone, we also include an indicator of organisational change over the previous two years. This variable, which is not available for all years in the sample, is defined in Appendix A6.2 and footnote 49.

Our final argument is a continuous variable proxying the importance of international trade and globalisation. It is the proportion of sales consisting of exports. Like the organisational change variable is only entered for the manufacturing sector. Descriptive statistics on all variables are provided in Tables 6.1 and 6.2.

[55] Specifically, panel survey respondents are asked to estimate the percentage share of total sales represented by materials cost, so that multiplying sales volume by 1 minus this share yields value added.

[56] Respondents in the Establishment Panel survey are asked to rate the technical condition of the plant's equipment compared with that of other firms in the industry/sector along a Likert scale where 1 indicates "state-of-the-art" (auf dem neuesten stand) equipment and 5 indicates "obsolete" equipment (völlig veraltet). In forming a modern technology dummy, we grouped categories 1 and 2.

Table 6.1: Descriptive Statistics of the Regression Sample, Manufacturing

	Full sample		Reduced sample	
Variable	**Mean**	**Std. dev.**	**Mean**	**Std. dev.**
Number of employees:				
Blue-collar workers				
– unskilled	264	523	288	506
– skilled	218	470	232	471
– highly skilled	20	57	22	53
White-collar workers	234	461	252	463
Daily wage (in DM):				
Blue-collar workers				
– unskilled	148	24	145	23
– skilled	170	23	167	22
– highly skilled	236	28	232	27
White-collar workers	215	29	211	28
Output (mill. DM)	314	709	322	644
Capital (mill. DM)	33.6	97.7	34.6	85.3
Export share	0.29	0.26	0.29	0.26
Index of technology	0.74	0.44	0.75	0.44
Investment in IT	0.80	0.40	0.80	0.40
Investment in other units	0.90	0.31	0.91	0.28
Investment in buildings	0.36	0.48	0.37	0.48
Organisational change			0.85	0.36
n	4982		2649	
Establishments	1171		688	

Notes: A description of the variables is provided in Appendix A6.2. The 'reduced sample' is obtained when dropping all establishments in which the organisational change variable is missing.

Table 6.2: Descriptive Statistics of the Regression Sample, Services

	Full sample		Sub-sample	
Variables	**Mean**	**Std. dev.**	**Mean**	**Std. dev.**
Number of employees:				
White-collar workers				
– unskilled	19	36	24	47
– skilled	330	432	305	509
– highly skilled	105	210	67	178
Blue-collar workers	225	597	345	837
Daily wage (in DM):				
White-collar workers				
– unskilled	156	32	161	36
– skilled	176	26	182	30
– highly skilled	257	47	250	48
Blue-collar workers	142	25	148	28
Output (mill. DM)	224	518	285	635
Capital (mill. DM)	39.1	118	51.9	158
Index of technology	0.69	0.46	0.76	0.43
Investment in IT	0.83	0.38	0.81	0.39
Investment in other units	0.78	0.42	0.78	0.42
Investment in buildings	0.53	0.50	0.49	0.50
Organisational change			0.82	0.38
n	1427		654	
Establishments	368		174	

Notes: See Table 6.1. The 'sub-sample' is based on a further cut of the services data designed to remove remaining not-for-profit units; see the text and footnote 50.

6.5 Findings

Estimated elasticities for the manufacturing and service sectors are provided in Tables 6.3 and 6.4, respectively. Beginning with manufacturing, we see that with the exception of the white-collar composite group, the own-wage elasticities are all of the expected sign, and those of unskilled workers and skilled workers are both well determined and the differences between them (and between them and the white-collar composite) are also statistically significant at the .05 level or better. Note, however, that our expectation that the absolute value of the unskilled elasticity would be larger than those of the other skill groups is *not* borne out. Unskilled blue-collar workers emerge as substitutes in production for skilled and highly skilled workers but not with white-collar workers as a collectivity. On the other hand, skilled and highly skilled workers are weakly complementary. As far as white-collar workers are concerned the only significant cross elasticity is, as noted earlier, the negative association with unskilled blue-collar workers.

Table 6.3: Employment Elasticities for Different Skills Groups, Manufacturing (within-plant estimation)

	Blue-collar workers			White-collar workers
	Unskilled	**Skilled**	**Highly skilled**	
Elasticities				
Wages:				
Blue-collar workers				
– Unskilled	-0.472***	0.735***	1.220***	-0.293**
– Skilled	0.700***	-0.849***	-0.155	0.099
– Highly skilled	0.151***	-0.020	-0.430	-0.061
White-collar workers	-0.378**	0.134	-0.635	0.254
Output	0.238	0.854**	0.611	-4.814***
Capital	0.403***	0.411***	0.561***	1.773***
Export share	0.056***	0.091***	0.020***	0.512***
Semi-elasticities				
Index of technology.	0.029***	0.021***	0.050***	0.040**
Investment in IT	0.019***	0.016***	0.031***	0.059***
Investment in other units	0.016***	0.014***	0.011***	0.067***
Investment in buildings	-0.006**	-0.009***	-0.021***	-0.024

Notes: ***, **, * denote statistical significance at the .01, .05 and .10 levels, respectively.

The elasticities are obtained from the parameter estimates of a (constrained) SUR regression after a within-plant transformation of the data. The corresponding heterogeneous labour demand equations have been derived from a Generalised Leontief cost function (see Appendix A6.1). The number of observations (establishments) is 4,982 (1,171).

With the exception of white-collar workers, the output elasticities are positive and statistically significant. They are well determined only for the skilled blue-collar worker category and the white-collar aggregate (although the latter association is perverse). The labour demand elasticities with respect to capital are uniformly well determined and of very similar magnitude for each of the blue-collar groups. And trade seems benign in the sense that a rising share of exports in total sales seemingly boosts labour demand throughout. But the effect is small for blue-collar workers: a 10 per cent increase in export share is associated with a less than one per cent increase in employment. For white-collar workers the growth in employment is anomalous – on this occasion, anomalously high.

The generally benign effect of exports has a counterpart in the influence of technology. For both measures – state-of-the-art/up-to-date technical equipment and investments in information technology – the semi-elasticites are all positive and well determined. For each labour category, upgrading to state-of-the-art equipment and going from no investment to some investment in IT has a positive, albeit still small effect on

employment. We have no explanation for the consistent but opposing directional effects of investment in other production units (positive) on property and buildings (negative) on labour demand.

Table 6.4: Employment Elasticities for Different Skills Groups, Services (within-plant estimation; sub-sample)

	Blue-collar workers			White-collar workers
	Unskilled	**Skilled**	**Highly skilled**	
Elasticities				
Wages:				
White-collar workers				
– Unskilled	-2.086***	-0.012	0.089	0.141**
– Skilled	-0.180	-0.508	-1.086**	0.926**
– Highly skilled	0.392	-0.328**	0.326	0.221
Blue-collar workers	1.874**	0.849**	0.671	-1.288**
Output	4.159***	0.976	-0.706	2.530**
Capital	0.262***	0.260***	0.367***	0.362***
Semi-elasticities				
Index of technology	0.122***	0.214***	0.231***	0.147***
Investment in IT	0.086***	0.065***	0.146***	-0.028
Investment in other units	0.008	-0.057***	-0.037**	0.011
Investment in buildings	0.156***	0.148***	0.228***	0.137***

Notes: See Table 6.3. The number of observations (establishments) is 654 (174).

Turning to services, perhaps the main difference from manufacturing is the emergence of a hierarchy in the pattern of own-wage elasticities. In particular, the own-wage elasticity of unskilled white-collar workers is strongly negative – a 10 per cent increase in the wage of unskilled white collar employees lowers their employment by 21 per cent – and is clearly differentiated from the experience of the two more skilled white-collar groups, the estimates for both of which groups are poorly determined. The own-wage elasticity of the blue-collar aggregate is also strongly negative and not significantly different from that of unskilled white-collar workers. There are few indications of either complementarity or substitutability between unskilled white-collar workers and their more skilled counterparts, although the skilled and the very highly skilled are clearly complementary inputs. Increases in the wages of blue-collar workers as a group lead to increases in both unskilled and skilled (although not highly skilled) white-collar employment.

Labour demand elasticities with respect to output for unskilled white-collar employees and blue-collar workers exceed unity and are well determined. Those for the two other white-collar categories are statistically insignificant. But, as was the case for manufacturing, there is strong evidence of complementarity between capital and labour. Similarly, technology is associated with increased employment. In fact, the semi-elasticities are somewhat stronger than observed for manufacturing in seven out of eight cases. Again, then, investing in IT and upgrading technology leads to increases rather than decreases in labour inputs. As far as labour demand elasticities with respect to investments in other production units and in property and buildings are concerned there is some reversal of findings: now the latter investments increase employment across the board while the former investments tend to reduce employment albeit very modestly.

Table 6.5: Employment Elasticities for Different Skills Groups, Manufacturing (within-plant estimation; reduced sample with the additional regressor 'organisational change')

	Blue-collar workers			White-collar workers
	Unskilled	**Skilled**	**Highly skilled**	
Elasticities				
Wages:				
Blue-collar workers				
– Unskilled	-0.492**	1.184***	1.945**	-0.658***
– Skilled	1.096***	-1.330***	0.015	0.105
– Highly skilled	0.235**	0.002	0.116	-0.197**
White-collar workers	-0.839***	0.144	-2.077**	0.750**
Output	0.139	1.754***	-0.832	-5.794***
Capital	0.599***	0.711***	0.354***	4.125***
Export share	0.040***	0.073***	0.030***	0.366***
Semi-elasticities				
Index of technology	0.040***	0.030***	0.054***	0.118***
Investment in IT	0.020***	0.015***	0.035***	0.043**
Investment in other units	0.003	0.013***	0.014*	0.024
Investment in buildings	-0.018***	-0.016***	0.002	-0.136***
Organisational change	0.013***	0.018***	0.018**	0.087***

Notes: See Table 6.3. The number of observations (establishments) is 2,649 (688).

Finally, we investigated the effects of organisational change on labour demand. We already noted the loss in observations that this caused (because of the irregularity with which this question is asked in the panel

survey) and so we only present results for the considerably larger manufacturing sample. We simply add the new regressor to an otherwise unchanged specification for manufacturing. As before the respective elasticities are provided. As can be seen from Table 6.5, the main result is of course that the introduction of organisational change is associated with *increases* in employment. The magnitudes of the semi-elasticities are small: initiating organisational change as opposed to not doing so increases the employment of blue-collar workers by between 1.3 and 1.8 per cent, although the effect is greater for the white-collar aggregate at just under 9 per cent. As far as the other variables are concerned there are scarcely any qualitative differences between the results for the restricted and full manufacturing samples. As expected, these and other differences (in magnitude) are explained by the reduction in sample size. (Results for the restricted manufacturing sample net of the organisational change variable are available on request.)

Stated baldly, the bottom lines from this empirical inquiry are fourfold. First, for manufacturing if not services, the own-wage elasticity of unskilled workers does not appear to be larger in absolute magnitude than that of skilled and yet more highly skilled groups. Second, capital and all the various skill categories seem to be complements in production. Third, (manufacturing) employment is increasing in export share. Finally, investing in technology and introducing organisational change are again productive for employment across the board.

6.6 Interpretation

Our analysis has used information on 1,171 manufacturing plants covering on average 360,000 employees (and 174 service sector establishments covering some 49,000 employees), and has used one of the longest panels of which we are aware. Our findings differ somewhat from those reported in the literature in a number of respects. Chief among these is the absence of the familiar hierarchy in the own-wage elasticities by skill group (e.g. FitzRoy and Funke, 1998), at least for manufacturing. It may be objected that our findings for manufacturing could reflect inaccuracy in the identification of skill. Although our subsequent experimentation using education levels and qualifications to define blue-collar skill groups in manufacturing proved abortive (because of limited numbers of workers in the highest category), we were able to obtain a common measure of skill across sectors using the occupational breakdown, suggested by Bauer and Bender (2004). Estimates based on these definitions – not reported here, but available from the authors on request – closely matched those reported in Table 6.3, based on employer definitions of skill.

Issues of hierachy in these elasticities notwithstanding, our estimates of the unskilled worker own-wage elasticity are always well determined, and are particularly strong in the case of services. Within manufacturing, unskilled workers emerge as substitutes in production for more skilled

workers, among the ranks of which there is however only very weak evidence of complementarity. For services, on the other hand, there is little evidence that unskilled and skilled (and yet more skilled) workers are affected by each other's wage. In both sectors, some strong substitute relationships between the composite skill groups and the more narrowly defined categories again suggest that further disaggregation is in order.

Complementarity between capital and the various skill categories is stronger than in previous research using the LIAB (e.g. Bellmann and Schank, 2000; Kölling and Schank, 2002). However, such studies use either a cross section of data or at best a short panel. Note also that, with the exception of the composite groups, our estimates of the labour elasticities with respect to capital fall within a narrow range.

Increased trade does not appear to have adverse consequences for any skill group. That is to say, the labour elasticities with respect to export share are not only uniformly positive but also well determined throughout. The estimated elasticities for unskilled blue-collar workers are smaller than for their skilled counterparts but the magnitudes are small for all blue-collar groups. But we would caution that the establishment panel does not contain information on the other side of the trade coin – imports – and so one cannot conclude in particular that trade is benign for low-skilled groups.

Perhaps most at odds with previous research, however, are our findings for technology. We find no evidence suggestive of skill-biased technical change insofar as this is captured by our two indicators. That is to say, neither upgrading to state-of-the-art equipment nor investing in information technology has negative consequences for any of our narrowly-defined skill categories. Interestingly, the technology findings carry over to organisational change, which innovations are seemingly associated with modest increases in employment across the skill groups in manufacturing industry. In sum, the semi-elasticities are positive and statistically significant throughout. These results are also consistent with the results for the capital stock.

Our principal finding nevertheless resides in the estimated own-wage elasticities for unskilled workers. We have found that a 10 per cent fall in the wages of unskilled workers would translate into a 5 per cent increase in the demand for blue-collar workers in manufacturing and, more controversially, into a 21 per cent increase in that of unskilled white-collar employees in services. If, as it is conventional to argue, rigid wages lie at the heart of the German employment problem, our estimates may suggest that one first-pass policy solution may lie in subsidising unskilled work. To establish the effect of wage subsidies on unskilled worker *un*employment, some additional assumption regarding the elasticity of wages with respect to unemployment is of course required (see Cahuc and Zylberberg, 2004, pp. 663-664).

6.7 References

Addison, J.T., Schank, T., Schnabel, C. and Wagner, J. (2003) 'Works Councils in the Production Process', Discussion Paper No. 812, Bonn: Institute for the Study of Labour/IZA

Bauer, T.K. and Bender, S. (2004) 'Technological Change, Organizational Change, and Job Turnover', *Labour Economics*, 11, 3, pp. 265-291

Bellmann, L. and Schank, T. (2000) 'Innovations, Wages and Demand for Heterogeneous Labour: New Evidence from a Matched Employer-Employee Data-Set', Discussion Paper No. 112. Bonn: Institute for the Study of Labour/IZA

Bender, S., Haas, A. and Klose, C. (2000) 'The IAB Employment Subsample, 1975-1995', *Schmollers Jahrbuch*, 120, 4, pp. 649-662

Berndt, E. and Christensen, L.R. (1974) 'Testing for the Existence of a Consistent Aggregate Index of Labor Inputs', *American Economic Review*, 64, 2, pp. 391-404

Bond, S.R. and van Reenen, J. (2006) 'Microeconometric Models of Investment and Employment', in Heckman, J.J. and Leamer, E.E. (eds.), *Handbook of Econometrics,* Volume 6. Amsterdam and New York: Elsevier (forthcoming)

Cahuc, P. and Zylberberg, A. (2004) *Labour Economics*, Cambridge, MA, and London, England: The MIT Press

Christensen L.R., Jorgenson, D.W. and Lau, L.J. (1973) 'Transcendental Logarithmic Production Frontier', *Review of Economics and Statistics*, 55, 1, pp. 28-45

Diewert, W.E. (1971) 'An Application of the Shephard Duality Theorem: A Generalized Leontief Production Function', *Journal of Political Economy*, 79, 3, pp. 481-507

Falk, M. and Seim, K. (1999) 'Workers' Skill Level and Information Technology: Evidence from German Service Firms', in Bellmann, L. and Steiner, V. (eds.), *Panelanalysen zu Lohnstruktur, Qualifikation und Beshäftigungsdynamik*. Beiträge zur Arbeitsmarkt- und Berufsforschung, Nuremberg: Bundesanstalt für Arbeit, pp. 79-116

Fitzenberger, B. (1999a) 'International Trade and the Skill Structure of Wages and Employment in West Germany', *Jahrbücher für Nationalökonomie und Statistik*, 219, 1-2, pp. 67-89

Fitzenberger, B. (1999b) *Wages and Employment across Skill Groups*: *An Analysis for West Germany*, Heidelberg: Physica Verlag

FitzRoy, F., and Funke, M. (1998) 'Skills, Wages, and Employment in East and West Germany', *Regional Studies*, 32, 5, pp. 459-467

Kölling, A. (2000) 'The IAB Establishment Panel', *Schmollers Jahrbuch*, 120, 2, pp. 291-300

Kölling, A. and Schank, T. (2002) 'Skill-Biased Technological Change, International Trade and the Wage Structure', Discussion Paper No. 14, Lehrstuhl für Volkswirtschaftslehre/Arbeitsmarkt- und Regionalpolitik, Friedrich-Alexander-Universität Erlangen-Nürnberg

Lindbeck, A. and Snower, D.J. (2000) 'Multitask Learning and the Reorganization of Work: From Tayloristic to Holistic Organization', *Journal of Labor Economics*, 18, 3, pp. 353-376

Wolf, E. and Zwick, T. (2002) 'Reassessing the Impact of High Performance Workplaces', Discussion Paper No. 02-07, Mannheim: Centre for European Economic Research/ZEW

Appendix A6.1: Technical Aspects

To represent the production (cost) possibilities, we select a flexible function that can be viewed as a second-order local approximation to an arbitrary cost function. Specifically, we deploy a Generalised Leontief Cost Function in which the elasticity of substitution between any pair of inputs can take any (positive) value; indeed, the greater is the corresponding coefficient in the cost function, the greater is the elasticity of substitution (Diewert, 1971).[57]

Capital is treated as a quasi-fixed factor. This assumption is our preferred way of tackling the optimal choice of the set of variable (labour) inputs.[58] We consider this approach appropriate in the data circumstances. Thus, although the maximum panel length is ten years, in many cases establishments are only observed for a few years. Furthermore, there is no direct measure of the capital stock: it can only be proxied using information on annual investment. The limitations of our measure of the capital stock are in part offset by a number of technological variables in the establishment panel; for example, dummy variables indicating the use of either state-of-the-art or up-to-date equipment, recent investments in information and communication technology, inter alia, and the introduction of organisational changes.

Formally, omitting establishment and time subscripts, the chosen function can be denoted as $C(W,y,Z;\alpha,\beta,\gamma)$, where $W=(w_1, w_2, w_3, w_4)$ is the vector of variable input prices, y is output, $Z=(z_1, z_2, z_3)$ is a column vector of non-wage variables comprising the capital stock (z_1), the export share (z_2), and a technology indicator (z_3), and (α,β,γ) are the parameters to be estimated. As a practical matter, we disaggregate z_3 into z_{31}, z_{32}, z_{33}, and z_{34}, denoting the presence of state-of-the-art/up-to-date equipment, investments in information and communication technology, investments in buildings, and investments in production units, respectively. Further, for a subsample of manufacturing, we will enter an additional regressor capturing organisational change.

The corresponding vector of conditional factor demands, obtained by applying Shephard's Lemma, is then given by $X=(x_1, x_2, x_3, x_4)$, where x_1 is the conditional factor demand of skill group i. A useful property of this flexible cost function is that the corresponding conditional demand functions are also linear in the parameters. A typical labour demand x_1 will be

$$x_1=x_1(W,y,Z;\alpha,\beta,\gamma),\ i=1,2,3,4. \qquad (1)$$

[57] An alternative representation of the technology is given by the Translog cost function (Christenson, Jorgenson, and Lau, 1973), which also can be viewed as a local second-order approximation of an arbitrary cost function. For this specification, factor shares rather than the conditional factor demands are linear in the relevant parameters of the cost function. The resulting system of cost share equations can also be estimated by the SUR method.

[58] Rationalisation of this approach in the context of labour demand estimation can be found in Bond and Reenen (2006).

Although these four demand functions can be estimated by OLS, there are well known gains in efficiency if they are estimated jointly in a system of seemingly unrelated regressions. We implement a SUR model with fixed effects, which amounts to applying a standard within transformation of the data (meaning that for each variable we take the difference from the mean of the production unit). The usual symmetry conditions are imposed on the system. Further, to avoid any bias in the estimated standard errors, the labour demand input is divided by output so that the system is specified in terms of input/output coefficients.

Finally, the relevant own- and cross-wage elasticities, as well as the elasticities of labour demand with respect to capital and the other indicators of technology, can be derived as follows. Formally, the elasticity of the labour demand for skill group i with respect to input price j is given by

$$\eta(x_i,w_j) = (\delta x_i/\delta w_j)(w_j/x_i),\ i,j = 1,2,3,4. \quad (2)$$

In turn, the output elasticity is

$$\eta(x_i,y) = (\delta x_i/\delta y)(y/x_i) \quad (3)$$

while the elasticity with respect to any of the variables (i.e. capital, export share, and technology) is

$$\eta(x_i,z_i) = \gamma_k z_i/x_i \quad (4)$$

For the dichotomous z_3 technology variables, the semi-elasticity is obtained by dividing the corresponding elasticity in (4) by z_{31}, z_{32}, z_{33}, and z_{34}, respectively. Given that the elasticities will differ at every data point, we adopt the usual procedure of computing them at the sample means.

Appendix A6.2: Description of variables

Variable	Description
Employee skill groups	Employees in the raw administrative records were first classified into four groups: three blue-collar worker categories (comprising the unskilled, skilled, and highly skilled) and one aggregate white-collar category made up of all white-collar grades. (The residual categories of home-workers, part-time workers, and apprentices were dropped from the sample.) White-collar workers were then disaggregated into three skill categories according to their education level: unskilled (individuals without a completed apprenticeship and without an Abitur), skilled (individuals with a completed apprenticeship and/or an Abitur), and highly skilled (individuals possessing a college, polytechnic, or university degree). As noted in the text, for the manufacturing sector analysis we used all three blue-collar skill categories and the single white-collar aggregate; whereas in the service sector we deployed all three white-collar categories and aggregated the blue-collar categories into a single grouping.
Wages	Daily wage in DM. Information on individual wages in the administrative data is right censored at the upper earnings limit for social security contributions. For such individuals, the predicted wage was obtained using separate Tobit regressions of the daily wage on age, gender, nationality, 3-digit occupational dummies, plant size, and industry and year dummies.
Output	Total sales in DM.
Capital	Sum of the current and the previous year's investment.
Export share	The percentage share of exports in the establishment's annual turnover.
Index of technology	Modern technology dummy, assuming the value of 1 if the plant's equipment is either state-of-the art or up-to-date compared with other firms in the same industry, 0 otherwise.
Investment in information and communication technology	IT dummy, assuming the value of 1 if the establishment has invested during the survey year in information and communication technology, 0 otherwise.
Investment in other units	Dummy variable assuming the value of 1 if the establishment has invested during the survey year in other plant and equipment, 0 otherwise.
Investment in buildings	Dummy variable if the establishment has invested during the survey year in buildings and real estate, 0 otherwise.
Organisational change	Dummy variable assuming the value of 1 if the establishment had (in the last two years) reorganised by shifting responsibilities and decision making to lower levels in the hierarchy, by setting up units with their own costs and results accounting, and by introducing team work and self-governing work groups, etc. The organisational change question was not asked in all waves of the establishment panel. The method of interpolation used in the present treatment is documented in the text (footnote 49).

Notes: In the employee-employer matching procedure, all establishments employing less than 20 employees were dropped from the sample. Further, inclusion required that each establishment had at least 2 workers in each skill category. Finally, establishments in which the employer-employee match yielded a difference in employment levels of 20 per cent or more were excised from the sample.

7 Analysing Working Time: Why Use Linked Employer-Employee Data?

Mark L Bryan[59]

ABSTRACT

Linked employer-employee data are essential to account fully for the differences across people in their working time. As well as capturing the effects of workers' personal attributes on hours worked, these data allow for specific workplace-level influences on hours. This analysis shows that workplace-level hours 'policies' or norms are strong drivers of working hours, accounting for nearly a third of the variation in 'explained' hours. They have an especially large effect in the expanding private services sector. Hours also vary widely within workplaces, depending on skill, occupation and family characteristics. The results point to a dual-pronged strategy to improve work-life balance: promotion of job mobility to enable workers to find jobs with suitable hours, and enhancement of already existing within-firm hours variation.

7.1 Introduction

The UK has a high and (until recently) increasing employment rate. Some 75 per cent of the working age population are now in employment and in its five-year strategy, the Department for Work and Pensions has announced its 'aspiration' to go even further and achieve an employment rate of 80 per cent.[60] By integrating groups with historically low participation rates (mainly mothers of young children, older workers, disabled people and ethnic minorities), the Government hopes the economy will benefit from previously untapped skills which can help sustain the growing retired population. But the flipside of an economy in which everyone who can work does work is a squeeze on the amount of time left for personal and family activities – perhaps especially for those labour market entrants, like mothers and some older people, who are also carers. So as well as introducing measures to stimulate labour supply, the Government has been engaged in a consultation and awareness-raising process that has culminated in the introduction of various new workplace entitlements. The new legislation includes the right to parental leave and

[59] Institute for Social and Economic Research (ISER) University of Essex.
[60] DWP (2005).

paid paternity leave, the extension of paid maternity leave, the right to emergency time off for employees with dependents, and the right for parents of young children to request flexible working patterns.[61]

To design effective working time polices we need to understand the factors which explain working hours and different working patterns, and so identify areas where intervention may be most beneficial (and least harmful to efficiency). Working time is one area where both workers and employers are likely to have quite strong preferences, but traditional analysis has been restricted to one side of the market only, usually the supply side. If there were perfect mobility in the labour market, so that workers could always find a job matching their hours preferences, this might not matter analytically. A supply-side analysis (based on individual-level data) could, in principle, fully explain differences in working hours between individuals. But as long as there is something 'specific' about the worker-firm match – a skill linked to that particular job, or the fact that the firm is conveniently located for the employee – there will be some 'cost' to breaking up the relationship. In that case, the hours of identical workers will typically differ across firms, and both worker and firm factors will be needed to explain working time. Unlike 'traditional' data sources, linked data show the influence both of individual workers' characteristics and also those of their employers.

This article focuses on the cross-sectional component of the 1998 Workplace Employee Relations Survey (WERS 98). This was a nationally representative cross-sectional survey of over 2000 workplaces with ten or more employees. As well as conducting interviews with a manager, and a worker representative where possible, it included survey responses from up to 25 individuals in each workplace. The WERS data have already been used in several studies to analyse family-friendly working practices. A positive relationship has been found between family-friendly policies and establishment performance.[62] Other studies have exploited one potential advantage of linked data, which is that both management and workers can be asked similar questions about the same topics.[63] For example, Budd and Mumford compared the availability of family-friendly practices as stated by the manager, with the availability perceived by workers. They concluded that workplace-level statistics on family-friendly policies probably overstate the true accessibility of these practices to employees.

I use the WERS data here in a different way, to assess the importance of workplace factors versus individual worker factors in determining hours of work. In other words, to what extent are working hours driven by a common workplace-level hours 'policy', and to what extent do they vary within workplaces? If they do vary within workplaces, how is this linked to different job and family characteristics? The matched data allow analysis of two specific aspects which are necessarily neglected in traditional

[61] For full details of this new legislation and the consultation process leading up to it, see the DTI Employment Relations website, in particular http://www.dti.gov.uk/er/fw_wlb.htm
[62] Gray (2002).
[63] See, for example, Dex and Smith (2002), Heywood et al (2005) and Budd and Mumford (2005).

studies restricted to employee-level data: differences in the working hours of observably identical workers across workplaces, and the extent to which workers are non-randomly 'sorted' into workplaces with different working hours. The approach is to split the variation of working hours into two components – differences in working hours *between* workplaces and differences *within* workplaces – and then link each type of variation to the observed characteristics of workers.[64] The next section introduces the sample from the WERS 98 data. Then in Section 7.3, I show how the variation in working time, as well as other personal and job characteristics, can be broken into the within- and between-workplace components. Looking across the workforce, these figures show whether or not people with particular characteristics (working hours, but also occupation, family structure etc) tend to be clustered into particular workplaces. Section 7.4 decomposes the total variation of hours into the parts due to personal characteristics, workplace effects and the two sets of factors acting together. The workplace effects are then examined in more detail in Section 7.5. In Section 7.6, I explore the links between family characteristics and working hours. I assess whether family circumstances affect hours primarily within workplaces, or because people with certain characteristics tend to be sorted into particular workplaces. Section 7.7 summarises the evidence and concludes.

7.2 Data

The basic sample consists of 1740 workplaces with, on average, 13 workers observed in each workplace, as shown in Table 7.1. The sample is smaller than the 2191 workplaces surveyed because in the remaining workplaces, either no employees returned the questionnaire or they did not provide the full information needed for the analysis.

Table 7.1: Numbers of workplace and individual observations

Sample	Number of workplaces (N_1)	Number of individuals (N_2)	Mean individuals per workplace (N_2/N_1)	Median individuals per workplace
Full	2191	–	–	–
With individual info	1782	28215	15.8	17
With valid data	1740	21833	12.5	13

The survey unit of the workplace (or establishment) is of course not the same as the idea of the 'firm'. Indeed, nearly three-quarters of the workplaces in WERS belong to larger organisations. But the factors that affect firm-level working hours, such as the possible need to coordinate staff work schedules, should also apply at the workplace level, and so I

[64] For more a more technical treatment see Bryan (2005).

treat the two concepts interchangeably. Also, to the extent that there is not free movement between different workplaces in the same firm, the workplace is perhaps the more relevant unit.

The measure of working time studied is the response to the following question in the employee survey:

'How many hours do you usually work each week, including any overtime or extra hours?'

As in other individual-level surveys, no reference period is given for 'usual' hours; the intention behind the question is that respondents average over any temporary fluctuations or seasonal variations. This response is the 'cleanest' measure of working time in the employee questionnaire. Respondents were also asked for the amount of overtime or extra hours worked (again, 'usually'). Therefore one could construct a measure of standard hours as the difference between the two; in practice, though, the standard hours measure would be considerably 'noisier' than the straight measure of total usual hours. In any case, total hours are a better reflection of the 'real' amount of time worked. Because it includes overtime working, the total hours measure covers a wide range. Thus 13 per cent of workers usually worked more than 48 hours per week, while 18 per cent worked 20 hours or less. Total usual hours averaged 36. The next section shows how much of this variation can be accounted for by the workplace a person belonged to, as well as introducing the other personal characteristics which also affect hours.

7.3 The (un)importance of workplace affiliation. A first look at the evidence

There are two types of worker characteristics which are relevant to hours determination: first, those variables affecting a person's particular job, and therefore hours, within a firm. Examples are education, occupation, age, job tenure, and even gender to the extent that women tend to be 'segregated' into certain jobs. The second type of characteristics are those which, having controlled for skill and occupation, are usually thought to affect the number of hours an employee wishes to work. These characteristics are usually termed labour supply or preference variables, and typical examples are marital status and the presence of dependent children in the household. Some of their effects may of course result from domestic obligations rather than true preferences, but they are classified here as labour supply characteristics in order to focus on worker-firm interactions (rather than the domestic division of labour). Preferences may operate as well through the first set of characteristics, for instance if someone chooses their occupation based on the hours it requires. The purpose of defining the more limited set of labour supply characteristics is to identify variables that affect hours through preferences only and not occupation.

One variable which may affect both the number of hours chosen by the firm and the number desired by the worker is the (average hourly) wage. The wage is omitted from the analysis because it itself can be affected by the number of hours actually worked, and so cannot be considered as a genuine 'independent' variable. Rather, the role of the wage will be reflected in the effects due to skill and occupation, in addition to their own independent effects.

It is useful first to ask how these basic characteristics are related to where somebody works. Do people with certain characteristics tend to be 'sorted' into particular workplaces, or are they randomly distributed across workplaces? For several of the variables, Table 7.2 reports the mean, variance and the proportion of the variance which can be accounted for by an employee's workplace. Technically, the variance share figures are produced using a regression equation in which the only explanatory variables are a set of categorical variables which identify the different workplaces. The share of the variance explained by the workplace is the adjusted R^2 from the regression.

The top row of Table 7.2 reports that mean total hours across the whole sample of individuals are 36.0, with a variance of 171.2, and that 41 per cent of this variation can be attributed to workplace affiliation. The second and third rows show the results for the hours variable expressed in two different forms – first as the logarithm of hours and then transformed into an indicator of part-time work – to check that the variance shares do not depend overly on the precise measure used. All three figures are similar and show that the weekly hours worked by an individual are strongly associated with the workplace to which they belong. Of course, these estimates do not account for any of the other hours determinants. If these other variables are also non-randomly distributed across workplaces, then we can expect the shares due to workplace affiliation to decline when they are added to the analysis.

Table 7.2: Share of variation in individual characteristics due to workplace variation

Dependent variable (worker-level outcome)	Mean	Variance	Proportion of variation due to workplace affiliation (adjusted R^2)
Total hours	36.03	171.16	0.41
Log total hours	3.48	0.27	0.41
Part time incidence	0.25	–	0.38
Degree level qualification	0.21	–	0.25
High-skilled non-manual	0.31	–	0.28
Less-skilled non-manual	0.26	–	0.34
Manual	0.44	–	0.43
Age	39.70	146.38	0.15
Tenure (months)	88.1	6102.7	0.22
Female	0.48	–	0.32
Married or cohabiting	0.70	–	0.08
Children under 5	0.14	–	0.03
Children 5-11	0.20	–	0.04
Children 12-18	0.20	–	0.05

Notes: (a) The number of individuals is 21833 and the number of workplaces is 1740 (mean number of individuals per workplace is 12.5).
(b) The proportion of variation is the adjusted R^2 from a regression of the individual variable on the set of workplace dummies. Individual probability weights are used.

To see how other characteristics are related to workplace affiliation, the next panel of Table 7.2 reports the variance shares for some measures of skill and occupation: degree level education, three broad occupational groups, age and tenure, as well as gender. All the estimates imply that these characteristics are not randomly distributed across workplaces. Instead, their incidence is relatively well explained by workplace affiliation. For example, the occupation proportions vary from 28 per cent to 43 per cent. The variable with the lowest share is age (15 per cent).

The final panel of the table shows the shares for labour supply characteristics: marital status and the presence of children in three age bands. In contrast with the other characteristics, little of the variation can be attributed to workplace affiliation. The highest estimate is 8 per cent for marital status and the highest estimate for the children dummies is 5 per cent for children aged 12–18 years. Overall, then, Table 7.2 shows that a person's workplace seems to have a strong association with both their hours of work and the type of job they do, but not with the sort of factors that influence their desired hours of work.

7.4 Decomposition of total weekly work hours

To get a complete picture of the way that the workplace influences work hours, we need to include the full set of personal characteristics in the analysis, and apportion the variance to the workplace effect, the effect of skill and occupation, the influence of labour supply preferences and the various effects of these factors acting together. These results are shown in Table 7.3, and note (1) under the table lists all the included characteristics. I first discuss results estimated from the full sample, which provide an economy-wide picture of work hours and are reported in the top panel of Table 7.3, before commenting on differences between industrial sectors.

The figure in column (3), the adjusted R^2, is the total proportion of the variance in hours which can be explained by the combined effects of workplace and personal characteristics. This figure is 57 per cent, which is somewhat higher than the 41 per cent explained by workplace affiliation alone (Table 7.2) and is a first indication that personal characteristics also matter for hours. The remaining unexplained proportion of 43 per cent will be a combination of random measurement error, 'random' variation in hours and unobserved personal characteristics. Depending on the size of this last component, the calculated variance contributions may underestimate the importance of personal characteristics to some degree. It is worth noting in this connection that standard labour supply equations typically only explain around 10 per cent of the variation in hours. The augmented framework presented therefore does rather well in accounting for hours variation.

After controlling for personal characteristics, do workplace factors still affect hours worked? As shown in column (6), workplace effects account for 18 per cent of total variation or 18/57 = 32 per cent of the explained variation (reported in italics under the shares of total variation). This points to a substantial role for workplace-level factors in the determination of total working hours. Notice that the variance share of 18 per cent is less than half the 41 per cent share when only workplace dummies were included (Table 7.2), showing that workers are indeed not randomly allocated across workplaces – this sorting is examined below. The workplace share is slightly bigger than any of the other components of the decomposition to be discussed, although slightly smaller than for all personal characteristics combined. To give an idea of the size of workplace effects in practice, there is a gap of just over six hours between the quarter of workplaces working the shortest hours and the quarter working the longest hours. So observably identical workers can be doing very different hours according to where they work. Workplace-level hours 'policies' or norms have a strong effects on the hours that workers end up doing.

Table 7.3: Decomposition of total weekly hours into contributions due to individual and workplace characteristics

				Share of variance due to:					
	Mean	Variance	Total adjusted R2 (explained variance)	Skill/occup chars	Preference chars	Workplace effects	Joint skill/ occup / workplace	Joint preference workplace	Joint skill/ occup / preference
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Total hours relative shares									
	36.03	171.16	0.565	0.161	0.039	0.178	0.112	0.037	0.039
% of explained									
			100.0	*28.4*	*6.9*	*31.5*	*19.7*	*6.6*	*6.8*
Total hours in:									
Manufacturing & infrastructure relative shares									
	42.22	74.39	0.325	0.093	0.029	0.161	-0.011	0.009	0.042
absolute shares									
		(74.39)	(24.05)	(6.94)	(2.13)	(11.99)	(-0.85)	(0.69)	(3.15)
% of explained									
			100.0	*28.8*	*8.9*	*49.8*	*-3.5*	*2.9*	*13.1*
Private services relative shares									
	33.25	204.22	0.603	0.154	0.032	0.219	0.142	0.034	0.022
absolute shares									
		(204.22)	(123.24)	(31.53)	(6.47)	(44.75)	(29.10)	(6.88)	(4.51)
% of explained									
			100.0	*25.6*	*5.2*	*36.3*	*23.6*	*5.6*	*3.7*
Public services relative shares									
	34.34	163.83	0.489	0.227	0.064	0.091	0.031	0.024	0.052
absolute shares									
		(163.83)	(80.17)	(37.19)	(10.46)	(14.92)	(5.05)	(4.01)	(8.54)
% of explained									
			100.0	*46.4*	*13.0*	*18.6*	*6.3*	*5.0*	*10.7*

Note: (1) The decompositions are based on least squares regressions on the following variables: dummies for workplace affiliation; 'skill / occupation' characteristics: age and age squared (calculated from midpoints of questionnaire age bands), tenure (calculated from midpoints of questionnaire tenure bands), dummies for highest educational qualification, receipt of training in the last 12 months, employment on fixed term or temporary contract, health problems affecting daily activities, 1 digit occupation, gender; 'preference' characteristics: marital status and presence of children less than 5, 12 and 19 years old. In addition, occupation, age, marital status and the children variables were interacted with gender.

(2) The relative variance shares sum to the adjusted R^2 (total proportion of explained variance).

(3) The absolute variance shares, in parentheses, sum to the total explained variance.

(4) The figures in italic are the percentage shares of total explained variance.

(5) Estimates are weighted using individual probability weights (variable EMPWT_NR).

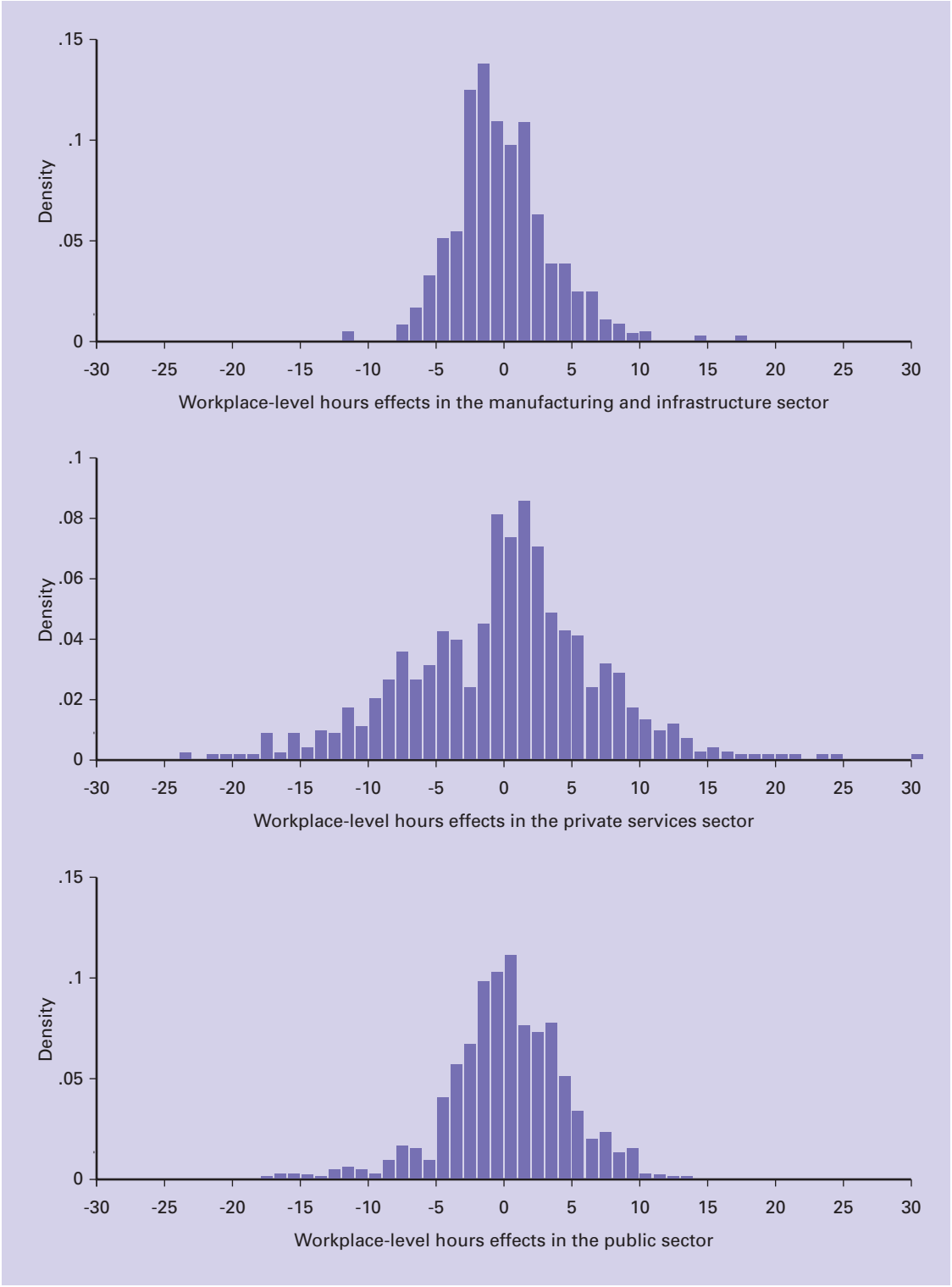
Columns (4) and (5) show the amount of variation which can be assigned to skill and occupation, and to labour supply preferences. Thus 16 per cent of total variation (and 28 per cent of explained variation) is due to

observed differences in skill and occupation, and 4 per cent (7 per cent) can be attributed to labour supply preferences. Since the calculations net out the workplace effect, they show that personal characteristics have an effect on hours *within* workplaces. The share due to preferences is quite small, but the choice of preference variables was deliberately restrictive, and some preferences will be operating through the other set of characteristics (by choice of occupation for instance).

The decomposition also shows that there is some sorting of workers into workplaces based on their personal attributes. Workers with skills that raise working hours tend to work in workplaces where, on average, everyone works longer hours – this effect can account for 11 per cent of the variance as shown in column (7) – and workers who prefer long-hours also tend to be sorted into long-hours workplaces, accounting for 4 per cent of variance (column (8). The preference sorting effect is perhaps surprising given the evidence in the raw data (Table 7.2) that workers with different family characteristics are not strongly sorted into different workplaces. However, those figures did not control for other relevant characteristics. It also turns out that the preference sorting effects are not estimated very precisely, as will be shown below.

The figures in the top panel of Table 7.3 reflect working hours variation in the economy as a whole. Not surprisingly, this aggregate analysis hides some important differences between industrial sectors, which are likely to stem from differences in capital usage and market structure. The remainder of Table 7.3 presents decompositions according to sector: 'manufacturing and physical infrastructure' (manufacturing, electricity, gas and water, and private-sector construction), private services and public services. Since the overall variance of hours differs greatly across sectors (in private services it is nearly three times as large as in manufacturing/infrastructure), the table also reports absolute variance shares. Consistent with the idea that in capital-intensive industries, hours schedules need to be coordinated (for example, on a production line), the manufacturing and physical infrastructure sector is characterised by relatively tightly bunched hours and, within the sector, an important role for workplace affiliation (50 per cent of explained variance). In the private service sector, there is wide variation in hours – possibly reflecting the need to fit in with customers' time schedules – which in part is due to widely differing workplaces: the absolute variance of workplace effects is 3-4 times bigger than in the other sectors. But skills and occupation also have a large effect on hours and, especially, workers with skills that raise hours tend to be clustered into long-hours workplaces (24 per cent of explained variance). We do not see sorting on skills to this degree in either of the other sectors. Finally, in the public sector, workplace effects are relatively unimportant (19 per cent of explained variance), despite quite wide variation of total hours (more than twice the variance of hours in the manufacturing and physical infrastructure sector). Instead, skills and preference characteristics account for large variance shares (46 per cent and 13 per cent of explained variance).

Figure 7.1: Workplace hours effects



7.5 Workplace effects

The charts in Figure 7.1 illustrate the dispersion of workplace effects – that is, the differences in the average hours of workplaces after netting out the influence of personal characteristics – in the three sectors, and especially the large differences in working hours between workplaces in private services. The gap between the quarter of workplaces with the shortest hours and the quarter with the longest hours in private services is over 8 hours.

Table 7.4: The industry correlations of workplace effects

	Manufacturing & infrastructure	Private services	Public services
Electricity, gas, water (SIC 2)	-0.938		
	(1.48)		
Construction (SIC 3)	1.891***		
	(2.96)		
Hotels and restaurants (SIC 5)		1.101	
		(1.38)	
Transport, storage and comms (SIC 6)		5.639***	
		(6.56)	
Financial intermediation (SIC 7)		2.161**	
		(2.49)	
Real estate, renting, business (SIC 8)		3.535***	
		(4.87)	
Public administration and defence (SIC 9)		2.545	-1.177**
		(0.39)	(2.04)
Education (SIC 10)		0.060	-3.268***
		(0.05)	(5.41)
Health and social work (SIC 11)		-2.212**	-3.313***
		(2.55)	(5.35)
Other social and pers services (SIC 12)		-0.152	-6.307***
		(0.15)	(7.40)
Observations	356	818	565
Adjusted R2	0.06	0.15	0.17

Notes: (1) Absolute value of t statistics in parentheses.

(2) * significant at 10%; ** significant at 5%; *** significant at 1%.

(3) The dependent variable is the workplace effect estimated previously in each sector.

(4) Dummy variables are also included to indicate: trade union recognition, workplace size, whether part of a larger organisation and its size, few competitors in product market, main product market is domestic, and unemployment to vacancy rate ratio in travel-to-work-area ≤ 3.

(5) The reference industries are respectively manufacturing, retail and the publicly-owned parts of construction, transport/communications and real estate.

(6) Estimates are unweighted.

How are the workplace effects related to various observable workplace, industry and regional factors? Based on regression equations of the workplace effects as a function of these characteristics, Table 7.4 shows

that a workplace's industry strongly affects its hours level, compared to a representative 'reference industry'. For instance, the private services column shows how much workplace-level hours depart from those in the retail sector. So a worker in property could expect to work 3.5 hours per week more than a comparable worker in retail, while a similar worker in transport would do 5.6 hours more than in retail. Other variables (not reported, but listed under the table) like workplace size also influence hours, but to a lesser extent than industry. However, the low R^2 figures in Table 7.4 also suggest that the major factors influencing hours at the workplace level are not observed in the data.

7.6 Effect of labour supply characteristics

The decompositions showed that personal characteristics affected hours both within workplaces and through the non-random allocation of workers to workplaces. Table 7.5 gives more detail of the effects associated with the labour supply characteristics, marital status and the presence of children, with separate estimates for men and women. The 'individual level' figures show the effect of each variable within the workplace, while the adjacent 'workplace mean' coefficients give the additional association (due to sorting) between the workplace effect and the proportion of workers with that particular characteristic. As an example, we would expect a woman in private services and with a child under 12 years old to be working 6.4 hours less than a similar woman in the same workplace but without any children. Comparing her to similar childless woman in another workplace, there would be an additional effect because of the change of workplace. If there is sorting, then knowing something about workforce composition, we can predict this additional gap. In this case, the workplace mean coefficient of –3.3 shows that in a workplace with 10 percentage points fewer women, the hours of the comparison woman would be higher by 3.3 x 0.1 = 0.3 hours. Thus the total difference would be 6.7 hours.

The main message of the table is that, within workplaces, women with young children work substantially shorter hours, and that in workplaces with a high proportion of women with children, *all* employees work shorter hours (in other words the workplace effect is smaller in these workplaces). This sorting effect seems to vary across sectors, however. In fact, it is only highly significant (statistically) in the public sector, where there is also evidence that married men tend to be sorted into workplaces with longer hours. This contrasts with statistical tests for sorting on skills and occupation, shown at the bottom of the table, which indicate strong sorting in all sectors.

Table 7.5: Family characteristics and total weekly hours

	Manufacturing & infrastructure		Private services		Public services	
	Coefficient:		Coefficient:		Coefficient:	
Variable	Individual level	W/place mean	Individual level	W/place mean	Individual level	W/place mean
Male * married	1.220***	1.025	0.590	3.978*	-0.387	5.352**
	(4.00)	(0.55)	(1.63)	(1.70)	(0.87)	(2.41)
Male * children <19	0.213	-1.876	0.141	0.433	0.196	-2.337
	(0.81)	(0.98)	(0.41)	(0.20)	(0.49)	(1.15)
Female * married	-0.585	2.462	-0.305	-2.298	-2.078***	0.828
	(1.33)	(0.80)	(0.99)	(1.33)	(5.92)	(0.49)
Female * child <12	-4.651***	-3.272	-6.403***	-3.273*	-6.167***	-3.530**
	(8.59)	(0.88)	(18.93)	(1.73)	(17.38)	(2.06)
Female *child 12-18	-1.151*	-1.767	-1.856***	-3.932*	-0.934**	-4.422***
	(1.82)	(0.46)	(4.96)	(1.80)	(2.56)	(2.63)
Number of individuals	5021		9462		7278	
Number of workplaces	356		818		565	
Tests of joint significance of workplace mean coefficients:						
All	$\chi^2(31) = 93.47$***		$\chi^2(35) = 366.03$***		$\chi^2(30) = 157.84$***	
Skill / occup characs	$\chi^2(26) = 89.38$***		$\chi^2(30) = 156.15$***		$\chi^2(25) = 69.56$***	
Preference characs	$\chi^2(5) = 2.37$		$\chi^2(5) = 13.16$**		$\chi^2(5) = 17.65$***	
Men's pref characs	$\chi^2(2) = 1.03$		$\chi^2(2) = 3.50$		$\chi^2(2) = 5.84$*	
Women's pref characs	$\chi^2(3) = 1.25$		$\chi^2(3) = 9.83$**		$\chi^2(3) = 11.64$***	

Notes: (1) Absolute value of t statistics in parentheses.

(2) * significant at 10%; ** significant at 5%; *** significant at 1%.

(3) Estimates are unweighted.

(4) Controls are also included for age and age squared (and interactions with female gender), job tenure, highest educational qualification, possession of a vocational qualification, whether received training in the last year, fixed term contract, temporary contract, existence of health problems limiting daily activities, occupation (and interactions with female gender), female gender.

7.7 Conclusions

Using the WERS 98 data, the analysis has shown that workplace-level hours 'policies' or norms are strong drivers of the hours that employees end up working. Overall, they account for nearly a third of the variation in hours explained by the analysis, and they have an especially large effect in the expanding private services sector. These differences across workplaces would not be identified in unlinked employee-level data, since one could not separate differences between workers from differences between firms. This demonstrates that linked employer-employee data are essential to account fully for the differences across people in working time.

But as well as differing between workplaces, hours also vary within them (accounting for over a third of the explained variance). Skill and occupation as well as family characteristics all affect hours within

workplaces. In particular, I have highlighted the large differences in the hours of women in the same workplace, and in comparable jobs, according to whether or not they have young children. Finally, just over a quarter of the variation in hours explained by the analysis is due to a sorting process of workers to firms. Workers in occupations that entail long hours also tend to be in workplaces where, on average, everyone works longer hours. There is somewhat weaker evidence that workers who prefer longer (or shorter) hours also sort into long-hours (or short-hours) workplaces.

What are the lessons for policy? Working hours are likely to become increasingly diverse with the expansion of the private service sector, which contains the largest spread of hours across workplaces. With restricted job mobility, it could be difficult to achieve the policy goal of fitting workers to jobs which enable them to reconcile work and home life. One strategy would to encourage job mobility. But the coexistence of between-workplace differences together with substantial variation of hours *within* workplaces suggests a dual-pronged approach: promotion of job mobility, but also the encouragement of within-firm flexibility, which already exists to some extent.

7.8 References

Bryan, M.L. (2005) 'Workers, Workplaces and Working Hours', unpublished paper, Colchester: University of Essex

Budd, J.W. and Mumford, K. (2005) 'Family-Friendly Work Practices in Britain: Availability and Perceived Accessibility', IZA Discussion Paper 1662, Bonn: IZA

DWP (2005) *Department for Work and Pensions Five Year Strategy: Opportunity and Security Throughout Life*, TSO (The Stationery Office)

Dex, S. and Smith, C. (2002) *The Nature and Pattern of Family-Friendly Employment Policies in Britain*, Bristol: Policy Press and Joseph Rowntree Foundation

Gray, H. (2002) 'Family-Friendly Working: What a Performance! An Analysis of the Relationship Between the Availability of Family-Friendly Policies and Establishment Performance', CEP Discussion Paper no. 0529, London: CEP

Heywood, J.S., Siebert, W.S. and Wei, X. (2005) 'The Implicit Costs and Benefits of Family Friendly Work Practices', IZA Discussion Paper 1581, Bonn: IZA

8 Using Linked Employer-Employee Data to Estimate the Earnings Costs of Business Closure in the UK

Alex Hijzen, Richard Upward and Peter Wright[65]

ABSTRACT

We estimate the earnings loss for workers whose employer goes out of business, using a random one per cent sample of all employees in the UK linked to a large panel of UK enterprises. We use difference-in-difference regression techniques to control for observable differences between displaced and non-displaced workers. We find that earnings losses are initially large but generally last less than four or five years. Earnings losses are mainly driven by periods of non-employment rather than wage losses for those who are successful in finding work again. This is important, partly because business closure is a very common occurrence: 10 per cent of the businesses in our sample are not in the sample in the following year. Business closure can also be politically significant. Governments in many countries intervene to prevent it, partly in the belief that the costs of closure are large and long-lasting.

8.1 Introduction

"…whilst we all feel immense empathy for those who lost their jobs there are a range of new job opportunities coming to the West Midlands." Margaret Hodge, Work and Pensions Minister.[66]

"The jobs we had were highly skilled. Working at Tesco's would obviously be nothing like the same kind of work and the pay would be nowhere near what we used to earn." Former MG Rover worker.[67]

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[66] BBC News, 17/6/2005.

[67] The Daily Telegraph 17/6/2005.

What happens to workers' earnings when their employer goes out of business? Accurate estimates of the earnings losses due to firm closure are clearly of direct policy interest. Research on job creation and destruction has shown that the entry and exit of firms is an important part of the way in which economies adjust to changing patterns of demand (Davis, Haltiwanger and Schuh 1996). The costs of firm exit are therefore likely to be a significant part of the overall 'adjustment cost' of changing patterns of production.

There is a large literature which estimates the effects of displacement on workers' earnings. This literature is dominated by estimates from the US. Kuhn (2002) suggests that this has partly been because of data availability, and partly because jobs were traditionally perceived to be less secure in the US than in other OECD economies. Surprisingly little is known about these costs for workers in the UK: Borland, Gregg, Knight & Wadsworth (2002) is the only study we are aware of.

We provide the first analysis that explicitly estimates the earnings losses due to enterprise closure in the UK. We further make the following contributions. First, we use a new, much larger, dataset to provide estimates of the earnings loss resulting from firm closure. Our data come from linking a one per cent sample of workers to a large panel (effectively a census from 1997 onwards) of enterprises in the UK from 1994-2003. Second, our definition of displacement is based on the disappearance of enterprises, rather than self-reported job loss. Because we observe firm exit over a long period we are able to track workers' earnings for several years after the displacement event.

Our main findings suggest the following. First, earnings losses are primarily associated with periods of non-employment (as defined by absence from the New Earnings Survey) rather than with falls in wages for those who are re-employed. This is in sharp contrast to findings from the US (e.g. Jacobson, Lalonde & Sullivan 1993). However, the only other UK study on worker displacement (Borland *et al.* 2002) find that wage losses for workers who move directly from job to job are negligible, and that losses are limited to those who experience some time out of work. Second, earnings losses do *not* appear to be particularly long-lived. After controlling for observable characteristics, displaced workers' earnings are not lower than non-displaced workers' five years after displacement.

In Section 8.2 we provide a detailed description of the data construction process. The methodological issues are explained and discussed in Section 8.3. Section 8.4 presents the results. Finally, Section 8.5 concludes.

8.2 Data

In order to evaluate the impact of business closure on workers we need longitudinal information on workers, linked to the businesses they work for, and we need to know when those businesses cease to exist. Survey

data on individuals or households (such as the British Household Panel Survey (BHPS) in the UK or the Panel Study of Income Dynamics (PSID) in the US) typically do not record the identity of workers' employers, nor are they able to identify business closure. We therefore use various datasets made available at the Business Data Lab of the Office for National Statistics.

The *New Earnings Survey* (NES) is a random sample of one per cent of employees who are part of the PAYE tax scheme. The last two digits of an individual's National Insurance number are used to select the sample, and so it can straightforwardly be linked across time to form the New Earnings Survey Panel Dataset (NESPD). Businesses can be identified by a PAYE reference number, although it should be noted that in some years this information is not available for all workers. PAYE reference numbers are available in 1994-1996 and every year from 1998 onwards. It is important to appreciate that the NES is a sample only of *employees*, and in addition probably undersamples low-paid employees and those who have recently changed employers (Elias & Gregory 1994).

Individuals in the NES may hold more than one job, and to simplify the subsequent analysis we keep only the highest-paid job for each individual in each year. We also remove the (very small) number of individuals with inconsistent measures of age and sex. The resulting sample has slightly over 150,000 observations per year.

The *Inter-Departmental Business Register* (IDBR) is a list of UK businesses maintained by the ONS. It is used for selecting the sample for various surveys of firms and employees conducted by ONS. A comprehensive description of the IDBR can be found in the Review of the Inter-Departmental Business Register (Office for National Statistics 2001). The IDBR is actually a 'live' register which changes frequently. The Business Data Lab does not (yet) have systematic snapshots of the IDBR going back through time.

The *IDBR linking file* is a subset of the IDBR which contains the link between an enterprise reference number and the PAYE reference number used in the NES. As far as we are aware, this file is only available for the years 1997 and 2004. Table 8.1 shows the number of enterprises and PAYE reference numbers covered by the linking files. Enterprises may have more than one PAYE reference number.

The *Annual Business Inquiry* (ABI) is an annual survey of businesses which, since 1994, has been sampled from the IDBR. The 'selected sample' of the ABI is a census of all large businesses employing 250 or more and a sample of smaller businesses. The 'non-selected sample' are those businesses in the sampling frame which were not selected for the survey. See Jones (2000) for a more detailed description. The *Annual Respondents' Database* (ARD) contains the information from the ABI for each year. The ARD comprises three aggregation categories. The lowest level of aggregation is the *local unit*: a single plant at a single address. An

Table 8.1: IDBR linking file

	1997	2004
Number of unique PAYE references	2,543,158	1,742,894
Number of unique enterprise references	2,069,297	1,149,834

'enterprise' may contain one or more local units, and is essentially a firm or business with a relative degree of autonomy. Finally, an *enterprise group* is the group of all enterprises under common control. In addition, an enterprise may record information via several reporting units. The vast majority of enterprises have a single reporting unit. However, those enterprises with multiple reporting units are on average very large, and will therefore be important in worker-level data.

It is most straightforward to link the data at the level of the enterprise, because both PAYE reference numbers and enterprise reference numbers are available in the linking file. The closure of an enterprise is also possibly a more easily identifiable economic event as far as workers are concerned. In contrast, the closure of a local unit may in fact be a case of business restructuring, and may lead to worker relocation within enterprises.[68]

[68] This is in itself an interesting issue, but not the focus of this paper.

8.2.1 MEASURES OF ENTERPRISE CLOSURE

Our measure of enterprise closure is based on the enterprise reference number in the ARD, and therefore relies on this reference number being recorded consistently over time. Our basic sample of enterprises is listed in Table 8.2, together with the number that exit. Obviously we cannot identify exiting enterprises in the final year of the data.

Table 8.2: ARD sample 1994-2003

Year	Continue	Exit	% Exiting	Total
1994	301,993	40,026	11.70%	342,019
1995	310,342	37,050	10.67%	347,392
1996	301,708	33,016	9.86%	334,724
1997	1,320,365	161,424	10.89%	1,481,789
1998	1,386,354	167,525	10.78%	1,553,879
1999	1,459,824	179,902	10.97%	1,639,726
2000	1,483,215	184,363	11.06%	1,667,578
2001	1,491,961	189,041	11.25%	1,681,003
2002	1,490,486	217,405	12.84%	1,692,949
2003				1,743,642
Total	9,546,248	1,209,752	11.26%	10,741,059

Comparing Table 8.2 with Table 8.1, we can see that in 1997 the ARD sample comprised 1,481,789 enterprises, while the linking file contains 2,069,297 unique enterprise references. In 2004, however, there appear to be far fewer unique enterprise reference numbers in the linking file. This fall in the number of enterprises seems unlikely to be genuine, though we cannot identify the cause. However, the number of successful links does not seem to be affected by this fall in the number of enterprises in the linking file.

8.2.2 THE LINKING PROCEDURE

We first link each year of the NES to the IDBR linking file. This is relatively straightforward because the link is at the level of the enterprise. Figure 8.1 illustrates the connection between the relevant files for one particular year.

Figure 8.1: The data-linking procedure

New Earnings Survey

2000

Year	N.I. no.	PAYE ref. no.
2000	1	A
2000	2	D
2000	3	E
2000	4	B
2000	5	C

1997 linking file

Year	N.I. no.	PAYE ref. no.
1997	A	a
1997	B	b
1997	C	c
1997		
1997	X	x
1997	Y	y
1997	Z	z

2004 linking file

2004	B	b
2004	C	f
2004	E	e
2004		
2004	X	x
2004	Y	y
2004	Z	z

ARD 2000

Year	Enterprise ref. no.	Reporting unit ref. no.	Local unit ref. no.
2000	a	a1	a11
2000	b	b1	b11
2000	b	b1	b12
2000	c	c1	c11
2000	c	c2	c21
2000	c	c2	c22
2000	d	d1	d11
2000	d	d2	d21
2000	d	d3	d31
2000			
2000	x	x1	z11
2000	y	y1	y11
2000	z	z1	z11

The left-hand panel shows the NES for the year 2000. Each of these individuals has a PAYE reference number, which can in theory be linked to an enterprise reference number using the linking files shown in the middle panel. These enterprise reference numbers can then be used to link to the ARD shown in the right hand panel. Note that some enterprises have multiple reporting units or multiple local units. Without additional information on, for example, location or industry, we cannot associate individuals with individual reporting units or local units.[69]

[69] In related work, Haskel and Pereira (2002) link two years of the NES to the ARD at the level of the reporting unit by using additional local unit information on postcode and industrial classification. This approach is problematic because industrial classification and postcode is not consistently recorded in the NES at the same level of aggregation, and because many postcodes in the NES appear to be miscoded.

Because the linking file contains a correspondence between PAYE reference numbers and enterprise reference numbers only for 1997 and 2004, there will be individuals in the NES for whom we cannot find an enterprise in the linking file, and individuals for whom we can only find a match in one particular year.

An enterprise which existed in the year of the linking file may not exist in the year of the NES. For example, an enterprise which existed in 1997 may not exist in 2000 (exit). Or an enterprise which did not exist in 2000 may exist in 2001 (entry). In Figure 8.1, enterprise *a* exits at some point between 2000 and 2004, and so does not appear in the 2004 linking file. We must therefore rely on the 1997 link in this case. Similarly, enterprise *e* enters at some point between 1997 and 2000, and therefore does not appear in the 1997 linking file.

The enterprise reference number may change over time. In Figure 8.1, PAYE reference number *C* is associated with two enterprise numbers: *c* in 1997 and *f* in 2004. This leads to individual number 5 being linked to possibly two apparently different enterprises. This problem may also be caused by PAYE reference numbers changing over time.

Table 8.3 shows the results of the link between the NES and the IDBR linking file.

Table 8.3: Linking NES to IDBR

Year	No link to either linking file	Link to 1997 linking file only	Link to 2004 only	Link to both linking files same ent. ref. number	Link to both different ent. ref. number	Total
1994	82,982	15,858	0	59,884	3,912	162,636
1995	43,500	16,943	0	92,712	6,801	159,956
1996	24,880	16,199	0	111,645	8,185	160,909
1997	151,885	0	0	0	0	151,885
1998	20,687	11,999	0	117,961	8,169	158,816
1999	21,819	9,902	0	119,154	8,163	159,038
2000	49,682	3,623	0	96,518	5,348	155,171
2001	140	5,907	N/A	140,688	8,686	155,421
2002	406	3,395	6,251	138,576	8,220	156,848
2003	878	1,534	30,052	116,377	5,345	154,186
Total	396,859	85,360	36,303	993,515	62,829	1,574,866

Note that in 1997 there are no PAYE reference numbers available in the NES and so we cannot link any individuals to the linking files. Before 1997 the number of links is rather low. It seems unlikely that this is due to enterprise entry and exit; it seems more likely to be due to changing enterprise reference numbers or changing PAYE reference numbers. The quality of the link appears to increase after 2000.

We can now link those individuals whose PAYE reference number matches an enterprise reference number to the ARD. Before we do this, however, we can increase the number of cases where an enterprise reference is available by utilising the longitudinal nature of the NES. Individuals who work for enterprise *A* at *t-1* and at *t+1*, but who have no enterprise reference number at *t* are assumed to have worked in enterprise *A* at *t*. Individuals whose local unit postcode and whose five-digit SIC code remain the same at *t+1* are assumed to be working for the same enterprise as at *t*. Following these rules allows us to link more individuals, particularly in 1997. Table 7.4 shows the number of links made between the NES and the ARD.

Table 8.4: Linking NES to ARD

Year	No link to either linking file	Link to 1997 linking file only	Link to 2004 only	Link to both linking files same ent. ref. number	Link to both different ent. ref. number	Total
1994	132,246	6,698	391	22,688	613	162,636
1995	115,363	8,134	573	34,955	931	159,956
1996	111,013	7,814	611	40,527	944	160,909
1997	87,819	6,232	445	55,419	1,970	151,885
1998	45,502	11,561	491	97,016	4,246	158,816
1999	40,180	9,468	620	104,960	3,810	159,038
2000	52,673	5,470	518	93,428	3,082	155,171
2001	28,454	5,427	881	116,385	4,276	155,423
2002	29,847	3,774	3,996	115,926	3,305	156,848
2003	30,839	474	19,516	102,358	999	154,186
Total	673,936	65,052	28,042	783,662	24,176	1,574,868

Table 8.5: Number of workers with linked enterprise reference numbers

Year	Unlinked	Linked	% Linked	Total
1994	132,859	29,777	18.31%	162,636
1995	116,294	43,662	27.30%	159,956
1996	111,957	48,952	30.42%	160,909
1997	89,789	62,096	40.88%	151,885
1998	49,748	109,068	68.68%	158,816
1999	43,990	115,048	72.34%	159,038
2000	55,755	99,416	64.07%	155,171
2001	32,730	122,693	78.94%	155,423
2002	33,152	123,696	78.86%	156,848
2003	31,838	122,348	79.35%	154,186
Total	698,112	876,756	55.67%	1,574,868

Note that the number of individuals with no link is much greater than in Table 8.3. This is largely due to the incomplete coverage of the ARD. Before 1997 the ARD only covered manufacturing sectors, for example. The final number of individuals with a linked enterprise reference number is shown in Table 8.5. The proportion of workers in the NES who can be associated with an enterprise ranges from less than 20% in 1994 (largely due to non-coverage of services in the ARD) to around 80% in more recent years.

8.2.3 ENTERPRISE CLOSURE IN THE LINKED DATA

Table 8.6 reports the proportion of workers experiencing enterprise closure in a given year, which is far lower than the proportion of enterprises which exit (Table 8.2). This is because the linked worker sample is effectively weighted by firm size, and large firms are less likely to exit.

We are able to use the longitudinal nature of the NES data to check the accuracy of the measure of enterprise closure. As noted earlier, if enterprise reference numbers are not coded consistently across time, this might cause inaccurate measures of business closure. We compare those cases where enterprise reference numbers disappear with the data with changes in the individual's PAYE reference number. Table 8.6 shows that in about 20 per cent of cases an enterprise reference number disappearance is not associated with a change in the PAYE reference number, which suggests that these enterprises did not in fact exit. We therefore code these as non-exits. This leaves 11,663 enterprise exits observed at the individual level.

Table 8.6: Number of workers in enterprises which exit

	Linked	Enterprise exit at t+1	% Exiting	Enterprise exit at t+1 and PAYE ref change	% Exiting
1994	29,777	435	1.46%	310	1.04%
1995	43,662	909	2.08%	654	1.50%
1996	48,952	1755	3.59%	1754	3.58%
1997	62,096	767	1.24%	767	1.24%
1998	109,068	2138	1.96%	1461	1.34%
1999	115,048	1565	1.36%	1376	1.20%
2000	99,416	1008	1.01%	661	0.66%
2001	122,693	3749	3.06%	2403	1.96%
2002	123,696	3859	3.12%	2277	1.84%
2003	122,348				
Total	876,756	16,185	1.85%	11,663	1.33%

8.2.4 STRUCTURE OF THE RESULTING LINKED DATA

In each year t = 1994, …, 2003 we observe N_t workers drawn from the New Earnings Survey, indexed I – 1, …, N. This information refers to April of each year. Each worker has a set of observable characteristics x_{it}, including variables such as the individual's age, sex, industry and occupation. For each worker we also observe y_{it}, a measure of their pay. The pay measure we use is gross weekly pay, including overtime payments.

In each period workers may be linked to the selected and non-selected data from the ARD. As noted, the number of linked workers varies from about 20 per cent in 1994 to over 80 per cent in 2003.

The most significant decision we make regards the treatment of individuals who are not observed in the NES in certain years. We cannot ignore them because to do so would remove any unemployment effects from the resulting estimates. Following Jacobson (1993), we assume that years in which an individual is not observed in the NES are years in which the individual is not employed. Jacobsen et al. assume earnings of zero for these periods. Rather than do this, we allocate these individuals standard rates of the job-seekers allowance.[70] This decision will undoubtedly give us an underestimate of the earnings of individuals who are not in the sample because some of those missed by the NES will not in fact be unemployed.

We should note that there are different methods that can be used to generate periods of unemployment. The first method assumes that any missing row between existing rows is a period of unemployment, but ignores missing rows at the beginning or the end of the sample. This ignores workers who leave the sample permanently. The second method adds in any missing rows from the sample period, giving a balanced panel. When using the second method we only consider workers aged 25-55 so that entry to and exit from the labour force is not confused with periods of unemployment. In Section 8.4 we look at the impact of these different assumptions.

Define $J(i,t)$ to be the function that maps worker i at time t to enterprise j (see Abowd, Kramarz & Margolis (1999)). For those workers who are linked to the ARD we observe a limited set of information on the enterprise, denoted $z_{J(i,t),t}$. This could be more simply written as z_{jt}.

A worker is defined as experiencing a business exit if the enterprise they were in at t no longer exists at $t+1$. Define a dummy

$$d_{it} = \begin{cases} 1 & \text{if firm } J(i,t) \text{ does not exist at } t+1 \\ 0 & \text{otherwise} \end{cases} \quad (1)$$

8.3 Methods

In common with the recent literature on policy evaluation,[71] we treat a worker displacement (or an enterprise closure) as if it were some kind of 'treatment' which may impact upon a worker's future labour market outcomes, in the same way as a training or welfare programme. The key problem is that we cannot observe outcomes for an individual who both experiences and does not experience displacement.

[70] Taken from www.statistics.gov.uk/STATBASE/Expodata/Spreadsheets/D3989.xls
[71] See Blundell and Costa Dias (2002) for a recent summary.

Let t^* be time relative to the year in which $d_{it} = 1$, so $t^* = 0$ in the year immediately before firm closure. Define w^1_{it} to be the sequence of earnings for a worker which experiences displacement at t^*. Define w^0_{it} to be the (hypothetical) sequence of earnings for the same worker in the absence of displacement. The total cost of displacement for worker i is

$$c_i = \sum_{t=t_1}^{t_2} w^1_{it^*} - w^0_{it^*} t_1 \leqslant 0, \qquad t_2 > 0$$

Note that this cost includes any difference in the sequence of earnings before as well as after the event.

In this paper we follow the methodology employed in Jacobson *et al*. to estimate c_i. The basic estimating equation for earnings is:

$$y_{it} = \alpha_i + \gamma_{t^*} + d_i\delta_0 + d_{it}\delta + x_{it}\,\beta + \epsilon_{it} \qquad (2)$$

Equation (2) includes a dummy indicating whether or not the individual is in the treatment group (d_i), a set of parameters for relative time γ_{t^*}, plus the relative time dummies interacted with d_i. Equation (2) also includes an individual-specific fixed effect α_i which is likely to be correlated with d_{it}, and therefore it is important to allow for this in the regressions. Finally, the vector x_{it} includes a set of covariates which vary across individual i and time t up to the point of displacement.

This method thus estimates c_i from the difference in mean earnings between a group of workers who are displaced at $t^* = 0$ (the treatment group) and a group who are not (the control group). Because the control group may have different observable characteristics to the treatment group, the difference in mean earnings is estimated conditional on a set of characteristics x_{it}. Differences between the treatment and control group which are not observed but which are fixed through time can be eliminated by comparing the within-individual change in earnings over time between the two groups, thus implementing a difference-in-difference estimator.

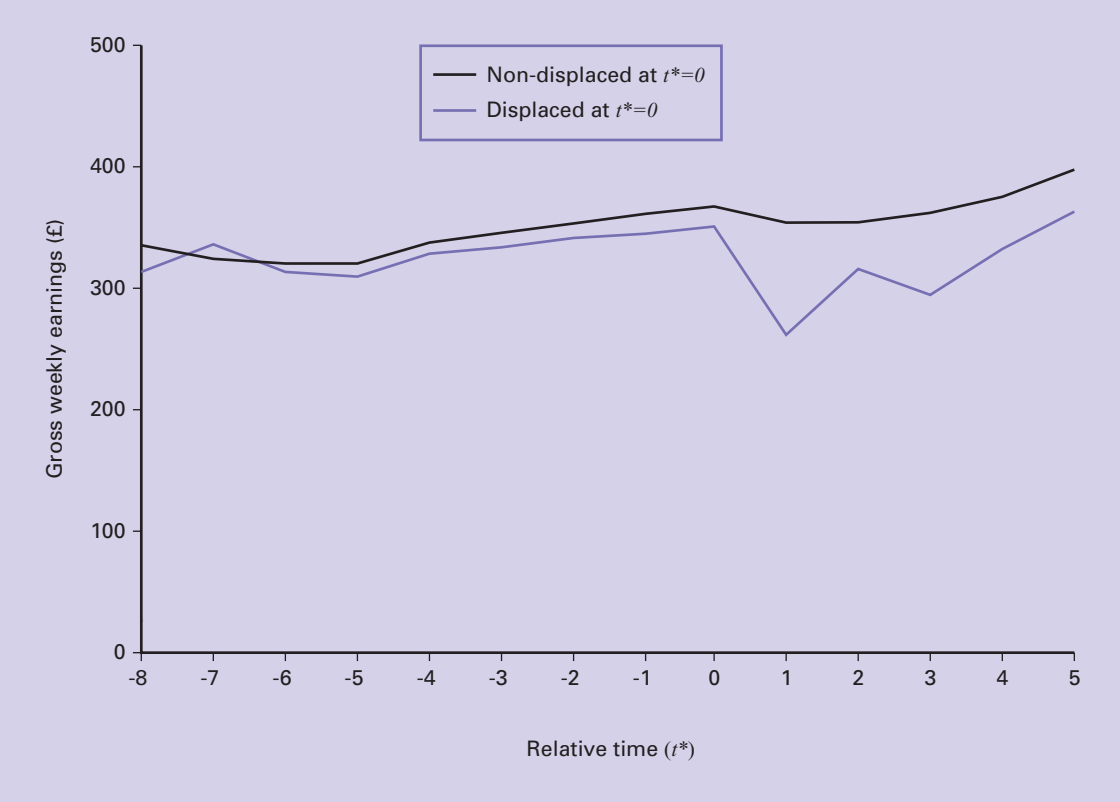
8.4 Results

8.4.1 AVERAGE EARNINGS COMPARISONS

The simplest aggregate comparison uses average earnings for the treatment and control group for each year before and after displacement. The treatment group are defined as those displaced in year $t^* = 0$ while the control group are those not displaced in year $t^* = 0$. A separate treatment and control group is therefore defined for each possible year of displacement (1994-2002). We then stack each of the treatment and control groups together to estimate an average effect for all years combined. Individuals may therefore appear in the control group several times, since

an individual who is not displaced in year t may also not be displaced in year $t+1$ and so on. The only restriction we place on the sample is that individuals must be employed (i.e. in the NES sample) in all five years

Figure 8.2: Average Earnings by Displacement Status



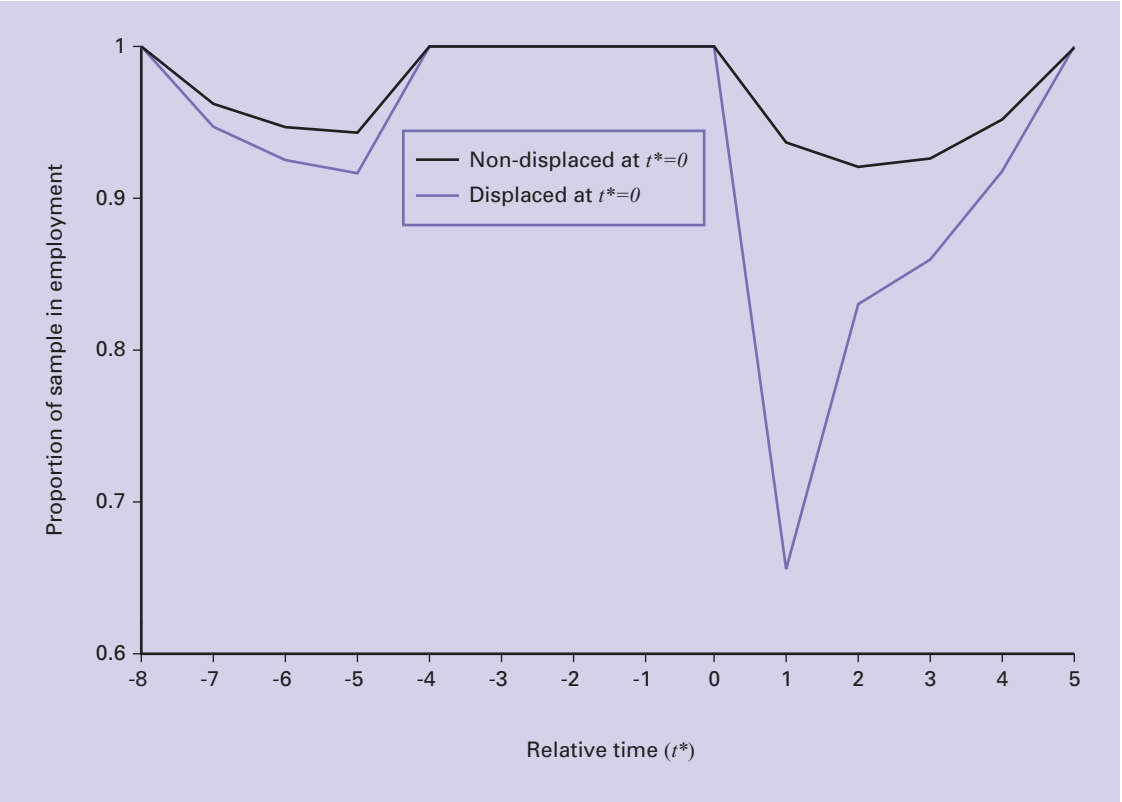
before displacement $-4 \leqslant t^* \leqslant 0$. This restricts the sample to displacement events in the period 1998-2002, which in turn means that at most we have five years of post-displacement earnings information.

Figure 8.2 shows that workers whose enterprise exits suffer falls in earnings of about 30 per cent in the first year after the displacement, and that earnings take between four and five years to return to the pre-displacement level. If we take the non-displaced as a counterfactual, we can see that the earnings of those who are displaced are also lower in most years before the displacement, and that the gap in earnings between the groups is greater at $t^* = 5$ than it was at $t^* = 0$.

One striking difference between this pattern of earnings and those presented by Jacobson et al. (Figure 8.1) is the earnings of the control group. In our sample the control group experience a small earnings loss at $t^* = 1$. This is due to the fact that we do not restrict the control group to include only those in employment in all years. Therefore although at $t^* = 0$ the whole sample is employed, a proportion of that sample (including some in the control group) will be unemployed at $t^* = 1$. Jacobsen et al. restrict the control group to include workers who are *never* unemployed.

The average earnings shown in Figure 8.2 are strongly affected by the proportion of the sample observed in the NES in each year, because those not observed are assumed to be unemployed and receiving job-seekers allowance. Figure 8.3 plots the proportion of the sample who are in employment (i.e. observed in the NES) in each year relative to $t^* = 0$. By definition the whole sample is employed from $-4 \leqslant t^* \leqslant 0$. More than 30 per cent of the displaced sample are non-employed at $t^* = 1$. The displaced

Figure 8.3: Proportion of sample observed in employment

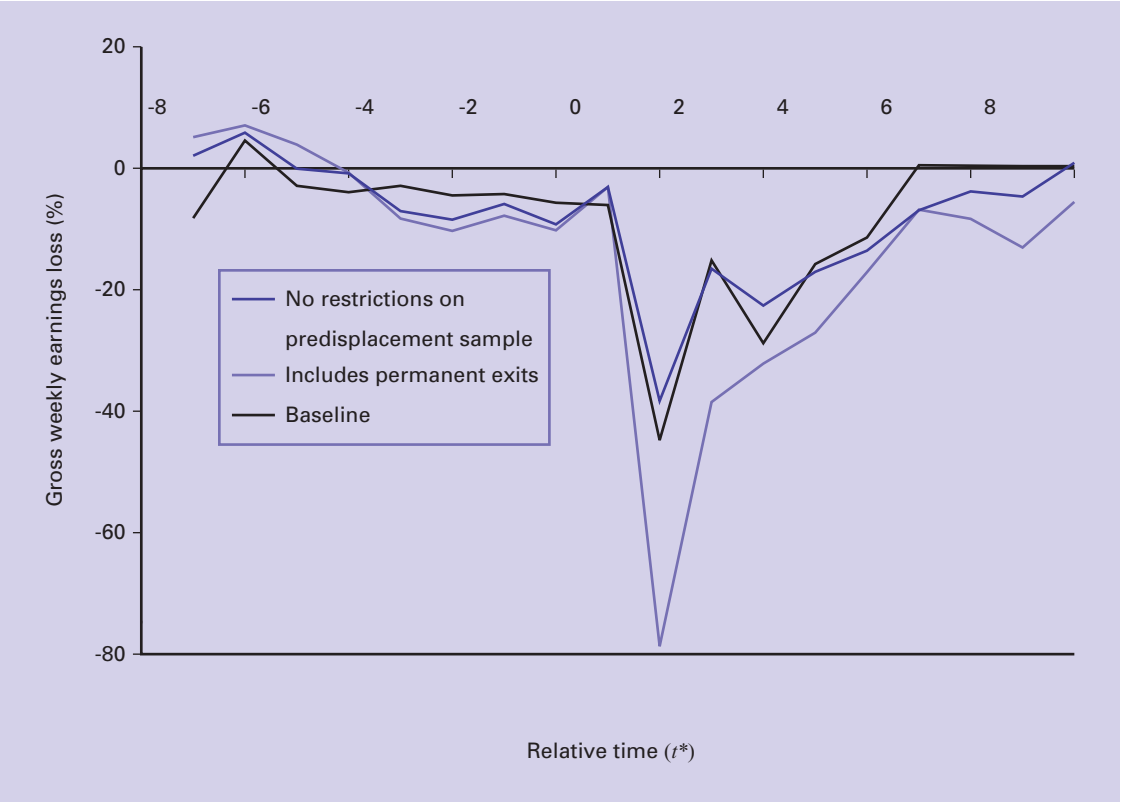


also have lower employment rates at $t^* < -4$. Note that the method we use to impute spells of unemployment (filling in gaps) means that employment rates at $t^* = -8$ and $t^* = 5$ are 1 by definition.

Figures 8.2 and 8.3 illustrate that the post-displacement difference in earnings between the treatment and control groups is largely due to different employment rates. There is some evidence at $t^* = 5$, however, that the treatment group have lower earnings despite all being in the sample.

To check the robustness of these results we plot the difference in earnings between the treatment and control groups under a number of different assumptions, shown in Figure 8.4. The solid line plots the proportional gap in earnings between the two lines shown in Figure 8.2. We then compare this with a sample which has no pre-displacement restriction on employment. This has the effect of slightly increasing the gap in earnings before displacement because the displaced have lower employment

Figure 8.4: Average Earnings Loss: Alternative Sample Definitions



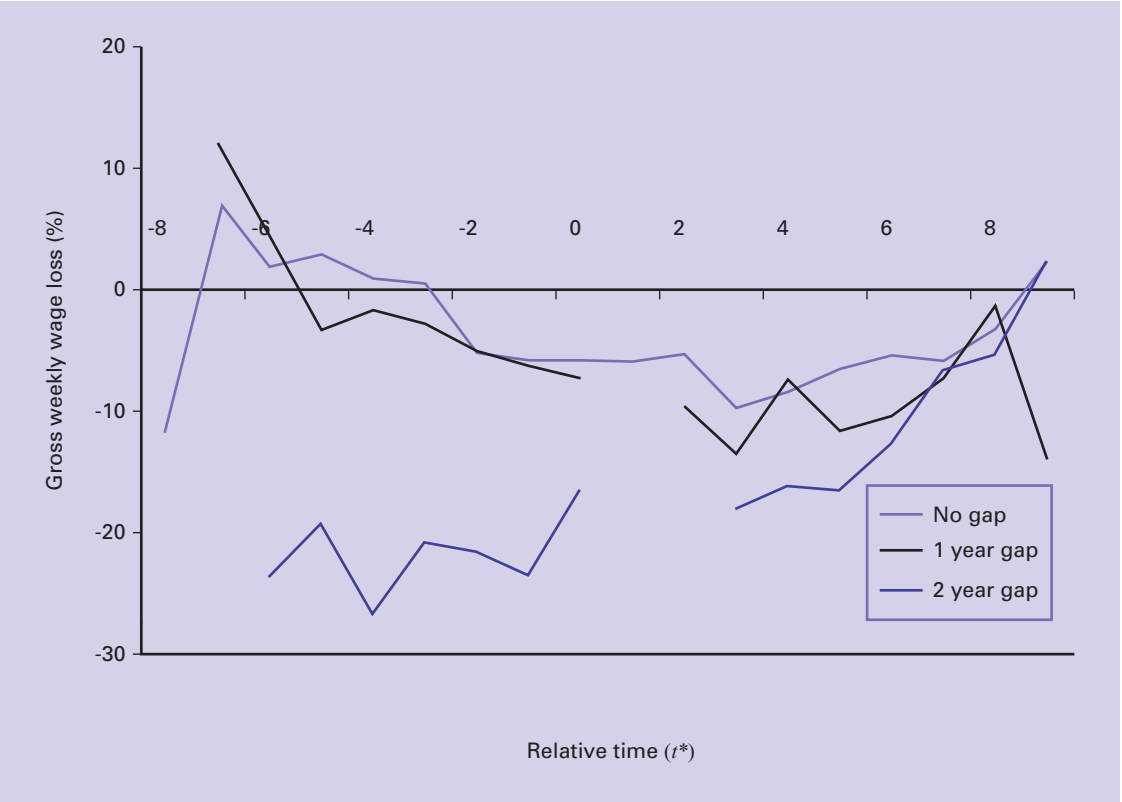
probabilities at $t^* \leq 0$, but has very little effect on the gap after displacement. One advantage of this sample is that we can follow earnings for up to nine years after displacement. It is interesting to note that the earnings gap has completely disappeared by $t^* = 9$.

We then consider the impact of our method of creating unemployment spells. The third line in Figure 8.4 shows the effect of assuming that permanent exits from the NES sample are unemployed for the remaining sample period. Unsurprisingly, this increases the earnings loss substantially at $t^* = 1$ because a large proportion of displaced workers disappear from the NES and do not reappear. Estimated earnings losses still reduce and after five or six years are only slightly larger than under the alternative assumption.

8.4.2 COMPARISONS OF PURE WAGE EFFECTS

As noted, earnings losses are driven mainly by the increased rates of non-employment in the displacement sample. This is in contrast to the results of Jacobsen et al., who claim large earnings losses even among those who are re-employed after displacement. To examine this issue more closely, we restrict the sample to those individuals who have a wage recorded in the NES and are therefore definitely in employment. We split the sample according to the length of the 'gap' between the displacement event and the subsequent observation in the NES. Thus an individual who was displaced in 1998 and first observed subsequently in 2000 would have a

Figure 8.5: Average wage loss by length of gap



gap of one year. In Figure 8.5 we plot average wage losses relative to a control group who do not experience displacement and who do not have a gap.

It is striking that displaced workers who are observed in the NES in the year after displacement (those with no gap) experience *no* additional wage loss in the year after displacement, although their wages are about 5 per cent lower before displacement. Individuals who are not observed in the NES in the years after displacement do tend to have lower post-displacement wages, but they also tend to have lower pre-displacement wages as well, so there is no clear evidence of wage losses if we look only at workers who are in employment (and hence observed in the NES). In fact, Figure 8.5 is more consistent with models of selection rather than models of wage loss due to the loss of firm-specific human capital. When a firm closes, the workers with the highest earnings ability are employed more quickly, while those with lower earnings ability experience periods of unemployment.

8.4.3 REGRESSION RESULTS

In this section we use regression methods to estimate the earnings loss experienced by displaced workers. The data used are identical to those used to draw the graphical comparisons. As before, treatment and control groups are defined for each year and then stacked.

Table 8.7 reports some baseline estimates of the impact of displacement which are directly comparable to the graphical comparisons shown in the previous sections, with the addition of estimated standard errors. OLS estimates on the unmatched sample (column 1) show that although mean wages are lower in the periods preceding displacement, none of these estimates are significantly different from zero. There is, however, a constant effect of being in the displacement group of -0.0365 which is just insignificant at 5 per cent. Wage losses in the periods following displacement are initially large (0.513 log points equates to a fall of 40 per cent), but decrease in size and are insignificantly different from zero after five years.

OLS estimates of Equation 2 are potentially biased because they treat the individual fixed effect α_i as part of the error term. We therefore then estimate Equation 2 using within-i mean deviations, which sweeps out any term which is fixed for an individual over time, including any unobservable. The results are shown in the second column of Table 8.7. Post-displacement wage effects now diminish more quickly and also tend to be smaller, suggesting that some of the raw difference in post-displacement wages is due to a negative correlation between α_i and d_{it}. It is interesting to see that some estimated differentials are actually positive, including that at $t^* = 5$. This is partly a result of sample selection at the beginning and end of the sample period. Due to the way in which unemployment spells are created, at $t^* = 5$ only those in employment are included in the sample (see Figure 8.3). If displacement serves to remove workers with low earning potential from the NES sample, we might observe wages of those who remain in the sample actually increasing.

Table 8.7: Baseline regression results

	Unmatched, conditional on covariates			
	OLS		FE	
displaced	-0.0365	(0.054)		
d(-7)	0.0094	(0.667)		
d(-6)	0.0037	(0.868)	0.0062	(0.684)
d(-5)	-0.0192	(0.397)	-0.0003	(0.983)
d(-4)	0.0035	(0.853)	0.0393	(0.005)
d(-3)	-0.0048	(0.798)	0.0293	(0.035)
d(-2)	0.0006	(0.975)	0.0329	(0.018)
d(-1)	-0.0078	(0.683)	0.0252	(0.070)
d	-0.0148	(0.447)	0.0199	(0.151)
d(+1)	-0.5132	(0.000)	-0.4867	(0.000)
d(+2)	-0.2069	(0.000)	-0.1643	(0.000)
d(+3)	-0.1401	(0.000)	-0.0400	(0.048)
d(+4)	-0.0914	(0.025)	0.0200	(0.401)
d(+5)	0.0161	(0.711)	0.1001	(0.002)
N*	1,692,802		1,692,802	
N	63,984		63,984	
R-squared	0.5092		0.412	

Notes

(1) Estimates of Equation (2). Dependent variable is log gross weekly pay.

(2) Regression includes full set of controls including sex, age, region, occupation, industry, public sector, union agreement and firm size.

(3) The notation d() indicates the displacement dummy interacted with relative time. All regressions also include dummies for relative time t^*.

(4) P-values in brackets. OLS standard errors are robust to within-i clustering.

In Table 8.8 we repeat the fixed-effects estimates of Equation 2 separately for each year of separation. Wage loss at $t^* = 1$ (the year after displacement) varies from -0.76 log points for those displaced in 2000 to -0.53 for those displaced in 2001. Note that the estimates for 2002 rely on a sample who are all employed in 2003, and this estimate is actually positive, albeit insignificantly different from zero. Again, this shows that a sample comprising only those who find work after displacement is probably not representative of all those who are displaced.

Table 8.8: Fixed-effect estimates by year of displacement

	Displaced in 1998		Displaced in 1999		Displaced in 2000		Displaced in 2001		Displaced in 2002	
	Coeff.	P-value	Coeff.	P_value	Coeff.	P_value	Coeff.	P_value	Coeff.	P_value
d(-6)									0.0087	(0.678)
d(-5)							-0.0406	(0.020)	-0.0338	(0.102)
d(-4)					-0.0051	(0.843)	-0.0013	(0.939)	0.0310	(0.126)
d(-3)			0.0083	(0.740)	-0.0332	(0.193)	0.0116	(0.501)	0.0165	(0.416)
d(-2)	0.0018	(0.948)	-0.0146	(0.560)	-0.0127	(0.617)	0.0119	(0.489)	0.0201	(0.321)
d(-1)	0.0032	(0.909)	-0.0456	(0.068)	-0.0097	(0.704)	0.0063	(0.713)	0.0106	(0.599)
d	-0.0240	(0.393)	-0.0277	(0.267)	-0.0360	(0.158)	0.0010	(0.952)	0.0269	(0.185)
d(+1)	-0.6564	(0.000)	-0.5883	(0.000)	-0.7643	(0.000)	-0.5336	(0.000)	0.0193	(0.515)
d(+2)	-0.2884	(0.000)	-0.3837	(0.000)	-0.2633	(0.000)	-0.0084	(0.695)		
d(+3)	-0.0879	(0.011)	-0.1445	(0.000)	-0.0850	(0.012)				
d(+4)	-0.0783	(0.032)	-0.0138	(0.684)						
d(+5)	0.0327	(0.396)								
N*	331,849		341,405		329,687		342,158		347,703	
N	36,745		37,295		35,484		37,011		37,875	
R-sq'd	0.3016		0.3856		0.4456		0.4743		0.4657	

Notes:

1. All regressions are within-i fixed-effects

2. All regressions include full set of controls in baseline regressions

8.5 Conclusions

We provide the first estimates of the earnings losses associated with enterprise closure in the UK. Our estimates are robust to different definitions of the sample used and to different estimation methods. Our key finding is that earnings losses are primarily associated with periods of non-employment (as defined by absence from the NES) rather than with falls in wages for those who are re-employed. This is at odds with the findings from the US, but possibly consistent with the only other UK study on worker displacement (Borland et al. 2002).

Our second key finding is that earnings losses do *not* appear to be particularly long-lived. After controlling for observable characteristics, displaced workers' earnings are not lower than non-displaced workers five years after displacement. A caveat to this finding is that it partly reflects the methods we have used to construct the sample, because permanent exits from the NES are not included.

These findings are preliminary. A key difficulty with the NES is that it is a sample of employees. This means that periods when individuals are not employed are not included in the data, and we do not know whether or not these periods are actually periods of unemployment. In addition, workers who change employer may be missing from the sample for a short period. Both of these facts suggest that non-appearance in the NES does not

necessarily imply periods of non-employment with associated large earnings losses. In this sense our estimates of earnings losses may in fact be overstated. We are currently working on identifying spells of unemployment more precisely using data on unemployment claimant recipients which can also be linked to the NES.[72]

8.6 References

Abowd, J., Kramarz, F. and Margolis, D. (1999) 'High wage workers and high wage firms', *Econometrica* 67, pp. 251–333

Blundell, R. and Costa Dias, M. (2002) 'Alternative approaches to evaluation in empirical microeconomics', Institute for Fiscal Studies cemmap working paper CWP10/02

Borland, J., Gregg, P., Knight, G. and Wadsworth, J. (2002) 'They get knocked down, do they get up again? Displaced workers in Britain and Australia', in P. Kuhn, ed., *Losing Work, Moving on: International Perspectives on Worker Displacement*, W.E. Upjohn Institute

Davis, S., Haltiwanger, J. and Schuh, S. (1996) *Job Creation and Destruction* MIT Press

Elias, P. and Gregory, M. (1994) 'The changing structure of occupations and earnings in Great Britain, 1975–1990 :an analysis based on the New Earnings Survey Panel Dataset', Department of Employment Research Series no. 27

Gregory, M. & Jukes, R. (2001) 'Unemployment and subsequent earnings: estimating scarring amongst British men 1984–1994', *The Economic Journal,* 111(475), pp. F607–F625

Haskel, J. & Pereira, S. (2002) 'Creating a matched employer/employee data set for the UK: report on merging the ABI and the NES', Mimeo, Centre for Research into Business Activity

Jacobson, L., LaLonde, R. & Sullivan, D. (1993) 'Earnings losses of displaced workers', *American Economic Review* 83, pp. 685–709

Jones, G. (2000) 'The development of the Annual Business Inquiry', *Economic Trends* 564, pp. 49–57

Kuhn, P., ed. (2002) *Losing Work, Moving on: International Perspectives on Worker Displacement*, W.E. Upjohn Institute

Office for National Statistics (2001) 'Review of the inter-departmental business register', National Statistics Quality Review Series No. 2

[72] See Gregory and Jukes (2001).

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