CESifo *Working Paper Series*

FAIR PAY AND A WAGEBILL ARGUMENT FOR WAGE RIGIDITY AND EXCESSIVE EMPLOYMENT VARIABILITY

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Working Paper No. 234

January 2000

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* I am very grateful for comments and suggestions from Andrew Oswald, John Hardman-Moore, Gavin Reid, Felix Fitzroy, Alan Sutherland and Neil Rankin.

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Abstract

This paper considers a two-period optimal contracting model in which firms make new hires in the second period subject to the constraint that they cannot pay discriminate either against or in favour of the new hires. Under an assumption on the information available to workers, it is shown that wages are less flexible than needed for efficient employment levels, with the result that too few hires are made in bad states of the world. Unemployment is involuntary. In an extension to the model, there may also be involuntary and excessive layoffs in some states of the world.

Keywords: Implicit contract theory, wage rigidity, involuntary unemployment

JEL Classification: J41, J63

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1 Introduction

This paper investigates the consequences, for wage and employment outcomes, of assuming that firms follow a fair wage policy. By a fair wage policy is meant that workers receive equal pay for equal work, irrespective of when they were hired. The analysis is conducted in the context of a competitive labour market model, and so it abstracts from aspects of imperfect competition often introduced in order to explain wage rigidity. Likewise, issues of adverse selection or moral hazard are abstracted from, so that there is no efficiency wage element to the analysis. Instead an attempt is made to concentrate solely on the effects of linking together the pay of new hires with that of incumbents. The imposition of the fair wage restriction leads to reduced wage volatility and increased employment variability, as well as involuntary unemployment.

A fair wage policy implies that if the contract wage of incumbent workers is not equal to the auction wage, then the same is true of the wage paid to new hires. There may be good reasons why wage contracts for *incumbents* should not specify auction wages; this need not of itself imply inefficient employment decisions as far as this group of workers is concerned (a point which dogged the theory of implicit contracts). If, however, these same wages must be paid to *new hires* then a divergence from auction wages *will* generally lead to inefficient hiring decisions being made.[3] In the model explored in this paper, a fair wage policy can lead to wage rigidity due to a difficulty in both raising the current contract wage upwards when the labour market is tight, and in reducing the wage when it is slack.

The upward rigidity is based on what I shall call the 'wage-bill argument'.[4] In essence the wage-bill argument is very simple. Suppose a firm needs to make

[3] This paper takes the point of view that the efficiency or otherwise of the hiring decision is of more importance than that of the layoff decision. While the existence and efficiency of layoffs have traditionally been a major concern of contract theory, they are not in practice very important in fluctuations (except possibly in major downturns): according to Hall and Lilien (1986), temporary layoffs do not contribute very much to total unemployment in the U.S.A.; in the U.K., during 1977-84 most variation in unemployment was due to changes in the rate at which workers *leave* unemployment (Pissarides (1986)). Likewise, in a recent study using detailed data on firm separations, Gautier, van den Berg, van Ours, and Ridder (1999) found that the total separation rate did not change very much with the level of economic activity.

[4] This term has also been used differently by Akerlof and Miyazaki (1980), who argue, by showing that workers can be retained and more insurance offered at no cost to the wage bill, that the canonical implicit contract model cannot explain layoffs.

new hires but the wage it would have to pay is above the wage which it is currently paying its workforce. Then, under the equal pay assumption, it faces a choice: either make the new hires and raise wages for *all* of its workforce, or leave wages where they were. The increase in the wage bill for the incumbent workers might make the former choice too expensive even if, considered alone, the potential new hires would be profitable.[5] For the downward rigidity, suppose that the wage at which the firm can hire is now lower than the wage being paid to incumbents. By the equal pay assumption, if the firm was to hire at the lower wage it would also have to pay its incumbents less. Obviously the firm would be happy to do this, but the incumbents would be correspondingly unhappy. I shall explore one particular model of why it may not be possible for wages to be lowered. The model assumes asymmetric information so that incumbent workers do not know how tight the labour market is. Then it may not be possible to have an incentive compatible wage contract with the incumbents in which the wage can be lowered (since the firm would always want to claim that the outside wage is low).

Working through the equilibria of the model, there is reduced wage variability relative to a model where the equal pay assumption is not invoked. In addition there will be *increased* employment variability, and the possibility of involuntary unemployment (and even involuntary layoffs). The increased employment variability might seem counter-intuitive in view of the idea of the wage-bill argument which applies in a "good" state of the world when a firm chooses *not* to employ new workers because of the extra costs of paying incumbents more, so that although the wage does not rise, neither does employment. In equilibrium, however, firms will set contract wages close to the auction wage in the good state of the world and *will* hire at the auction wage in this state. Because the wage is set at a relatively high level, in a "bad" state of the world the firm will choose to hire fewer workers than would be the case with a flexible wage. In addition, new workers who are not hired in the bad state will be involuntarily unemployed. The reason why a firm does not set the contract wage near to the auction wage pertinent to the bad state is that a

[5] At first sight this argument might appear to be stating no more than the problem faced by a monopsonist: employing more workers entails an increased wage to be paid to all. Such an interpretation would not be correct however. The argument given here applies even when the labour market is competitive. The crucial distinction is that the traditional monopsonist argument is relevant when the firm is making a single decision about the desired workforce, whereas the argument here applies to a situation where the decision to make new hires is subsequent to, and the wage paid independent of, the initial hiring decision.

firm which does this will not choose, by the wage-bill argument, to raise its wage to hire in the good state. It is as if it is committing itself to a low wage. Hence, although it gains by being able to hire cheaply in this bad state, it cannot hire in the good state, and the latter loss outweighs the former gain.[6]

There are a number of theories of *downward* rigid wages, many of them based on arguments which prevent unemployed workers from undercutting the wages of incumbents (see Section 1.1 for discussion of some of these). In the two-period competitive contracting equilibrium analysed here, with shocks in period 2 to the value product of labour, however, downward rigidity on its own will not affect equilibrium levels of employment. It would only be necessary to pay a sufficiently low period-2 wage to ensure efficient employment decisions can be made in bad states, compensating workers with higher period-1 wages. In good period-2 states, the firm can hire new workers if necessary at a higher wage than that being paid to incumbents. Introducing the equal pay assumption, however, means that a firm wishing to hire in good states must offer all workers a high wage, and this forces the optimal contract to specify a relatively high second period wage, as already explained. Thus the *upward* rigidity arising from the wage-bill argument is crucial to the results.

While the formal model of the paper uses an optimal contracting framework in the presence of asymmetric information, the underlying idea is much more general. There is evidence that firms in many industries follow "wage policies". One firm may pay higher or lower wages than other firms within the same industry to seemingly identical workers; wages do not seem to vary one-for-one according to fluctuations in marginal value products of workers, either cross-sectionally within a firm ("pay compression") nor over time. In particular, wages are often associated with jobs, and may be relatively unresponsive to hiring conditions. See Manning (1996) for a discussion of the evidence. A possible reason for the stability of such wage policies is due to the wage-bill argument. Suppose that incumbent workers are unlikely to leave the firm even if they could earn more elsewhere. This can be due to costs of search, relocation, training, as well as non-pecuniary factors that attach them to the firm. Under the equal pay assumption, a firm paying a lower wage than competitors would have little incentive to raise wages, *even if it would wish to pay more to new*

[6] Ex ante, the wagebill saving in the good state to a low wage firm is of no benefit. A worker who signed up for such a firm will anticipate that the wage will remain low. Thus the *ex post* incentive to save on wage costs by not hiring in the good state does not produce an *ex ante* saving in wages since a worker will have to be compensated (in the first period of the model) for low future wages.

hires, as it would have to pay all its workers more, and not raising the wage may not lead to (too many) quits. Likewise a tightening of the labour market may have little impact on the wage being paid, for the same reason. A wage policy, once established, is likely to persist.

1.1 On the Equal Pay Assumption

The equal pay for equal work restriction is commonly used in theoretical work (see Section 4), but is it a reasonable assumption? By simply imposing the restriction, I am implicitly assuming the existence of a social norm which demands equal pay. There is justification for this approach. Certainly there are well documented examples (see Fitzroy (1999) for a recent one), where workers are paid the same wage irrespective of when they were hired and under what labour market conditions. This is even true despite clear productivity differences between workers, which suggests that a wage is associated with the job description rather than the actual productivity of the worker. Likewise, there are exceptions which arguably prove the rule, such as the two-tier wage policies introduced following deregulation of airlines in the U.S., where low morale, non-cooperation between differently salaried employees, and inappropriate conduct towards passengers were much in evidence (Salpukas (1987)). Personnel management texts treat the need for equitable pay as virtually self-evident: "The need for equity is perhaps the most important factor in determining pay rates....Pay rates must ... be equitable internally in that each employee should view his or her pay as equitable given other employees' pay rates in the same organization" Dessler (1984, p. 223), quoted in Akerlof and Yellen (1990)).

Still, this begs the question of *why* such a norm might exist. A number of explanations have been offered. A standard explanation is that workers worry about relative pay as well as absolute pay, and wage differences can affect morale and hence productivity. A recent statement of this position is found in Bewley (1998), based on observations from a large scale interview survey:

> Downward rigidity of the pay of new hires derives from that of existing employees, because all pay rates within a firm are tied together. Reduced hiring pay increases differentials between existing and new employees in each job, unless the pay of existing employees is cut as well. The higher differentials

> violate established standards of equity incorporated in a company's internal pay structure, angering new employees when they discover they are underpaid. Internal pay structure is a set of rules relating pay to position, skill, seniority or contribution. This structure is created in large part to achieve internal equity, which is both uniformity in the application of the rules setting pay and a set of beliefs about fair relations between pay and its determinants.
>
> Managers regarded any violation of internal equity as potentially disruptive. Lack of equity spawns jealousies, resentments, and perceptions of unjust treatment. (p.477)

It can be objected to this line of thinking, however, that even if the relatively underpaid perform less well than otherwise, the overpaid may work harder, and it is not clear that the latter is offset by the former (see Lazear (1991)). Equity theory, as proposed by social psychologists (see Adams (1963)), is one theoretical approach which can explain concern with relative pay. It is based on the idea that individuals (here: workers) have a clear idea of a fair relationship between inputs (their work) and outputs (their pay), and deviations from this lead to attempts by the worker to re-establish a fair relationship by varying actual or perceived inputs. Thus a worker who receives less than fair pay may respond by reducing effort in order to re-establish a fair relationship between inputs and outputs (see, e.g., Fehr, Gächter, and Kirchsteiger (1996) for experimental evidence in support of the hypothesis that effort responds positively to the wage). Likewise a worker who receives more, might respond by increasing effort, though there is an argument that in this case it is easier to restore a fair relationship by increasing 'perceived' effort (e.g., the worker re-evaluates her belief about the quality of her work in an upwards direction). Akerlof and Yellen (1990) argue that one can interpret the experimental evidence to say that equity theory supports a model where underpaid workers reduce their effort, while overpaid workers do not increase effort, which is one answer to the objection raised by Lazear. In such a model, the costs in terms of reduced effort of paying some workers less than others simply may exceed the savings in terms of lower wages. In the economic literature, most discussion of the equity issue has been in the context of explaining "pay compression", that is to say, having a wage structure in which wages do not vary as much as individual workers' productivities (which is generally thought to obtain in organizations). This is true of the Akerlof and Yellen (1990) paper. Lazear (1989) has argued that pay compression might be optimal in industries where cooperation between workers is important (its absence can imply a motivation to ensure *other* workers perform badly). Pay compression, however, is in a sense much stronger than what I am assuming, as all workers have identical productivities here (ignoring training costs), differing only according to the time of hiring.[7]

Apart from ideas linked to fairness, equity and cooperation, there may also be more conventional economic arguments to suggest why new workers cannot be brought in at a wage lower than that paid to incumbents due to the possibility that a firm might use this to *replace* its current expensive workforce. Moore (1983) shows that if it is necessary to retain at least one worker to train the new employees, then there is a unique von Neumann-Morgernstern stable set consisting of configurations in which all workers receive the same wage. Gottfries (1992) argues on the basis of the difficulty of distinguishing between voluntary quits and fires (e.g., due to the possibility that employers can induce quits by making life unpleasant for an employee: see Carmichael (1983), MacLeod and Malcomson (1989)) that a wage differential would give an employer the incentive to replace as many workers as possible (this idea is more fully worked out in Gottfries and Sjostrom (1998)). Akerlof and Miyazaki (1980) also argue that paying a lower wage to new hires might create an incentive for the firm to replace the current workforce. On the other hand, there may be good reputation arguments for why a firm might resist bringing in new workers at a *higher* wage than that being paid to incumbents: it might damage the firm's reputation for not responding to workers' attempts to use their bargaining power to increase their wages. Incumbents might reason that if new workers can be paid more, then it will be worth them too bargaining for higher pay (as suggested by Manning (1996)).

A possible objection to the equal pay assumption is that many firms operate seniority ladders which can be used to wage discriminate. There are a number of points to be made here. First, if pay relativities are fixed then a firm may not, for example, be able to benefit from a low outside wage unless it can cut the wage rate attached to the lowest seniority. A second point relates to the fact that the wage-bill argument applies here when *the labour market was tight*, so that to avoid

[7] In this case theoretical papers often simply treat the assumption as virtually self-evident. For example Carruth and Oswald (1987) state (p.432) that "a two-tier system of discriminatory wage payments ...[is]...almost never observed in the world."

this problem, a firm would have to hire new workers at a *higher* seniority than existing workers. This seems more implausible than the reverse scenario, though if the *only* constraint is that a firm cannot hire at a wage higher than that being paid to incumbents, it could achieve a first best outcome by paying all incumbents a fixed wage close to the highest possible spot wage, and making all new hires at the spot wage; the problem with this is that a high (period 2 in the model) wage for the incumbents would need to be compensated by low or even negative wages at the point of hiring (period 1) which might be infeasible; moreover a very large differential between incumbents and new hires might well exacerbate the incentives already remarked upon for employers to force "voluntary" quits. A third point is that the equal pay assumption might be more appropriate for less skilled workers, while pay discrimination is arguably more prevalent amongst the more skilled. Thus the implications of the paper might be more relevant for the former group, and may thus contribute towards an explanation for why unemployment rates tend to be more prone to variation amongst the less skilled; see, e.g., van Ours and Ridder (1995) and Hoynes (1999). This observation is also consistent with evidence that in low-wage industries, wages respond less to changes in value products than they do in high-wage industries (Johansen (1999)).

1.2 Outline of Paper

In Section 2, the basic model is described. In Subsection 2.1, conditions are outlined under which the implementation of an efficient allocation is possible. In Subsection 2.2, a symmetric inefficient equilibrium is characterised, with wages which do not vary sufficiently to allow for efficient levels of hiring in the bad state; this leads to involuntary unemployment. In Subsection 2.3, a situation is considered where the symmetric equilibrium fails to exist. An asymmetric equilibrium is analysed, in which some firms pay low period-2 wages and do not hire in the good state, while other firms pay higher wages and do hire. The properties of this equilibrium remain similar in that there are inefficiently low numbers of hires in the bad state, and involuntary unemployment in the sense that workers who fail to get a job envy those who succeed in getting a job with a high-wage firm. In Section 3, the possibility of layoffs is introduced. In a state with asymmetric shocks, laid-off workers may find employment with another firm. It is shown that the wage-bill problem can lead to excessive layoffs when all firms receive a bad shock. Moreover, such layoffs are involuntary. Section 4 discusses related literature in which the equal assumption plays a major role, and Section 5 contains concluding comments.

2 The Model

As already mentioned, the wage-bill argument is developed under the assumption that both workers and firms are risk-neutral and that the information upon which a labour contract can be conditioned is very limited. The assumption that workers and firms are risk neutral implies that there is no risk-sharing motive for reducing the variability of wages. Instead we shall demonstrate that reduced variability of wages, in comparison to the predictions of the standard competitive model, can result from the interplay of the wage bill argument and asymmetric information.[8]

The model is partial equilibrium. In the first period of a two-period model, firms enter into (binding) contracts with workers. First period demand is certain, and firms produce and pay a wage to their workers. At the end of the first period, a randomly selected fraction $(1-\gamma)$ of a firm's labour force leaves the labour market and is replaced by an equal number of one-period lived new entrants. In the second period, the value product of labour is uncertain (but common to all firms) and it is assumed that there is a bad (low value product) state and a good (high value) state. Once the uncertainty is realised, firms decide whether to hire (or fire) and what wage to pay, consistent with any contract, and subject to the constraint that all workers receive the same wage.

With completely contingent contracts and risk neutrality, the restriction that all workers receive the same wage does not affect the allocation. A contract which specifies the spot wage in each state in period 2 can achieve this. It is assumed, however, that a labour contract can only be conditioned on information directly

[8] The asymmetric information assumption is by no means necessary for the general argument to go through. An alternative model might assume that workers are risk averse, so that an optimal contract with the incumbents will avoid excessive wage variability and for this reason it may not be desirable to reduce the wage to market clearing levels. The asymmetric assumption is somewhat stronger than that traditionally made in the implicit contract literature which effectively assumes that aggregate labor supply is observable to workers (e.g., Chari (1983), Green and Kahn (1983) and Grossman and Hart (1981)). It does however lead to a form of contract that is arguably more in accordance with observations—a fixed wage is specified and the employer chooses employment levels unilaterally (Oswald (1986)).

verifiable by an individual worker, namely, apart from the date, his employment status (which I assume is either fully employed or laid-off). Similarly, in the absence of the equal wage restriction, the non-contingent contract will have no affect on the allocation as compared to a contingent contracts equilibrium. Since the period 2 employment decision can effectively be taken independently of the wage being paid to incumbents, an efficient employment decision concerning new hires will be made in period 2. It is the combination of the two assumptions which drives the results.

The form of the non-contingent contract is justified by assuming that the state of nature and the employment level of the firm and any of its correlates are unobservable to the worker, or at least unverifiable.[9] Under this assumption, the contract cannot make the second period wage contingent on the state of nature,[10] and the competitive allocation may no longer be implementable. In a bad state of nature, the firm will not be able to cut the wage below that specified in the contract, which means there may be unemployed workers willing to work at a wage strictly below their marginal product, but the firm cannot employ them because of the equal pay restriction. The only way to avoid this is to specify in the contract a low second period wage—equal to a new worker's supply price in the bad state. The drawback of doing this is that in the good state the wage bill argument might apply—firms would rather stay at a low wage with their existing workforce than expand, even though the cost of newly hired workers would be smaller than their additional out-

[9] In many contexts a firm's employment level may be difficult to define precisely; it may be possible to shift production or aspects of production to other firms, or plants of the same firm if the contracts are plant level contracts. (See Stiglitz (1986) for elaboration of this point.) The assumption also rules out the wage being conditioned on the going wage for new hires. This makes less sense in a competitive labour market than it would in a monopsonistic or search environment where "the going wage" is not well defined. Even if employment was observable, it does not seem unreasonable to suppose that contracts which made the wage contingent on the firm's employment would be met with a high degree of suspicion by employees, who would be required to understand not only the firm's decision problem but also possible market conditions in order to calculate what such a contract was worth. (This is not to deny that the equilibrium constructed here also makes strong demands on a worker's computational abilities: he or she has to figure out that in high demand states the wage will rise to the market clearing level.)

[10] This need not be inconsistent with the results of firm surveys which suggest that a major reason for firms not cutting pay in recessions is that worker morale will suffer (see especially Blinder and Choi (1990), Campbell and Kamlani (1997), and Bewley (1998)), if this is due to a feeling that the firm has breached an implicit agreement not to cut wages; as Bewley (1998, p. 480) puts it: "the main drawback of paycuts is that they fill the air with disappointment and *an impression of breached promise* [emphasis added]." It is conceivable that this potential reduction in morale is the means by which the implicit contract is enforced, a suggestion made by Campbell and Kamlani (1997), as opposed to the alternative interpretation of why morale might suffer based around a "fair wage" theory. Experimental evidence that implicit contracts can be enforced by such reciprocity can be found in Fehr, Gächter, and Kirchsteiger (1997).

put. I shall find cases where this conflict leads to all firms specifying a period 2 wage which is higher than the bad state supply price of labour, and consequently where there is too little employment in the bad state (and involuntary unemployment). There may also exist situations in which some firms choose the lower wage, and this leads (additionally) to inefficiently low employment in such firms in the good state.

In more detail, there are two periods, 1 and 2, and a large number of firms in a competitive industry, each having an identical revenue function $f(l,\ M)$, where $l \geq 0$ is employment and $M > 0$ is a productivity or revenue shock. It is assumed that $\partial f/\partial l$ is linear and given by $\partial f/\partial l(l, M) = M - \alpha l$ for $l \leq M/\alpha$ (and zero otherwise). Note that M is an additive common shock across firms. There is no uncertainty in period 1, with $M = m$, while in period 2, $M = m_l$ with probability p_l and $M = m_h$ with probability $p_h \equiv 1 - p_l$, $0 < p_l < 1$, and $m_l < m_h$. For notational convenience I shall write $f(l) \equiv f(l, m)$, $f_l(l) \equiv f(l, m_l)$, and $f_h(l) \equiv f(l, m_h)$. In each period the industry specific supply of labour, divided by the number of firms, is L, with each worker withdrawing from the market at the end of period 1 with probability $(1 - \gamma)$ (exogenous separations), and $(1 - \gamma)L$ (per firm) of new workers appearing in period 2. It is not known ex ante which workers will withdraw, and it is assumed that the number of workers employed by each firm is large, so that it can be taken that a precise fraction $(1 - \gamma)$ of a firm's period 1 workforce withdraws.[11]

It is assumed that workers are expected utility maximizers, being risk neutral with zero discount rate, and having a disutility of work of $\overline{u}$ per period. Consequently for wages above reservation utility, aggregate labour supply is inelastically supplied at level L per firm. (Note that hours of work are not variable in this analysis). If a period 1 worker leaves the labour market at the end of period 1, then he receives zero utility in period 2. Thus the utility of a period 1 worker who receives a contract specifying a wage w_1 in period 1 and a possibly random wage $\widetilde{w}_2$ in period 2 is $w_1 + \gamma E\widetilde{w}_2$, where $E\widetilde{w}_2$ is the expectation of w_2^h, assuming that the worker is employed (i.e., not laid off) in all dates/states. Firms are similarly assumed to be risk neutral with zero discount rate, and to maximise expected discounted profits.

[11] It is not strictly necessary for the argument that γ should be less than 1 as long as there are new entrants in period 2. Likewise a similar argument could be made in a one-period model, in which new workers become available after the state of nature is revealed. Nevertheless neither feature complicates the analysis unduly, and the idea of turnover is important for the spirit of the analysis, while in a one-period model it is more difficult to justify why a firm shouldn't wait until the state of nature is revealed before hiring.

I will make assumptions which ensure that it is not efficient to hire workers in period 1 and replace them with new workers in period 2 (otherwise the first-best allocation could be achieved by such one-period employment contracts). A natural way of doing this is—adopted here—is to assume that there are training costs of t per worker. If these are sufficiently high, the benefits from moving to one-period contracts in terms of wage flexibility will be offset by the additional training costs.[12] I shall return to this point below, but for the moment the possibility of a firm simultaneously laying off workers and taking on new entrants will be ignored.

As already discussed, a labour contract can only be made contingent on a worker's employment status. This implies that a contract will specify a wage for period 1, w_1, and a wage for period 2, w_2, together with lay-off pay w_2^L if the worker is laid off in period 2. However, for the moment I shall make assumptions which ensure that all period 1 workers will be retained in period 2, so lay-off pay can be ignored.

Initially, I shall suppose that, for simplicity's sake, the bad state in period 2 is such that at full employment (i.e., L workers per firm) the MVP is no greater than the disutility of work plus training cost, but in period 1 and in the good state in period 2, MVP exceeds (or equals) the disutility of work plus training cost, so that efficiency requires possibly less than full employment in the bad state, but full employment in the latter two situations. I shall additionally assume that productivity in the bad state is such that some new workers should be taken on:

Case 1 $f_l'(L) \leq \overline{u}+t$ and $f'(L), f_h'(L) \geq \overline{u}+t$ (i.e., m, $m_h \geq \overline{u}+\alpha L+t \geq m_l$), and $f_l'(\gamma L) > \overline{u}+t$.

Because of the fact that firms should take on new workers in both period 2 states, as mentioned above, layoffs can be ignored. To see that the wage-bill argument can prevent the implementation of the contingent contracts allocation (which must be Pareto efficient), note that it is *necessary* (but not sufficient) to imple-

[12] If the state of nature is observable but not *contractible,* can one-period contracts do better than long-term contracts by allowing for potential flexibility in w_2? Without attempting a formal analysis of this situation, it is easy to conceive of circumstances under which short-term contracts are not superior to long-term contracts. For example, suppose that workers suffer a mobility cost c of changing jobs, and that firms can make a take-it-or-leave-it offer in period 2. Then in the bad state the firm can offer $\overline{u}$, while in the good state it could offer $w_2^h - c$, where w_2^h is the spot wage. If c is large enough that $w_2^h - c \leq \overline{u}$, then this is equivalent to a long-term contract which has $w_2 = \overline{u}$, a contract which turns out to be suboptimal.

ment the contingent contracts allocation to have a contract (w_1, w_2) which satisfies $w_2 = \overline{u}$, to ensure efficient employment in the bad state for new workers being taken on.[13] In addition, a condition is needed that says in the good state firms will prefer raising the wages of all workers to the competitive (auction) rate to leaving them at w_2 and not hiring (it is assumed that the firm can implement a higher wage than specified in the contract if it desires since workers will not object). Write π $(w, M) := \max_l\{f(l, M) - (w+t)l\}$ as a firm's optimal one-period profits with value product shock M facing a wage for all workers of w and having to pay training costs for all workers. Then this latter condition is

$$\pi(\widetilde{w}_2^h, m_h) + t\gamma L \geq f_h(\gamma L) - w_2\gamma L, \tag{1}$$

where $\widetilde{w}_2^h$ is the spot wage in the good state assuming a symmetric allocation (i.e., $\widetilde{w}_2^h = f_h'(L) - t$) and $t\gamma L$ is added to the LHS since the firm does not have to train the γL workers inherited from period 1. See Figure 1 (drawn for $t = 0$): a firm will prefer to stay at w_2 if area A exceeds area B.[14] To see that there are cases where

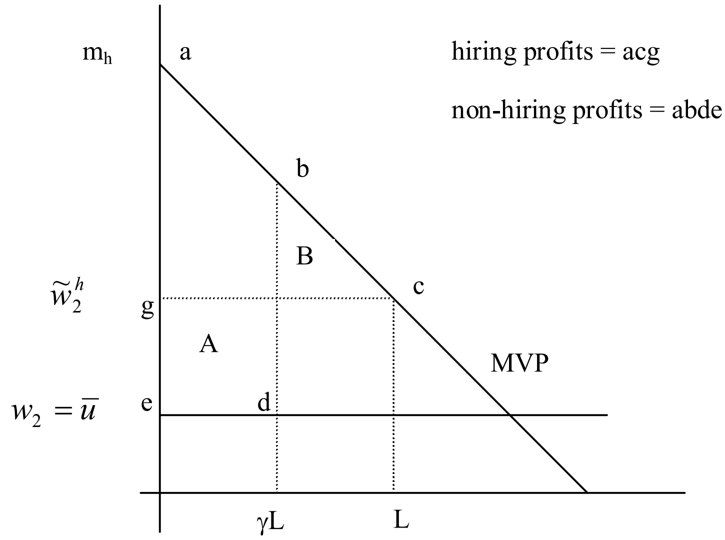

Figure 1: The Hiring Decision

the contingent contracts solution is not implementable, after rewriting equation (1)

[13] If $w_2 > \overline{u}$, and by assumption the firm cannot cut the wages of those workers already under contract, a firm will only be able to hire new workers at a wage of at least w_2 and will therefore employ an inefficiently low number of new workers.

[14] As mentioned, this is only a necessary condition: a firm intending to hold its wage to w_2 in the good state would generally do better by choosing period 1 employment higher than L, and it is the profit from this strategy which must be less than the L.H.S. of (1). This point is developed below.

in terms of the parameters and substituting $\widetilde{w}_2^h = f_h'(L) - t$ and $w_2 = \overline{u}$, we see (1) is violated whenever

$$a\,L\,\left(1+\gamma^2\right) - 2\,\gamma\,\left(m_h - t - \overline{u}\right) < 0. \tag{2}$$

Clearly, for m_h sufficiently high, (2) holds, and thus the contingent contracts equilibrium cannot be implemented and any equilibrium must be inefficient.

If the contingent contracts equilibrium cannot be implemented, what takes its place? To analyse the possible equilibria, take m and m_l to be fixed, and increase m_h, starting from its minimum value $\overline{u}+\alpha L+t$, so that in an efficient allocation there is just full employment in the good state (i.e., where $\widetilde{w}_2^h = \overline{u}$). At $m_h = \overline{u}+\alpha L+t$, the following is an equilibrium contract: $(w_1^*, w_2^*) = (f'(L)-t, \overline{u})$. This follows from the fact that it implements the contingent contracts equilibrium with the contingent contract specifying $\widetilde{w}_1 = f'(L) - t \equiv m - \alpha L - t$, a wage for the bad state $\widetilde{w}_2^l = \overline{u}$ and a wage for the good state $\widetilde{w}_2^h = \overline{u}$. If all firms were to offer this contract, each hiring L workers, then each worker receives a utility of w_1 (period 2 utility is zero, whether or not an exogenous separation occurs). All new hires that take place in period 2 (in either state) take place at a wage of $\overline{u}$, and the equilibrium is efficient.

Now consider increasing m_h above $\overline{u}+\alpha L+t$. The contingent contract would be as before, except that now $\widetilde{w}_2^h = f_h'(L) - t \equiv m_h - \alpha L - t > \overline{u}$. This implements a first-best allocation since it guarantees efficient employment levels. Suppose that the same non-contingent contract, $(w_1^*, w_2^*) = (f'(L)-t, \overline{u})$, as before, is offered. In the good state, employers would choose either to take on new workers at a wage of $\widetilde{w}_2^h$ (this is the equilibrium wage for new hires provided all firms hire), or to make no hires and pay the incumbents $w_2^* = \overline{u}$. The point is, although the non-contingent contract does not specify the wage $\widetilde{w}_2^h$ in the good state, because $\widetilde{w}_2^h > w_2^*$ the firm is able to deviate from the non-contingent contract by offering a higher wage than that specified. Suppose that all other firms are choosing to make new hires, thus implementing the contingent contract with the wage in the good state being $\widetilde{w}_2^h$. What is the best alternative strategy for a firm? Since the contractual terms alone do not determine a worker's utility (which depends on expectations of a higher than contracted wage in the good state), explicit assumptions concerning a worker's information and beliefs about a particular firm is needed.

A1. A period 1 worker cannot observe the period 1 employment levels at a firm.

This assumption is most in keeping with the nature of the non-contingent contract (which rules out making the contract contingent on period 2 employment levels). It implies that a firm, intending not to hire in the good state, could offer the non-contingent contract (w_1, w_2) and take on fewer or more workers than optimal for a firm intending to hire in the good state, since a worker would not be able to observe such an intended deviation at the time of signing the contract. Note that the worker would get a lower utility with such a deviant firm.

I shall make the following assumption about workers' beliefs in period 1:

A2. If any contract (w_1, w_2) is offered, then workers put probability one on the firm making new hires in the good state provided it has an incentive to do so, assuming that it can make as many hires as it wishes in period 1.

2.1 Implementation of the First-Best

I start by deriving the conditions under which the contingent contracts equilibrium *can* be implemented. To do this it will be convenient to consider first the more general problem where the contract on offer is any feasible (w_1, w_2).

Suppose that w_2 is sufficiently high that it allows hiring in the bad state (i.e., $w_2 \geq \overline{u}$), but not high enough to allow hiring in the good state. Assuming a contract (w_1, w_2) is acceptable to workers, the profits from intending to hire in the good state, at a wage w_2^h, are given by optimizing by choice of $\overline{n}$:

$$f(\overline{n}) - (w_1 + t)\overline{n} + p_l(\pi(w_2, m_l) + t\overline{n}') + p_h(\pi(w_2^h, m_h) + t\overline{n}'), \tag{3}$$

where $\overline{n}$ is a firm's choice of period 1 employment, and denote by $\overline{\Pi}(w_1, w_2, w_2^h)$ the optimized value of (3) and $\overline{n}(w_1, w_2, w_2^h)$ the optimal employment decision. However, the firm can 'deviate' by not hiring in the good state: in this case it will choose a period 1 employment level, n, to maximise

$$f(n) - (w_1 + t)n + p_l(\pi(w_2, m_l) + tn') + p_h(f_h(n') - w_2 n'), \tag{4}$$

where an employment variable written with a prime signifies γ times the unprimed variable, and denote by $\Pi^d(w_{1,} w_2)$ the optimized value of (4).

Then provided

$$\overline{\Pi}(w_1^*, w_2^*, \widetilde{w}_2^h) \geq \Pi^d(w_1^*, w_2^*), \tag{5}$$

it is an equilibrium for all firms to offer (w_1^*, w_2^*) and hire in the good state. This follows because if all other firms are offering (w_1^*, w_2^*), then $\overline{n}(w_1^*, w_2^*, \widetilde{w}_2^h) = L$ (since the contingent contracts equilibrium is implemented), and the going utility for period 1 workers is that of the contingent contracts equilibrium as (5) and assumption A2 guarantee that workers anticipate a wage of $\widetilde{w}_2^h$ in the good state. Finally, no other contract can do better than the contingent contracts solution, given the level of utility that has to be offered to workers.

Solving for the critical value of m_h, say m_h^*, such that (5) holds with equality, yields

$$m_h^* = \frac{\alpha L \left(\sqrt{(1+p_h)\,(1+\gamma^2 p_h)} - 1\right)}{\gamma\, p_h} + t + \overline{u}. \tag{6}$$

Below m_h^*, the contingent contracts solution can be implemented, but above this level of m_h, it cannot as firms simply would not choose to hire in the good state;[15] instead they would leave wages at $w_2 = \overline{u}$. Intuitively, at low values of m_h the good-state spot wage is low relative to $\overline{u}$, and so only a small increase in the wage is needed in order to be able make new hires, and the wage-bill implications are small. At higher values, a large increase is needed and wage-bill considerations will prevent this from being made.

2.2 Symmetric Inefficient Equilibria

A symmetric equilibrium is such that all firms offer the same contract (w_1, w_2) to period-one workers, and follow the same hiring strategy in both periods. To find a symmetric equilibrium when $m_h > m_h^*$, we need to look for a higher level of w_2 than $\overline{u}$, such that there is an incentive to raise wages in the good state to $\widetilde{w}_2^h$ (i.e., so that (5) is satisfied for the new contract). I shall refer to a contract for which the firm has an incentive to hire in the good state as a "hiring contract." Roughly speaking, in Figure 1, it is necessary to raise w_2 above $\overline{u}$ until area A is brought just back to equality with B (this is only approximate because it assumes that the deviation strategy involves the same number of period-one hires as the hiring strategy, whereas in fact the deviation strategy involves labour hoarding).

[15] Since there is a unique positive solution for m_h^*, and since $\overline{\Pi}$ is greater than Π^d at $m_h = \overline{u} + \alpha L + t$ and easily seen to be strictly smaller immediately above m_h^*, it follows that at all values of m_h higher than m_h^*, $\overline{\Pi}$ is strictly less than Π^d.

This assumes that any symmetric equilibrium must involve hiring in the good state at $\widetilde{w}_2^h$. To see this, note that there cannot be a symmetric equilibrium such that w_2 is below $\widetilde{w}_2^h$ and expected to remain there in the good state, since the reservation wage of new workers would be at most w_2 and each firm would wish to employ more than L workers at this wage. Thus there would be an incentive for a firm to raise wages a tiny amount above w_2 to ensure it can get all the workers it needs (such an increase has essentially no wage-bill consequences). Likewise it cannot be the case that the wage rises to some level $w_2' < \widetilde{w}_2^h$, as again firms would want to employ more than L workers at this wage (given they are hiring, they will hire up to the MVP curve) and would be prepared to pay a small amount more.

For $m_h > m_h^*$, an equilibrium contract $(\overline{w}_1, \overline{w}_2)$ must in fact satisfy an equality version of (5):

$$\overline{\Pi}(\overline{w}_1, \overline{w}_2, \widetilde{w}_2^h) = \Pi^d(\overline{w}_1, \overline{w}_2), \tag{7}$$

since if the L.H.S. of (7) were to be strictly larger than the R.H.S., a firm could offer a slightly lower w_2, and workers would still know that the firm has an incentive to raise the wage to $\widetilde{w}_2^h$ $(= f_h'(L) - t)$ in the good state. Provided this contract offers the same utility to workers (so that w_1 is raised slightly), they will be happy accepting it, while because the wage in the bad state is lower, it is more efficient than the putative equilibrium contract and thus yields higher profits. More formally, given that the other firms are offering $(\overline{w}_1, \overline{w}_2)$, is it possible to offer a credible hiring contract (w_1, w_2) giving workers the same utility but with $w_2 < \overline{w}_2$ and $w_1 > \overline{w}_1$ (which will be more profitable than $(\overline{w}_1, \overline{w}_2)$)? As just argued, (7) is a necessary condition to prevent this; the general condition that needs to be satisfied is, for all (w_1, w_2) offering workers at least the utility from $(\overline{w}_1, \overline{w}_2)$ and with $w_2 < \overline{w}_2$,

$$\overline{\Pi}(w_1, w_2, \widetilde{w}_2^h) < \Pi^d(w_1, w_2). \tag{8}$$

Inequality (8) ensures that no such contract would be viewed by workers as a credible hiring contract. In the Appendix it is demonstrated that at the putative equilibrium satisfying (7), this condition is satisfied. Solving for the contract satisfying (7), and period 1 labour market equilibrium,

$$\overline{n}(w_1, w_2, w_2^h) = L, \tag{9}$$

yields a contract wage of

$$\overline{w}_2 = m_h - \frac{\alpha L \left(\sqrt{(1+p_h)\,(1+\gamma^2 p_h)} - 1\right)}{\gamma\, p_h} - t. \tag{10}$$

Combining (6) and (10) implies that above m_h^*, $\overline{w}_2 > \overline{u}$, as expected, and by routine calculation, $\overline{w}_2 < \widetilde{w}_2^h$.

There is an additional constraint to check, however, before one can conclude that this is an equilibrium. Given that $\overline{w}_2 > \overline{u}$, an alternative deviation strategy for the firm is to offer a contract which workers anticipate will *not* involve new hires in the good state.[16] Such a contract, say $(\underline{w}_1, \underline{w}_2)$, while losing out on profitable hires in that state, benefits in the bad state from being able to attract workers at a low wage (optimally $\underline{w}_2 = \overline{u}$).[17] I shall refer to such a contract as a "non-hiring contract." The profits from such a strategy are

$$f(\underline{n}) - (\underline{w}_1 + t)\,\underline{n} + p_l\,(\pi(\underline{w}_2, m_l) + t\underline{n}'\,) + p_h\,(f_h(\underline{n}') - \underline{w}_2\underline{n}'\,)\,, \tag{11}$$

where $\underline{n}$ is the period 1 employment choice (and $\underline{n}' \equiv \gamma\underline{n}$). Assuming (w_1, w_2, w_2^h) represents the wage expectations of workers if they accept a contract with a hiring firm, let $\underline{\Pi}(w_1, w_2, w_2^h)$ be the optimized value of (11), by choice of $\underline{n}$ and $(\underline{w}_1, \underline{w}_2)$, subject only to the constraint that the contract offers the going utility to period 1 workers:

$$\underline{w}_1 + \gamma\underline{w}_2 \geq w_1 + \gamma(p_l w_2 + p_h w_2^h) \tag{12}$$

(as mentioned, this involves $\underline{w}_2 = \overline{u}$), and denote by $\underline{n}(w_1, w_2, w_2^h)$ the optimal choice of $\underline{n}$. Thus we need to impose the constraint that

$$\overline{\Pi}(\overline{w}_1, \overline{w}_2, \widetilde{w}_2^h) \geq \underline{\Pi}(\overline{w}_1, \overline{w}_2, \widetilde{w}_2^h). \tag{13}$$

It turns out (see Appendix) that provided $p_h \geq 0.5$, and that firms want to hire in the bad state, then (13) always holds. The intuition for this can be seen in Figure 2 which plots the situation most favourable to the non-hiring strategy, namely where efficient employment in the low state just equals L. The hiring strategy makes

[16] When $w_2 = \overline{u}$, this can never be a profitable strategy, hence it cannot prevent the implementation of the contingent contracts solution studied earlier.

[17] The other deviation strategy, which also involved not hiring in the good state, suffers in comparison by having a higher second period wage, namely $\overline{w}_2$ itself, but benefits from giving unsuspecting workers a lower total utility.

additional profits from new hires equal to area A in the high value state (hiring at $\widetilde{w}_2^h$), but gains only area B in the low state from hiring at wage $\overline{w}_2 > \overline{u}$, whereas the non-hiring strategy gains $B + C$ in the low state and nothing in the high state. Since $A = B + C$, if $p_h = 0.5$, average profits under the hiring strategy will be larger by $0.5B$, and larger *a fortiori* if $p_h > 0.5$. (The wage being paid to incumbents can be ignored as they receive the same present value payment under either scheme.) This argument is not quite precise as it assumes period-one employment equals L under either scheme, while in fact the non-hiring strategy will employ slightly more (so as to benefit from the high value product in the high state).

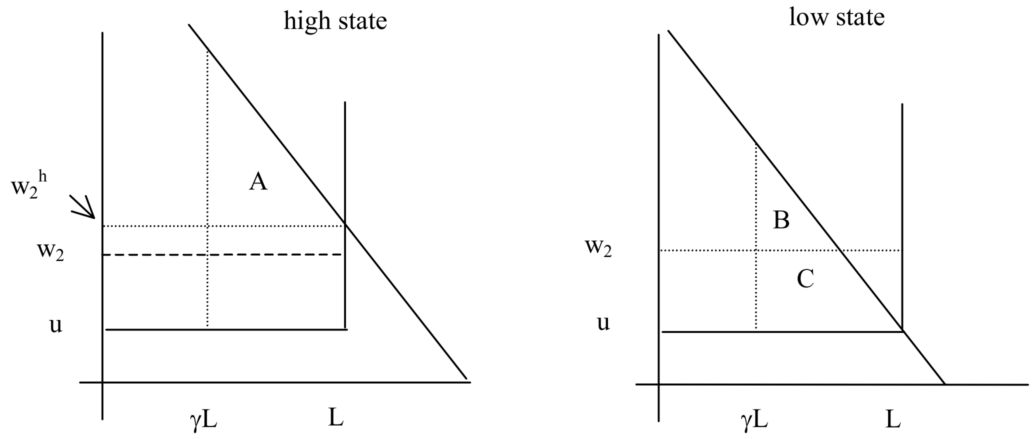

Figure 2: Hiring vs. non-hiring strategies

Since $\overline{w}_2 > \overline{u}$, it follows that employment in the bad state is smaller than in the (Pareto-efficient) contingent contracts equilibrium, unemployed workers are involuntarily unemployed in the sense that they envy those (identical workers) who are being offered employment, and employment is also more variable (there is full employment in the good state in both cases but more unemployment in the bad state with non-contingent contracts). We can summarise this in:

Proposition 1 *In Case 1, for m_h sufficiently high ($m_h > m_h^*$), and provided firms are hiring in the bad state, there is a symmetric equilibrium contract with period-2 wage $\overline{w}_2 > \overline{u}$, and there is inefficiently low employment in the bad state (and hence excessive employment variability).*

It can be checked that the solution in terms of wages and employment outcomes is invariant to changes in demand shocks and training costs provided they change by the same amount in period 2, and that the change in the period-one shock m is a fraction $(1-\gamma)$ of the change in t. Thus, for sufficiently large t, even if it was technologically feasible, a strategy of replacing the entire workforce at the end of period 1 will be less profitable than the strategies considered above.

2.3 Asymmetric Equilibria

The above analysis was valid for the situation (Case 1) where m_l was sufficiently low that it was efficient to have less than full employment in the bad state. In this section I will show that even for higher values of m_l unemployment might still result in the bad state, although it also turns out that there may no longer be a symmetric equilibrium.[18] Instead there will be an asymmetric equilibrium in which firms split into two groups: one following a hiring strategy offers a high period 2 wage and hires new labour in the good state, while the other follows a non-hiring strategy and offers a low period 2 wage ($=\overline{u}$) and does not hire in the good state. The former gains by being efficient in the good state, the latter by being efficient in the bad state. The symmetric equilibrium analysed in the previous subsection fails as the non-hiring strategy $(\underline{w}_1, \underline{w}_2)$ becomes more profitable than the putative equilibrium strategy $(\overline{w}_1, \overline{w}_2)$ as m_l rises, so that (13) is violated. Equilibrium is restored by having a positive fraction of firms using the non-hiring strategy, which reduces the good-state wage (each hiring firm has to hire more labour and is thus lower down its MVP curve); this reduces the inefficiency of the hiring strategy in the bad state so that it can be made equally profitable with the non-hiring strategy.

To solve for this equilibrium, let β denote the fraction of low-wage firms, w_2^h the spot wage in the good state, and $\overline{n}_2^h$ the period 2 employment of high-wage firms. Then we replace (9) by

$$\beta\underline{n}(\overline{w}_1, \overline{w}_2, w_2^h) + (1-\beta)\overline{n}(\overline{w}_1, \overline{w}_2, w_2^h) = L, \tag{14}$$

and require that the labour market clears in the good state:

$$\beta\gamma\underline{n}(\overline{w}_1, \overline{w}_2, w_2^h) + (1-\beta)\overline{n}_2^h = L, \tag{15}$$

[18] The analysis of this section is generally valid for cases where the non-hiring strategy dominates the hiring strategy in any putative symmetric equilibrium. For example, if $p_h < 0.5$, or if the slope of the MVP curve varies with the state, this can happen even in Case 1.

where hiring firms are in equilibrium in the good state:

$$f_h'(\overline{n}_2^h) - t = w_2^h. \tag{16}$$

In addition, as before, we require

$$\overline{\Pi}(\overline{w}_1, \overline{w}_2, w_2^h) = \Pi^d(\overline{w}_1, \overline{w}_2), \tag{17}$$

but we also impose

$$\overline{\Pi}(\overline{w}_1, \overline{w}_2, w_2^h) = \underline{\Pi}(\overline{w}_1, \overline{w}_2, w_2^h), \tag{18}$$

so that firms are indifferent between the hiring and non-hiring strategies. In the absence of an analytic solution to this system of equations, I have computed the solution,[19] as a function of m_h, when other parameters are set as follows: $\overline{u} = 0.1, t = 0.2, m = 1.5, m_l = 1.4, \gamma = 0.8, p_h = 0.5, \alpha = 1, L = 1$. For these parameter values, in the first-best allocation there is full employment even in the bad state, at a wage of 0.2 ($> \overline{u}$). I find that for values of m_h between 1.509 and 1.738 there is an asymmetric equilibrium of the kind just analysed (and no symmetric equilibrium). Figure 3 shows how both $\overline{w}_2$ and total employment in the bad state vary as functions of m_h. In this range, $\overline{w}_2$ is sufficiently high that aggregate labour demand in the bad state falls short of supply ($= 1$). As demand in the good state increases, this pushes up $\overline{w}_2$, reducing employment in the bad state. At the same time, β varies between 0.225 to 0.334. For $m_h \leq 1.509$, there is full employment in the bad state (although any asymmetric equilibrium has an inefficient allocation of labour across firms), while for $m_h \geq 1.738$, $\overline{w}_2$ is sufficiently high that hiring firms will choose not to hire in the bad state, and may even want to lay off workers (see below). The qualitative properties of this equilibrium remain similar to the symmetric one in that there are inefficiently low numbers of hires in the bad state, and involuntary unemployment in the sense that in the bad state workers who fail to get a job envy those who succeed in getting a job with a high-wage firm, as do those new entrants who accept work with non-hiring firms. There is "dualism" for period-2 entrants in the bad state, in that they can always accept work with a low wage firm but would prefer to find employment with a high-wage firm, while period-1 workers are indifferent about the firm for which they work.

[19] The analogue of (8) was checked numerically.

Figure 3: Employment and Wages in Asymmetric Equilibria

3 Layoffs and Mobility

In this section layoffs and ex post mobility of labour are added to the model. I maintain the assumption that contracts are binding, but a laid-off worker is free to look for employment with another firm, and for simplicity it is assumed that there are no mobility costs. The specification of shocks differs in two ways from what has gone before. First, it is assumed that there is an additional state which is sufficiently bad that firms will choose to layoff workers. This ("very bad") state will (again) be assumed to be symmetric across firms, so that this change to the model, by itself, will not lead to any ex-post mobility (no firm will be hiring laid-off workers as all suffer equally). The second variation is that in the good state a fraction of firms will receive a bad shock (the same as in the very bad state for simplicity). Such firms will want to lay off workers, who in turn will be able to find work elsewhere.

I maintain the assumption that workers are not able to observe general market conditions (or contracts cannot be conditioned on them), which implies that the firm cannot condition layoff pay on the state. If the only layoff state were the symmetric (very bad) one, then it would be desirable to fully insure workers against unemployment as this would create the right incentives for the firm: it would only layoff workers if their marginal product falls short of their disutility of work.[20] On

[20]The argument in the text suggests that if there was no asymmetric layoff state, employment would be efficient in the symmetric layoff state. From simulations, this is approximately correct,

the other hand, if the only layoff state were the asymmetric one, a firm should pay less layoff pay, since the opportunity cost of the worker is equal to the outside wage. It would then be efficient to set layoff pay so that the effective cost to retaining the worker—the firm's wage plus layoff pay—is equal to the outside wage.[21] If all wages were equal, this would imply zero layoff pay. (In fact the outside wage will be higher because the contract wage is always lower than the spot wage in the good state; thus a somewhat negative layoff pay would be called for given the assumption that mobility costs are zero.) When both symmetric and asymmetric states are present, and since the contract can only specify a single (i.e., non-contingent) layoff pay, a compromise between these two extremes will generally be optimal, so in the very bad state, layoff pay will offer less than full insurance, and layoffs will be involuntary.

While none of the above has anything to do with the wage-bill argument *per se*, it turns out that the fact that the wage-bill argument pushes the period-two wage above $\overline{u}$ implies that more layoffs are made in the symmetric very bad state than would otherwise be the case. The reason for this is that as layoff pay is low, the cost of retaining a worker is close to the contract wage rather than the true opportunity cost ($\overline{u}$), and so excessive layoffs are made. As m_h rises and the wage-bill effect grows, the contract wage increases and this effect is exacerbated.

Let p_{vb} be the probability of the very bad state, in which all firms receive the MVP shock m_{vb} (with revenue function $f_{vb}(\cdot)$), and let p_{hb} be the probability of the good state times the probability of receiving the shock m_{vb} in the good state, while p_{hg} is the corresponding probability of receiving m_h in the good state. The $l-$state is as before, and $p_{vb} + p_l + p_{hb} + p_{hg} = 1$.

Assume that in *vb*- and *hb*-states, layoffs do occur, and, as before, new hires are made in the *l*-state but some new workers are left unemployed, while there is full employment in the good state. Then if the contract (w_1, w_2, w_L) is offered (and acceptable) to workers the profits from intending to hire in the good state with the

although there turn out to be fractionally too few layoffs. The reason is that layoff pay can also be used to discourage a non-hiring deviation strategy; since this involves hiring a larger period 1 workforce, more layoffs are needed in the symmetric layoff state, and setting $\overline{w}_L$ too high discriminates more against this strategy.

[21] By "efficient" here is meant in the relationship between worker and firm; efficient layoff decisions allow the firm to increase profits given the going utility that has to be offered to workers.

good shock, at a wage w_2^h, are given by optimizing by choice of $\overline{n}$, $\overline{n}_L$:

$$f(\overline{n}) - (w_1 + t)\overline{n} \qquad +p_l(\pi(w_2, m_l) + t\overline{n}') + p_{hg}(\pi(w_2^h, m_h) + t\overline{n}') \qquad (19)$$
$$+(p_{vb} + p_{hb})(f_{vb}(\overline{n}_L) - w_2\overline{n}_L - w_L(\overline{n}' - \overline{n}_L)),$$

where $\overline{n}$ is a firm's choice of period 1 employment, and $\overline{n}_L$ is the choice of employment in the layoff states (which is the same in both cases as the shock is the same). Denote by $\overline{\Pi}(w_1, w_2, w_L, w_2^h)$ the optimized value of (19) and $\overline{n}(w_1, w_2, w_L, w_2^h)$ and $\overline{n}_L(w_1, w_2, w_L, w_2^h)$ the optimal employment decisions. The profits from deviating by not intending to hire in the good state are given by:

$$f(n) - (w_1 + t)n \qquad +p_l(\pi(w_2, m_l) + tn') + p_{hg}(f_h(n') - w_2n') \qquad (20)$$
$$+(p_{vb} + p_{hb})(f_{vb}(n_L) - w_2n_L - w_L(n' - n_L)),$$

where n is the choice of period 1 employment, n_L is the choice of employment in the layoff states, and denote by $\Pi^d(w_1, w_2, w_L)$ the optimized value of (20).

A symmetric equilibrium contract $(\overline{w}_1, \overline{w}_2, \overline{w}_L)$ in which $\overline{w}_2 > \overline{u}$ will satisfy $\overline{n}(\overline{w}_1, \overline{w}_2, \overline{w}_L, w_2^h) = L$, $f_h'(\overline{n}_2^h) - t = w_2^h$, where $\overline{n}_2^h$ is the choice of employment when the shock is m_h with w_2^h the spot wage in the good state, and $p_{hb}(p_{hb} + p_{hg})^{-1}\overline{n}_L(w_1, w_2, w_L, w_2^h) + p_{hg}(p_{hb} + p_{hg})^{-1}\overline{n}_2^h = L$, which is the labour market clearing condition in the good state. In addition, $(\overline{w}_1, \overline{w}_2, \overline{w}_L)$ must maximise $\overline{\Pi}(w_1, w_2, w_L, w_2^h)$, taking w_2^h as given, subject to the constraints that $\overline{\Pi}(w_1, w_2, w_L, w_2^h) = \Pi^d(w_1, w_2, w_L)$, as before, and that the utility offered by the contract, $w_1 + \gamma(p_{vb}(\lambda(\overline{u} + w_L) + (1-\lambda)w_2) + p_l w_2 + p_{hg} w_2^h + p_{hb}(\lambda(w_2^h + w_L) + (1-\lambda)w_2))$, equals the going rate (the same expression evaluated at $(\overline{w}_1, \overline{w}_2, \overline{w}_L)$), where λ, a function of (w_1, w_2, w_L, w_2^h), is the layoff probability $(\gamma\overline{n}(w_1, w_2, w_L, w_2^h) - \overline{n}_L(w_1, w_2, w_L, w_2^h))/\gamma\overline{n}(w_1, w_2, w_L, w_2^h)$.

Again resort is made to numerical solutions. For illustration purposes, parameter values are set to $\overline{u} = 0.1$, $t = 0$, $m = 1.3$, $m_{vb} = 0.6$, $m_l = 1.4$, $\gamma = 0.7$, $p_{vb} = 0.1$, $p_l = 0.3$, $p_{hg} = 0.5$, $p_{hb} = 0.1$, $\alpha = 1$ and $L = 1$. Figure 4 plots the solution, over the range of values for m_h for which $\overline{w}_2 > \overline{u}$ and hires take place in the low state, as a function of m_h, for the following variables: $\overline{w}_2$, unemployment in the low state (which equals $\overline{w}_2$ in this case), and unemployment in the symmetric layoff state. The situation in the low state is very much as before; increases in m_h push up the second-period contract wage, with the result that in the low state fewer workers are taken on. There is, however, a similar (but smaller) effect on employment in the symmetric layoff state, even though each firm is laying off workers. Because the wage is higher, the incentive to layoff would be higher provided layoff pay is unchanged. In fact layoff pay increases with m_h too, but at a slower rate than $\overline{w}_2$ because otherwise in the asymmetric layoff state, the effective cost of retaining a worker ($\overline{w}_2 - \overline{w}_L$) would be unchanged despite the true opportunity cost, w_2^h, increasing with m_h; the outcome is thus a compromise between inefficiently high layoffs in the symmetric state and inefficiently low layoffs in the asymmetric state.[22]

Figure 4: Wages and Unemployment with Layoffs

4 Related Literature

As mentioned earlier, the most common use of the equal pay for equal work assumption has been in non-competitive labour market models (such as union-firm wage-bargaining models) where the outside wage is *always* beneath that paid to incumbents (so that what I have called the wagebill argument is not relevant). For example Carruth and Oswald (1987) make this assumption. In their paper an efficient union-firm bargain implies (for relatively high levels of demand) that an increase in demand can result in outsiders (to the union) being taken on at a wage which is constant and (by assumption) equal to that received by insiders. A related

[22]Similar qualitative results would be achieved if zero layoff pay was *imposed*, rather than allowing for layoff pay to be chosen optimally as here; unemployment would increase at the same rate in both the symmetric very bad state and the low state.

argument is found in Gottfries (1992), who also considers efficient union bargaining, analysing a model in which the equal pay assumption is imposed (a major contrast with the Carruth and Oswald (1987) paper is that Gottfries has an explicit stochastic model with nominal and real shocks). He shows that nominal contracting, provided all firms use it, can lead to minimal or even zero private losses, mainly because the insiders (the original union members prior to any expansion of the workforce) are relatively unaffected by shocks which translate into fluctuations in hiring (as in this paper, he concentrates on situations where there are new hires, ruling out layoffs); for example an increase in (aggregate) demand can lead to a *decrease* in the optimal wage because it is desirable, due to the equal pay assumption, as the workforce expands, to pay a lower wage (higher wages paid to outsiders are pure loss from the point of view of the two bargaining parties, and so the larger the number of outsiders, the lower the wage should be)[23], but it can also lead to an increase in the wage if the firm is sufficiently risk-averse, so that profits do not fluctuate too procyclically. The point is that for reasonable parameterizations, having a fixed nominal contract will not be too far from being optimal. Thus, in both Carruth and Oswald (1987) and Gottfries (1992), the equal pay assumption can lead to some form of wage rigidity. The argument, however, is quite different from that of the current paper. Both papers (and the literature generally) differ from this one, as far as the equal pay assumption is concerned, by imposing that the outsiders have reservation wages *below* any wage that insiders might receive—even in "good" states of the world. Wages are kept constant in the face of rising demand to prevent too much surplus "leaking" to outsider. These papers are thus firmly in the insider-outsider tradition where union members (insiders) are always able to earn strictly more than the outsiders' reservation wage.[24] By contrast, here there is a competitive market for labour and in good states of the world, the outsiders' reservation wage is *higher* than that needed to be paid to insiders; the equal pay assumption also bites in such situations when the firm decides to hire outsiders.

The assumption has not played much of a role in the implicit contract literature. The canonical model assumes that there is a fixed labour pool for each firm, or at least once a worker is attached to a firm it becomes ex post immobile; moreover

[23]See also Oswald (1993) on this point.

[24]The equal pay assumption, combined with the insider-outsider model, can lead to hysterisis in unemployment; see, e.g., Blanchard and Summers (1986), Gottfries and Horn (1987), Lindbeck and Snower (1987), Burda (1990) and Gottfries and Westermark (1998).

the models generally last one-period with no new workers entering the market after contracts are signed; consequently there is no possibility of new hires from outside a firm's existing workforce (see, e.g., Azariadis (1975) and Rosen (1985); Baily (1974) considers a dynamic model but again new hires from outside the firm are not considered). One exception is Akerlof and Miyazaki (1980), who consider, in an otherwise fairly standard complete information set-up, the effect of ex post labour mobility between firms after the state of nature is revealed.[25] They impose the equal pay assumption and obtain the result, in a two-industry model, that if layoffs are to occur, it must be in a situation where one industry receives a good shock and the other a bad shock. Counterintuitively, if both receive bad shocks, then no layoffs can occur (in contrast to the model studied here where inefficiently low employment and excessive layoffs can occur when *all* firms receive a bad shock). A second exception is Polemarchakis and Weiss (1978) who consider mobility in a general equilibrium model with asymmetric sectoral shocks. They analyse, in a two-sector full employment model, the efficiency or otherwise of employment flows, and demonstrate the possibility of multiple equilibria. In one equilibrium, wages are rigid in the face of shocks, and the reason why firms in one sector facing a positive shock do not increase wages to bid workers away from the other (negative shock) sector is precisely a wage-bill argument of the type considered here.[26] The implications of wage rigidity are, however, quite different from those considered here; within each sector employment variability is *reduced* in the constant wage equilibrium relative to the flexible wage equilibrium and the first best.

The equal pay for equal work assumption has also been used in search models of the labour market, although the canonical model of the matching literature treats each firm-worker match independently (typically with match surplus being split between the two parties), so that there is no imposition of equal wages across all employees of each firm. Exceptions to this include Manning (1996) (building on the work of Albrecht and Axell (1984) and Mortensen and Burdett (1989)), who imposes an assumption of equal pay within a company, even though productivities vary in a

[25] Other papers which include ex post mobility in an implicit contracting world include Arnott, Hosios, and Stiglitz (1988) and Meyer (1987), which only consider the possibility of workers leaving the firm, and not the possibility of new hires (which is crucial here) and Hosios (1986), which allows for new hires but does not impose equal pay.

[26] This is the only example of which I am aware of a similar use of a wage-bill argument as presented in the current paper.

known fashion across workers.[27]

5 Concluding Comments

This paper has investigated the consequences of a fair pay restriction which rules out discriminating either against or in favour of new hires. In conjunction with an assumption which limits the degree to which wages can be conditioned on the state of nature, the fair pay restriction implies that wages can be less flexible, and employment more variable, than would be the case in the absence of the restriction. Moreover involuntary unemployment can result, and if layoffs are required, they can be excessive and again involuntary.

While the labour market was assumed to be competitive, it would be desirable to see whether similar results hold when there is imperfect competition, for example, with monopsonistic labour markets. In the competitive model, the firm is faced with a stark choice when the spot wage is above the contract wage: either leave the wage where it is and fail to make new hires, or raise the wage up to the spot wage. In a monopsonistic market, the choice would be how *far* to increase the wage; wagebill considerations will presumably lead to a smaller increase than otherwise. The actions of one firm moderating its wage increases might lead to an externality in that the reservation wage of workers is lower than it otherwise would be, so that other firms will not have to raise wages so far in order to attract a given number of new workers (this effect is absent in the current model), thus moderating further the size of wage increases. This is currently work in progress. A further desirable extension would be to derive the fair pay restriction from more basic assumptions, rather than imposing it as here.

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[27] Manning's paper concerns firms choosing a single wage in order to maximise long-run average profit, and it analyses steady-state search equilibrium; hence the firm faces a monopsonist problem rather than a wage-bill problem as identified here (see Footnote 4).

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6 Appendix

(1) First, it is shown that a non-hiring strategy is never preferable to the equilibrium hiring strategy. For notational simplicity, define $A \equiv \sqrt{(1+p_h)}$ and $B \equiv \sqrt{(1+\gamma^2 p_h)}$. The (nonnegative) solution to (7) and (9) yields, along with (10),

$$\begin{aligned} \underline{w}_1 &= m + \gamma\, m_h - t - \gamma\, \overline{u} + (p_h B)^{-1}\, \alpha\, L\, \{-A + B + \\ &\quad p_h\, \left(A - \gamma^2\, A - 2\, B\right) + \gamma\, {p_h}^2\, (\gamma\, A - B)\, \}, \end{aligned}$$

$$\begin{aligned} \underline{n} &= \left(\alpha\, p_h\, \left(1+\gamma^2\, p_h\right)^{\frac{3}{2}}\right)^{-1} \{\alpha\, L\, (A - B + \gamma\, {p_h}^2\, (-(\gamma\, A) + B) + \\ &\quad p_h\, \left(-A + \gamma^2\, A + 2\, B\right)) - \gamma\, p_l\, p_h\, B\, \left(m_h - t - \overline{u}\right)\} \end{aligned} \tag{21}$$

and

$$\overline{w}_1 = m - \alpha\, L - (1-\gamma)\, t$$

After substituting in these solutions into (3) and (11), we get the following (unwieldy) expression for $\overline{\Pi}(\overline{w}_1, \overline{w}_2, \widetilde{w}_2^h) - \underline{\Pi}(\overline{w}_1, \overline{w}_2, \widetilde{w}_2^h)$:

$$\begin{aligned}
&\frac{1}{2\,\gamma^2\,{p_h}^2\,(\alpha + \alpha\,\gamma^2\,p_h)}(\alpha^2\,L^2\,(2 - 2\,\gamma^2 - p_h + 8\,\gamma^2\,p_h \\
&-\gamma^4\,p_h - {p_h}^2 - 3\,\gamma^2\,{p_h}^2 + 2\,\gamma^3\,{p_h}^2 + 2\,\gamma^4\,{p_h}^2 - 2\,\gamma^2\,{p_h}^3 - 4\,\gamma^3\,{p_h}^3 + 2\,\gamma^4\,{p_h}^3 \\
&-2\,\gamma^4\,{p_h}^4 + 2\,(-p_l)\,AB\,\big(1 + \gamma^2\,(-p_l\,(3 + \gamma\,p_h))\big)) + \gamma^2\,p_l\,{p_h}^2\,(m_h - t - \overline{u}) \\
&\big(-2\,m_l + m_h\,\big(1 + \gamma^2\,(-1 + 2\,p_h)\big) + t + \overline{u} + \gamma^2\,(-2\,m_l\,p_h + t + \overline{u})\big) \\
&-2\,\alpha\,\gamma\,L\,p_l\,p_h\,(m_l + m_h\,\big(-1 + \gamma^2 - 3\,\gamma^2\,p_h - \gamma^3\,{p_h}^2 + AB\,\big(1 + \gamma^2\,(-1 + 2\,p_h)\big)\big) \\
&-AB\,\big(m_l + \gamma^2\,m_l\,p_h - \gamma^2\,p_l\,(t + \overline{u})\big)) + \gamma^2\,(m_l\,p_h - p_l\,(2 + \gamma\,p_h)\,(t + \overline{u}))).
\end{aligned}$$

The second derivative of $\overline{\Pi}(\overline{w}_1, \overline{w}_2, \widetilde{w}_2^h) - \underline{\Pi}(\overline{w}_1, \overline{w}_2, \widetilde{w}_2^h)$ with respect to m_h (where $\overline{w}_1, \overline{w}_2$ are being treated as depending on the parameters of the model) is

$$\frac{p_l\,(1 - \gamma^2 + 2\,\gamma^2\,p_h)}{\alpha + \alpha\,\gamma^2\,p_h},$$

which is positive and hence any stationary point (w.r.t. m_h) is a minimum. To determine whether $\overline{\Pi}(\overline{w}_1, \overline{w}_2, \widetilde{w}_2^h) - \underline{\Pi}(\overline{w}_1, \overline{w}_2, \widetilde{w}_2^h)$ can be negative, minimize then with respect to m_h , which leads to the following minimized value:

$$\begin{gathered}
(2\,\alpha\,(1 + \gamma^2\,(-1 + 2\,p_h)))^{-1}\,(\alpha^2\,L^2\,(p_h - 2\,\gamma\,p_h + \gamma^2\,(-p_l + {p_h}^2)) \\
-2\,\alpha\,\gamma\,L\,p_l\,(1 + \gamma\,p_h)\,(-m_l + t + \overline{u}) - p_l\,(1 + \gamma^2\,p_h)\,(-m_l + t + \overline{u})^2.
\end{gathered} \tag{22}$$

Evaluating (22) at the lowest value of m_l allowed in Case 1 (i.e., $\alpha\gamma L + \overline{u} + t$) yields

$$\frac{\alpha\,(-1 + \gamma)^2\,L^2\,(1 - \gamma^2\,p_l)\,p_h}{2 + \gamma^2\,(-2 + 4\,p_h)},$$

which is strictly positive. On the other hand, at the largest value of m_l allowed in Case 1 (i.e., $\alpha L + \overline{u} + t$), the corresponding value is

$$\frac{\alpha\,(1 - \gamma)^2\,L^2\,(-1 + 2\,p_h)}{2 + \gamma^2\,(-2 + 4\,p_h)},$$

which is nonnegative provided $p_h \geq 0.5$. Also, the second derivative of (22) with respect to m_l is given by

$$-\frac{p_l\,(1 + \gamma^2\,p_h)}{\alpha\,(1 + \gamma^2\,(-1 + 2\,p_h))} < 0,$$

so that (22) is necessarily positive at all intervening values for m_l. So far, this assumes an interior solution for $\underline{n}$. In fact, as m_h increases, then $\underline{n}$ declines (the reason being that the equilibrium contract offers period 2 wages higher in both states by the increase in m_h, while the marginal employee under the $(\underline{w}_1, \underline{w}_2)$ contract—which must offer an equivalent increase in expected utility to period 1 employees—generates extra income equal to the increase in m_h only in the good state, and so this employee becomes unprofitable), so it is necessary to check that $\underline{n}$ remains positive. Solve for the critical m_h (in terms of the other parameters), say $\overline{m}_h$, such that in equilibrium firms just choose not to hire in the bad state:

$$\overline{m}_h = \frac{\gamma\, m_l\, p_h + \alpha\, L\, \left(-1 - \gamma^2\, p_h + AB\right)}{\gamma\, p_h}. \tag{23}$$

This is the highest value of m_h under consideration. Substitute this value for m_h back into (21), yielding

$$\underline{n} = \frac{\alpha\, L\, \left(1 + p_l \gamma^2\, + \gamma\, p_h\right) - \gamma\, p_l\, \left(m_l - t - \overline{u}\right)}{\alpha\, \left(1 + \gamma^2\, p_h\right)} > L$$

(since $m_l - t - \overline{u} \leq \alpha L$, and using $p_h \geq 0.5$). Consequently $\underline{n}$ is indeed interior, and thus the computations above are valid. It follows, finally, that (13) holds for all parameter values in Case 1, provided $p_h \geq 0.5$.

(2) To consider the question of whether it is possible profitably to offer some other contract which workers anticipate will involve hiring in the good state, first note, as argued intuitively in the text, that such a contract must involve a lower period 2 wage than $\overline{w}_2$. To see this formally, consider choosing a period 2 wage $\widehat{w}_2$, with $\widehat{w}_1$ being determined by the equal utility condition $\widehat{w}_1 + \gamma(p_l \widehat{w}_2 + p_h \widetilde{w}_2^h) = \overline{w}_1 + \gamma(p_l \overline{w}_2 + p_h \widetilde{w}_2^h)$, say $\widehat{w}_1(\widehat{w}_2)$, and consider the value of profits $\overline{\Pi}(\widehat{w}_1(\widehat{w}_2), \widehat{w}_2, \widetilde{w}_2^h)$. After straightforward manipulation,

$$\frac{d^2 \overline{\Pi}(\widehat{w}_1(\widehat{w}_2), \widehat{w}_2, \widetilde{w}_2^h)}{d\widehat{w}_2{}^2} = \frac{(1 + \gamma^2 p_l)\, p_l}{\alpha} > 0. \tag{24}$$

Moreover, consider the value of $\widehat{w}_2$, say $\widehat{w}_2^*$, which is sufficiently high so that the firm just chooses not to hire in the bad state. This is found by setting optimal employment in the bad state equal to $\gamma \overline{n}(\widehat{w}_1(\widehat{w}_2), \widehat{w}_2, \widetilde{w}_2^h)$ (where $\overline{n}(\cdot)$ is as defined below (3)):

$$\begin{aligned} \frac{m_l - t - \widehat{w}_2^*}{\alpha} \quad &= \quad (\alpha\, p_h)^{-1} \left\{ \alpha\, L\, \left(-1 + 2\, p_h + \gamma\, {p_h}^2 + p_l\, AB\right) \right. \\ &\qquad \left. -\gamma p_l\, p_h\, \left(m_h - t - \widehat{w}_2^*\right) \right\}. \end{aligned}$$

As $\widehat{w}_2$ is reduced below $\overline{w}_2$ (and $\widehat{w}_1$ increased above $\overline{w}_1$), $\overline{n}$ is also reduced as period 1 employment satisfies $MVP - t = \widehat{w}_1 - \gamma t$ (the γt term represents a saving on period 2 training costs); at the same time optimal employment in the bad state will rise, so the firm will hire more in the bad state; thus $\widehat{w}_2^* > \overline{w}_2$. At $\widehat{w}_2^*$ we have, again by straightforward calculation, $d\overline{\Pi}(\widehat{w}_1(\widehat{w}_2), \widehat{w}_2, \widetilde{w}_2^h)/d(\widehat{w}_2) \mid_{\widehat{w}_2 = \widehat{w}_2^*} = 0$, which implies from (24) that for all lower values of $\widehat{w}_2$, $\overline{\Pi}(\widehat{w}_1(\widehat{w}_2), \widehat{w}_2, \widetilde{w}_2^h)$ is decreasing in $\widehat{w}_2$, and for all higher values, $\overline{\Pi}(\widehat{w}_1(\widehat{w}_2), \widehat{w}_2, \widetilde{w}_2^h)$ is constant in $\widehat{w}_2$ since as there are no hires in the bad state, there is no cost to higher levels of $\widehat{w}_2$ (it is exactly offset by a lower $\widehat{w}_1$).

So a firm would never want to increase $\widehat{w}_2$ above $\overline{w}_2$, and would like to shift the wage profile towards period 1. Is this is credible? To show that it is not, I need to demonstrate that at lower period 2 wages the incentive to deviate by not hiring in the good state is strictly positive, i.e., (8) holds. To do this, consider $\phi(\widehat{w}_2) \equiv \overline{\Pi}(\widehat{w}_1(\widehat{w}_2), \widehat{w}_2, \widetilde{w}_2^h) - \Pi^d(\widehat{w}_1(\widehat{w}_2), \widehat{w}_2)$ as $\widehat{w}_2$ is varied below $\overline{w}_2$ (it equals zero at $\overline{w}_2$ by definition of $\overline{w}_2$):

$$\begin{aligned}\phi(\widehat{w}_2) \;=\; & \left(2\,\alpha\,p_h\,\left(1+\gamma^2\,p_h\right)\right)^{-1}[\alpha^2\,L^2\,\{{p_h}^2+\gamma^4\,{p_l}^2\,p_h\,(1+p_h)\\ & +\gamma^2\,\left(2-2\,AB-5\,p_h+6\,AB\,p_h+3\,{p_h}^2-4\,AB\,{p_h}^2+2\,{p_h}^3\right)\}\\ & -2\,\alpha\,\gamma\,L\,\left(-1-\gamma^2\,p_l\right)\,p_h\,(p_l-p_h-p_l AB)\,(m_h-t-\widehat{w}_2)\\ & +\gamma^2\,\left(2+\gamma^2\,{p_l}^2-3\,p_h\right)\,{p_h}^2\,(-m_h+t+\widehat{w}_2)^2].\end{aligned}$$

The second derivative of this w.r.t. $\widehat{w}_2$ is:

$$\phi^{''}(\widehat{w}_2) = \frac{\gamma^2\,\left(2+\gamma^2\,{p_l}^2-3\,p_h\right)\,p_h}{\alpha\,\left(1+\gamma^2\,p_h\right)}, \tag{25}$$

which is greater than or less than 0 according as p_h is less or greater than $(3+2\,\gamma^2-\sqrt{9+4\,\gamma^2})/(2\,\gamma^2)$ (which lies between 0.6 and 0.7). Thus $\phi(\widehat{w}_2)$ is either convex or concave (or both). Evaluating $\phi^{'}(\widehat{w}_2)$ at $\widehat{w}_2 = \overline{w}_2$ yields

$$\phi^{'}(\overline{w}_2) = \gamma\,L\,\left(p_l + \frac{A\,\left(-1+2\,p_h\right)}{B}\right) > 0,$$

so at least locally, cutting $\widehat{w}_2$ below $\overline{w}_2$ is not credible. Consequently if $p_h \geq (3+2\,\gamma^2-\sqrt{9+4\,\gamma^2})/(2\,\gamma^2)$ (so that $\phi(\widehat{w}_2)$ is concave) it follows that $\phi(\widehat{w}_2) < 0$ for all $\widehat{w}_2 < \overline{w}$, as was to be shown. The case $p_h < (3+2\,\gamma^2-\sqrt{9+4\,\gamma^2})/(2\,\gamma^2)$ is more tricky. First, consider the value of $\phi(\widehat{w}_2)$ at $\widehat{w}_2 = \overline{u}$. Evaluating this at m_h^* (the maximum value for m_h such that the contingent contracts solution is implementable; see (6)) yields a value of 0 (recall that this is the defining characteristic of m_h^*). Next, consider increasing m_h above m_h^*:

$$\frac{d\phi(\overline{u})}{dm_h} = \frac{\gamma\,(\alpha+\alpha\,\gamma^2\,p_h)^{-1}\,\{\alpha\,L\,\left(1+\gamma^2\,p_l\right)\,\left(1-2\,p_h-p_l\,AB\right)}{+\gamma\,\left(2+\gamma^2\,{p_l}^2-3\,p_h\right)\,p_h\,\left(m_h-t-\overline{u}\right)\}}, \tag{26}$$

and evaluating this at $m_h = m_h^*$:

$$\frac{d\phi(\overline{u})}{dm_h}\,|_{m_h=m_h^*} = \gamma\,L\,\left(-p_l - \frac{AB\,\left(-1+2\,p_h\right)}{1+\gamma^2\,p_h}\right),$$

which is negative (recall that $p_h \geq .5$). Substitute $\overline{m}_h$ (see (23)) into optimal period 1 employment $\overline{n}(\widehat{w}_1(\widehat{w}_2), \widehat{w}_2, \widetilde{w}_2^h)$ (the optimal employment choice for the contract $(\widehat{w}_1(\widehat{w}_2), \widehat{w}_2)$ assuming new hires will be made in the good state) at $\widehat{w}_2 = \overline{u}$:

$$\overline{n}(\widehat{w}_1(\overline{u}), \overline{u}, \widetilde{w}_2^h) \mid_{m_h = \overline{m}_h} = \frac{\alpha\, L\ (1+\gamma^2 p_l) - \gamma\, p_l\ (m_l - t - \overline{u})}{\alpha}.$$

Since, by assumption in Case 1, $\alpha L \geq m_l - t - \overline{u}$, this expression is at least $L(1-\gamma p_l(1-\gamma)) > 0$. (Thus, as m_h gets larger, the equilibrium utility for each worker is increasing, but for the contract with $\widehat{w}_2 = \overline{u}$, $\widehat{w}_1$ is not so large such that it is optimal to employ no workers in period 1.) It follows that optimal employment should the firm offer $(\widehat{w}_1(\overline{u}), \overline{u})$ and plan not to hire in the good state is also positive, since it must be at least equal to $\overline{n}(\widehat{w}_1(\overline{u}), \overline{u}, \widetilde{w}_2^h)$ (the $\overline{n}$th worker employed is profitable given that the firm plans to hire in the good state; should it plan not to hire, this worker would have the same value in period 1 and in the bad state, but a higher value in the good state). Substituting $m_h = \overline{m}_h$ into (26):

$$\frac{d\phi(\overline{u})}{dm_h} \mid_{m_h = \overline{m}_h} = \{\alpha\, L\ \left(-1 + AB + p_h - 2\, AB\, p_h - \gamma^2\ \left(3 + \gamma^2\,(-1+p_h)^2 - 4\, p_h\right)\ p_h\right)$$
$$+\gamma\ \left(2 + \gamma^2\,(-1+p_h)^2 - 3\, p_h\right)\ p_h\ (m_l - t - \overline{u})\}\gamma\ \left(\alpha + \alpha\,\gamma^2\, p_h\right)^{-1}, \qquad (27)$$

which has a maximum value (as m_l is varied in Case 1) at $m_l - t - \overline{u} = \alpha L$. Substituting this in, it can be checked that (27) is nonpositive given that $p_h \geq 0.5$. $\frac{d^2\phi(\overline{u})}{dm_h^2}$ is the same as the R.H.S. of (25), which is thus positive. To summarise: $\frac{d\phi(\overline{u})}{dm_h}$ is negative at m_h^*, nonpositive at $\overline{m}_h$, and by virtue of $\frac{d^2\phi(\overline{u})}{dm_h^2} > 0$, $\frac{d\phi(\overline{u})}{dm_h}$ must be negative at all values for m_h in between m_h^* and $\overline{m}_h$. Since $\phi(\overline{u}) = 0$ at m_h^*, $\phi(\overline{u}) < 0$ for all m_h in between m_h^* and $\overline{m}_h$. Finally, since $\phi(\widehat{w}_2)$ is convex, it now follows from $\phi(\overline{w}_2) = 0$ that $\phi(\widehat{w}_2) < 0$ for all $\overline{u} \leq \widehat{w}_2 < \overline{w}_2$ and for all m_h in between m_h^* and $\overline{m}_h$.