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Abstract

We develop a model of incomplete employment contracts such that employees have some discretion over effort, which depends on their work morale. Nominal wage cuts have a strong negative effect on morale, while employee involvement in workplace decision-making tends to increase morale. We derive predictions on how these two mechanisms affect the decisions of firms to cut nominal wages. Using matched employer-employee and manager survey data from Great Britain, we find support for our model: nominal wage cuts are only half as likely when managers think that employees have some discretion over how they perform their work, but this reduced likelihood recovers partially when employees are involved in the decision-making process at their workplace.

Keywords: Wage rigidity; Reciprocity; Workplace relations; Employer-employee data

JEL codes: E24, E70, J31, J41

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1. Introduction

Firms tend to avoid cutting nominal wages. Survey responses from compensation managers suggest that this is because of concerns about damaging employee morale and productivity.[1] This provides an explanation for downward nominal wage rigidity, a well-established empirical fact and a central theme in macroeconomics, affecting a wide range of issues from optimal exchange rate regimes to macroeconomic stabilisation.[2] Despite a large body of empirical literature measuring the extent of nominal wage rigidity, much less is known about whether those managers' concerns systematically translate into actual restraint about wage cuts.[3] This paper attempts to deepen the understanding of this issue.

The idea that wage cuts damage employee morale and productivity relies on two premises. First, wage cuts may be perceived as unfair, especially when there is no apparent explanation for them, because employees are not involved in the decision-making processes at their workplace. Second, employees have some discretion over how they perform their jobs, and can use that margin to retaliate against unfair treatment from their employer. In this paper, we study theoretically and empirically how these two features of the employment contract – namely, employee involvement in workplace decision-making and contractual incompleteness – affect a firm's decision to cut nominal wages. To do so, we develop a model in which employees can choose their work effort after observing the wages set by the firm. A nominal wage cut leads to a drop in effort and productivity, since employees retaliate against what they perceive as unfair treatment. This negative response is somewhat mitigated when employees feel involved in workplace decision-making, because involvement boosts employee morale. We test the predictions of our model using a longitudinal matched employee-employer dataset of wages that is linked to a manager survey from Great Britain. Confirming our predictions, year-to-year nominal wage cuts are only half as likely when managers believe that their employees have some discretion over how they perform their jobs, but this likelihood recovers by up to 10 percent when employees are also involved in the decision-making process at their workplace.

The contribution of this paper goes beyond the existing literature in a number of ways. First, we uncover a significant form of heterogeneity in the frequency of nominal wage cuts, which is based on two *observable* features of the employment contract: employee involvement in decision-making and contractual incompleteness. This matters, since we bridge the existing gap between models of wage-setting that are based on unobservable variables (such

[1] See Kaufman (1984), Bewley (1999), Campbell and Kamlani (1997), and Agell and Lundborg (1995, 2003).

[2] Dupraz et al. (2019) argue that downward nominal wage rigidity is needed to account for the sharp increase in unemployment during recessions. Christiano et al. (2005) identify rigid nominal wages as the crucial nominal friction needed in New Keynesian models to match the empirical persistence of unemployment and inflation. Schmitt-Grohé and Uribe (2016) argue that economic interventions can be justified if excess supply in the labour market does not self-correct through wage adjustments in systems with fixed exchange rates.

[3] See Elsby and Solon (2019) for a recent survey of the empirical evidence on nominal wage rigidity.

as fairness, morale, and effort), and what can be measured in the data. We then use a unique longitudinal dataset to quantitatively evaluate the economic significance of the two aforementioned features of the employment contract. Our findings suggest that compensation managers tend to act on their concerns about morale and fairness, and these concerns are mitigated by the use of employee involvement practices. The results not only help explain when but also to what extent we observe heterogeneity in the frequency of nominal wage cuts across firms.

Our dataset is ideally suited for our analysis. It combines information on managers' perceptions of their employees' characteristics from the Workplace Employment Relations Study, with accurate payroll-based data on wages and workplace characteristics from the Annual Survey of Hours and Earnings from Great Britain. This approach means that we lose some observations through the linking of the two datasets, but it also offers a number of important advantages. First, the dataset contains information on the two key dimensions we are interested in: the degree of employees' discretion over how they perform their jobs and how much they are involved in workplace decision-making. Importantly, these variables are measured from the manager's perspective. Since wages are set by firms in our model, it is the employer's perspective that matters. Second, our dataset allows us to analyse employer-reported wage data, which are more accurate than data from household surveys (Elsby et al., 2016). Results about the frequency of nominal wage cuts based on household survey data have frequently been discounted on the grounds that self-reported wages contain substantial response errors. Third, our dataset provides detailed records on basic wages, hours worked, and extra pay components. These allow us to study basic wages *per hour* separately from extra pay components, comparing like-for-like measures of hourly pay over time, and to analyse separately the role of extra pay components, such as incentive pay.

Our theoretical framework is in the sociological tradition of efficiency wage models (Akerlof, 1982; Akerlof and Yellen, 1990), building on their more recent dynamic versions developed by Elsby (2009) and Dickson and Fongoni (2019). We consider employment contracts in which the extent of an employee's discretion over how much effort to exert can vary. Effort depends on morale, which in turn depends on the employee's evaluation of the wage relative to a reference "fair" wage, modelled in our case by the past wage: wage increases boost morale and effort, while wage cuts have the opposite effect. We assume that employees are loss averse, which results in them being particularly averse to wage cuts. A sense of involvement in decision-making can increase employee morale, by mitigating the demoralising effect of wage cuts. This framework generates two novel and testable predictions: firms cut wages less frequently when employees have more discretion; and conditional on this, wage cuts occur more frequently when employees are involved in workplace decision-making.

We estimate models for the conditional likelihood of a year-to-year basic wage cut among employees who stay with the same employer. We find that basic wage cuts are substantially less likely when managers think that employees have some discretion over their performance, corroborating a key prediction of the model. For example, the likelihood of receiving a wage cut decreases from 20.6 to 11.6 percent if the manager thinks that employees have some discretion at work. We also find that, conditional on employees having some discretion, basic wage cuts are more likely when managers perceive employees to be involved in workplace decision-making. The point estimates of involvement in decision-making are smaller than for discretion, but statistically significant: the conditional likelihood of a year-to-year basic wage cut increases from 11.6 to 12.3 percent if employees are involved. Both results confirm the key predictions of our theoretical framework. We also investigate the relevance of the predictions by considering the role of extra pay components (e.g., incentive pay, travel allowances) - firms might prefer to cut pay along this margin rather than cutting basic wages. To investigate this, we estimate models for the conditional likelihood of a year-to-year cut for employees that receive only basic wages (no extra pay) as well using gross wages (the basic wage plus extra pay). We find that having some discretion decreases the likelihood of receiving a basic wage cut even more so among those employees that receive only basic wages, while the effect of having some discretion on the likelihood of receiving a gross wage cut is weaker, but still significantly negative. The estimated effect of involvement remains positive, but becomes statistically insignificant in both models. These findings suggest that extra pay can offer a margin for downward wage adjustments that might impact employee performance less adversely than cuts in basic wages.

Related Literature

Our conceptual framework around nominal wage cuts is informed by findings from survey responses of compensation managers, as well as from developments in the behavioural economics of employment relations. The consensus is that managers refrain from cutting nominal wages due to concerns about morale, fairness, and reciprocity (Bewley, 1999; Fehr et al., 2009). Morale is particularly important for fostering productivity and cooperation in the workplace, and it is in the firm's interest to preserve it and treat employees fairly. Nominal wage cuts, if perceived as unfair, can be detrimental to morale, and can be particularly costly to implement in terms of the consequent productivity losses from any employee retaliation. This reasoning, which forms the basis for efficiency wage theories, is based on the premise that the employment contract is incomplete (Williamson, 1975; Okun, 1981), such that employees have some discretion on the pace, quality, and amount of work they perform. Discretionary effort is not contractible.

Are wage cuts always perceived as unfair? Compensation managers also report that information sharing and justifications around such decisions can alleviate the mentioned adverse effects of nominal wage cuts (Campbell and Kamlani, 1997; Bewley, 1999). In a recent laboratory experiment, Guido et al. (2022) find that subject-employees' negative effort response to wage cuts is significantly weaker when they are informed about an exogenous decrease in their subject-firm's payoff. The authors also find that subject-firms cut wages more sharply when they know their employees are informed. These observations are supported by organisational psychology studies (Greenberg, 1990; Schaubroeck et al., 1994), which also find that information provision and participation in decision-making increase an employee's sense of control over the allocation of the wage fund, reduce feelings of hostility, enhance job satisfaction, and promote organisational commitment (Bordia et al., 2004; Timming, 2012). Employee involvement, defined by Wang and Seifert (2017) as information sharing and employee participation in decision-making, may reduce the detrimental effects of nominal wage cuts on morale, allowing firms to cut wages more frequently.

Our paper contributes to two strands of literature. From a theoretical perspective, it contributes to the dynamic efficiency-wage models of downward wage rigidity of Elsby (2009) and Dickson and Fongoni (2019) among others. Elsby (2009) analyses a dynamic wage-setting model in which employees' aversion to nominal wage cuts generates downward wage rigidity. Dickson and Fongoni (2019) develop a theory of employee reciprocity and optimal firm wage-setting based on morale, fairness, reference dependence, and loss aversion in the evaluation of wages by employees. They provide a formal framework in which they analyse both the sources and consequences of wage rigidity for wage setting and hiring. The model in our paper here combines and extends both frameworks, by explicitly modelling the extent of employee discretion on the production of output, alongside the interplay between employee involvement and morale. From an empirical perspective, our paper contributes to the recent literature on downward nominal wage rigidity. This literature typically analyses administrative data on total earnings, finding little evidence of nominal wage rigidity (see the recent survey by Elsby and Solon, 2019). However, two recent papers by Grigsby et al. (2021) and Schaefer and Singleton (2022) show that basic wage cuts occur very rarely in administrative payroll-based data, and basic wage freezes are far more common than previously thought. However, only a few studies examine which employee characteristics affect the likelihood of wage cuts (e.g., Kahn, 1997; Elsby et al., 2016), and even fewer studies examine the connection between workplace characteristics and nominal wage rigidity (e.g., Schaefer and Singleton, 2022). The only study that analyses at least one of the dimensions proposed here is Wang and Seifert (2017), which presents survey evidence that the adverse impact of real wage cuts on job satisfaction is mitigated when employees feel involved in workplace decision-making. Importantly, the authors measure this variable from the employee's perspective, while our framework clearly points to the firm's perspective as being decisive.

The paper is structured as follows: Section 2 develops a model of effort choice and optimal wage-setting, and derives testable predictions; Section 3 describes the two datasets that we combine, as well as our sample selection; Section 4 presents probit model estimates on how employee discretion and involvement affect the conditional likelihood of year-to-year nominal wage cuts, along with a number of robustness checks; and Section 5 concludes.

2. Theoretical model

In this section, we develop a model of employee effort choice and firm wage-setting behaviour. Our framework combines the dynamic wage-setting model of Elsby (2009) with the theory of morale and asymmetric reciprocity of Dickson and Fongoni (2019), extending both in two ways. First, we explicitly model the extent to which the employment contract is incomplete. This enables us to characterise how the discretionary and non-contractible component of an employee's effort affects a firm's optimal wage-setting policy. Second, we model the link between employee involvement and employee morale, to analyse how the former affects the employee's choice of effort and, therefore, the optimal wage-setting policy of firms.

This theoretical framework generates two important insights. The cost of implementing nominal wage cuts is proportional to the degree of contractual incompleteness, as the resulting drop in employees' discretionary effort may outweigh the benefit of reducing the labour cost. However, employee involvement in decision-making can help to mitigate the aversion of employees to nominal wage cuts, making them more likely to occur.

2.1 Environment

We consider a representative one-employee-one-firm employment relationship. Time is discrete. At the beginning of each period, the firm observes the aggregate state of the economy and decides on the nominal wage to pay its employee. After evaluating the wage, the employee decides how much discretionary effort to exert. Since choices are sequential, and we assume both the firm and the employee have complete and perfect information, the model can be solved by backward induction.[4] Hence, wage setting can be thought of as the outcome of a two-stage game in which the firm makes a take-it-or-leave-it wage offer to the employee, who subsequently chooses effort.[5] For simplicity, we abstract from participation decisions and assume that the employee will accept any wage contract. Nevertheless, as long as there is a wedge between the reservation wage and the reference wage, the results established below remain valid.

In what follows, we adopt the convention of denoting forward values with a prime $'$ and backward values with the subscript $_{-1}$. The aggregate state of the economy is captured by

[4] See Dickson and Fongoni (2019) for more details on the validity of backward induction as an equilibrium solution concept in such a setting.

[5] Alternatively, this setting can be derived from a wage bargaining framework in which the employees have no bargaining power. For evidence on the relative incidence of take-it-or-leave-it wage offers and wage bargaining in employment relationships, see Hall and Krueger (2012) and Brenzel et al. (2014).

a nominal shock Z (e.g., a shock to nominal aggregate demand). The evolution of Z is given by the cumulative distribution function $F(Z'|Z)$, with some initial value Z_0, and it evolves according to $Z' = Z\exp(\Pi + \xi')$, where Π is the inflation rate and $\xi' \sim \mathcal{N}(0,\sigma^2)$.

2.1.1 The firm's profit

The firm's nominal output in each period is given by $Y(Z,E) = ZE$, where E is the effort exerted by the employee. The employment contract is incomplete: the employee's effort is, at least in part, discretionary. We assume that E is determined as follows:

$$E = \alpha e^c + [1-\alpha]e^d \ , \tag{1}$$

where $e^c > 0$ denotes the contracted effort, which is the minimum level of effort required by the employment contract. The discretionary component of effort is e^d and is chosen by the employee. The parameter $\alpha \in [0,1]$ captures the degree of incompleteness of the employment contract. A larger value of α implies that the contract is less incomplete, so the employee's discretionary effort has a smaller impact on output. For instance, the contract of an assembly-line employee who performs a highly specialised task would be characterised by a high value of α. In contrast, the contract of a product designer or researcher would be characterised by a low value of α.

Let W denote the nominal wage contract, and let $\tilde{e}^d$ denote the employee's optimal choice of discretionary effort, which we derive below (throughout the paper the tilde over a variable/function is used to denote endogenous variables/functions which are obtained as a result of an optimal choice). The firm's nominal profit in each period is then given by:

$$Z\{\alpha e^c + [1-\alpha]\tilde{e}^d\} - W \ , \tag{2}$$

after substituting for the employee's effort E in the production function using Equation (1). If $\alpha = 1$, then the firm's production function collapses to a linear function with labour as the only input. If $\alpha = 0$, then the model collapses to the class of models analysed in, for instance, Elsby (2009) and Dickson and Fongoni (2019). From here on, we focus on the intermediate case of $\alpha \in (0,1)$, and study how the degree of contractual incompleteness affects the firm's optimal wage-setting policy.[6]

[6] In Appendix A.2, we analyse the predictions of the model for the case in which $\alpha = 1$.

2.1.2 The employee's payoff

The employee's utility in each period takes the following form:

$$u(e^d, W, W_{-1}) = W - \Big\{0.5[e^c + e^d]^2 - b[e^c + e^d]\Big\} + M(e^d, W, W_{-1})\ . \tag{3}$$

The first term captures the benefit of being paid the wage W. The second term captures the employee's intrinsic psychological net cost of effort, which implies that if there were no relative pay considerations, then the employee would choose to exert $\tilde{e}^d = b - e^c$. We refer to this as 'normal' discretionary effort and denote it with $\tilde{e}^n \equiv b - e^c$. We assume that $b > e^c$ and that b is sufficiently large such that utility is positive for any given positive wage W and discretionary effort level e^d.[7] Finally, the term $M(e^d, W, W_{-1})$ captures a 'morale function' (Dickson and Fongoni, 2019) that depends on the employee's evaluation of the wage with respect to a reference 'fair' wage, which in our model is given by the past wage W_{-1}.[8] We assume that M takes the following form:

$$M(e^d, W, W_{-1}) = e^d \Big\{[1-\varphi]\mu(\ln W - \ln W_{-1}) + \varphi[\ln W - \ln W_{-1}]\Big\}\ , \tag{4}$$

where μ is a piecewise-linear gain-loss function that exhibits loss aversion: $\mu(x) = x$ if $x \geq 0$, and $\mu(x) = \lambda x$ if $x < 0$; and $\lambda > 1$ is an employee's degree of loss aversion. The parameter $\varphi \in (0,1)$ captures the second key extension of our model – the extent to which the employee is involved in the decision-making process in the firm. We assume that φ is fixed and positively correlated with the extent of employee involvement. As such, the morale function captures the psychological cost, or benefit, of discretionary effort associated with the employee's evaluation of the wage relative to the past wage, as well as their utility from being involved in decision-making within the firm.

The morale function in Equation (4) has a number of important features. First, it captures the effects of nominal wage changes on an employee's utility: a wage increase implies some additional benefit of exerting effort, hence, higher effort will increase utility; a wage cut implies that effort is more psychologically costly to exert, and lower effort will increase utility. Since effort is discretionary, the morale function implies that the employee's preferences exhibit reciprocity: when a firm improves the terms of the contract by increasing the wage (which the employee perceives as a kind action), the employee will positively reciprocate by increasing effort (a kind action toward the firm); and *vice versa*, when a firm decreases the wage (perceived as an unkind action), the employee will negatively reciprocate by decreasing effort (an unkind action towards the firm). Second, loss aversion implies that a nominal

[7] Since we abstract from participation decisions, this assumption simply ensures that the employee will prefer employment to unemployment.

[8] The assumption that past contracts can serve as a reference point is supported by a large body of evidence from behavioural economics, see, e.g., Kahneman et al. (1986), Bewley (2007), Sliwka and Werner (2017) in the context of labour markets, and Fehr et al. (2011), Bartling and Schmidt (2015) and Herz and Taubinsky (2017) in the context of incomplete contracts.

wage cut has a stronger negative effect on an employee's morale than an equally-sized wage increase has a positive effect. Loss aversion is the behavioural source underlying an employee's particular aversion to nominal wage cuts (Dickson and Fongoni, 2019). Finally, the specific formulation in Equation (4) implies that a higher degree of involvement (higher value of φ) attenuates the impact of wage cuts on morale and, therefore, reduces the additional psychological cost of effort that employees will perceive as a consequence of a nominal wage cut. All else equal, as employees receive both nominal wage cuts and raises over the duration of their employment relationships, higher involvement will increase morale, on average.[9]

2.2 Optimal wage-setting and discretionary effort

In what follows, we characterise more formally the behaviour of employees and firms. We first derive the employee's optimal choice of discretionary effort, for a given nominal wage W relative to W_{-1}. Then we derive the firm's optimal wage-setting policy, considering the employee's effort response.

As long as the employment contract is incomplete, $\alpha < 1$, effort will be discretionary. In each period, the employee will choose the optimal level of effort $\tilde{e}^d$ that maximises their utility (23) for a given W and W_{-1}.

Lemma 1. *For all $\alpha \in (0,1)$, the employee's optimal choice of effort is given by:*

$$\tilde{e}^d = \tilde{e}^d(W, W_{-1}, \gamma) = \begin{cases} \tilde{e}^n + \ln W - \ln W_{-1} & \text{if} \quad W > W_{-1} \\ \tilde{e}^n & \text{if} \quad W = W_{-1} \\ \tilde{e}^n + \gamma[\ln W - \ln W_{-1}] & \text{if} \quad W < W_{-1}\,; \end{cases} \tag{5}$$

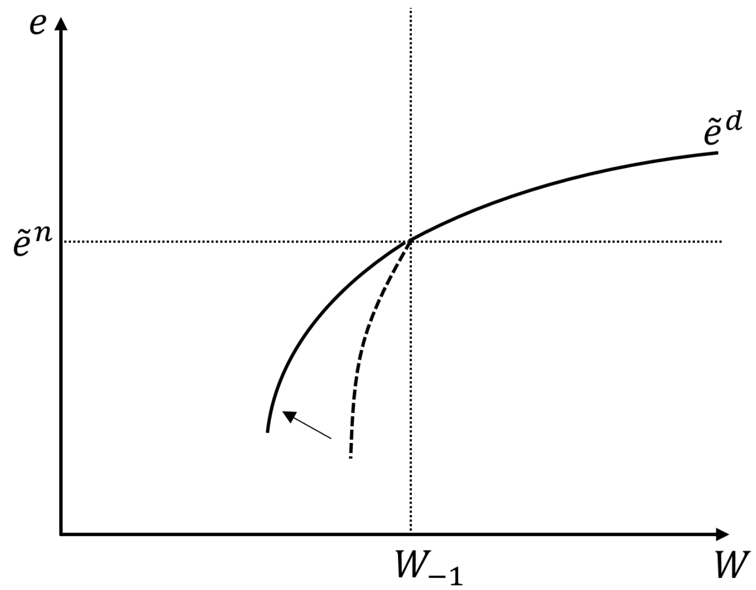
whereby $\gamma \equiv \{[1-\varphi]\lambda + \varphi\}$. It follows that $\gamma \in (1, \lambda)$.

Figure 1 displays $\tilde{e}^d$ as a function of the nominal wage W relative to W_{-1}, as implied by Lemma 1: following an increase in the wage, the employee will exert $\tilde{e}^d > \tilde{e}^n$, while in response to a wage cut, the employee will exert $\tilde{e}^d < \tilde{e}^n$. If the wage is frozen, then the optimal effort choice is $\tilde{e}^d = \tilde{e}^n$, which is independent of the absolute wage level.

The strength of the response to a nominal wage cut compared to a wage rise is determined by an employee's coefficient of loss aversion and their degree of involvement in decision-making. For a given degree of involvement, φ, effort responds more strongly to nominal wage cuts than to nominal wage increases, due to loss aversion. The more an

[9] Alternatively, we could model involvement in decision-making as a device through which the employer can inform their employee about the state of the economy, which in turn affects the employee's perception about the fairness of the wage they are paid by changing their reference point, for instance. In Appendix A.3, we illustrate the implications of such an extension and show that its predictions are consistent with what we obtain from our current approach. Nevertheless, we prefer our current approach as it allows us to characterise a continuous mapping between the degree of involvement and the probability of nominal wage cuts.

FIGURE 1: Optimal choice of discretionary effort



Notes: The arrow shows the effect of an increase in involvement φ on optimal discretionary effort $\tilde{e}^d$. The dashed line shows optimal discretionary effort before the increase in involvement. The visible kink at $(W_{-1}, \tilde{e}^n)$ represents the impact of loss aversion on effort.

employee is loss averse (the greater λ), the stronger is their relative response to wage cuts, because γ is larger. In addition, as the degree of involvement becomes larger, the strength of the response to wage cuts becomes smaller, all else equal. This implies that involvement practices will attenuate an employee's negative response to nominal wage cuts, because they reduce the impact of nominal wage cuts on morale as γ gets smaller. The effect of an increase in φ on the optimal choice of effort is displayed in Figure 1, which shows that involvement effectively 'flattens the kink' in the optimal-effort function caused by loss aversion.

We now characterise the firm's optimal wage-setting policy. Anticipating the response of the employee, and for a given W_{-1} and Z, in each period the firm will set the wage that maximises the expected discounted sum of profits. This optimisation problem can be expressed recursively as follows:

$$J(W_{-1}, Z) = \max_{W} \left\{ Z\{\alpha e^c + [1-\alpha]\tilde{e}^d(W, W_{-1}, \gamma)\} - W + \frac{\delta}{\exp(\Pi)} \int J(W, Z') dF(Z'|Z) \right\}, \quad (6)$$

where $\tilde{e}^d(W, W_{-1}, \gamma)$ is given by Equation (5). The firm's problem in Equation (6) falls within the class of wage-setting problems that have been analysed by Elsby (2009), and Dickson and Fongoni (2019). The reader is referred to these papers and to Appendix A.1 for a more detailed treatment. The following proposition characterises the optimal wage policy, denoted by $\widetilde{W}$, in the environment considered in this paper.

Proposition 1. *For all $\alpha \in (0,1)$, the firm's optimal wage policy is given by:*

$$\widetilde{W} = \begin{cases} \frac{1-\alpha}{\overline{u}(\gamma)} Z \quad > W_{-1} & if \quad Z > Z^u(W_{-1}) \\ W_{-1} & if \quad Z \in [Z^l(W_{-1}), Z^u(W_{-1})] \\ \frac{1-\alpha}{\overline{l}(\gamma)} Z \quad < W_{-1} & if \quad Z < Z^l(W_{-1}) \,; \end{cases} \tag{7}$$

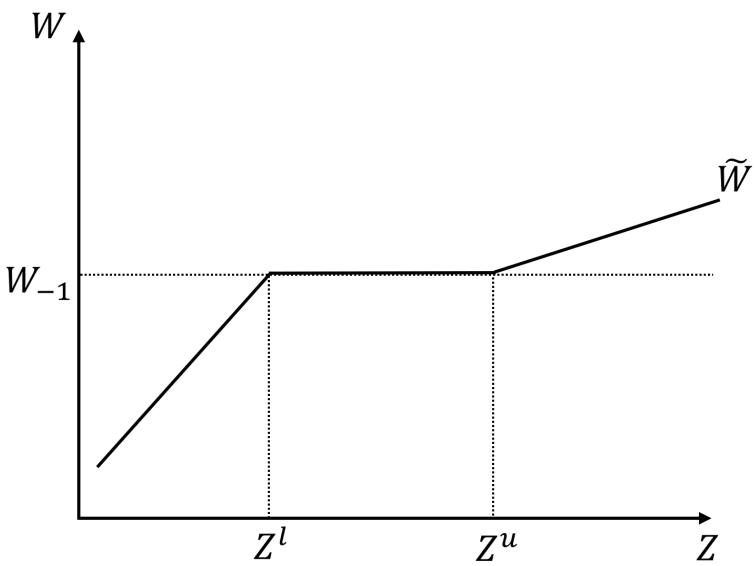
whereby

$$Z^u(W_{-1}) = \frac{\overline{u}(\gamma)}{1-\alpha} W_{-1} \,, \quad Z^l(W_{-1}) = \frac{\overline{l}(\gamma)}{1-\alpha} W_{-1} \,; \tag{8}$$

$\overline{u}(\gamma)$ and $\overline{l}(\gamma)$ are functions of the other model parameters; and $\overline{u}(\gamma) > \overline{l}(\gamma)$ since $\gamma > 1$.

Figure 2 shows the firm's optimal wage policy established in Proposition 1: if the employment contract is incomplete, then the nominal wage set by the firm in each period is non-decreasing in the aggregate state Z, and there is a range of Z – namely $[Z^l(W_{-1}), Z^u(W_{-1})]$ – in which the wage is not adjusted. This 'range of rigidity' is non-empty due to the employee being particularly averse to nominal wage cuts. In this region, the benefit of reducing the nominal wage would be more than offset by the reduction in output due to the employee's negative effort response. Moreover, the stronger this response (i.e., the larger is γ), the greater the range of rigidity. Combining this with the results established in Lemma 1, we can deduce that a higher degree of involvement will make wage cuts less costly to firms, such that the range of rigidity shrinks, as long as the employment contract is incomplete.

FIGURE 2: Optimal wage-setting policy



Notes: The solid line displays the optimal wage policy, $\widetilde{W}$ as a function of the nominal shock Z.

The wage policy in Proposition 1 also implies that the less incomplete the contract is (i.e., the larger is α), the lower the optimal wage paid to the employee. Intuitively, in employment contracts where discretionary effort is less relevant for output, firms have a lower incentive to pay an 'efficiency wage' to boost morale and appeal to employees' reciprocity.

2.3 Predictions about the frequency of nominal wage cuts

In this section, we analyse how both contractual incompleteness and employee involvement in decision-making within the firm affect the probability of an employee experiencing nominal wage cuts.

The results established in Proposition 1 imply that firms will cut the nominal wage whenever the benefit of doing so outweighs the drop in output due to the employee's effort response. More precisely, the nominal wage will be cut whenever the realisation of Z is low enough such that $Z < Z^l(W_{-1})$. We denote a log nominal wage change between two periods as $\Delta \ln \widetilde{W} \equiv \ln \widetilde{W} - \ln W_{-1}$. For a given distribution of Z, it is possible to express the probability that the nominal wage is cut, conditional on the past wage, as:

$$\mathbb{P}\{\Delta \ln \widetilde{W} < 0 | W_{-1}\} = F(Z^l(W_{-1})|Z_{-1}, W_{-1}). \tag{9}$$

The next two propositions establish how α (completeness) and φ (involvement) affect this probability.

Proposition 2. *The probability of nominal wage cuts, conditional on* W_{-1}*, is increasing in* α*.*

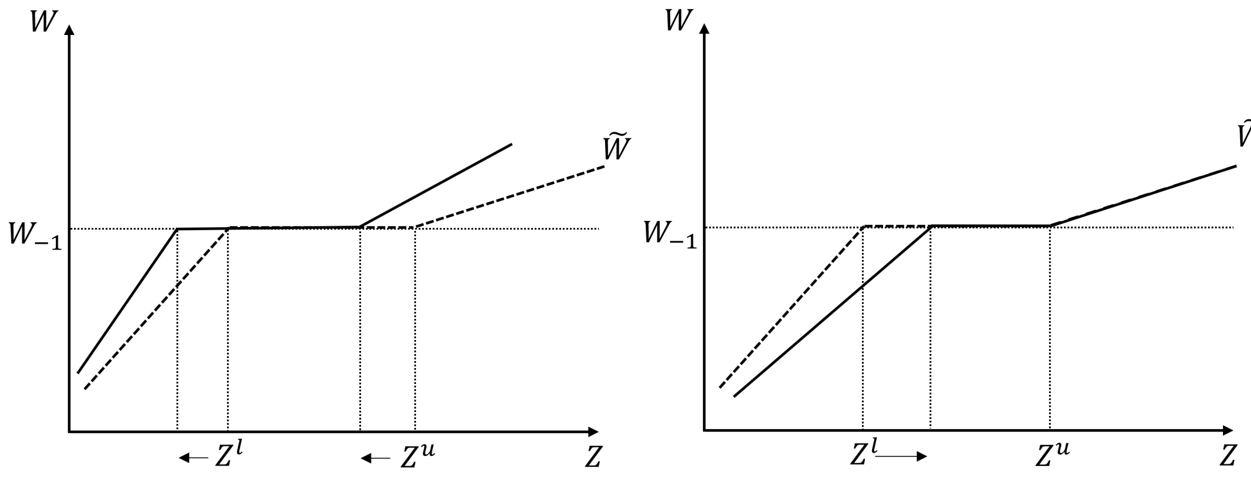
Proposition 2 establishes that the less incomplete the contract is, the less employees can retaliate for a wage cut by reducing their discretionary effort, and the more likely the firm will be to cut nominal wages. The effect of a decrease in α (and therefore of an increase in discretion) on the firm's optimal wage policy is shown in panel A of Figure 3.

Proposition 3. *The probability of a nominal wage cut, conditional on* W_{-1}*, is increasing in* φ*.*

Conditional on the employment contract being incomplete, Proposition 3 establishes that the more the employee is involved in the decision-making process at the firm, the smaller will be the effect of a given nominal wage cut on morale, which implies that the likelihood of experiencing nominal wage cuts is larger. This effect is shown in panel B of Figure 3.

These propositions are inherently testable, but they require either an experimental setting or data from real-world employment relationships about the degree of contractual incompleteness and employee involvement in decision-making, importantly, both observed from the perspective of the firm. In the remainder of the paper, we construct a dataset containing such information and subsequently test both predictions about the likelihood of employees receiving nominal wage cuts.

FIGURE 3: Effects of discretion and involvement on the firm's optimal wage-setting policy



A. Effect of an increase in discretion (α) B. Effect of an increase in involvement (φ)

Notes: The dashed lines indicate the optimal wage policy before the respective parameter change. These comparative statics results are confirmed by numerical simulations of the model, which also show that the effect of φ on Z^u is non-monotonic, with Z^u decreasing in φ (increasing in γ) only for a small range of high values of φ (small values of γ).

3. Data and sample construction

3.1 Data

For the empirical analysis, we use two datasets from Great Britain: the Annual Survey of Hours and Earnings (ASHE) and the Workplace Employment Relations Study (WERS).[10]

The ASHE is an ongoing longitudinal panel of employees, based on a one percent random sample of all employees who pay income tax or make National Insurance contributions in Great Britain. Firms provide information from the pay period that includes a specific date in April, either by returning a survey questionnaire or directly through their payroll by a special arrangement with the Office for National Statistics (ONS). This setup implies that we only have data each year for employees in the panel who were employed on the survey reference date. Firms are legally obliged to report employee earnings with reference to payrolls, making the ASHE data more accurate than those obtained from household surveys (Elsby et al., 2016). The longitudinal aspect of the ASHE allows us to track employees over time. The ASHE dataset contains only limited information about employee characteristics and their workplaces, but the accuracy and scope of the pay information make it ideal for measuring how wages per hour change from year-to-year (Schaefer and Singleton, 2019).

[10]See Office for National Statistics (2020) and Department for Business, Innovation and Skills, National Institute of Economic and Social Research, Advisory, Conciliation and Arbitration Service, Policy Studies Institute (2018). For the latter, also see the description and analysis of the 2004 WERS by Kersley et al. (2013).

We analyse two wage measures: the nominal basic wage per hour and the gross wage per hour. The basic wage, typically a salary or an hourly wage rate, is an employee's earnings before any extra payments are received. The ASHE contains information on both the weekly basic earnings received and the basic hours worked within a reference week in April. We divide basic weekly earnings by basic weekly hours to obtain basic earnings per hour, hereafter referred to simply as the 'basic wage'.[11] Schaefer and Singleton (2022) show that the basic wage in ASHE accounts for over 90 percent of all labour income for job stayers over the period 2006-18. Additionally, basic wages are the most persistent and procyclical component of labour income, which makes them the best proxy for marginal labour costs, the key variable in macroeconomic workhorse models (see Schaefer and Singleton, 2022 for Great Britain and Grigsby et al., 2021 for the United States). The second more general wage measure that we study, nominal gross pay per hour, includes basic earnings plus all other extra payments that an employee could receive from their job, e.g., overtime, shift premiums, and incentive pay. We divide weekly nominal gross earnings by total weekly hours worked (basic hours plus overtime hours) to obtain gross earnings per hour, hereafter referred to as the 'gross wage'.

We use the 2004 WERS to collect the relevant information on employee and workplace characteristics. This was the fifth in a series of national surveys on employment relations at the workplace in Britain.[12] For a nationally representative sample of workplaces, it collected information from managers and up to 25 randomly selected employees per workplace. The WERS records the 4-digit code of the largest occupational group within a workplace, and it requires the managers to provide their answers regarding workplace characteristics and its employees with respect to this occupational group.[13]

The two key variables in the WERS that we are interested in are the following. First, managers were asked to what extent employees "have discretion over how they do their work?" The possible answers were 'A lot', 'Some', 'Little', or 'None'. We say that employees are perceived as having discretion when the manager answered either 'A lot' or 'Some'. The second key variable is involvement. Managers were asked how much they agreed with the following statement: "We do not introduce any changes here without first discussing the implications with employees." If managers indicated that they either 'Strongly agree(d)' or 'Agree(d)', then we say that employees are perceived as being involved in workplace decision-making. It is important that the WERS provides the extent of employee discretion and involvement from the manager's perspective, which is the relevant perspective according to our theory. However,

[11]Hourly wages can decline year-to-year either because earnings decline while hours worked remain constant, or because earnings remain constant while hours worked increase, or a combination of both. Since our theory does not distinguish between the origins of a wage cut, we do not distinguish how hourly wages changed in the empirical analysis.

[12]The follow-up to our version of the WERS was published in 2011. We prefer to use the WERS 2004 because the sample sizes after linking workplaces to the ASHE are much larger for the earlier year.

[13]Occupational coding follows the UK Standard Occupational Classification 2000.

the WERS does not collect information on individual employee wages over time, which is why we combine it with the ASHE.

3.2 ASHE–WERS dataset and sample construction

To link the ASHE and WERS datasets we use firm identifiers as described by Davis and Welpton (2008). This allows us to use the ASHE to track the previous and subsequent careers of employees who were in workplaces observed in the 2004 WERS. The 2004 link gives us 5,922 jobs (employer-employee matches). Larger workplaces in WERS are more likely to be linked to ASHE because they employ a disproportionate share of all employees (Davis and Welpton, 2008).[14]

The number of employees and workplaces in our matched ASHE-WERS dataset is displayed in Table 1 below. In total, we have 14,819 employee-year observations, obtained by tracking employees over time who stayed in the same firm from year-to-year. Starting with the link in 2004, we use the employee and firm identifiers in the ASHE to track firm-stayers forwards and backwards for two years, such that we have observations for 2002-06.[15] Before linking to the WERS, we also trimmed the top and bottom one percent of observations in the basic wage distribution of the 2002-06 pooled ASHE datasets.

TABLE 1: ASHE and WERS match

	Number of matched employees	Number of firms
2002-03	3,322	447
2003-04	4,234	511
2004-05	4,060	500
2005-06	3,203	415
Total	14,819	1,873
Unique	5,021	576

Notes: WERS and ASHE are linked in 2004, providing 5,922 employer-employee matches. For the backwards-linking, we identify 4,234 matches that correspond to employees who were employed by the same firm in 2003 and 2004. Out of those 4,234 employees, 3,322 employees were employed by the same firm again in 2002 and 2003. The forward-linking follows a similar pattern.

Our focus is on job stayers and the likelihood of them receiving pay cuts. We define a 'job stayer' as an employee whom we observe working in the same firm as in the previous April,

[14] Davis and Welpton (2008) analyse the representativeness of the linked ASHE-WERS 2004 dataset and find that the compositions of gender, age, and hours worked match the ones in nationally representative data. However, the linked data contain relatively fewer private sector firms, and more employees whose pay is affected by a collective agreement.

[15] For years prior to 2002, many firm identifiers are missing in the ASHE, which prevents us from linking firms across time in earlier periods. We do not link observations further forwards, because the sample size of the ASHE was reduced by 20% from 2006 to 2007, with that reduction targeting those industries that exhibit the least variation in their earnings patterns, possibly creating endogeneity issues when analysing pay changes over time.

such that we can measure year-to-year wage changes. An alternative, stricter definition of 'job stayer' may also require an employee to be recorded with the same occupation from year to year. Below we will report results for both definitions. We define a 'cut' as a year-to-year negative change in wages which exceeds −0.5 log points.[16] Our variables of interest in terms of discretion and involvement are only observed for the year 2004. After having matched employees in the ASHE and WERS, we use these 2004 values also for the other years in our matched dataset, since it seems reasonable that such workplace-level characteristics are relatively persistent over a short period in the absence of large macroeconomic shocks. However, any random, unobserved changes to workplace characteristics would have the effect of classical measurement error, attenuating our model estimates toward zero.

3.3 Descriptives

Table 2 displays descriptive statistics for all job stayers in the ASHE for 2003-04 and for job stayers in our ASHE-WERS matched analysis sample. In our matched dataset, firms are on average larger than in the ASHE and basic wage cuts and freezes occur less frequently. Gross wages, which are the sum of basic wages and all extra pay components (overtime pay, shift premium pay, incentive pay, and other pay such as meal allowances), are cut more frequently than basic wages; on average 25.7 percent of job stayers in the ASHE experience year-to-year cuts in gross wages (24.2 percent in the linked ASHE-WERS sample). Around 52.9 percent of job stayers in the ASHE receive no other pay in addition to basic wages, this share is 45 percent in the linked sample. Overtime pay is received by 32.5 percent of job stayers in the ASHE, compared with 31.3 in the linked dataset. The average hourly basic wage in our sample is £12.82, which is higher than in the ASHE. This is likely explained by the already mentioned firm-size differential between the datasets, and the fact that the matched ASHE-WERS dataset contains more public sector employees than the ASHE (44.8% vs. 63.3%, respectively).[17] The higher share of public sector employees is also associated with a higher share of employees whose pay is set with reference to a union agreement: 33.7% in the ASHE and 49.1% in our matched dataset.

Table 3 displays the distribution of job stayers across industries in the ASHE and in our ASHE-WERS baseline sample. The two distributions are roughly similar, except that our baseline sample under-represents job stayers in industries with UK SIC 2003 code

[16] We follow the recommendation of Schaefer and Singleton (2022) by using year-to-year basic wage changes of more than −0.5 log points as defining a basic wage cut. This definition takes into account the presence of small measurement errors in the data on hours worked in ASHE (see Schaefer and Singleton (2022) for a detailed description of such measurement error). Accordingly, a 'freeze' occurs when wages only change in the interval (−0.5, 0.5) log points.

[17] The employee counts of firms are provided in the ASHE dataset from the Inter-Departmental Business Register (IDBR), which is the official list of UK enterprises. We use the more common term 'firm' interchangeably with 'enterprise', which refers to a UK-specific administrative definition of an employer that could contain several local units or plants.

TABLE 2: Descriptive statistics for job stayers in ASHE and ASHE-WERS

	ASHE 2003-04	ASHE-WERS 2002-06
Basic wage cuts	0.181	0.146
Basic wage freezes	0.096	0.055
Gross wage cuts	0.257	0.242
Gross wage freezes	0.068	0.041
Only basic wage	0.529	0.450
Has overtime pay	0.325	0.313
Male	0.513	0.509
Age (years)	42.08	42.38
Hourly basic wage	£10.93	£12.82
Full-time	0.757	0.801
Private sector	0.633	0.448
Collective agreement	0.337	0.491
Firm size (N. employees)	17,736	19,942
Firm growth, year-to-year	0.2%	0.4%
N: job stayers	103,856	14,819

Notes: 'Basic wages' give weekly basic earnings divided by weekly basic hours worked. 'Gross wages' give weekly basic earnings plus extra pay divided by basic hours worked plus overtime hours. 'Full-time' gives the share of employees who work more than 30 hours per week. 'Firm size' refers to the total number of employees in the firm, and 'Firm growth' refers to the year-to-year percent change in the total number of employees in the firm. Variables such as age and firm size refer to the second linked year of a job-stayer observation.

50-59 (Wholesale and Retail Trade; Repair of Motor Vehicles, Motorcycles and Personal and Household Goods; Hotels and Restaurants), and over-represents job stayers in industries with UK SIC code 75-89 (Public Administration and Defence; Compulsory Social Security Education; Health and Social Work). The last three columns of Table 3 show the distribution of job stayers in workplaces where the manager reports some/no discretion and/or employee involvement in workplace decision-making across industries. In our baseline sample, the largest share of job stayers with no discretion is employed by firms in industries with UK SIC code 01-49 (Agriculture, Hunting and Forestry; Fishing; Mining and Quarrying; Manufacturing; Electricity, Gas and Water Supply; Construction). The large majority of job stayers who are perceived as having some discretion and involvement is employed in industries with UK SIC code 75-89 (Public Administration and Defence; Compulsory Social Security; Education; Health and Social Work).

4. Estimation and results

Guided by our theoretical framework, we define three distinct groups of job stayers, all as perceived by their managers: (1) Employees who have no discretion about how they perform their job; (2) Employees who have some discretion but are not involved in workplace

TABLE 3: Shares of job stayers across industries (%), according to workplace characteristics

			Discretion & involvement, ASHE-WERS		
SIC 2003	ASHE 2003-04	ASHE-WERS 2002-06	No discretion	Discretion & no involment	Discretion & involvement
01-49	20.95	21.08	29.47	25.70	14.38
50-59	17.28	5.81	8.21	6.37	4.11
60-64	3.81	7.61	20.95	1.35	0.91
65-74	19.39	11.77	12.45	10.31	11.75
75-89	35.23	51.03	27.97	53.72	64.97
90+	3.34	2.70	0.94	2.56	3.87
N: job stayers	103,856	14,819	4,906	2,230	7,683

Notes: Column totals might not sum to 100 due to rounding.
SIC 01-49: Agriculture, Hunting and Forestry; Fishing; Mining and Quarrying; Manufacturing; Electricity, Gas and Water Supply; Construction
50-59: Wholesale and Retail Trade; Repair of Motor Vehicles, Motorcycles and Personal and Household Goods; Hotels and Restaurants
SIC 60-64: Transport, Storage and Communication; F
SIC 65-74 Financial Intermediation, Real Estate, Renting and Business Activities;
SIC 75-89: Public Administration and Defence; Compulsory Social Security; Education; Health and Social Work
SIC 90+: Other Community, Social and Personal Service Activities; Private Households Employing Staff and Undifferentiated Production Activities of Households for Own Use

decision-making; (3) Employees who have some discretion and are involved in workplace decision-making. Table 4 displays descriptive statistics for each group.

TABLE 4: Descriptive statistics for job stayers in the ASHE-WERS, 2002-06, according to workplace characteristics

	No discretion	Discretion & no involvement	Discretion & involvement
Basic wage cuts	0.172	0.130	0.134
Basic wage freezes	0.056	0.051	0.054
Gross wage cuts	0.284	0.222	0.220
Gross wage freezes	0.036	0.040	0.044
Only basic wages	0.361	0.448	0.507
Has overtime pay	0.356	0.343	0.278
Male	0.611	0.498	0.448
Age (years)	41.37	42.49	43.00
Hourly basic wage	£12.12	£13.97	£12.94
Full-time	0.825	0.781	0.792
Private sector	0.676	0.447	0.307
Union agreement	0.348	0.486	0.584
Firm size (N. employees)	27,931	12,597	16,974
Firm growth, year-to-year	−0.5%	0.5%	0.9%
N: job stayers	4,906	2,230	7,683

Notes: See Table 2.

The percentage of employees who are perceived as having no discretion and receive only basic wages is 36.1 percent, which is *smaller* than among employees with discretion. This is perhaps surprising, because extra pay components such as incentive pay are often thought to be used by firms to motivate employees. Table 4 also shows that employees with no discretion tend to experience basic wage cuts (17.2 percent) more frequently than employees with discretion (13 and 13.4 percent). Once we consider extra pay components in addition to basic wages, the pattern is similar. The percentage of year-to-year gross wage cuts is 28.4 percent among job stayers with no discretion, while the share of gross wage cuts among job stayers with discretion is around 22 percent. Moreover, the hourly basic wage of job stayers with no discretion is £12.12, which is lower than for other job stayers. This finding is consistent with our theoretical framework: firms would not pay relatively higher (efficiency) wages to employees without discretion, since for these employees effort would not be as responsive to the wage.

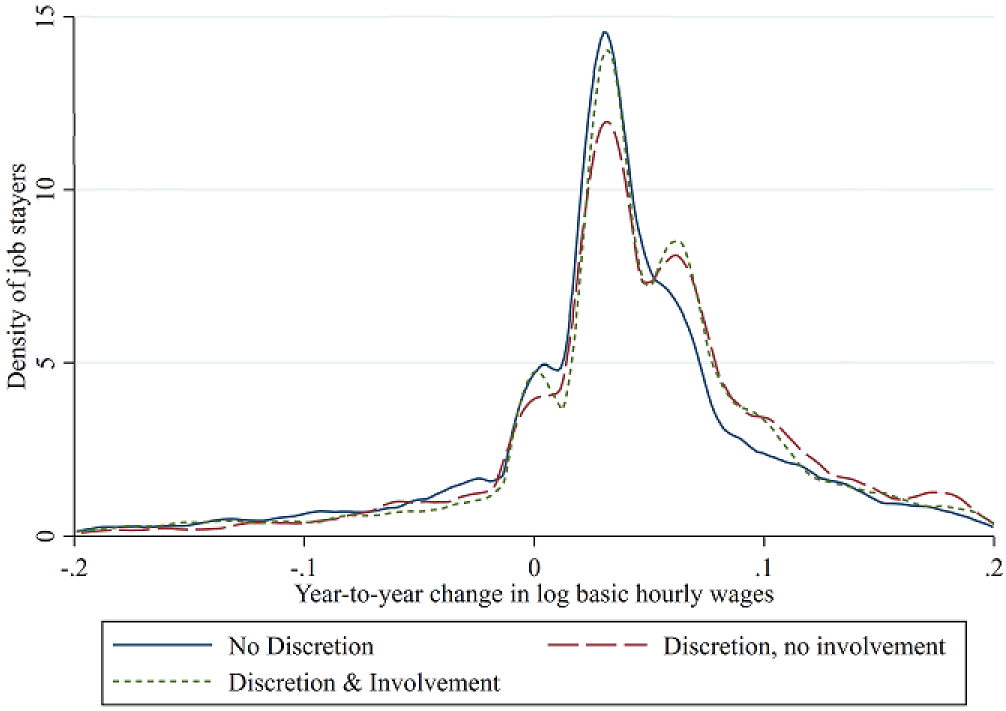
4.1 Kernel density estimates

Figure 4 displays kernel density estimates for the distribution of year-to-year changes in nominal log basic hourly wages for different groups of employees. We compare employees who are perceived as having no discretion in how they perform their work with employees who have some discretion, where the latter group is further split depending on whether managers perceive they are involved in workplace decision-making or not. Compared to employees with discretion, Figure 4 suggests that employees with no discretion experience both wage cuts and wage freezes more frequently, as well as lower wage growth. This is consistent with the prediction established by Proposition 2 on the frequency of nominal wage cuts. The relationship between involvement and nominal wage changes among employees who have some discretion is less clear in Figure 4. Although employees who are involved in decision-making experience wage freezes more frequently than employees who are not, they also experience wage cuts less frequently, which is in contrast to the prediction established by Proposition 3. Finally, employees who are involved in decision-making are less likely to see their wages grow by more than ten log points relative to those without involvement. To control for differences in observable characteristics between employees and test for statistically significant differences in the likelihood of wage cuts, we estimate the regression models described in the next section.

4.2 Empirical strategy

We estimate probit models for the conditional likelihood of a year-to-year basic wage cut among job stayers. The following process describes whether a wage cut between periods t

FIGURE 4: Kernel density estimates for the distributions of year-to-year nominal changes in log basic hourly wages for job stayers



Notes: Data are pooled across job stayers in all years 2003-2006, i.e., the sample described in Tables 2-4. The kernel estimator uses the Epanechnikov function and optimal Silverman plug-in bandwidth.

and $t-1$ is observed for job stayer i in firm j:

$$\text{WageCut}_{ijt} \equiv \ln\left(W_{ijt}\right) < \ln\left(W_{ijt-1}\right) - 0.005 = \begin{cases} 1 & \text{if} \quad y^*_{ijt} > 0\,, \\ 0 & \text{otherwise}\,, \end{cases} \tag{10}$$

which accounts for possible classical measurement errors in wages as described in Section 3, and whereby the latent variable is:

$$\begin{aligned} y^*_{ijt} = {} & \omega_0 + \omega_1 \text{Discretion}_{ij} + \omega_2 \text{Involvement}_{ij} + \omega_3 (\text{Discretion} \times \text{Involvement})_{ij} \\ & + \beta_1 \text{Male}_i + \beta_2 \text{Age}_{it-1} + \beta_3 \text{Age}^2_{it-1} \\ & + \gamma_1 \text{PrivateSector}_{jt-1} + \gamma_2 \ln\left(\text{FirmSize}_{jt-1}\right) + \gamma_3 \Delta \ln\left(\text{FirmSize}_{jt}\right) \\ & + \delta_1 \text{UnionAgreement}_{ijt-1} + \delta_2 \text{Full-time}_{ijt-1} + \delta_3 \ln\left(\text{BasicWage}_{ijt-1}\right) \\ & + \varepsilon_{ijt}, \quad \varepsilon_{it} \sim \mathcal{N}(0,1)\,. \end{aligned} \tag{11}$$

Here, WageCut_{ijt} represents a basic wage cut, defined as a year-to-year decline in the basic wage of job stayer i in firm j. The first row of Equation (11) displays the main variables of our framework: Discretion_{ij} is an indicator variable that equals one if the manager thinks that employee i in firm j has some discretion over how they perform their job, and is zero otherwise. Involvement_{ij} is an indicator variable that equals one if the manager thinks that employee i in firm j is involved in workplace decision-making, and is zero otherwise. Both variables Discretion and Involvement are measured in 2004 and constant within firm-job-stayer matches throughout our sample period. Our theory predicts that involvement should only matter for the likelihood of wage cuts if employees have some discretion over how they work, because otherwise managers do not need to be concerned with the possible negative consequences of wage cuts on morale. Therefore, we also include an interaction term of Discretion and Involvement in the model. This term equals one if managers think that employees have some discretion *and* are involved in decision-making at their workplace. The second row of (11) displays employee-specific variables: an indicator variable for the employee's gender, and terms for the employee's age and age squared, both measured in years. The third row shows firm-specific variables: an indicator of whether the employer is in the private or non-private sector, the natural logarithm of firm size (measured by the total number of employees), and the change in the natural logarithm of firm size, to proxy for the state of the firm. The fourth row displays employee-firm-specific variables: an indicator of whether the employee's wage is set according to a collective agreement (either national, sub-national, or industry-level), an indicator of whether the job is a full-time position (more than 30 hours per week), and the natural logarithm of the employee's basic wage.

4.3 Results

We first estimate the relation between Discretion, Involvement, and the likelihood of a year-to-year basic wage cut among job stayers. We show that when managers think that employees have some discretion over how they perform their work, the likelihood of a wage cut decreases significantly, regardless of the degree of involvement in workplace decision-making. We further document that, conditional on an employee having some discretion, involvement in decision-making increases the likelihood of a wage cut, and this effect becomes statistically significant once we control for observable characteristics.

Table 5, panel A, column (1) shows that basic wage cuts are significantly less likely when managers think that their employees have some discretion over effort but are not involved in decision-making. The corresponding predicted probability in panel B indicates that an employee who is not involved in decision-making is 6.5 percentage points (19.4-12.9=6.5) less likely to receive a wage cut if they have some discretion relative to having no discretion. This finding supports the prediction established in Proposition 2 that managers refrain from cutting wages when they think that employees have some discretion over effort, since such cuts might decrease employees' morale and negatively affect their productivity. The effect of being involved in decision-making on the likelihood of a wage cut is negative, but not statistically significant. The estimated coefficient of the interaction term is positive, consistent with the prediction of Proposition 3, but also not significant.

TABLE 5: Probit estimates for the likelihood of a year-to-year nominal wage cut for job stayers

	Baseline sample (1)	(1) with added controls (2)	(2) for 3-digit occupation match (3)
Panel A. Coefficient estimates			
Discretion (ω_1)	-0.266^{***}	-0.374^{***}	-0.455^{***}
	(0.095)	(0.085)	(0.109)
Involvement (ω_2)	-0.111	-0.179^{**}	-0.191^{**}
	(0.115)	(0.073)	(0.091)
Discretion × Involvement (ω_3)	0.129	0.216^{**}	0.246^{**}
	(0.135)	(0.098)	(0.115)
Male (β_1)		-0.012	-0.041
		(0.044)	(0.052)
Age (β_2)		-0.007	-0.005
		(0.009)	(0.011)
Age^2 (β_3)		0.000	0.000
		(0.000)	(0.000)
PrivateSector (γ_1)		-0.019	-0.046
		(0.088)	(0.102)
ln(FirmSize) (γ_2)		0.048^{**}	0.058^{**}
		(0.022)	(0.024)
Δln(FirmSize) (γ_3)		0.066	0.096
		(0.097)	(0.092)
UnionAgreement (δ_1)		0.084	0.090
		(0.092)	(0.115)
Full-time (δ_2)		-0.399^{***}	-0.394^{***}
		(0.063)	(0.069)
ln(BasicWage) (δ_3)		0.440^{***}	0.510^{***}
		(0.051)	(0.061)
Constant (ω_0)	-0.891^{***}	-1.948^{***}	-2.093^{***}
	(0.075)	(0.247)	(0.321)
Year-fixed effects	✓	✓	✓
Panel B. Predicted probabilities (at sample means)			
Discretion × Involvement:			
0 × 0	0.194	0.206	0.215
0 × 1	0.165	0.159	0.164
1 × 0	0.129	0.116	0.107
1 × 1	0.133	0.123	0.117
N: job stayers	14,819	14,819	11,751

Notes: Coefficient estimates and predicted probabilities of the probit model given by Equations (10) & (11). ***, **, * indicate significance from zero of the model coefficients at the 1%, 5% and 10% levels, respectively, two-sided tests, and standard errors in parentheses that account for clustering at the firm-level.

Column (2) of Table 5 displays the estimates and predicted probabilities when we include additional covariates in the regression model as described above. The coefficient estimates of discretion and involvement are more negative in this case – having some discretion decreases the probability of receiving a nominal wage cut by 9 percentage points (20.6 - 11.6 = 9) when not involved in decision-making. The coefficient of the interaction term is now significantly positive, indicating that wage cuts are *more* likely when managers perceive that employees with discretion are involved in decision-making, supporting a key prediction of our theory, established in Proposition 3. The predicted probability of a wage cut increases by 0.7 percentage points (12.3-11.6=0.7) for a job stayer who has some discretion and who is also involved in decision-making, relative to a job stayer who is not involved but still has discretion. The significantly negative coefficient on Involvement by itself suggests that there is not a general tendency of firms adopting employee involvement practices to be able to cut nominal wages more often. We also find that the higher the basic wage in the previous year, the more likely are basic wage cuts from year-to-year, and that employees working more than 30 hours per week (full-time) are significantly less likely to experience basic wage cuts. Our results from this estimation also suggest that employees in larger firms are significantly more likely to experience wage cuts, and whether an employee is working for a firm with a growing or shrinking number of employees does not significantly affect the likelihood of receiving wage cuts.

As described earlier, the WERS contains information about employee discretion and involvement in the largest occupation in a firm. In column (3) of Table 5, we exclude all employees in our ASHE-WERS linked dataset who were not working in the same 3-digit occupation that the managers were referring to in their answers in the WERS. This decreases our sample size, but should also decrease possible attenuation bias due to measurement error in our variables Discretion and Involvement. Indeed, the negative impact of discretion without involvement on the likelihood of a wage cut becomes larger. We find that having discretion decreases the predicted probability of receiving a wage cut by more than half (21.5-10.7) for an employee who is not involved in decision-making. The effect of involvement if employees have no discretion over their work is significantly negative. The estimated coefficient on the interaction term in this more selected sample is, again, significantly positive – the predicted probability of a wage cut increases by 1 percentage point (11.7-10.7=1), or by almost 10 percent, for a job stayer with discretion who is also involved in decision-making.

4.4 Robustness checks

Variations of benchmark probit models

We experimented with a number of variations to capture nonlinear effects of firm growth and other controls, but our results remained virtually unchanged. We also included the natural logarithm of the square of basic wages to investigate possible non-linear effects (e.g., the effect of the minimum wage), but the coefficient of this variable was not significant. Finally, we also looked at the degree of employee turnover within a firm; if it is easier to replace employees for jobs in which there is no discretion, then we might expect wage cuts to be more prevalent among employees in these jobs. This might be an alternative explanation for why we observe a negative effect of discretion on the probability of receiving a wage cut. However, we did not find any evidence that this is the case.

In addition, we estimate an ordered probit model for the conditional likelihood of a year-to-year basic wage cut, freeze, and rise among job stayers. As before, we control for differences in various relevant observable characteristics of job stayers and workplaces. The following process describes whether the observed outcome y_{ijt} between periods t and $t-1$ for job stayer i in firm j is a wage rise (base category), wage freeze, or wage cut:

$$y_{ijt} = \begin{cases} \text{WageRise}_{ijt} \equiv \ln\left(W_{ijt-1}\right) + 0.005 < \ln\left(W_{ijt}\right) & \text{if} \quad y^*_{ijt} < \kappa_1 \,, \\ \text{WageFreeze}_{ijt} \equiv \ln\left(W_{ijt-1}\right) - 0.005 \leq \ln\left(W_{ijt}\right) \leq \ln\left(W_{ijt-1}\right) + 0.005 & \text{if} \quad \kappa_1 < y^*_{ijt} < \kappa_2 \,, \\ \text{WageCut}_{ijt} \equiv \ln\left(W_{ijt-1}\right) - 0.005 > \ln\left(W_{ijt}\right) & \text{if} \quad y^*_{ijt} > \kappa_2 \,. \end{cases} \tag{12}$$

The parameters κ_1 and κ_2 are thresholds to be estimated for the ordered probit model. With a slight abuse of notation, we keep the latent variable y^*_{ijt} and all covariates as described in Equation (11). Table 6 displays the predicted probabilities at sample means for a wage rise, freeze, and cut.[18] These results support the predictions of our theoretical framework. An employee who is not involved in decision-making is 11.3 percentage points (22.4-11.1=11.3) less likely to receive a wage cut when they have some discretion compared to when they have no discretion. The estimated coefficient of the interaction term is significantly positive, such that, conditional on having some discretion over effort at work, employee involvement is associated with an increase in the likelihood of a wage cut of 1.1 percentage points (12.2-11.1 = 1.1). These findings are consistent with the predictions of our model, strengthening our main findings on the likelihood of wage cuts reported in the previous section.

In terms of wage rises, column (1) shows that having some discretion has a strong positive impact on the predicted conditional likelihood of a wage rise, regardless of involvement: the probability of a wage rise is 4.7 percentage points (82.6-77.9=4.7) higher among employees with involvement, and even 13.8 percentage points (84.1-70.3=13.8) higher among employees without involvement. We also find that, conditional on having some discretion, involvement in decision-making decreases the predicted probability of a wage rise by 1.5 percentage points (82.6-84.1=-1.5). These results are also consistent with our model (see Figure 3).

Finally, the results for wage freezes in column (2) imply that having some discretion decreases the likelihood of receiving a wage freeze by 2.4 percentage points (4.9 - 7.3 = - 2.4) compared with having no discretion, and that being involved in decision-making increases this probability by 0.3 percentage points (0.52-0.49=0.3). This latter result does not support the predictions of our model. Nevertheless, the relatively small number of observations for wage freezes in the data leads to coefficients that are imprecisely estimated relative to those

[18]The coefficient estimates are available from the authors upon request.

for wage rises and wage cuts, which is why we prefer to put more weight on the findings for these latter outcomes.

TABLE 6: Predicted probabilities of nominal wage changes at sample means: ordered probit estimates

Discretion × Involvement	Wage rise (1)	Wage freeze (2)	Wage cut (3)
0 × 0	0.703	0.073	0.224
0 × 1	0.779	0.061	0.160
1 × 0	0.841	0.049	0.111
1 × 1	0.826	0.052	0.122
N: job stayers	11,715	11,715	11,715

Notes: Results for job stayers in the sample of matched 3-digit occupations, controlling for year-fixed effects and observable characteristics as in Equation (11).

TABLE 7: Probit estimates for the likelihood of year-to-year nominal cuts in basic wages and gross wages for job stayers

	If basic wage income only (1)	Using gross wages (2)
Panel A. Coefficient estimates		
Discretion (ω_1)	−0.425***	−0.223***
	(0.118)	(0.077)
Involvement (ω_2)	−0.201	−0.019
	(0.131)	(0.068)
Discretion × Involvement (ω_3)	0.208	0.067
	(0.158)	(0.083)
Covariates included	✓	✓
Year-fixed effects	✓	✓
Panel B. Predicted probabilities (at sample means)		
Discretion × Involvement:		
0 × 0	0.185	0.281
0 × 1	0.136	0.274
1 × 0	0.093	0.211
1 × 1	0.094	0.225
N: job stayers	4,984	11,751

Notes: Coefficient estimates of the probit model given by Equations (10) & (11), for indicated pay variables. ***, **, * indicate significance from zero of the model coefficients at the 1%, 5% and 10% levels, respectively, two-sided tests, and standard errors in parentheses that account for clustering at the firm-level.

Extra pay components and gross wages
One potential concern is that the large estimates for the coefficient of Discretion on the likelihood of basic wage cuts could be driven by the presence of extra pay components. We might expect extra pay components, such as incentive pay, to be more prevalent among employees who are considered to have some discretion over how well they perform their job. In such a case, firms might be able to cut pay along this margin rather than having to cut basic wages. To investigate this, we repeat the estimation from column (3) of Table 5 for job stayers who did not receive any extra pay in addition to basic wages in both years. Column (1) of Table 7 displays the results of this exercise for basic wage cuts. Panel A shows a significantly negative coefficient for discretion, with a predicted probability of a wage cut that is 9.2 percentage points (18.5-9.3=9.2) lower for a job stayer with discretion and no involvement. The estimated coefficient of the interaction term is positive, consistent with previous findings, but no longer statistically significant. We also analyse how employee discretion and involvement affect the likelihood of a year-to-year cut in gross wages, the sum of basic wages and extra pay (column (2) of Table 7). The coefficient estimate of Involvement is no longer significant: there is no evidence that involvement in decision-making affects the likelihood of experiencing cuts in gross wages. However, we find that Discretion also significantly decreases the likelihood of a gross wage cut.

5. Summary and concluding remarks

Wage cuts can be perceived as unfair by employees, with negative consequences for morale and productivity. Hence, it can be in the firm's interest to refrain from cutting wages. This concern might explain why nominal wage cuts occur relatively rarely. However, our understanding of a firm's concerns about the potential costs of nominal wage cuts is mainly based on evidence from surveys of compensation managers. Much less is known about the empirical and quantitative consequences of such concerns, in so far as how they systematically affect the actual frequency of observed nominal wage cuts.

In this paper, we provide some evidence of how two important features of the labour contract can affect decisions to cut nominal wages. In our theoretical framework, we show that contractual incompleteness and employee involvement could be two crucial factors underlying a firm's concern about the cost of implementing nominal wage cuts. Next, we empirically investigate the predictions stemming from our model using a novel matched employee-employer dataset from Great Britain, merging the WERS and ASHE datasets. We find that nominal wage cuts are 6.5 to 10.8 percentage points less likely to occur when managers think that their employees have some discretion over how they perform their work, and cuts become 0.7 to 1 percentage points more likely when, conditional on the employment contract being incomplete, employees are perceived to be involved in the decision-making process. Our results on the effects of discretion suggest that firms do tend to act on their concerns for morale and fairness when deciding on whether to cut nominal wages. But, while there are reasons to think that employee involvement can alleviate these concerns, we find that its effect on the likelihood of receiving nominal wage cuts is relatively small compared to the impact of discretion.

To the best of our knowledge, our paper is the first to document and quantitatively evaluate a form of heterogeneity in the frequency of nominal wage cuts, based on two observable key features of the employment contract. Yet, our study cannot address the question of causality. It could be that exactly those firms who have to cut wages are the ones that choose to involve their employees in decision-making. In the absence of exploitable natural experiments, we have attempted to address causality using various potential instrumental variables, but without success due to too weak first-stage regression estimation results. Future research should aim to overcome this shortcoming of our study.

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When are wages cut? The roles of incomplete contracts and employee involvement

Online Appendix

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Appendix A. Further details of the theory

A.1 Mathematical proofs

Proof of Lemma 1. If $W = W_{-1}$, then $M(e^d, W, W_{-1}) = 0$ and optimal discretionary effort is characterised by the first-order condition: $-[e^c + e^d] + b = 0$, which implies that $\tilde{e}^d = b - e^c$. If $W \neq W_{-1}$, then the optimal effort choice is instead characterised by the first-order condition: $-[e^c + e^d] + b + \frac{\partial M(e^d, W, W_{-1})}{\partial e^d} = 0$, where $\frac{\partial M(e^d, W, W_{-1})}{\partial e^d} = \ln W - \ln W_{-1}$ if $W > W_{-1}$, and $\frac{\partial M(e^d, W, W_{-1})}{\partial e^d} = \{[1-\varphi]\lambda + \varphi\}[\ln W - \ln W_{-1}]$ if $W < W_{-1}$, which implies that we can solve for $\tilde{e}^d$ explicitly, as stated in the lemma. We assume b is large enough, such that $\tilde{e}^d > 0$ for any given W and W_{-1}. ■

Proof of Proposition 1. Standard recursive arguments can be used to show that there exists a unique solution to the functional Equation (6), and that at least one optimal wage policy exists. Moreover, if J is concave, then the first-order conditions will be sufficient for the characterisation of a global maximum, implying that the optimal wage policy is unique.

Suppose for now that J is concave (we will show that this is the case at the end of the proof). The first-order condition that characterises the solution to the firm's wage-setting problem in (6), which we denote with with $\widetilde{W}(W_{-1}, Z)$, is given by:

$$Z[1-\alpha]\frac{\partial \tilde{e}^d(W, W_{-1}, \gamma)}{\partial W} - 1 + \frac{\delta}{\exp(\Pi)}\frac{\partial}{\partial W}\left\{\int J(W, A')dF(Z'|Z)\right\} = 0 \quad \forall W \neq W_{-1}; \tag{13}$$

in which $\frac{\partial}{\partial W}\left\{\int J(W, A')dF(Z'|Z)\right\} = \int \frac{\partial J(Z, A')}{\partial W_{-1}} dF(Z'|Z)$ is the related envelope condition, where the equality holds due to the continuity of the value function and application of Leibniz's rule. To ease the notational burden, we denote the combined discount factor by $\psi \equiv \frac{\delta}{\exp(\Pi)}$ and the envelope condition by $\Omega(W, Z) \equiv \int \frac{\partial J(Z, A')}{\partial W_{-1}} dF(Z'|Z)$. Note that $\frac{\partial \tilde{e}^d(W, W_{-1}, \gamma)}{\partial W}$ captures the marginal effect of a wage change on effort in the current period (where $\frac{\partial \tilde{e}^d(W, W_{-1}, \gamma)}{\partial W} = \frac{1}{W}$ if $W > W_{-1}$ and $\frac{\partial \tilde{e}^d(W, W_{-1}, \gamma)}{\partial W} = \gamma\frac{1}{W}$ if $W < W_{-1}$), while $\Omega(W, Z)$ captures the marginal effect of a wage change on the expected continuation value of the employment relationship in the future.

In this class of models, it is known that the resulting optimal wage takes the form of a trigger policy, characterised by two thresholds: a lower threshold Z^l, which is such that if $Z < Z^l$, then profit is maximised where the first-order condition (13) is satisfied at a wage strictly below W_{-1}; and an upper

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threshold Z^u, which is such that if $Z > Z^u$, then profit is maximised where the first-order condition (13) is satisfied at a wage exceeding W_{-1}. Instead, if $Z^l \leq Z \leq Z^u$, profit will be maximised at the kink, i.e., where $W = W_{-1}$. These thresholds, $Z^l \equiv Z^l(W_{-1})$ and $Z^u \equiv Z^u(W_{-1})$, are implicitly defined by:

$$Z^u(W_{-1})[1-\alpha]\frac{1}{W_{-1}} - 1 + \psi\Omega(W_{-1}, Z^u(W_{-1})) = 0 \tag{14}$$

$$Z^l(W_{-1})[1-\alpha]\gamma\frac{1}{W_{-1}} - 1 + \psi\Omega(W_{-1}, Z^l(W_{-1})) = 0. \tag{15}$$

To complete the characterisation of the optimal wage, $\widetilde{W}(W_{-1}, Z)$, it is necessary to solve for the functions $Z^u(W_{-1})$ and $Z^l(W_{-1})$, which in turn requires knowledge of Ω. To begin with, consider Ω, which takes the following form:

$$\Omega(W,Z) = -[1-\alpha]\int_0^{Z^l(W)} \gamma\frac{Z'}{W}\,dF(Z'|Z) - [1-\alpha]\int_{Z^l(W)}^{Z^u(W)} 1\,dF(Z'|Z) - [1-\alpha]\int_{Z^u(W)}^{\infty} \frac{Z'}{W}\,dF(Z'|Z) + \psi\int_{Z^l(W)}^{Z^u(W)} \Omega(W,Z')\,dF(Z'|Z). \tag{16}$$

Define the equation above as $(T\Omega)(W,Z)$, and consider a subset of (W,Z) around the optimum, assuming that both the state and control spaces are compact. This implies that Ω is bounded, and that the operator T maps the space of bounded functions into itself. Denote this space by $\mathscr{B}(W,Z)$. Next, one can verify that for given $\Omega, \hat{\Omega} \in \mathscr{B}(W,Z)$ and $\Omega(W,Z) \leq \hat{\Omega}(W,Z)$, then $(T\Omega)(W,Z) \leq (T\hat{\Omega})(W,Z)$ (monotonicity), and that there exists a $\beta \in (0,1)$ such that $[T(\Omega + a)](W,Z) \leq (T\Omega)(W,Z) + \beta a$ (discounting). These imply that Blackwell's sufficient conditions for a contraction are satisfied, and that T is a contraction mapping with a unique fixed point.

To find an explicit solution for the optimal wage policy, we now follow the method developed by Elsby (2009), which consists of the following steps: First, solve for the function Ω via the method of undetermined coefficients, which allows finding the functions $\Omega(W_{-1}, Z^u(W_{-1}))$ and $\Omega(W_{-1}, Z^l(W_{-1}))$. Then, use these functions and the definitions of the thresholds in (14) and (15) to explicitly solve for $Z^u(W_{-1})$ and $Z^l(W_{-1})$ (note, this step requires a numerical solution method).

To solve for Ω, we conjecture that $\Omega(W,A) = d_1\frac{Z}{W} + d_2$. Application of the method of undetermined coefficients yields (after some algebra):

$$\Omega(W,Z) = -[1-\alpha]\frac{Z}{W}\exp(\Pi)\left[\frac{\gamma\mathbf{P}^- + \mathbf{P}^+}{1-\psi\exp(\Pi)\mathbf{P}^=}\right] - \frac{[F(Z^u(W)) - F(Z^l(W))]}{1-\psi[F(Z^u(W)) - F(Z^l(W))]}; \tag{17}$$

where:

$$\mathbf{P}^- \equiv \Phi\left(\frac{\ln Z^l(W) - [\ln Z + \Pi]}{\sigma} - \sigma\right);$$

$$\mathbf{P}^= \equiv \left[\Phi\left(\frac{\ln Z^u(W) - [\ln Z + \Pi] - \sigma^2}{\sigma}\right) - \Phi\left(\frac{\ln Z^l(W) - [\ln Z + \Pi] - \sigma^2}{\sigma}\right)\right];$$

$$\mathbf{P}^+ \equiv \Phi\left(-\frac{\ln Z^u(W) - [\ln Z + \Pi]}{\sigma} + \sigma\right);$$

stem from our assumption on the stochastic process governing Z and from the application of the theory of partial expectations to a log-normally distributed random variable (Φ denotes the c.d.f. of the standard Normal).

Next, we can characterise the functions $\Omega(W_{-1}, Z^u(W_{-1}))$ and $\Omega(W_{-1}, Z^l(W_{-1}))$, which are given by (17), in which Z is substituted by $Z^u(W_{-1})$ and $Z^l(W_{-1})$, respectively. This yields:

$$\Omega(W_{-1}, Z^u(W_{-1})) = -[1-\alpha]\frac{Z^u(W_{-1})}{W_{-1}}\exp(\Pi)\left[\frac{\gamma\Phi_1(G)+\mathbf{k}_3}{1-\psi\exp(\Pi)[\mathbf{k}_1-\Phi_1(G)]}\right] - \frac{[\mathbf{k}_2-\Phi_2(G)]}{1-\psi[\mathbf{k}_2-\Phi_2(G)]}; \tag{18}$$

$$\Omega(W_{-1}, Z^l(W_{-1})) = -[1-\alpha]\frac{Z^l(W_{-1})}{W_{-1}}\exp(\Pi)\left[\frac{\gamma\mathbf{k}_1+\Phi_5(G)}{1-\psi\exp(\Pi)[\Phi_3(G)-\mathbf{k}_1]}\right] - \frac{[\Phi_4(G)-\mathbf{k}_2]}{1-\psi[\Phi_4(G)-\mathbf{k}_2]}; \tag{19}$$

where $G \equiv \frac{Z^u(W_{-1})}{Z^l(W_{-1})}$, and:

$$\begin{aligned}
\mathbf{k}_1 &= \Phi\left(\tfrac{-\Pi-\sigma^2}{\sigma}\right); & \mathbf{k}_2 &= \Phi\left(\tfrac{-\Pi}{\sigma}\right);\\
\mathbf{k}_3 &= \Phi\left(-\tfrac{-\Pi-\sigma^2}{\sigma}\right); & \Phi_1(G) &= \Phi\left(\tfrac{-\ln G-\Pi-\sigma^2}{\sigma}\right);\\
\Phi_2(G) &= \Phi\left(\tfrac{-\ln G-\Pi}{\sigma}\right); & \Phi_3(G) &= \Phi\left(\tfrac{\ln G-\Pi-\sigma^2}{\sigma}\right);\\
\Phi_4(G) &= \Phi\left(\tfrac{\ln G-\Pi}{\sigma}\right); & \Phi_5(G) &= \Phi\left(-\tfrac{\ln G-\Pi-\sigma^2}{\sigma}\right).
\end{aligned}$$

Then, substituting (18) and (19) into (14) and (15), respectively, it is possible to solve for $Z^u(W_{-1})$ and $Z^l(W_{-1})$, obtaining (after some algebra):

$$Z^u(W_{-1}) = \frac{1}{1-\alpha}\left[\frac{1-\psi\exp(\Pi)[\mathbf{k}_1-\Phi_1(G)]}{1-\psi[\mathbf{k}_2-\Phi_2(G)]}\,\frac{1}{1-\psi\exp(\Pi)\{1+[\gamma-1]\Phi_1(G)\}}\right]W_{-1}; \tag{20}$$

$$Z^l(W_{-1}) = \frac{1}{1-\alpha}\left[\frac{1-\psi\exp(\Pi)[\Phi_3(G)-\mathbf{k}_1]}{1-\psi[\Phi_4(G)-\mathbf{k}_2]}\,\frac{1}{\gamma-\psi\exp(\Pi)\{1+[\gamma-1]\Phi_3(G)\}}\right]W_{-1}. \tag{21}$$

Note that these functions depend on G, which is yet unknown. To proceed, define a new function $\mathbf{T}(G) \equiv \frac{Z^u(W_{-1})}{Z^l(W_{-1})}$, which is a function of G but not of W_{-1}. Hence the relevant value of G can be obtained by finding the fixed point(s) of the mapping $\mathbf{T}(G) = G$. Numerical solution methods applied to the model of this paper reveal that there exists a unique fixed point, and that $G > 1$. This implies that the $\Phi_i(G)$s for $i = \{1,2,3,4,5\}$ will be some constants, as will the coefficients in the square brackets of Equations (20) and (21). Denote these coefficients $\overline{u}(\gamma)$ and $\overline{l}(\gamma)$, respectively, and notice that they are functions of the model parameters $\{\delta, \Pi, \sigma, \gamma\}$. Hence, it follows that $Z^u(W_{-1}) = \frac{1}{1-\alpha}\overline{u}(\gamma)W_{-1}$ and $Z^l(W_{-1}) = \frac{1}{1-\alpha}\overline{l}(\gamma)W_{-1}$, and that $Z^u(W_{-1}) > Z^l(W_{-1})$ since $G > 1$, and that if $\gamma = 1$, then $Z^u(W_{-1}) = Z^l(W_{-1})$. To see this, assume that $G = 1$, which implies that: $\ln G = 0$; and therefore that $\Phi_1(G) = \Phi_3(G) = \mathbf{k}_1$; and $\Phi_2(G) = \Phi_4(G) = \mathbf{k}_2$. By substituting these coefficients in (20) and (21), it can now be verified that $Z^u(W_{-1}) = Z^l(W_{-1})$ and $G = 1$ (essentially, if $\gamma = 1$, it can be verified that $G = 1$ is a fixed point of the mapping $\mathbf{T}(G)$). Hence $\overline{u}(\gamma) = \overline{l}(\gamma)$ if $\gamma = 1$.

It is now straightforward to show that if $Z > Z^u(W_{-1})$, the optimal wage is given by $\widetilde{W} = \frac{1-\alpha}{\overline{u}(\gamma)}Z$, while if $Z < Z^l(W_{-1})$, the optimal wage is given by $\widetilde{W} = \frac{1-\alpha}{\overline{l}(\gamma)}Z$, and that if $Z \in [Z^l(W_{-1}), Z^u(W_{-1})]$, the optimal wage is given by $\widetilde{W} = W_{-1}$.

Finally, to prove that J is concave in W, it is sufficient to show that the second derivative of J with respect to W is negative. Taking the second derivative of the value function (6) for all $W \neq W_{-1}$ yields:

$$\frac{\partial^2 J(W,Z)}{\partial W^2} = Z[1-\alpha]\frac{\partial^2 \tilde{e}^d(W_{-1},W,\gamma)}{\partial W^2} + \psi\frac{\partial\Omega(W,Z)}{\partial W}, \tag{22}$$

in which $\frac{\partial^2 \tilde{e}^d(W_{-1},W,\gamma)}{\partial W^2} < 0$, but the sign of $\frac{\partial\Omega(W,Z)}{\partial W}$ is yet unknown. To find $\frac{\partial\Omega(W,Z)}{\partial W}$, we can use the definition of Ω in (16), and then use the method of undetermined coefficient as before, conjecturing that $\frac{\partial\Omega(W,Z)}{\partial W} = d_3\frac{Z}{W^2}$, which yields (after some algebra):

$$\frac{\partial\Omega(W,Z)}{\partial W} = [1-\alpha]\frac{Z}{W^2}\exp(\Pi)\left[\frac{\gamma\mathbf{P}^- + \mathbf{P}^+}{1-\psi\exp(\Pi)\mathbf{P}^=}\right].$$

Substituting this into (22), and using the expression from the first-order condition (13) derived above to substitute for a common factor obtained after some algebra (in which we substitute for Ω using its explicit solution obtained in (17)), it yields the following expression for the second derivative of J with respect to W:

$$\frac{\partial^2 J(W,Z)}{\partial W^2} = -\frac{1}{W}\left[\frac{1}{1-\psi[F(Z^u(W)) - F(Z^l(W))]}\right],$$

which is strictly negative, confirming the concavity of the value function $J(W,Z)$. ■

Proof of Proposition 2. The probability in (9) can be expressed as: $F(Z^l(W_{-1})|Z_{-1},W_{-1}) = \int^{Z^l(W_{-1})} dF(Z|Z_{-1},W_{-1})$, where $Z^l(W_{-1}) = \frac{\bar{l}(\gamma)}{1-\alpha}W_{-1}$. Hence, partial differentiation of the expression above with respect to α yields:

$$\frac{\partial F(Z^l(W_{-1})|Z_{-1},W_{-1})}{\partial\alpha} = \frac{\bar{l}(\gamma)}{[1-\alpha]^2}W_{-1}f(Z^l(W_{-1})|Z_{-1},W_{-1}) > 0\ .$$

■

Proof of Proposition 3. First, note that as φ increases, γ becomes smaller, which implies that $\bar{l}(\gamma)$ approaches $\bar{u}(\gamma)$. Moreover, from the results established in the proof of Proposition 1, we know that if $\varphi \to 1$, then $\gamma \to 1$ and $\bar{l}(\gamma) \to \bar{u}(\gamma)$. From this, since $\bar{u}(\gamma) > \bar{l}(\gamma)$ for all $\varphi < 1$ and $\gamma > 1$, and using the results established in the proof of Proposition 1, we can deduce that $\bar{l}(\gamma)$ is decreasing in γ. Next, express the probability in (9) as: $F(Z^l(W_{-1})|Z_{-1},W_{-1}) = \int^{Z^l(W_{-1})} dF(Z|Z_{-1},W_{-1})$, where $Z^l(W_{-1}) = \frac{\bar{l}(\gamma)}{1-\alpha}W_{-1}$. Partial differentiation of the expression above with respect to φ yields:

$$\frac{\partial F(Z^l(W_{-1})|Z_{-1},W_{-1})}{\partial\varphi} = \frac{1}{1-\alpha}\frac{\partial\bar{l}(\gamma)}{\partial\gamma}[1-\lambda]W_{-1}f(Z^l(W_{-1})|Z_{-1},W_{-1}) > 0\ ,$$

since we have established that $\frac{\partial\bar{l}(\gamma)}{\partial\gamma} < 0$, and the fact that $\lambda > 1$. ■

A.2 A model of complete contracts $\alpha = 1$

In the main text, we considered the case in which $0 < \alpha < 1$, i.e., incomplete contracts, and by varying α we derived predictions on how the extent of contractual incompleteness can affect firms' wage-setting decisions, in particular, the likelihood of nominal wage cuts. In this section, we consider a version of the model in which the employment contract is complete, i.e., when $\alpha = 1$. In this case, the nature of the employment contract changes substantially, implying that we will need to introduce a number of additional (standard) assumptions.

To begin with, note that if the employment contract is complete, then the employee has no choice but to exert the contractually agreed level of effort, e^c, and discretionary effort will be zero, $e^d = 0$. Hence, the effect of a relative wage comparison on morale, and the resulting reciprocity, might be irrelevant in this case, as the employee does not have the means to retaliate, apart from quitting. These considerations imply that we express an employee's utility under complete contracts, denoted by u^c, only in terms of their material payoff:

$$u^c(W) = W - \left[0.5(e^c)^2 - be^c\right].$$

Next, we introduce the notion of an employee's participation constraint. This is necessary for a positive equilibrium wage to exist, since, otherwise, firms would find it optimal to set the wage toward zero in our setting (the wage-setting problem is not a convex optimisation problem anymore, because the firm's value function is not concave in W). Denote the employee's per-period payoff of being unemployed by u^u. There are several ways to interpret u^u: the outside option; the employee's reservation utility; or the employee's opportunity cost of being employed. Following the evidence reported in Chodorow-Reich and Karabarbounis (2016), who document that the opportunity cost of employment is procyclical, we assume that an unemployed worker's per-period payoff is strictly increasing in the aggregate state of the economy. More precisely, $u^u = u^u(Z)$, with $u^{u\prime} > 0$ and $u^{u\prime\prime} \leq 0$.

Finally, we assume that unemployed workers face a per-period constant probability of finding a job, given by h, while employees face a per-period constant probability of losing the job, given by s. Hence, we can write an employee's present discounted values of being employed or unemployed, respectively, as:

$$V(W) = u^c(W) + \delta[1-s]\mathbb{E}[V(W')] + \delta s\mathbb{E}[U(Z')|Z]$$

$$U(Z) = u^u(Z) + \delta h\mathbb{E}[V(W')] + \delta[1-h]\mathbb{E}[U(Z')|Z]\ ,$$

which imply that employees will only accept wage contracts such that $V(W) \geq U(Z)$, and will otherwise quit or keep searching for a job.

We now turn to the firm. Under complete contracts, the firm's output is given by $Y(Z,E) = Ze^c$ and the firm's problem can be expressed as:

$$\begin{aligned} J(Z) \quad &= \max_W \left\{ Ze^c - W + \tfrac{\delta[1-s]}{\exp(\pi)}\mathbb{E}[J(Z')|Z] \right\} \\ &\text{s.t.}\ \ V(W) \geq U(Z)\ . \end{aligned}$$

Firms will set the wage that maximises their expected present discounted value of profits, subject to the employee's participation constraint. One way to tackle this problem is to find an employee's reservation wage first, that is, the value of the wage such that the employee is indifferent between accepting a wage contract or quitting/keep on searching, and then use this to define the lower bound of the control space characterising the firm's action set.

Lemma A.1. *There exists a reservation wage* $\underline{W}(Z)$*, such that* $V(\underline{W}) = U(Z)$*, where* $\underline{W}' > 0$.

Proof. The reservation wage $\underline{W}$ is the wage such that $V(W) = U(Z)$. Hence, it is implicitly given by

$$u^c(\underline{W}) - u^u(Z) + \delta[1-s-h]\{\mathbb{E}[V(W')] - \mathbb{E}[U(Z')|Z]\} = 0 ,$$

where we assume the parameters of the model are such that $u^c(0) < 0$, hence $\underline{W}$ exists and it is unique. Next, implicit differentiation implies:

$$\frac{\partial \underline{W}}{\partial Z} = -\frac{-\frac{\partial u^u}{\partial Z} - \delta[1-s-h]\frac{\partial \mathbb{E}[U(Z')|Z]}{\partial Z}}{\frac{\partial u^c}{\partial \underline{W}}} > 0 ,$$

which allows us to deduce that the reservation wage is increasing in Z. ■

Lemma A.2. *In each period, the optimal wage set by firms is given by* $\widetilde{W} = \underline{W}(Z)$.

Proof. It is straightforward to see that the firm will maximise expected profit by setting the lowest possible wage. However, the firm is now constrained by the employee's reservation wage, which, in fact, characterises the corner solution of the optimisation problem. Hence the optimal wage is $\widetilde{W} = \underline{W}(Z)$. ■

Under complete contracts ($\alpha = 1$), the optimal wage changes smoothly with changes in the aggregate state of the economy, there is no range of rigidity, and the probability of receiving nominal wage cuts in the event of a negative shock is equal to 1. Relative to the case of incomplete contracts ($\alpha < 1$), in an employment relationship in which employees do not have discretion on how much effort to exert ($\alpha = 1$), the probability of experiencing nominal wage cuts is higher.

A.3 Alternative modelling approach for involvement

In the framework developed in Section 2, we modelled employee involvement as a morale-boosting component of the employee's utility. In this section, we consider an alternative approach, by modelling the effect that involvement could have on employees' understanding of firms' economic conditions and their internalisation of this when forming their perceptions of the fair wage. The idea we want to capture is that if employees are involved in the decision-making process, then they will be more aware of the economic and financial conditions of their firm, and will therefore adjust accordingly their expectations about how much they should be paid.

To implement this approach, we assume the reference 'fair' wage R to be an increasing function of both the past wage W_{-1} *and* the firm's economic conditions, captured in this case by the nominal shock Z. One possible form of R is:

$$R(W_{-1}, Z) = W_{-1}^{1-\beta} Z^{\beta} ,$$

where $\beta \in [0,1]$ captures the degree of employee involvement in decision-making, which in this case would capture the extent to which the employee becomes informed about the economic conditions of the firm. According to this formulation, the more the employee is involved, the more sensitive is their reference point to changes in the firm's economic conditions. Hence, this assumption implies that the employee's reference wage will increase (they would expect to be paid a higher wage) following positive shocks, while the employee's reference wage will decrease (they would expect to be paid a lower wage) following negative shocks.

This version of the model implies that the employee's utility in each period takes the following form:

$$u(e^d, W, R) = W - \left\{0.5[e^c + e^d]^2 - b[e^c + e^d]\right\} + e^d \mu(\ln W - \ln(W_{-1}^{1-\beta} Z^{\beta})) \,, \tag{23}$$

and that the employee's optimal choice of discretionary effort is given by:

$$\tilde{e}^d = \begin{cases} \tilde{e}^n + \ln W - \ln(W_{-1}^{1-\beta} Z^{\beta}) & \text{if } W > R \\ \tilde{e}^n & \text{if } W = R \\ \tilde{e}^n + \lambda[\ln W - \ln(W_{-1}^{1-\beta} Z^{\beta})] & \text{if } W < R \,. \end{cases} \tag{24}$$

For simplicity, we assume that the firm is myopic $\beta = 0$, and consider fully incomplete contracts $\alpha = 0$ (the former assumption is made for illustrative purposes, as it considerably eases the exposition). Anticipating the response of the employee, and for a given W_{-1} and Z, in each period the firm will set the wage that maximises the per-period profit. This optimisation problem can be expressed as:

$$\max_W Z[\tilde{e}^n + \mu(\ln W - \ln(W_{-1}^{1-\beta} Z^{\beta}))] - W \,.$$

Lemma A.3. *If $\alpha = 0$, $\delta = 0$, and for all $\beta \in [0,1]$, the firm's optimal wage policy is given by:*

$$\widetilde{W} = \begin{cases} Z & > W_{-1} \quad \text{if } Z > Z^u(W_{-1}) \\ W_{-1}^{1-\beta} Z^{\beta} & \leq W_{-1} \quad \text{if } Z \in [Z^l(W_{-1}), Z^u(W_{-1})] \\ \lambda Z & < W_{-1} \quad \text{if } Z < Z^l(W_{-1}) \,; \end{cases}$$

where

$$Z^u(W_{-1}) = W_{-1} \,, \quad Z^l(W_{-1}) = \frac{1}{\lambda^{\frac{1}{1-\beta}}} W_{-1} \,.$$

Proof. We follow the steps laid out in the proof of Proposition 1, which in this case allow us to solve explicitly for the firm's optimal wage policy. The first-order condition characterising the solution to the firm's problem is given by:

$$Z \frac{\partial \mu(\ln W - \ln(W_{-1}^{1-\beta} Z^{\beta}))}{\partial W} - 1 = 0 \quad W \neq R \,.$$

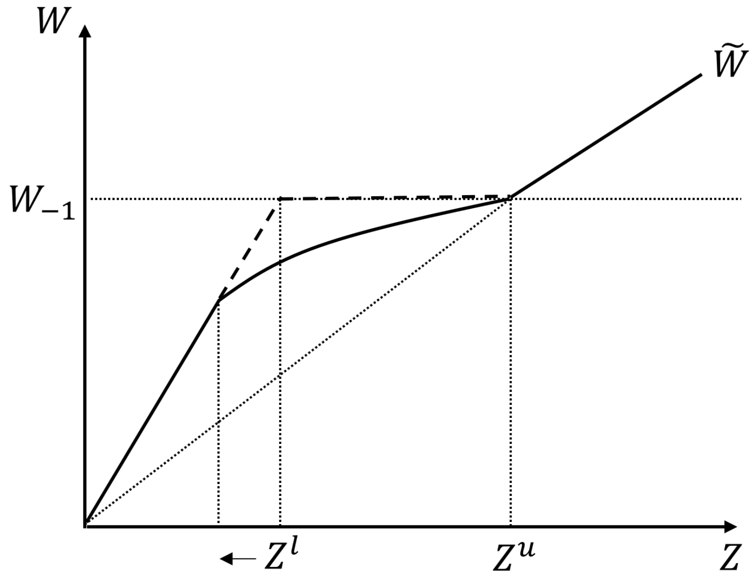
Once again it is convenient to define two thresholds, Z^l and Z^u, such that if $Z < Z^l$, then profit is maximised where the first order condition is satisfied at the wage $W < R$, while if $Z > Z^u$, then profit is maximised where the first order condition is satisfied at the wage $W > R$. If $Z \in [Z^l, Z^u]$, profit will be maximised at the wage $W = R$. These thresholds are defined by:

$$Z^u(W_{-1})\frac{1}{W_{-1}^{1-\beta}Z^u(W_{-1})^\beta} - 1 = 0$$
$$Z^l(W_{-1})\lambda\frac{1}{W_{-1}^{1-\beta}Z^l(W_{-1})^\beta} - 1 = 0\ ,$$

which can be solved explicitly for $Z^u(W_{-1})$ and $Z^l(W_{-1})$ yielding: $Z^u(W_{-1}) = W_{-1}$ and $Z^l(W_{-1}) = \frac{1}{\lambda^{\frac{1}{1-\beta}}}W_{-1}$. Next, from the first-order condition it is straightforward to show that if $Z > Z^u(W_{-1})$, the optimal wage is given by $\widetilde{W} = Z$, and that if $Z < Z^l(W_{-1})$, the optimal wage is given by $\widetilde{W} = \lambda Z$. While if $Z \in [Z^l, Z^u]$, the optimal wage is given by $\widetilde{W} = R = W_{-1}^{1-\beta}Z^\beta$, which is increasing in Z for all $\beta \in (0,1]$. ■

Note that, although $Z^l(W_{-1})$ is decreasing in the degree of involvement β, we still obtain the prediction that involvement, $\beta > 0$, increases the probability of receiving nominal wage cuts relative to the case of no involvement, $\beta = 0$, which is consistent with Proposition 3 established in Section 2. However, in this version of the model, for any given $\beta \in (0,1]$ the optimal wage changes smoothly with changes in Z, there is no range of rigidity and the probability of receiving nominal wage cuts in the event of a negative shock equals 1. That is, nominal wages will always be cut in response to negative shocks when employees are involved, regardless of the extent of involvement. This is because as employees are involved in decision-making and learn about the firm facing a negative shock, their reference point always decreases, allowing firms to pay them a lower nominal wage without incurring the cost of negative reciprocity. These considerations are shown in the figure below.

FIGURE A1: Effect of involvement on the optimal wage policy



Note: The dashed line shows the firm's optimal wage-setting policy with no involvement, $\beta = 0$; while the solid line shows the firm's optimal wage-setting policy with involvement, for a given $\beta > 0$. The arrow shows the effect of an increase in involvement, from 0 to a positive value, on the threshold Z^l.