How Does Innovation Affect Worker Well-being?

By
Erling Barth*, Alex Bryson** and Harald Dale-Olsen*
*Institute for Social Research, Oslo, Norway
**National Institute of Economic and Social Research and Centre for Economic Performance, London, UK

Abstract

Using private sector linked employer-employee data for Britain we explore the effects of management innovations on worker well-being. We find management innovations are associated with lower worker well-being and lower job satisfaction, an effect which becomes more pronounced when we account for the endogeneity of innovation. The effect is ameliorated when workers are covered by a collective bargaining agreement.

Key-words: innovation; well-being; job satisfaction; trade unions

JEL-codes: J28; J51; J81; L23; 031

Acknowledgement: We thank the Norwegian Research Council for funding (grant No. 173591/S20). We are grateful to participants at the University of Lancaster seminar for comments. Alex Bryson thanks the sponsors of the Workplace Employment Relations Survey (Department for Business Enterprise and Regulatory Reform, Acas, ESRC and PSI) and the UK Data Archive for access to the WERS data. Corresponding author: Alex Bryson, e-mail: a.bryson@niesr.ac.uk.

1. Introduction

Innovation may take many forms, including process innovations in labour deployment and capital investment, and innovations in products and services, but it is commonplace to assume that firms must be innovative in order to survive and prosper. There is empirical evidence to support this claim. For example, the success of Wal-Mart in the United States is attributed, in part, to innovations in its supply chain and distribution networks (Holmes, 2008). Movement towards flexible specialisation in the Italian textiles industry allowed it to produce high value-added goods which sustained it in the face of global competition from low-cost producers (Piore and Sabel, 1982). Innovations in lean production, total quality management and 'high-involvement management practices' have been cited as the reasons for the commercial success of Japanese car manufacturers (Wood, 1989), US steel producers (Ichniowski et al. 1997) and in manufacturing more generally (Bloom and Van Reenen, 2007). On the other hand, a failure or inability to innovate can be to the detriment of firms, especially in highly competitive markets. Thus, in a recent survey of CEO's conducted by the Economist Intelligence Unit one-third of those questioned identified 'failure to innovate' as one of the top three risks facing their companies over the next three years (EIU, 2005). Some are citing a failure to innovate as a major reason for the current plight of the automotive industry in the United States.

Although change is known to have adverse effects on well-being relatively little attention has been devoted to the effects of managerial innovations on worker well-being. Most of the research has concentrated on the effects of innovation on job creation and destruction. Recent firm-level evidence indicates process innovations lead to job destruction, particularly in the short-term, but that these are often compensated for by employment growth arising from product and service innovation (Harrison et al., 2008). This innovation-induced job shake-out may be met with some trepidation by incumbent workers, potentially leading to stress and anxiety. In addition innovations in work practices arising from the introduction of new work methods or processes associated with the deployment of new technologies may have positive or negative effects on worker well-being depending on whether they are job enriching or a source of labour intensification.

Few studies are able to assess the links between workplace innovations and employee well-being because they lack the necessary information. In this paper we use linked employer-employee data for British private sector workplaces to explore the effects of managerial innovations on employees' well-being. We consider innovations in products and services, and process innovations in relation to both labour organization and capital investment, exploring their effects on fourteen measures of employee subjective well-being (SWB).

Managers are rarely free to innovate at will. Innovation can be met with resistance or hostility by employees who are either fearful of change or believe it will be to their detriment. Where employees have sufficient bargaining power, they may even be able to block management attempts to innovate. Some unions were notorious for enforcing restrictive labour practices in Britain during the 1960s and 1970s leading to lower labour productivity in unionised workplaces compared with their non-union counterparts (Metcalf, 1989). This, coupled with the union wage premium, meant unions had a negative impact on profitability. However, these productivity and profitability deficits began to decline in the 1980s and had largely disappeared by the 1990s (Blanchflower and Bryson, 2008; Menezes-Filho, 1997). One possible reason for this might be differential rates of managerial innovation over that period in the union and non-union sectors. Certainly, by the beginning of the 21st Century new labour working practices were just as evident in the union sector as they were in the non-union sector and, in some cases, more widespread (Wood and Bryson, 2008). We therefore devote particular attention to the role of trade unions in mediating the effects of innovation on worker well-being.

We have three main findings. First, managerial innovations are associated with lower worker well-being and lower job satisfaction, ceteris paribus. Second, the effect becomes more pronounced when we account for the endogeneity of innovation. Third, the effect is ameliorated when workers are covered by a collective bargaining agreement.

The remainder of the paper is structured as follows. Section Two reviews the theoretical and empirical literatures linking innovation to worker well-being and the mediating role played by unionization. Section Three introduces our data. Inter alia it details the key well-being, innovation and unionisation variables used in the analysis and reports on the factor analyses used to create our innovation measures. Section Four outlines the empirical strategy we adopt. Section Five reports our results and Section Six concludes.

2. Theoretical and Empirical Literature

Theory suggests innovation may have either positive or negative effects on worker well-being. Worker well-being may be adversely affected where workers believe managerial innovations are to their detriment, where they generate uncertainty associated with future loss, and where they are introduced in a way that is perceived to be unfair. However, not all innovations will be perceived in the same fashion by workers because some are more likely to impinge on their working conditions and work arrangements than others. For example, changes to working hours or work organization may have a greater direct effect on workers than, say, the introduction of a new product or service that requires no major change to working arrangements.

Those innovations to which researchers have devoted the most attention are what are sometimes referred to as innovative working practices (IWPs) and are akin to the practices that are also sometimes described as 'new', 'high-involvement', 'high commitment' or 'high performance'. There are, broadly speaking, two schools of thought on whether IWPs are to the detriment of worker well-being. The first holds that IWPs may offer employees opportunities to improve the quality of their working lives, via devolved decision-making powers and responsibilities. Since workers often demand greater decision-making power at the workplace, more control over how they do their work, and more input into managerial decision- making (e.g. Freeman and Rogers, 1999) it seems reasonable to assume that IWPs will lead to increased job satisfaction and well-being. Since IWPs imply more skills acquisition they should also be associated with greater long-term employment security. Writers in this school recognise that not all workers benefit, for example because of job cuts and associated insecurity (Black et al., 2004); and not all workers prefer greater decision-making. The second, more pessimistic, school of thought is that IWPs may entail labour intensification: more is being demanded of workers in terms of their commitment and effort; and, because of market rigidities, workers have little choice but to engage with them. IWPs are often associated with high levels of work intensity and worker stress, even when they are also associated with higher work commitment (Ramsay et al., 2000) or higher job control (Gallie, 2005).

A number of studies have looked at the impact of IWPs on job quality and find mixed evidence (Godard, 2004). Some (e.g. Barker, 1993; Godard 2001) support the pessimistic school of thought finding that some practices are associated with work overload. Others (e.g. Appelbaum et al., 2000) have found no adverse effects of some IWPs on stress levels; while Doeringer et al (2002) found that manufacturing start-ups which adopt IWPs offer jobs with relatively high pay, good training, job security and opportunities for participation. Of particular note is Wood's (2008) study since he uses the Workplace Employment Relations Survey 2004, the data used in this paper. Wood (2008) confirms Karasek's (1979) theory that worker well-being is negatively related to job demands and positively related to job control, and that high job controls reduce the negative association between job demands and well-being.[1]

IWPs are often introduced as part of broader structural and organizational changes such as the introduction of new plant or technology, changes in management structure, or the introduction or redesign of products and services. Such innovation may also bring with it the threat of job loss, resulting in job insecurity which, in turn, is associated with negative worker affect (De Witte, 1999). Job insecurity may be engendered by innovations such as product innovations, regardless of whether they entail IWPs. For instance, they may entail shifts in productive capacity either within or across plants, leading to the closure of particular plants or production lines. Even if a worker's job is not at risk, her wellbeing may suffer from the knowledge that her work colleagues may be at risk.

It is not simply the nature of a managerial innovation that may affect worker well-being. How it is introduced can also matter. Employees' perceptions of fairness or equity are associated with SWB (Warr, 2007: 135-140). Innovations may result in perceptions of distributive (in)justice depending upon the allocations of rights and rewards accruing to workers and they may result in perceptions of procedural (in)justice depending upon the process that governed the introduction of the innovation. As Warr (2007: 137) notes unjust outcomes and procedures are themselves experienced as negative, thus directly affecting SWB, as well as influencing perceptions of environmental features that also affect SWB, such as perceptions of supervisors or the organization in general. This may arise if employees believe the 'psychological contract' based on reciprocity between employer and employee has been breached. The empirical research reviewed by Warr finds links between perceptions of unfairness at the workplace and emotional exhaustion, distress, and lower job satisfaction (op. cit.).

Trade unions may play an important role in mitigating or exacerbating the negative effects of managerial innovation on worker well-being for a number of reasons. First, unions may play a role in negotiating on behalf of their members over the nature of a workplace innovation. Worker well-being may be viewed as a public good, that is, a good affecting the well-being of everyone in such a way that one individual's partaking of the good does not preclude others from doing so. Without a union, individuals will lack the incentive to pursue public goods since,

[1] In a similar vein, Bordia et al's (2004) case study links organizational change to psychological stress through perceived loss of control. Pollard (2001) shows that workplace reorganization caused significant increases in distress and in systolic blood pressure and that uncertainty was a key factor.

as Freeman and Medoff (1984:8–9) argue: "Without a collective organization, the incentive for the individual to take into account the effects of his or her actions on others, or to express his or her preferences, or invest time and money in changing conditions, is likely to be too small to spur action". Unions with a strong bargaining position may be able to block innovations which appear particularly detrimental to workers. Where management innovations proceed they may be significantly modified by the union such that they are more acceptable to employees than might have been the case in the absence of trade union representation.

Via their union representatives employees have the opportunity to refashion innovations to their advantage, either in response to union-oriented consultations or through the union's role as negotiator with the employer. Consultation and negotiation with union representatives gives employees a 'say' in the innovation process which can enhance worker well-being, irrespective of the final shape of the innovation, simply because workers feel they have had some meaningful involvement in the process. This can lead to heightened perceptions of procedural fairness and the sense that employees have some control over how their working environment is being reshaped.

The third way in which unions may ameliorate the negative impact of innovations on employee well-being is as a guarantor of job security to employees in face of potentially productivity-enhancing labour reorganisation. Unions often link the acceptance of innovations to job security commitments, thus increasing the credibility of managerial assurances that innovations do not come at the expense of jobs. These agreements often take the form of job security guarantees (JSG's) which seek to avoid compulsory redundancies if at all possible. JSG's are more prevalent in union than in non-union workplaces and, although job cuts are just as likely where JSG's are present, the probability of compulsory redundancy is lower (Bryson and White, 2006; White and Bryson, 2006). As a consequence, JSG's reduce employee perceptions of job insecurity (Bryson et al., 2009) and may thus facilitate managerial innovation.[2]

Fourth, social psychologists argue that social supports can help people cope with high demands under conditions of low control (Payne, 1979), as in the case of workers facing managerial innovations. Wood (2008: 157) argues that trade unions can be regarded as a source of social support which, under Karasek and Theorell's (1990: 75) model, helps to limit the impact of work

[2] Black and Lynch (2004: footnote 5) make the point that, because worker-management agreements are rarely legally enforced unions can help overcome the incentive incompatibility problems that can arise which were first discussed by Malcolmson (1983).

strain on worker well-being. However, in his empirical analysis he finds union membership is not correlated with well-being or job satisfaction.

A fifth means by which unions may mediate the link between managerial innovations and worker well-being is through their efforts to secure higher wages in return for productivity-enhancing innovations. This may be seen as a form of rent-sharing on the part of unions, or the negotiation of compensatory wage differentials in return for what might be regarded as the disamenities associated with managerial innovation. If unions are particularly adept at capturing innovation-generated rents this may act as a disincentive for firms to innovate in the first place.[3] In practice, innovative practices are at least as prevalent in unionized workplaces as they are in non-unionized workplaces in Britain (Wood and Bryson, 2008). However, ceteris paribus wages are higher in innovative unionised workplaces than they are in innovative non-unionized workplaces, a finding consistent with unions extracting a wage premium in return for managerial innovations (Bryson et al., 2005). Such a premium is more likely to take the form of higher base wages than incentive payments designed to complement innovations in work practices. This is because unions tend to be opposed to performance-based payments (Bryson et al., 2008). In any event, even if workers do not like innovation they may be more sanguine about it if their wages rise as a consequence.

For all these reasons it seems that unions may be able to assuage employees' worst feelings about managerial innovations, potentially contributing to the higher productivity of innovations in unionized plants compared to non-unionized plants (Bryson et al., 2005). Similarly in the manufacturing sector in the United States unions are associated with a higher rate of innovation and with higher labour productivity in the presence of innovative practices (Black and Lynch, 2004).[4]

[3] It is often argued that unions lower the incentive to invest in new capital since unions expropriate a portion of the rents arising from investment, thus lowering the returns to investment relative to non-union firms (Hirsch, 1992). Grout (1984) makes a similar point with respect to R&D investments. Even if the will to invest is there, lower profitability in union firms will mean there is less internal capital available for reinvestment than in non-union firms. The counter-argument is that the union wage premium increases the cost of labour relative to capital in unionized firms relative to non-unionized ones, thus leading to capital intensification. Empirical studies for the United States (Hirsch, 1990, 1992) and Britain (Denny and Nickell, 1991) suggest that unionised firms do make lower investments in capital than non-union firms.

[4] There are a number of reasons why managerial innovations may prove more productive in the presence of trade unions. First, for reasons discussed, innovations may have greater worker approval where unions have been involved in their development, thus avoiding worker resistance. Second, in their role as agents for management (Vroman, 1990) unions can help monitor worker effort, thus reducing the likelihood of shirking. This may help ensure the effectiveness of group incentive schemes, for example. Third, unions reduce voluntary quit rates (Willman et al., 2008), thus lengthening job tenure. As well as increasing the length of time over

On the other hand, there are reasons why unionization may exacerbate negative effects of innovation on worker well-being. First, by increasing the flow of information between unions and management, unions can heighten employees' awareness of problems and short-comings with management and their innovations, thus increasing employee dissatisfaction (Freeman and Medoff, 1984:142). As Gallie et al. (1998:113–4) point out, "unionism as an oppositional form of representation may highlight organizational inefficiencies and colour perceptions of management competence." Second, unionized workers are more prone to express their voice "loudly" to ensure that it is heard, resulting in "voice-induced complaining", a bargaining stance which can be distinguished from "true" dissatisfaction (Freeman and Medoff, 1984:142). The third reason is that unions increase the stock of dissatisfied workers because dissatisfied workers are less likely to quit in unionized workplaces than they are in nonunionized workplaces. This is so because the union offers a voice outlet for worker dissatisfaction that is less costly than quitting (Freeman and Medoff 1994:141). In doing so, unions raise average workplace tenure, which is associated with greater dissatisfaction (Bryson and McKay 1997). Finally, where management does not involve unions in the innovation process, worker discontent arising from unmet expectations and perceptions of procedural unfairness may result in lower well-being than in circumstances where the absence of a union is associated with lower worker expectations of involvement.

It is difficult establishing the causal relationship between managerial innovation and employee well-being because innovations are not randomly assigned to workplaces and their employees. It is even conceivable that some management innovations are introduced to combat low morale and job dissatisfaction such that innovation is endogenous with respect to well-being. Similarly, union coverage is not randomly assigned to workplaces or to workers. Indeed, there is a substantial literature which seeks to account for the endogeneity of unionisation in isolating the causal impact of unionization of job satisfaction.[5] Thus efforts to assess the mediating effect of unionisation on the links between innovation and worker well-being should account for the potential endogeneity of both innovation and unionisation.

---

which employers can recoup their investments in innovations, this also increases the likelihood that employers will acquire the firm-specific skills required to deploy and operate the innovations efficiently.

[5] For a review of this literature see Bryson et al. (2005).

3. Data

Our data are the linked employer-employee Workplace Employment Relations Survey 2004. The survey covers all sectors of the British economy with the exception of mining and quarrying; agriculture, hunting and forestry; fishing; private households with employed persons; and extra territorial bodies. However, we confine our analyses to private sector workplaces. Workplaces with at least 5 employees were sampled from the Inter-Departmental Business Register with a view to conducting a face-to-face interview with the manager at the workplace responsible for employment relations. The response rate was 64%. The respondent's permission was sought to distribute an eight page self-completion questionnaire to a randomly selected set of employees at the workplace or, in the case of workplaces with fewer than 26 employees, all of them. This permission was granted in 86% of cases. A further 10% of workplaces did not return any questionnaires. The overall response rate for the employee questionnaire was 61%.[6]

3.1: Well-being measures

Our data contain two sets of well-being measures. The first set is employee responses to the following question: "Thinking of the past few weeks how much of the time has your job made you feel each of the following.. tense, calm, relaxed, worried, uneasy, content?" Responses are coded on a 5-point scale: "all of the time", "most of the time", "some of the time", "occasionally", "never". These measures have their origins in Warr's (2007: 19-49) anxiety-contentment axis for measuring SWB. Warr distinguishes between the two ends of this axis along the two dimensions of pleasure and mental arousal. Anxiety, as measured by feeling tense, worried or uneasy, is associated with negative affect but entails a high level of arousal. Contentment, on the other hand, as measured by feeling calm, contented or relaxed, is associated with positive affect and entails low levels of arousal.[7] Principal components factor analysis[8] of the six SWB measures revealed two factors, one containing the measures of negative affect and the other containing the measures of positive affect. This confirms Wood's (2007: 159) analysis which also used WERS 2004 but for the whole economy. However, as explained by Wood (op. cit.), there are good reasons to treat the items as forming a one-dimensional scale. Thus, following Wood, we combine the six items into a single scale. Taken together these six anxiety-commitment items have a Cronbach's alpha of 0.85. Our single summative SWB score rescales

[6] For more information about the survey see Kersley et al. (2006).

[7] Our data contain no information relating to Warr's other key axis for measuring SWB, namely depression-enthusiasm (depression being low affect and low arousal, while enthusiasm is high affect and high arousal). Since some of the predictors of depression-enthusiasm are known to differ from those for anxiety-contentment (Warr, 2007: 23) we cannot be sure how these other aspects of well-being may be associated with managerial innovations.

[8] We use orthogonal varimax principal components analysis with rotation.

the five-point scores for each measure into (-2, 2) scales where '-2' is "never" and '2' is "all of the time" having reverse-coded the negative affect items such that higher scores indicate higher positive affect. The scale thus runs from (-12, 12). Just over one-third (35%) of the sample score below zero; one-tenth (10%) score zero; and the remaining 55% have positive scores.

Our second dependent variable is job satisfaction. Job satisfaction captures the pleasure-displeasure axis in Warr's concept of subjective well-being. We use all eight facets of job satisfaction available in the data. Employees are asked: "How satisfied are you with the following aspects of your job?... achievement you get from your work; the scope for using your own initiative; the amount of influence you have over your job; the training you receive; the amount of pay you receive; your job security; the work itself; the amount of involvement you have in decision-making at this workplace?" Responses are coded along a 5-point Likert scale ranging from "very satisfied" to "very dissatisfied". Principal component analysis identifies a single factor with an eigen value above 1 (2.74) explaining 78% of the variance in the items. Factor loadings ranged from 0.26 (pay) to 0.80 (initiative). The Cronbach's alpha for all eight job satisfaction items is 0.85.[9] Our single summative job satisfaction score rescales the five-point scores for each measure into (-2, 2) scales where '-2' is "very dissatisfied" and '2' is "very satisfied". The scale thus runs from (-16, 16). One fifth (20%) of the sample score below zero; 30% score between 0 and 4; and the remaining 50% score 5 or more.[10]

3.2: Innovation measures

It is common in the literature to characterise workplace practices as 'innovative' or 'new' when, in fact, it is unclear whether they are indeed innovations or new. We overcome that problem in this paper by focusing our attention on changes in practices in the two years prior to the survey. Our innovation variables are based on managerial responses to the following question:

"Over the past two years has management here introduced any of the changes listed on this card? PROBE: Which others? UNTIL 'None'.:

1) Introduction of performance related pay
2) Introduction or upgrading of computers

[9] Again, these results are very similar to those reported by Wood (2008: 160) even though his analysis relates to the whole economy.

[10] The correlation between the SWB and job satisfaction scales is 0.45. If one regresses them against one another they account for 20% of the variance in the other.

3) Introduction or upgrading of other types of new technology

4) Changes in working time arrangements

5) Changes in the organisation of work

6) Changes in work techniques or procedures

7) Introduction of initiatives to involve employees

8) Introduction of technologically new or significantly improved product or service

9) NONE None of these"

All eight innovations are positively correlated with correlations ranging between 0.19 (introduction of incentive pay and the introduction of new technology) and 0.65 (changes in work techniques and procedures and changes in work organization). Principal components analysis revealed two factors with eigen values above one.[11] The first factor (eigen value 1.90), accounting for 59% of the variance in innovation, contains the four labour-oriented innovations, namely items 4, 5, 6 and 7 above.[12] The Cronbach's alpha for these items is 0.65. The second factor (eigen value 1.59), accounting for 49% of the variance in innovation, contains the three capital-oriented innovations, that is, items 2, 3, and 8.[13] The introduction of performance-related pay is positively correlated with both factors, but its factor loadings are not high (0.32 and 0.18 respectively) indicating that this particular managerial innovation does not belong to either factor. This is consistent with the literature in which incentive payments are often introduced as a means of supporting labour innovations such as the introduction of employee involvement practices (Huselid, 1995). We construct three count variables, one which sums all eight innovations (NCHANGE); a second for labour innovations based on items 4, 5, 6, and 7 with a maximum value of 4 (NLABCHG), and a third for capital innovations based on items 2, 3, and 8 with a maximum value of 3 (NCAPCHG). One-quarter (25%) of workplaces had introduced no labour innovations in the previous two years; one-fifth had introduced one innovation (21%), another fifth (22%) had introduced two, a further fifth (19%) had introduced three, and 13% had introduced all four. One-fifth (20%) of workplaces had introduced none of the three capital innovations; one-quarter (24%) had introduced one; 29% had introduced two; and one-quarter (26%) had introduced all three. Twelve percent of workplaces had introduced performance related pay in the previous two years.

[11] The factor analysis reported in this paragraph uses STATA's factormat command which is intended for use with dummy variables. We report on the workplace-level data but results are virtually identical when run on employee-level data.

[12] The factor loadings range between 0.50 for employee involvement initiatives and 0.72 for changes in work techniques or procedures.

[13] The factor loadings range between 0.59 for the introduction of new or improved products or services and 0.73 for the upgrading or introduction of new technology.

Where managers had innovated they were asked what type of involvement trade unions, joint committees and the employees affected had in "introducing and implementing this change". The pre-coded responses were: "they decided; they negotiated; they were consulted; they were informed; no involvement". Among employees who had experienced innovations in the last two years, 20% were in workplaces where there had been no employee involvement in the introduction of the innovation. Twelve per cent worked at workplaces where it had been subject to negotiation or was actually decided by employees; 56% were in workplaces where there had been consultation over innovation; and 38% were in workplaces where they had been informed about innovation. (The figures for negotiation, consultation and information sum to over 100% because in some cases workplaces took different approaches with respect to unions, joint committees and employees).

3.3: Unionization variables

The analysis uses both individual-level and workplace-level indicators of unionization. At the individual-level we know whether the employee is a trade union member or not and whether she is covered by collective bargaining. The membership data are derived from the employee self-completion questionnaire. The coverage data are provided by the workplace manager for each single-digit occupation in the workplace. For each occupation present the manager is asked: "Which of the following statements most closely characterises the way that pay is set for [occupational group]?" The first three pre-coded answers are: "collective bargaining for more than one employer eg. industry-wide agreement"; "collective bargaining at an organization level"; "collective bargaining at this workplace".[14] We link these data to the employee through her occupation which is collected in the self-completion questionnaire. Unlike the United States, although coverage and membership are positively correlated they are far from synonymous.

Two-thirds (66%) of employees were uncovered members; a further 12% were uncovered union members; 12% were covered members; and 10% were covered non-members. The correlation coefficient for membership and coverage was 0.40.

Our workplace-level variable capturing unionization is a (0,1) dummy identifying union recognition, that is, the presence of one or more trade unions recognised for pay bargaining. The survey question refers to "any trade unions or staff associations recognised by management

[14] These data were edited and cleaned by the original research team. The variables can be identified in the deposited data file as the NFSOC* dummies.

for negotiating pay and conditions for any sections of the workforce here". Just under one-third (32%) of the private sector workplaces in our estimation sample had a recognised trade union.[15]

3.4: Control variables

In addition to union membership and coverage status, individual-level analyses contain age (9 dummies); academic qualifications (8 dummies); vocational qualifications (3 dummies); single-digit occupation (9 dummies); and dummies for disability, gender, ethnicity and having any dependent children. The dummy for male is interacted with the dependent child dummy.

As well as the unionization variables, workplace-level analyses contain controls for single-digit industry (11 dummies); region (10 dummies); log workplace employment size and its squared term; the percentage of employees who are female and its squared term; and single dummies for low travel-to-work-area unemployment (below 1.2%) and location in an urban area. The following dummy variables were used as instrumental variables entering innovation and unionization models (see below): single-establishment organization; the market for the main product/service is 'local'; the workplace produces several different products or services; and whether the workplace had benchmarked itself against other workplaces.[16] Some variants of our models also included age of establishment and the state of the market for the workplace's products or services.[17]

4. Empirical Approach

4.1: Individual-level analyses

The individual-level analyses estimate effects of innovation on worker well-being using the additive scales for SWB and job satisfaction described in Section 3.1. We argue that the rescaling makes simple linear models appropriate. The main relationship between the well-being of worker i employed in workplace f can be expresses by Equation 1:

---

[15] We also experimented with workplace-level union density, that is, the percentage of employees at the workplace who belong to a trade union. Mean workplace union density for the estimation sample was 18%. We also experimented with alternative categorical measures of density since over half (54%) had no union members at all.

[16] The survey question is: "I'd now like to ask you about benchmarking By this I mean examining the way things are done at other workplaces and comparing them with this establishment. Over the past two years, has this establishment benchmarked itself against any other workplaces?"

[17] The survey asks: "Looking at this list, which of these statements best describes the current state of the market in which you operate (for its main product or service)...the market is growing, the market is mature, the market is declining, the market is turbulent?"

1) $$W_{if} = \beta_1 Innovations_f + \beta_2 Union_{if} + \beta_3 Innovations_f XUnion_{if} + \beta'_x X_{if} + \varepsilon_{if},$$

where W_{if} expresses well-being (or job satisfaction), $Innovations_f$ express the number of innovations introduced in workplace f (different measures), $Union_{if}$ expresses a dummy for union coverage (which actually varies at the worker level), $Innovations_f XUnion_{if}$ expresses a cross-term between innovations and union, while the X's express our control vector and ε_{if} represents a standard normal distributed error term.

We start, however, by running simple OLS regression of Equation 1) without the union variables, where the innovation count variables described in Section 3.2 enter the models separately alongside the individual-level controls described above. The models are unweighted and so provide within-sample estimates, rather than population estimates. Individuals' probability of sample selection is not independent of one another since they are clustered within sampled workplaces. Standard errors are adjusted to account for this using clustering and we use the robust estimator to tackle heteroskedasticity in the error terms.[18] Sample sizes vary a little across the well-being and job satisfaction models. For well-being the unweighted number of employee observations is 13,181 and they are clustered in 1,230 private sector workplaces (an average of nearly 12 employees per workplace).[19] For job satisfaction the unweighted number of employee observations is 12,394 and they are clustered in 1,227 workplaces. Next we add the union-dummy, and then we finally estimate the regression described by Equation 1 (with union dummy and cross-term).

Whilst these models provide a good approximation for the independent correlation between well-being and innovation, they make no attempt to account for the potential endogeneity of innovation or unionization with respect to worker well-being. This can arise for a number of reasons.

First, managerial innovation is not random, and may even be a response to worker well-being, in which case our results will be plagued by reverse causation. For instance, managers may wish to introduce changes in response to employee ill-being or dissatisfaction with current arrangements, in which case treating innovation as exogenous will overstate any negative effects of innovation on well-being. Alternatively, managers may wish to capitalise on times when employees are

[18] Thus we take into account the so-called Moulton-critique (Moulton, 1990).
[19] We lose over 2,100 observations by excluding workers with missing data on items used in the analysis. This is another reason why we decide to estimate within-sample rather than population estimates.

'feeling good' by introducing innovations, thus potentially minimising opposition to change. If so, this could result in an understatement of any negative effects of innovation on well-being.

Second, workers may select into workplaces according to their preferences such that a non-random group of employees will be subject to managerial innovations. If this worker selection cannot be accounted for by observable characteristics entering our models, and if it is also correlated with individuals' propensity for well-being or satisfaction, it will bias our estimates of innovation's effect on well-being. For example, naturally optimistic and resilient workers may be more prepared to join workplaces which innovate. It is also plausible that employers intent on innovating seek to recruit and retain these sorts of workers. Either way, if unaccounted for this will induce an upward bias in our estimates of innovation's effects on well-being.

Similarly, unionization is not ascribed to workplaces and workers randomly. Indeed, union organizing is often assisted by a sense of grievance on the part of workers since it can trigger greater desire for union assistance and increases the net benefits of unionizing. This can help explain the negative effects of unionization on job satisfaction found in the literature (Bryson et al., 2005).

To try to overcome these selection problems in the analyses of individual-level employee well-being we take two approaches. In the first approach, we add workplace fixed effects to our models. This changes Equation 1) to the relationship described by Equation 2):

2) $$W_{if} = \beta_2 Union_{if} + \beta_3 Innovations_f XUnion_{if} + \beta'_x X_{if} + \alpha_f + \varepsilon'_{if} ,$$

where most variables are defined as previously, while α_f expresses a fixed workplace-level well-being effect and ε'_{if} represents a standard normal distributed error term. We are able to estimate this model because we have multiple employee observations per establishment.[20] But because innovation is measured at workplace-level it falls out of these fixed effect models. However, the interaction between innovation and individual-level unionization does not, so we are able to establish how innovation affects workers in the same workplace according to their union membership and coverage status.

[20] The number of observations per workplace varies from 1 to 25. The modal number of observations per workplace is 15 and the mean is 14.

Our second approach to tackling selection bias arising from unobservables is to instrument the innovation and union variables. OLS estimation of Equation 1) rests on the assumptions that COV(Innovations$_{f}$,ε_{if})=0 and COV(Union$_{if}$,ε_{if})=0. If these assumptions are not satisfied, and we suspect they are not, then a solution to this violation is to identify variables explaining the variation in union and innovations, but not directly correlated with worker well-being (i.e., introduce instruments). Using STATA's –ivreg2- command we run several two-stage least squares regressions.

First we focus on the relationship between innovation and well-being. In the first stage we estimate an OLS model of innovation incorporating a set of instruments which, we argue, have an impact on firms' propensity to innovate but can be reasonably excluded from the second stage equation which estimates well-being (or job satisfaction). The first is being a single-establishment organization. Single-site organizations must bear the full fixed costs of innovation, whereas those belonging to a multi-site firm can share them with other plants in the same network. The latter can also learn about the potential benefits of innovation from other workplaces in the same firm. Thus we anticipate a lower incidence of innovation in single-site firms than in those workplaces belonging to multi-site firms. Although well-being is likely to be associated with establishment size, this is already accounted for in the regression: there is no reason to suspect any additional impact from employment in a single-site firm. The second instrument is benchmarking: those that benchmark are more likely to innovate since they seek to emulate the best practice among their peers. However, there is no reason to suspect that benchmarking will have any effect on worker well-being. The final two instruments characterise aspects of the product market that the establishment competes in. Product and service diversity is likely to increase the propensity to innovate because both the opportunity and, perhaps, the necessity to innovate are greater where one has more products/services going to market. But, there is no reason to suspect a relationship between product diversity and well-being. Finally, local product markets tend to be less competitive than those subject to regional, national or international competition. Since competition is known to be a strong predictor of innovation (Aghion et al., 2005) production for a local market is an indicator of the firm's ability to compete without the need to innovate at the same rate as firms in more competitive markets. Again, there is no theoretical reason for its inclusion in the employee well-being equation.

Next, in a further set of analyses we introduce instruments to account for the endogeneity of both innovation and individual coverage by collective bargaining. In these analyses we run two first-stage regressions, one for innovation and one for coverage. We use a set of three instruments. The first is a single-site firm: the marginal costs of a union organizing in a single-site firm are greater than for a multi-site firm, thus reducing the likelihood of collective bargaining coverage. The second is benchmarking: firms intent on keeping abreast of competitor firms' production processes are also more likely to aspire to good labour standards such as those which come with collective bargaining. Finally we use a dummy variable identifying workplaces facing 'bad' market conditions, that is, where their product market is mature or declining. These are workplaces that face lower incentives to invest in innovation and are also those workplaces that were set up in traditional industries which are now in decline. These industrial sectors are more highly unionized since there is a strong firm cohort effect on employers' decisions to unionize in Britain with older workplaces much more likely to unionize (Millward et al., 2000). However, there is no reason to think that being in a mature or declining product market will influence employee well-being.

We run a range of diagnostic tests designed to see how credible these identification assumptions are, and for justification purposes, just note that we find that they perform well. The results from the diagnostic test are reported in detail in Section 5.

4.2: Workplace-level analyses

One of the difficulties with the individual-level analyses outlined above is that our data on innovation are workplace-level information: we cannot be sure which workers were most affected by the innovation, and which were largely unaffected. We therefore estimate models which explore the relationship between mean workplace-level well-being and job satisfaction and workplace innovation. We adopt two approaches when it comes to measuring workplace-level well-being.

In the first approach, we run a two-stage procedure which allows us to isolate the workplace component of employees' well-being scores having 'stripped out' the association between these scores and observable employee characteristics. This is done by incorporating workplace fixed effects into the analysis of individual-level well-being, alongside the individual-level controls referred to in Section 3.4. All these individual-level controls are arguably exogenous, with the possible exceptions of union membership and coverage, which are interacted. This first stage regression can be expressed by Equation 3):

$$3)\, W_{if} = \beta_1 Unionmemb._{if} + \beta_2 Union\,\mathrm{cov}._{if} + \beta_2 U\,\mathrm{cov}\, XUmember_{if} + \beta'_x X_{if} + \alpha_f + \tilde{\varepsilon}_{if}\,,$$

where most variables are defined as previously, while α_f expresses a fixed workplace-level well-being effect and $\tilde{\varepsilon}$'s represents standard normal distributed error terms.

This first stage uses STATA's –areg- command and the robust estimator to obtain the corrected standard errors. From this first stage we use the predict command in STATA to recover the coefficients from the workplace fixed effects, i.e., $\hat{\alpha}_f$. These $\hat{\alpha}_f$'s are, in effect, the workplace-level well-being (job satisfaction) means stripped of the effects of observable worker characteristics in that workplace.

Our second approach is to use the workplace-level mean of well-being directly without running the first stage to obtain $\hat{\alpha}_f$, we calculate $\overline{w}_f = \sum_{n_f} W_{if} / n_f$. W_{if} denotes the previously defined worker well-being, while n_f denotes the number of workers observed at the workplace.

In both approaches we then estimate regressions using $\hat{\alpha}_f$ or the workplace-level mean of well-being as the dependent variable in regression on the workplace-level controls outlined in Section 3.4. Equation 4) describes the $\hat{\alpha}_f$ regression. (The regression of the workplace level mean of well-being is identical except for notational changes).

$$4) \qquad \hat{\alpha}_f = \beta_1 Innovations_f + \beta'_y Y_f + \nu_f\,,$$

where the Y's express our control vector and ν_f represents a standard normal distributed error term.

We estimate Equation 4) using OLS in the first place and then 2SLS (STATA's ivreg2), when we instrument innovation and unionization in much the same way as we did at the individual-level. The difference this time is that the right-hand side variables are the workplace-level ones, rather than individual-level, and the left-hand side variable is also a workplace-level variable.

One issue which does not arise in the individual-level analysis is that the workplace-level analysis relies on aggregation of employee-level responses to construct the mean well-being and satisfaction dependent variables. There are two concerns. First, there is a concern about efficiency since the dependent variable is a mean of individual worker responses and the standard deviation of the stochastic error term will vary with the number of observations used to construct that mean. There is, perhaps, an argument for weighting the analysis by the number of employee observations in the workplace. The survey design is such that in workplaces with up to 25 employees all employees are sampled whereas, in workplaces with more than 25 employees 25 employees are sampled randomly such that the probability of selection is 25/(number of workplace employees). Second, the response rate among employees selected for the survey varies a great deal across sampled workplaces. The mean response rate is 52%, ranging from 0% in the case of 14% of workplaces to 100% in 5% of workplaces.[21] If individual employees' propensity to respond to the employee self-completion questionnaire is partly a function of employee well-being such that those with the lowest well-being and satisfaction scores are least likely to comply with the request, the workplace mean will be higher than the "true" mean for the workplace. If innovation or unionization is driving this lower well-being and the response rate, this may induce a bias in our estimates of their effects on mean workplace-level well-being. In fact, the workplace employee response rate was positively correlated with innovation and uncorrelated with the well-being and job satisfaction measures. Nevertheless we undertook some sensitivity checks to ensure our results were robust to workplace response rates. To tackle the first issue we test the sensitivity of our results to weighting the analysis with the number of employee observations at the workplace since the variance of the mean falls with the number of employee observations. To tackle the second issue we test the sensitivity of our results in workplace sub-samples with high and low employee response rates.

5. Results

5.1: Individual-level employee well-being and job satisfaction

Table 1 presents OLS estimates of the association between innovation and employee well-being as measured by the additive well-being scale. Panel A presents results using the additive innovation scale. Panels B and C present identical models but replace the global innovation count measure with the additive scales for labour and capital innovations respectively. In each

[21] In addition 251 workplaces – 15% of all the private sector workplaces in the employer sample – refused to grant permission to survey employees at the workplace.

case four models are presented. Model (1) enters the innovation variable alone. Model (2) adds individual-level control variables. Model (3) incorporates the dummy for the individual's collective bargaining coverage status and Model (4) interacts the innovation count variable with coverage status. The pattern of results is identical in each panel. In the absence of controls there is a strong negative association between innovation and employee well-being (Model (1)). When individual-level controls are included in Model (2) the innovation coefficient falls somewhat suggesting that the sorts of workers whose well-being is adversely affected by innovations have observable traits that predispose them to lower well-being. Model (3) introduces the employee's coverage status. This has a strong significant negative association with individual well-being. However, the introduction of coverage status does very little to the innovation coefficients. Finally, Model (4) incorporates an interaction between innovation and coverage status. This is positive and statistically significant at a 95% confidence level in Panel A and at a 90% confidence level in Panels B and C. This indicates that where employees are subject to managerial innovations their coverage by collective bargaining ameliorates the negative association between innovation and employee well-being.

[INSERT TABLE 1 ABOUT HERE]

We tested the sensitivity of these results to model specification. First, we added the dummy variable for the introduction of performance-related pay in the previous two years to Model (4) in Panels B and C. This was not statistically significant and it did not affect the results. Second, we replaced the coverage variable with a variable which captured covered membership. Being a covered member was associated with lower well-being than simply being covered. However, the interactions with innovations were similar to those presented in Table 1.

Rerunning Table 1 replacing well-being with job satisfaction produces similar results.[22] All three innovation measures are strongly negatively associated with job satisfaction. The innovation coefficient drops a little with the introduction of controls. The negative association with coverage is larger than in the case of well-being but, as in the case of Table 1, its introduction does little to the innovation coefficients. Although the interaction between innovation and coverage is positive it is not as well determined as in the case of well-being and only reaches

[22] The job satisfaction models are available from the authors on request. The sample size falls a little for the job satisfaction equations (N=12,394) due to missing observations on one or more job satisfaction items.

statistical significance (t=1.70, significant at a 90% confidence interval) in the case of labour innovations.

If the way in which innovation is introduced affects worker well-being one might expect this to show up in models replacing the innovation count with the nature of managerial engagement over the introduction of innovation. We tested this proposition on workplaces that had introduced innovations in the previous two years, replacing the innovation count with dummies identifying when innovation had been subject to negotiation with employees (including a small number of cases where management said they had made the decision regarding innovation), consultation with employees, or information provision to employees, evaluated against a base category of innovation with no employee engagement. Although negotiation over innovation was positively correlated with well-being the effect was only statistically significant among non-unionized workers (t=1.70 for uncovered workers at t=1.77 where there was no recognized trade union). Coefficients for consultation and information provision were negative and statistically non-significant.

The results are a little different for job satisfaction. Without controls, all forms of engagement with employees over innovation are negatively associated with job satisfaction relative to innovation with no employee engagement. When controls are introduced, the negative effect is confined to consultation and information provision and, when coverage status is added, the only significant effect is the negative association with information provision. When the sample is split into unionized and non-unionized workers, negotiation over innovation is positive in the unionized sector and negative in the non-unionized sector though, in both cases, the coefficients are not significantly different from innovation without employee engagement. In interpreting these results it is worth bearing in mind that we do not instrument for employee engagement and thus we can not discount the possibility that employers are more likely to engage with employees over innovations in response to worker dissatisfaction.

[INSERT TABLE 2 ABOUT HERE]

Table 2 introduces workplace fixed effects into the models presented in Table 1 Model (4). Employees' well-being is very strongly associated with the workplace they work in: the fixed effects models account for around 20% of employee well-being, compared to 6% in the OLS models. The interaction between coverage and the innovation counts in Model (1), which are positive and statistically significant in the OLS, become non-significant and, in the case of the "all innovations" count and labour innovations, the coefficient switches sign. The big negative significant main effect for coverage in the OLS drops to near-zero and becomes non-significant. These results suggest that the coverage effects apparent in the OLS are accounted for by differences in coverage status across workplaces: there is no difference in well-being between 'like' covered and uncovered employees in the same workplace. (Similar patterns emerge if one replaces coverage with covered membership). Coverage effects are also absent in the fixed effects job satisfaction models (Table 2, Panel B).

[INSERT TABLE 3 HERE]

Table 3 compares OLS estimates of innovation and coverage effects on employee well-being with estimates derived from an instrumental variables approach which accounts for the potential endogeneity of innovation and unionization. Model (1), which presents OLS estimates for individual-level well-being with the controls used in Table 1 Model (1), confirms the negative association between the innovation count and employee well-being. In Model (2) we endogenise innovation using the instruments as described in Section Four: this results in a big increase in the negative effect of innovation. These results are apparent for all three innovation count measures. This underestimate of the innovation effect when it is treated as exogenous suggests innovations are introduced at times when employees have have positive underlying feelings about their work, or else employers who wish to innovate recruit employees who are generally positive and well-disposed towards their work.

Model (3) treats innovation and coverage as exogenous: both are negatively and significantly associated with well-being. When endogenised in Model (4) the coverage effect increases whereas the effect of innovation becomes statistically non-significant, inspite of an increase in the size of the coefficient in the case of capital innovations. The OLS reported in Model (5) treats innovation and coverage, and their interaction, as exogenous. Both innovation and coverage are associated with lower employee well-being, whereas the interaction is positive and significant for all innovations and labour innovations. In the case of capital innovations the interaction is positive but not statistically significant. Finally, Model (6) seeks to instrument for innovation, coverage and their interaction. The innovation coefficients rise but inflation in the standard errors means that the innovation effect is less precisely estimated than in Model (5), in spite of the larger coefficients for innovation in Model (6). The coverage coefficients increase markedly and are negative and statistically significant in Panels A, B and C. The innovation*coverage cross-term coefficients also rise, and are statistically significant in all three panels, albeit at a 90% confidence interval in Panels B and C. Thus it appears that both innovation and coverage lower employee well-being, but coverage helps ameliorate the negative effects of innovation.

We run a range of diagnostic tests designed to assess the credibility of our identification assumptions. First, we find that the instruments are separately and jointly statistically significant in the innovation equations. Second, using a Hansen J statistic we find that our estimates pass the test of over-identification, that is to say, the instruments can reasonably be excluded from the second stage well-being and satisfaction models. Third, using using STATA's –endog- option we confirm the endogeneity of innovation as a regressor. Finally, we use the Kleibergen-Paap Wald rk F statistic to see whether our estimates suffer from weak instruments.[23] When instrumenting for innovation alone the statistic is very satisfactory (the F-statistic is between 15 and 30). The F-statistic is lower when instrumenting for innovation and coverage – usually between 5 and 10 – and even lower when instrumenting for the cross-term. This should be taken into account when interpreting the results.

Running Table 3 models on job satisfaction produces very similar results to those reported above. Innovation effects rise markedly when innovation is endogenised. When innovation, coverage and the cross-term are endogenised all coefficients rise. Furthermore, all the effects remain statistically significant (with the exception of labour innovations).

5.2: Workplace-level employee well-being and job satisfaction

Table 4 presents estimates of $\hat{\alpha}_f$ namely the workplace fixed effect coefficients from the first stage –areg- equation estimating individual-level well-being. Models (1) to (3) present OLS estimates and treat innovation and unionization as exogenous. Innovation is associated with lower mean employee well-being at the workplace (Model (1)). The size and significance of this effect are unaffected by the introduction of workplace-level union recognition, which is itself negative but non-significant. However, when innovation and unionization are interacted in Model (3) the unionization coefficient is negative and statistically significant, as is the innovation coefficient. The cross-term is positive and statistically significant, albeit only at a 90% confidence level in the case of capital innovations. These results, which hold for all three

[23] This test is similar to the Cragg-Donald but, unlike Cragg-Donald, it accounts for heteroskedasticity.

measures of innovation, reflect those presented in Table 1 for individual-level worker well-being. Model (4) endogenises innovation but is otherwise equivalent to the OLS results in Model (1). The innovation coefficient rises markedly when endogenised, as was the case in the individual-level analyses. Finally Model (5) instruments innovation and unionization. Although the innovation coefficients drop a little compared to Model (4) they remain large and precisely estimated. The negative unionization coefficients are larger than in the equivalent OLS analyses in Model (2) and, in the case of Panel C, the coefficient is statistically significant.[24]

[INSERT TABLE 4]

Running identical models on the raw workplace-level mean of employee well-being, as opposed to $\hat{\alpha}_f$, produces very similar results (Appendix Table A1), the primary difference being larger coefficients associated with workplace unionization leading to more statistically significant effects.

[INSERT TABLE 5]

Rerunning the equivalent of Table 4 models on the workplace fixed effect coefficients for job satisfaction reveals a slightly different pattern of results (Table 5). First, in the case of two of the innovation measures (NCHANGE and NCAPCHG) the negative effects of innovation on workers only become significant once innovation is endogenised. The link between labour innovations (NLABCHG) and lower job satisfaction is apparent even when innovation is treated as exogenous, but the effect strengthens when it is endogenised. The second difference is that workplace unionization is more strongly associated with lower job satisfaction than it is with lower well-being: the effects are strong and statistically significant throughout and, as in the case of well-being, become more pronounced once unionization is endogenised. Third, although the cross-term is positive throughout it is never statistically significant. Thus, in the workplace-level analyses, it appears any amelioration of the negative effects of innovation by unionization is confined to well-being.

If one switches to modelling the raw mean job satisfaction at workplace-level (Appendix Table 2) results are similar to those presented in Table 5, with one exception: the innovation coefficients

[24] The diagnostic tests for endogeneity, over-identification, under-identification and weak instruments were all satisfactory. However, endogenising the cross-term suffered from a weak instruments problem which is why we do not present these estimates.

in Model (5) are smaller and, in the case of "all innovations" and labour innovations, become statistically non-significant.

We ran sensitivity tests to establish the robustness of results to different treatments of the employee responses which are aggregated to produce the workplace-level measures of well-being. First we ran the equivalent of Table 4 weighting the regressions by the number of employee observations used to construct the workplace mean. The pattern and statistical significance of the results presented in Table 4 are replicated, with the exception of capital innovations in OLS Models (1) and (2) which become statistically non-significant. Second we ran the equivalent of Table 4 on two sub-samples with high and low employee response rates using 65% as the cut off. The results for workplaces with high employee response rates replicate those in Table 4, with the exception of the effects of capital innovation in Models (1) and (2) which become statistically non-significant due to a small decline in their coefficients and the cross-term for capital innovation and unionization in Model (3) which, despite increasing in size, is less precisely estimated (t=1.54). Among the sub-sample with lower response rates (less than 65%) results are very similar to Table 4 except the cross-terms in Panels B and C become statistically non-significant despite the coefficients rising.

6. Conclusions

Using private sector linked employer-employee data for Britain we explore the effects of management innovations in the previous two years on worker well-being. We find management innovations are associated with lower worker well-being and lower job satisfaction. This is the case for three different count measures of innovation – a global measure and measures for labour innovations and capital innovations. The findings hold for analyses run at the level of individual employees and workplace-level analyses of mean employee well-being. Furthermore, these effects become more pronounced when we account for the endogeneity of innovation, perhaps indicating that innovative employers select workers who are better able to cope with change, or that employers only innovate when worker well-being is high, thus making them more resilient to change. It is also possible that workers with higher well-being select into innovative workplaces.

Workers often look to trade unions to negotiate with management over change at the workplace to ensure that any changes that do take place take account of employee interests. We find little direct evidence that negotiation, consultation or information provision in relation to innovation is associated with an amelioration of the negative effect of innovation on employee well-being. However, the effect is ameliorated when workers are covered by a collective bargaining agreement or are employed in a workplace recognising a union for pay bargaining. This effect is not always precisely estimated and should be considered alongside the generally negative effect of bargaining coverage and union recognition on worker well-being. Furthermore, individual-level analyses of worker well-being which control for workplace fixed effects indicate no significant differences between covered and uncovered employees in the same workplace, thus indicating that the union effect operates across employees in 'like' unionized and non-unionized workplaces.

The literature on worker well-being is dominated by analyses of job satisfaction. The effects of innovation and unionization on individual well-being are similar whether one uses SWB or job satisfaction as the measure of well-being. However, results differ in the workplace-level analyses. In particular, union negative effects are more pronounced for job satisfaction than they are for SWB and the ameliorating effect of unionization in limiting innovation's negative effects on well-being is is confined to the SWB measure.

References

Aghion, P., Bloom, N., Blundell, R., Griffith, R. and Howitt, P. (2005) "Competition And Innovation: An Inverted-U Relationship," *Quarterly Journal of Economics*, Vol. 120, No. 2, 701-728

Barker J.R. (1993) "Tightening the Iron Cage: Concertive Control in Self-Managing Teams." *Administrative Science Quarterly,* Vol. 38, No. 3 (September), pp. 408-37.

Black, S. E. and L. M. Lynch (2001). "How to compete: the impact of workplace practices and information technology on productivity." *Review of Economics and Statistics* 83 (3): 434-445.

Black, S. E., Lynch, L. M. and Krivelyova, A. (2004) 'How Workers Fare When Employers Innovate', *Industrial Relations*, Vol. 43, 1: 44-66

Bloom, N. and Van Reenen, J. (2007) 'Measuring and Explaining Management Practices Across Firms and Countries', *The Quarterly Journal of Economics, CXXII*, 1351-1408

Bordia, P., Hunt, E., Paulsen, N., Tourish, D., DiFonzo, N. (2004) 'Uncertainty during organizational change: is it all about control?', *European Journal of Work and Organizational Psychology*, 13 (3), 345–365

Bryson, A., Cappellari, L. and Lucifora, C. (2009) 'Workers' Perceptions of Job Insecurity: Do Job Security Guarantees Work?', *Labour: Review of Labour Economics and Industrial Relations*, Vol. 23, s1, 177-196, DOI: 10.1111/j.1467-9914.2008.00433.x

Bryson, A., Cappellari, L. and Lucifora, C. (2005) *Why So Unhappy? The Effects of Unionisation on Job Satisfaction*, IZA Discussion Paper No. 1498, IZA, Bonn

Bryson, A., Forth, J. and Kirby, S. (2005) 'High-performance practices, trade union representation and workplace performance in Britain', *Scottish Journal of Political Economy*, 53, 3: 451-491

Bryson, A. and McKay, S. (1997) 'What about the workers?', in Jowell, R., Curtice, J., Park, A., Brook, L., Thomson, K., and Bryson, C. *British Social Attitudes: the 14th Report*, pp23-48

Bryson, A., Pendleton, A. and Whitfield, K. (2008) *The Changing Use of Contingent Pay at the Modern Workplace*, NIESR Discussion Paper No. 319

Bryson, A. and White, M. (2006) *Unions, Within-Workplace Job Cuts and Job Security Guarantees*, Centre for Economic Performance Discussion Paper No. 733

Denny, K. and Nickell, S. (1991) 'Unions and investment in British manufacturing industry', *British Journal of Industrial Relations*, 29, 1, pp. 113–21

De Witte, H. (1999) 'Job insecurity and psychological well-being: review of the literature and exploration of some unresolved issues', *European Journal of Work and Organizational Psychology*, 8, 155-177

Doeringer, Peter B., Christine Evans-Klock, David G. Terkla. (2002) *Start-up Factories—High-Performance Management, Job Quality and Regional Advantage*, Oxford University Press and W.E. Upjohn Institute for Employment Research, New York, 273 pp.

Economist Intelligence Unit (2005) 'CEO Briefing White Paper', http://www.oracle.com/global/hk/corporate/press_050221.html

Freeman, R. B. and Rogers, J. (1999) *What Workers Want*, Cornell, Ithaca, NY

Gallie, D. (2005) "Work Pressure in Europe 1996-2001: Trends and Determinants", *British Journal of Industrial Relations*, Vol. 43, 3: 351-375

Gallie, D., M. White, Y. Cheng and M. Tomlinson (1998). *Restructuring The Employment Relationship*. Oxford, Clarendon Press.

Godard, J. (2001). "The transformation of work and high performance? The implications of alternative work practices for the experience and outcomes of work." *Industrial and Labor Relations Review* 54 (4): 776-805.

Godard, J. (2004) "A Critical Assessment of the High-Performance Paradigm", *British Journal of Industrial Relations*, Vol. 42, 2: 349-378

Green, F. (2006). *Demanding Work. The Paradox of Job Quality in the Affluent Economy*. Woodstock, Princeton University Press

Harrison, R., Jaumandreu, J., Mairesse, J. and Peters, B. (2008) 'Does Innovation Stimulate Employment? A Firm-level Analysis Using Comparable Micro-data from Four European Countries', NBER Working Paper #14216

Hirsch, B. T. (1990) 'Innovative Activity, Productivity Growth and Firm Performance: Are Unions a Spur or Deterrent?' in Albert N. Link and V. Kerry Smith (eds.) *Advances in Applied Microeconometrics*, Greenwich, Conneticut, JAI Press

Hirsch, B. T. (1992) 'Firm investment behaviour and collective bargaining strategy', *Industrial Relations*, 31, 1, pp. 95–121

Holmes, T. (2008) 'The Diffusion of Wal-Mart and Economies of Density', *NBER Working Paper #13783*, Cambridge, Mass.

Huselid, M. A. (1995), 'The Impact of Human Resource Management Practices on Turnover, Productivity, and Corporate Financial Performance', *Academy of Management Journal*, 38, 635-672

Ichniowski, C., Shaw, K. and Prennushi, G. (1997) 'The Effects of Human Resource Management Practices on Productivity: A Study of Steel Finishing Lines', *American Economic Review*, 87: 291-313

Karasek, R. A. (1979) 'Job Demands, Job Decision Latitude, and Mental Strain: Implications for Job Redesign', *Administrative Science Quarterly*, 24: 2, 285-308

Karasek, R. and T. Theorell (1990), *Healthy Work*, New York: Basic Books

Machin, S. and Wadhwani, S. (1991) 'The effects of unions on organisational change and Employment' *The Economic Journal*, 101, pp. 835–54

Malcomson, J. (1983). 'Trade unions and economic efficiency', *The Economic Journal*, 93, pp. 50–65

Menezes-Filho, N. A. (1997) 'Unions and profitability over the 1980s: Some Evidence On Union-firm Bargaining in the United Kingdom', *The Economic Journal*, 107, 651-670

Metcalf, D. (1989) 'Water Notes Dry Up: The Impact of the Donovan Reform Proposals and Thatcherism At Work on Labour Productivity in British Manufacturing Industry', *British Journal of Industrial Relations*, 27, 1: 1-31

Moulton, B.R. (1990) 'An Illustration of a Pitfall in Estimating the Effects of Aggregate Variables on Micro Units', *Review of Economics and Statistics*, 72, 334-38

Nickell, S. J. and Wadhwani, S. (1991). 'Employment determination in British industry: investigations using micro data' *Review of Economic Studies*, 55, 5, pp. 955–70

Osterman, P. (2000) 'Work reorganization in an era of restructuring: Trends in diffusion and effects on employee welfare' *Industrial and Labor Relations Review* 53 (2): 179-196.

Payne, R. L. (1979), 'Demands, Supports, Constraints and Psychological Health', in C. J. Mackay and T. Cox (eds), *In Response to Stress: Occupational Aspects* (London, IPC Business Press) pp. 85–105

Piore, M. J. And Sabel, C. F. (1984) *The Second Industrial Divide: Possibilities for Prosperity*, Basic Books: New York

Pollard, T. M. (2001) 'Changes in mental well-being, blood pressure and total cholesterol levels during workplace reorganization: the impact of uncertainty', *Work and Stress*, 15, 1: 14-28

Rasmay, H., Scholarios, D. and Harley, B. (2000) 'Employees and high- performance work systems', *British Journal of Industrial Relations*, 39: 501-532

Vroman, S. B. (1990). "The union-nonunion wage differential and monitoring costs." *Economics Letters,* 32(4): 405-409

Warr, P. (2007) 'Work, Happiness, and Unhappiness', Mahwah: New Jersey

White, M. and Bryson, A. (2006) *Unions, Job Reductions and Job Security Guarantees: The Experience of British Employees*, Centre for Economic Performance Discussion Paper No. 745

Willman, P., Gomez, R. and Bryson, A. (2008) *Trading Places: Employers, Unions and the Manufacture of Voice*, CEP Discussion Paper No. 884

Wood, S. (1989) (ed.) *The Transformation of Work?* London: Unwin Hyman

Wood, S. (2008) 'Job characteristics, employee voice and well-being in Britain', *Industrial Relations Journal*, 39: 2, 153-168

Table 1: OLS for correlation between innovation and well-being

	Model (1)	Model (2)	Model (3)	Model (4)
Panel A: Innovation = NCHANGE				
nchange	-0.144	-0.108	-0.104	-0.131
	(5.34)**	(4.40)**	(4.20)**	(4.65)**
covered			-0.296	
			(2.46)*	
_Icovered_1				-0.769
				(3.02)**
_IcovXnchan_1				0.118
				(2.08)*
Constant	1.871	2.670	2.698	2.795
	(16.20)**	(11.05)**	(11.16)**	(11.41)**
R-squared	0.00	0.06	0.06	0.06
	Model (1)	Model (2)	Model (3)	Model (4)
Panel B: Innovation = NLABCHG				
nlabchg	-0.212	-0.175	-0.167	-0.200
	(5.17)**	(4.68)**	(4.46)**	(4.67)**
covered			-0.289	
			(2.41)*	
_Icovered_1				-0.598
				(2.83)**
_IcovXnlabc_1				0.151
				(1.76)
Constant	1.726	2.589	2.620	2.674
	(18.29)**	(11.16)**	(11.27)**	(11.40)**
R-squared	0.00	0.06	0.06	0.06
Panel C: Innovation = NCAPCHG				
ncapchg	-0.226	-0.141	-0.135	-0.180
	(4.24)**	(2.81)**	(2.68)**	(3.20)**
covered			-0.324	
			(2.70)**	
_Icovered_1				-0.676
				(2.70)**
_IcovXncapc_1				0.190
				(1.60)
Constant	1.728	2.515	2.554	2.630
	(15.76)**	(10.64)**	(10.77)**	(11.00)**
R-squared	0.00	0.06	0.06	0.06

Notes:

(1) Unweighted OLS of EWELLSC well-being scale. Robust estimator with clustered standard errors. T-stats in parentheses. *=significant at 95% confidence interval; **=significant at 99% confidence interval.

(2) N=13,181

(3) Model (1) no controls. Models (2)-(4) contain following controls: age (9 dummies); academic qualifications (8 dummies); vocational qualifications (3 dummies); single-digit occupation (9 dummies); and dummies for disability, gender, ethnicity and having any dependent children. The dummy for male is interacted with the dependent child dummy.

Table 2: Individual well-being and job satisfaction with workplace fixed effects

	Model (1) Innovation=NCHANGE	Model (2) Innovation=NLABCHG	Model (3) Innovation=NCAPCHG
Panel A: Well-being			
covered	-0.031	0.215	-0.376
	(0.08)	(0.65)	(1.08)
Covered*innovation	-0.019	-0.155	0.153
	(0.22)	(1.15)	(0.93)
Constant	2.218	2.219	2.212
	(9.39)**	(9.39)**	(9.36)**
R-squared	0.201	0.201	0.201
Panel B: Job satisfaction			
Covered	-0.016	-0.159	0.287
	(0.04)	(0.41)	(0.71)
Covered*innovation	0.067	0.198	-0.020
	(0.69)	(1.25)	(0.11)
Constant	2.783	2.782	2.787
	(9.90)**	(9.90)**	(9.91)
R-squared	0.256	0.256	0.256

Notes:

(1) Unweighted –areg- workplace fixed effects models. Panel A estimates are for the EWELLSC well-being scale. Panel B estimates are for the SATSC8 job satisfaction scale. Robust estimator with clustered standard errors. T-stats in parentheses. *=significant at 95% confidence interval; **=significant at 99% confidence interval.

(2) N=13,181 for well-being models. N=12714 for satisfaction models.

(3) All models contain controls as per Table 1.

Table 3: Individual Well-being using Instrumental Variables

	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)
Panel A: Innovation=NCHANGE						
Nchange	-0.109	-0.396	-0.104	-0.078	-0.132	-0.407
	(4.41)**	(4.85)**	(4.21)**	(0.57)	(4.67)**	(1.75)
Covered			-0.292	-2.626	-0.767	-9.492
			(2.43)*	(2.44)*	(3.01)**	(2.57)**
Cov*Nchange					0.118	1.743
					(2.09)*	(1.97)*
Panel B: Innovation=NLABCHG						
Nlabchg	-0.177	-0.616	-0.169	-0.132	-0.202	-0.651
	(4.74)**	(4.77)**	(4.51)**	(0.52)	(4.73)**	(1.39)
Covered			-0.285	-2.542	-0.599	-10.518
			(2.37)*	(2.01)*	(2.83)**	(2.11)*
Cov*Nlabchg					0.153	3.616
					(1.79)	(1.66)
Panel C: Innovation=NCAPCHG						
Ncapchg	-0.139	-1.089	-0.133	-0.220	-0.178	-1.125
	(2.78)**	(4.31)**	(2.65)**	(0.64)	(3.16)**	(1.80)
Covered			-0.322	-2.738	-0.671	-9.576
			(2.68)**	(3.06)**	(2.68)**	(2.54)*
Cov*Ncapchg					0.188	3.835
					(1.59)	(1.91)

Notes:

(1) N=13,153 for well-being models.

(2) All models contain controls as per Table 1 Model (1).

(3) Unweighted models. Robust estimator with clustered standard errors. T-stats in parentheses. *=significant at 95% confidence interval; **=significant at 99% confidence interval.

(4) Model (1) is OLS. Model (2) is –ivreg2- where innovation is instrumented with single-establishment organization, benchmarking, diverse products/services and local product market. Model (3) is OLS. Model (4) is –ivreg2- where innovation and coverage are instrumented with single-establishment organization, benchmarking, and mature/declining product market conditions. Model (5) is OLS. Model (6) is –ivreg2- where innovation,coverage and the cross-term are instrumented with single-establishment organization, benchmarking, and mature/declining product market conditions.

Table 4: OLS and –ivreg2- for workplace-level well-being using $\hat{\alpha}_f$.

	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)
Panel A: Innovation=NCHANGE					
nchange	-0.111	-0.110	-0.162	-0.535	-0.472
	(3.50)**	(3.48)**	(4.02)**	(3.88)**	(3.16)**
unionrec		-0.212			-1.050
		(1.39)			(1.14)
_Iunionrec_1			-0.821		
			(2.88)**		
_IuniXnchan_1			0.157		
			(2.66)**		
Constant	2.574	2.597	2.671	3.066	3.111
	(4.54)**	(4.59)**	(4.72)**	(4.99)**	(5.08)**
R-squared	0.10	0.10	0.10		
Panel B: Innovation=NLABCHG					
nlabchg	-0.167	-0.164	-0.233	-0.901	-0.829
	(3.64)**	(3.58)**	(3.99)**	(3.93)**	(3.06)**
unionrec		-0.191			-0.522
		(1.26)			(0.51)
_Iunionrec_1			-0.618		
			(2.58)*		
_IuniXnlabc_1			0.214		
			(2.44)*		
Constant	2.460	2.481	2.527	2.528	2.580
	(4.33)**	(4.38)**	(4.45)**	(4.23)**	(4.33)**
R-squared	0.10	0.10	0.10		
Panel C: Innovation=NCAPCHG					
ncapchg	-0.138	-0.140	-0.210	-1.241	-1.166
	(2.07)*	(2.09)*	(2.46)*	(3.08)**	(2.86)**
unionrec		-0.227			-1.946
		(1.49)			(2.12)*
_Iunionrec_1			-0.610		
			(2.21)*		
_IuniXncapc_1			0.217		
			(1.72)		
Constant	2.575	2.602	2.658	3.613	3.760
	(4.53)**	(4.59)**	(4.68)**	(4.90)**	(5.04)**
R-squared	0.09	0.09	0.10		

Notes:

(1) Models (1), (2) and (3) are OLS. Models (4) and (5) are –ivreg2-. The following dummy variables were used as instrumental variables for innovation in Model (4) and innovation and unionization in Model (5): single-establishment organization; the market for the main product/service is 'local'; the workplace produces several different products or services; and whether the workplace had benchmarked itself against other workplaces.

(2) Dependent variable $\hat{\alpha}_f$ are workplace fixed effect coefficients from first stage –areg- equation estimating individual-level well-being with individual control variables as per Table 1.

(2) All models are unweighted and use robust estimator. T-stats in parentheses. *=significant at 95% confidence interval; **=significant at 99% confidence interval.

(3) N=1,228 workplaces.

(4) All models contain following controls: single-digit industry (11 dummies); region (10 dummies); log workplace employment size and its squared term; the percentage of employees who are female and its squared term; and single dummies for low travel-to-work-area unemployment (below 1.2%) and location in an urban area.

Table 5: OLS and –ivreg2- for workplace-level job satisfaction using $\hat{\alpha}_f$.

	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)
Panel A: Innovation=NCHANGE					
nchange	-0.057	-0.055	-0.068	-0.663	-0.401
	(1.44)	(1.40)	(1.44)	(3.74)**	(2.02)*
unionrec		-0.862			-4.243
		(4.33)**			(3.27)**
_Iunionrec_1			-1.010		
			(2.70)**		
_IuniXnchan_1			0.038		
			(0.48)		
Constant	3.381	3.473	3.491	4.093	4.247
	(4.65)**	(4.80)**	(4.81)**	(5.14)**	(5.19)**
R-squared	0.16	0.17	0.18		
Panel B: Innovation=NLABCHG					
nlabchg	-0.131	-0.118	-0.138	-1.181	-0.618
	(2.20)*	(2.00)*	(1.93)	(4.00)**	(1.75)
unionrec		-0.846			-3.967
		(4.26)**			(2.83)**
_Iunionrec_1			-0.969		
			(3.08)**		
_IuniXnlabc_1			0.061		
			(0.51)		
Constant	3.326	3.417	3.430	3.423	3.802
	(4.59)**	(4.74)**	(4.75)**	(4.46)**	(4.85)**
R-squared	0.16	0.18	0.18		
Panel C: Innovation=NCAPCHG					
ncapchg	-0.012	-0.019	-0.038	-1.370	-1.152
	(0.14)	(0.23)	(0.39)	(2.70)**	(2.14)*
unionrec		-0.867			-4.972
		(4.34)**			(3.93)**
_Iunionrec_1			-0.975		
			(2.73)**		
_IuniXncapc_1			0.061		
			(0.38)		
Constant	3.325	3.426	3.442	4.618	4.951
	(4.55)**	(4.72)**	(4.73)**	(4.88)**	(5.03)**
Observations	1228	1228	1228	1228	1228
R-squared	0.16	0.17	0.17		

Notes:

(1) Models (1), (2) and (3) are OLS. Models (4) and (5) are –ivreg2-. Instrumentation is as per Table 4.

(2) Dependent variable $\hat{\alpha}_f$ are workplace fixed effect coefficients from first stage –areg- equation estimating individual-level job satisfaction with individual control variables as per Table 1.

(2) All models are unweighted and use robust estimator. T-stats in parentheses. *=significant at 95% confidence interval; **=significant at 99% confidence interval.

(3) N=1,228 workplaces.

(4) All models contain controls as per Table 4.

Appendix Table 1: OLS and –ivreg2- for workplace-level well-being using EWELLSC

	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)
Panel A: Innovation=NCHANGE					
nchange	-0.136	-0.135	-0.198	-0.684	-0.584
	(4.04)**	(4.01)**	(4.65)**	(4.61)**	(3.67)**
unionrec		-0.303			-1.668
		(1.88)			(1.69)
_Iunionrec_1			-1.047		
			(3.50)**		
_IuniXnchan_1			0.192		
			(3.06)**		
Constant	4.095	4.128	4.218	4.732	4.802
	(6.88)**	(6.96)**	(7.11)**	(7.14)**	(7.24)**
R-squared	0.13	0.13	0.14		
Panel B: Innovation=NLABCHG					
nlabchg	-0.202	-0.198	-0.281	-1.142	-0.992
	(4.13)**	(4.05)**	(4.52)**	(4.58)**	(3.43)**
unionrec		-0.278			-1.082
		(1.74)			(1.00)
_Iunionrec_1			-0.794		
			(3.13)**		
_IuniXnlabc_1			0.258		
			(2.76)**		
Constant	3.956	3.986	4.041	4.042	4.149
	(6.64)**	(6.70)**	(6.79)**	(6.26)**	(6.49)**
R-squared	0.13	0.13	0.14		
Panel C: Innovation=NCAPCHG					
ncapchg	-0.179	-0.181	-0.266	-1.611	-1.504
	(2.55)*	(2.58)*	(2.97)**	(3.68)**	(3.36)**
unionrec		-0.322			-2.762
		(1.99)*			(2.68)**
_Iunionrec_1			-0.785		
			(2.75)**		
_IuniXncapc_1			0.262		
			(2.00)*		
Constant	4.105	4.144	4.212	5.454	5.661
	(6.87)**	(6.96)**	(7.06)**	(6.70)**	(6.78)**
R-squared	0.13	0.13	0.13		

Notes:
(1) Models (1), (2) and (3) are OLS. Models (4) and (5) are –ivreg2-. Instrumentation and controls are as per Table 4.
(2) Dependent variable is mean workplace-level employee well-being.
(3) All models are unweighted and use robust estimator. T-stats in parentheses. *=significant at 95% confidence interval; **=significant at 99% confidence interval.
(3) N=1,228 workplaces.

Appendix Table 2: OLS and –ivreg2- for workplace-level job satisfaction using SATSC8

	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)
Panel A: Innovation=NCHANGE					
nchange	-0.059	-0.056	-0.071	-0.596	-0.311
	(1.43)	(1.38)	(1.45)	(3.34)**	(1.54)
unionrec		-0.987			-4.609
		(4.83)**			(3.51)**
_Iunionrec_1			-1.167		
			(3.04)**		
_IuniXnchan_1			0.046		
			(0.57)		
Constant	7.526	7.631	7.653	8.158	8.324
	(10.06)**	(10.28)**	(10.27)**	(10.12)**	(9.92)**
R-squared	0.19	0.21	0.21		
Panel B: Innovation=NLABCHG					
nlabchg	-0.137	-0.122	-0.149	-1.092	-0.464
	(2.24)*	(2.02)*	(2.03)*	(3.68)**	(1.29)
unionrec		-0.970			-4.428
		(4.76)**			(3.11)**
_Iunionrec_1			-1.135		
			(3.52)**		
_IuniXnlabc_1			0.083		
			(0.67)		
Constant	7.470	7.574	7.592	7.559	7.981
	(10.03)**	(10.25)**	(10.24)**	(9.76)**	(9.87)**
R-squared	0.19	0.21	0.21		
Panel C: Innovation=NCAPCHG					
ncapchg	-0.002	-0.009	-0.030	-1.148	-0.923
	(0.02)	(0.11)	(0.30)	(2.28)*	(1.71)
unionrec		-0.991			-5.167
		(4.84)**			(4.10)**
_Iunionrec_1			-1.105		
			(3.03)**		
_IuniXncapc_1			0.065		
			(0.39)		
Constant	7.459	7.574	7.591	8.550	8.897
	(9.92)**	(10.16)**	(10.16)**	(9.03)**	(8.98)**
R-squared	0.19	0.21	0.21		

Notes:
(1) Models (1), (2) and (3) are OLS. Models (4) and (5) are –ivreg2-. Instrumentation and controls are as per Table 4.
(2) Dependent variable is mean workplace-level employee job satisfaction.
(2) All models are unweighted and use robust estimator. T-stats in parentheses. *=significant at 95% confidence interval; **=significant at 99% confidence interval.
(3) N=1,228 workplaces.