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LABOUR MARKETS WITH COMPANY WAGE POLICIES

A. MANNING

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The Centre for Economic Performance
The London School of Economics and Political Science
Houghton Street London WC2A 2AE
Telephone 071 955 7284 Fax 071 955 7595

ABSTRACT

In the conventional perfectly competitive model of the labour market, wage-setting is individualistic in the sense that identical workers should receive identical wages in different firms and different workers should receive different wages in the same firm. But, in reality, wages often seem to be attached more to the job than the worker, with identical workers receiving different wages in different firms and different workers receiving the same wage in a single firm. There is what we call a Company Wage Policy. In this paper we explore the consequences of assuming that the labour market is characterised by company wage policies. We consider a number of issues; the nature of wage dispersion and unemployment, the effects of benefits, minimum wages and unions, and the incentives to acquire skills. We show that, in general, company wage policies imply labour market behaviour that is very different from the perfectly competitive model, and seems more in line with empirical evidence. Finally, we consider why company wage policies might exist.

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Alan Manning

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Introduction

In the textbook model of the perfectly competitive labour market equally productive workers would receive identical wages in different firms and workers who differ in their productivity would receive different wages even if they worked for the same firm. In this situation, it is natural to think of the wage as attached to the individual rather than the firm for whom they work,[1] a practice which is reflected in the typical specification of earnings equations in which the explanatory variables are mainly personal characteristics, and findings that employer characteristics are important are regarded as something of a puzzle.

Many economists have felt that this is not a good description of the actual workings of many segments of the labour market. There are a number of pieces of evidence for this. First, seemingly identical workers receive different rewards depending on who they work for (Slichter, 1950 and, more recently, Krueger and Summers, 1988 *inter alia*). Secondly, many firms (both union and non-union) seem to have less variation in wages among workers doing a particular job than there are differences in productivity, and this seems to be known to the employer. This observation forms the basis of the paper of Frank (1984) who explained it as the result of preferences for status. As an example, consider Machin and Manning (1993) who, in a sample of 450 residential homes for the elderly (all non-union) found that about one third had no wage variation whatsoever among their care assistants and there was generally very little wage variation in the others. It would seem unbelievable that there was no variation in the marginal product of the workers.

It would seem that wages are often attached more to the firm (or more accurately the job within a firm) than the individual. It makes sense to talk of a "Company Wage Policy" as was the habit of the so-called neo-realist labour economists of the early 1950s (see Kaufman, 1988, for an overview and Lester, 1948, for a book with that title). On the other hand, as Kaufman points out, in the textbook model of the perfectly competitive model that came to be more influential in economics, it makes little sense to talk about a company wage policy as every firm must pay the market wage for the particular quality of worker it wants to employ.

Consider the following two informal arguments to try to convince oneself of the relevance of the Company Wage Policy idea. First, is the following experiment. Walk into an employer and say that you are interested in working for that firm. If the perfectly competitive model is correct, the employer should take a good look at you and, on the basis of the information available, make you a wage offer (conceivably negative) at which they would be prepared to employ you.[2] You then decide whether you want the job at the offered wage. Now try it; my own experience is that this is not normally a good description of reality. Wage policies are simply not that individualistic. More common is the employer operating a hiring rule; deciding whether, at the going wage for the job, you would be a profitable employee. This is the idea behind the Company Wage Policy (CWP) assumption.

Secondly, consider how the data in Katz and Krueger (1992) is collected. They 'phoned Texan fast food restaurants and asked for information on the starting wage. This was a concept understood perfectly by the respondents (who provided answers) but could not be defined unambiguously by a company operating an individualistic wage policy unless one made the unbelievable assumption that all applicants to the firm were of the same quality.

In this paper, we analyze a labour market with the simplest possible form of a CWP assumption, namely that each firm pays a common wage to all its workers irrespective of their characteristics. This is, of course, a simplification, but one that we believe is helpful for giving insights into the workings of labour markets. The aim is to provide a coherent alternative model of the labour market to the textbook competitive model. For this reason, we discuss existence, uniqueness and efficiency of the CWP equilibrium as these issues are often prominent in setting-up competitive models. But, ultimately, what matters is how the CWP assumption produces predictions that differ from those of the competitive model. As we will argue below, there are important differences with respect to the nature of wage

dispersion, unemployment, the incentives to acquire skills, the effects of unemployment benefits, minimum wages, trade unions and selective employment policies.

The model we present below does have important antecedents in the existing theoretical literature. In many ways, it is simply an extension of the models of Albrecht and Axell (1984), and Burdett and Mortensen (1989) and we will frequently draw on the insights of those papers. These are models designed to explain equilibrium wage dispersion between firms. They assume that all workers are equally productive and this is the assumption that we relax here. We believe that this is important for a full understanding of the effect of the CWP assumptions. For example, in the models cited above, there is always more wage dispersion in equilibrium than there would be in the perfectly competitive equilibrium simply because, in that equilibrium, all workers would receive the same wage. In contrast, matters are more complicated in our model as, while there is more wage dispersion between firms, there is less variation within firms than in the competitive equilibrium. And, as we show below, the view of unemployment and the effect of minimum wages is also different.

One paper with similar ideas to this one, in terms of non-individualistic wage-setting, is Burdett and Wright (1992). In the main model of that paper the wage is not adjusted to the individual circumstances of the two sides of the bargain. But, in their model, all skills are specific whereas in the model presented here all characteristics are general.

The plan of the paper is as follows. In the next section we outline the basic model and describe equilibrium conditions. We then prove the existence of an equilibrium, provide a sufficient condition for uniqueness and consider efficiency. We then prove an equivalence result: as the labour market becomes frictionless the CWP equilibrium approaches the competitive equilibrium so that the existence of a CWP does not in itself show that labour market outcomes need be substantively different from those of a competitive model. We then analyze a set of issues; wage dispersion, unemployment, incentives for skill acquisition, unemployment benefits, minimum wages, trade unions and selective employment policies to consider how the implications of the CWP model differ from those of the competitive model. Finally, we conclude with a brief discussion of why CWPs might exist although it should be noted that this is maintained as an assumption through most of the paper.

1. The Model

We make the following assumptions about the labour market.

(A1) Workers

There is a mass of M of workers. Each worker is characterised by a pair (p,b) where p is the number of efficiency units of labour supplied by the individual (their quality) and b is the monetary equivalent of the utility derived from unemployment. These characteristics are assumed to be perfectly observable[3]. The distribution of the characteristics in the population is given by a density function $\phi(p,b)$. It is sometimes convenient to decompose $\phi(p,b)$ into a conditional and marginal density function $\phi(p,b)=h(b|p).g(p)$. We make the following assumptions about these distributions:

- both $h(b|p)$ and $g(p)$ are continuous in their arguments on some bounded compact support.
- there is some p with $g(p)>0$ such that $H(p|p)\geq H_0>0$ where $H(b|p)$ is the distribution function of b conditional on p.

These assumptions are convenient and it is probably possible to relax them. The second assumption ensures that a non-zero measure of workers have p>b so that it is possible to have employment in the economy.

(A2) Firms

There is a fixed mass of firms, normalised to unity. Each firm has a constant returns to scale revenue function[4].

(A3) Matching Technology

Unemployed workers receive job offers at a rate λ_0, employed workers at a rate λ_1. Both λ_0 and λ_1 are finite and strictly positive. Job offers are drawn at random from firms (in the language of Burdett

and Vishwanath, 1988, we have a random matching model). All workers, employed and unemployed, have an exit rate q from the labour market and are replaced by new workers who initially enter unemployment.

(A4) Wage-Setting

Firms set wages once-for-all to maximise their steady-state profits. Wages are not adjusted to the characteristics of the worker (this is the CWP assumption). Denote by F(w) the distribution function of wages.

In this set-up it is important to realise that not all matches between workers and firms will be consummated even when it would be efficient to do so (ie the marginal product exceeds the utility from unemployment). When a worker meets a firm, employment will only result if, given the wage, the worker wants the job and the firm wants the worker. It should be obvious that the optimal strategy for an unemployed worker is to accept the job if the wage exceeds some reservation wage r(p,b;F) where the notation reflects the fact that it will depend on the worker's characteristics and the wage distribution. For an employed worker the optimal strategy is to accept the job if it exceeds the current wage. On the firm's side it should be obvious that the optimal strategy is to demand the worker if their marginal product exceeds the wage ie if their quality, p, exceeds the offered wage w. The consequence of this is that some efficient matches are not consummated; this will be very important in discussing the implications of the CWP model below.

The assumption that wages are determined before the worker and individual firm meet and are not fine-tuned to the worker's characteristics is where the model here differs importantly from the matching models of Diamond (1982a,b) and Pissarides (1985) in which wages are determined by individualistic bargaining after the worker and firm are matched. The result of this is that a match will always be consummated as long as the reservation wage of the worker is less than their marginal product. Which assumption about wage-setting is more appropriate, probably depends on the segment of the labour market in which one is interested; the assumption made here seems more appropriate for many anonymous markets for unskilled workers. For example, it seems sensible to think of the ability of an unskilled worker in a fast-food restaurant or a supermarket to negotiate their wage as essentially zero.

The labour market outcome for a given F is summarized by the reservation wage rule for workers r(p,b;F), which we can then use to derive the steady-state labour supply to a firm paying w of workers with characteristics (p,b) which we denote by L(w;p,b;F) and the steady-state profits earned by a firm paying w which we denote by Π(w;F). The following information provides information about these functions.

Proposition 1: Given F:

i. the workers' reservation wage rule is unique and given by the solution to:

$$r(p,b;F) + (\lambda_1 - \lambda_0)\int_{r(p,b;F)}^{p} \frac{[F(p)) - F(x)]\,dx}{q + \lambda_1[F(p) - F(x)]} = b \qquad (1)$$

ii. the steady-state supply of labour with characteristics (p,b) to a firm paying wage w is given by:

$$L(w;p,b;F) = \frac{q\lambda_0 M\phi(p,b)}{[q+\lambda_1[F(p)-F(w)]].[q+\lambda_1[F(p)-F(\bar{w})]]}\cdot\frac{[q+\lambda_1(F(p)-F(r(p,b;F)))]}{[q+\lambda_0(F(p)-F(r(p,b;F)))]} \qquad (2)$$

for p ≥ w ≥ r(p,b;F) and equal to zero if w<r(p,b;F) and where:

$$F(\bar{w}) = \lim_{\epsilon \to 0_+} F(w-\epsilon) \qquad (4)$$

iii. the steady-state profits earned by a firm paying w can be written as:

$$\Pi(w;F) = \int_{w}^{\bar{p}} \int_{\underline{b}}^{\rho(w,p;F)} (p-w).L(w;p,b;F)\; db\; dp \qquad (3)$$

or:

$$\Pi(w;F) = q\lambda_0 M.\int_{w}^{\bar{p}} \frac{(p-w).H(\rho(w,p;F)\,|\,p)g(p)dp}{[q+\lambda_1[F(p)-F(w)]].[q+\lambda_1[F(p)-F(\bar{w})]]} \qquad (4)$$

where r(p,ρ(w,p;F);F) = w i.e ρ(w,p;F) is the highest level of b such that employment will be desired by the worker at wage w if they are of quality p and the wage distribution is F. From (1) this is given by:

$$\rho(w,p;F) = w + (\lambda_1 - \lambda_0)\int_{w}^{p} \frac{[F(p)) - F(x)]\,dx}{q + \lambda_1[F(p) - F(x)]} \qquad (5)$$

Proof: See Appendix.

The intuition for these results is very simple. (1) is the traditional reservation wage rule modified for the fact that the wage offer distribution is truncated above by the worker's marginal product.

The reservation wage is higher for individuals with a higher b, but the effect of p is more complicated. If $\lambda_0>\lambda_1$ so that off-the-job search is more effective than on-the-job search then r is increasing in p; individuals with better labour market prospects are more choosy. But, if $\lambda_0<\lambda_1$, r is decreasing in p as individuals with better labour market prospects want to get quickly into employment which can then be used as a route to better jobs. (2) gives the labour supply for the firm. Given p,b and F labour supply is an increasing function of w as the quit rate is lower for high wage firms and their recruitment higher. This means that firms have some monopsony power, and thinking of the textbook model of monopsony will be helpful for understanding some, but not all, of the results presented later in the paper. There is a discontinuity in labour supply at any wage paid by a mass of firms as a firm paying a slightly higher wage suddenly begins to obtain recruits from that mass and this raises employment discontinuously.

Given Proposition 1, we are now in a position to discuss equilibrium.

2. Equilibrium: Existence, Uniqueness and Efficiency

a. Existence

In an equilibrium it must be the case that all offered wages must yield the same level of profits and no other wage offers higher profits. We can summarise this in the following definition.

Definition: F is an equilibrium wage distribution if there exists a Π^* (the equilibrium level of profits) such that:

i. $\Pi(w;F) \leq \Pi^*$ for all $w \in \mathbf{R}$ (6)
ii. The set of w such that $\Pi(w;F) < \Pi^*$ is of measure zero with respect to F.

We can prove the following result.

Proposition 2: Under the assumptions (A1)-(A4) above, an equilibrium exists and the equilibrium distribution function, F(w), satisfies a Lipschitz condition:

$$F(w') - F(w) \leq K.(w'-w) \quad \textit{for all } (w,w'),\ w' \geq w$$

for some positive finite K.
Proof: See Appendix.

One of the implications of the Lipschitz condition is that there can be no mass points in the equilibrium wage distribution in this model as in Burdett and Mortensen (1989). It should be noted that there are special cases in which a closed-form analytical expression can be provided for the equilibrium wage distribution. For details of these see Burdett and Mortensen (1989). But, for example, no closed form equilibrium has been provided for any case with heterogeneity in worker quality. As this is a crucially important case for understanding the full implications of a CWP assumption, there seems little alternative to working with assumptions that do not produce an elegant analytic solution.

It should also be noted that we have considered equilibrium with a fixed number of firms. It is straightforward to consider the model with a variable number of firms and a fixed set-up cost. Then Π^* would be the set-up cost and exogenously given and the number of firms would affect the ratio of workers to firms M and also the job offer arrival rates.[5]

b. Uniqueness

Proposition 2 tells us nothing about the number of equilibria. In general, it would seem that equilibrium is not unique[6]. But, one can provide a sufficient condition for uniqueness as is done in the following Proposition.

Proposition 3: If $\lambda_0=\lambda_1$, then equilibrium is unique.
Proof: See Appendix.

The intuition for Proposition 3 is simple; if $\lambda_0=\lambda_1$ the reservation wage is b ie it is independent of the wage offer distribution. The assumption in Proposition 3 is certainly not necessary as an example in which there is no heterogeneity in b or p analyzed by Burdett and Mortensen (1989) demonstrates.

c. Efficiency

There is also some interest in whether the CWP equilibrium is efficient. In the discussion of efficiency that follows we will use total surplus as our welfare criterion. If lump-sum transfers are available we can ensure that anything that increases total surplus can be a Pareto improvement. It should be readily apparent that the CWP equilibrium does not generally maximise the total surplus as a competitive equilibrium would. Efficiency would be attained if every match in which the marginal product of the worker exceeds their value of leisure is consummated[7]. This condition is not generally satisfied by the CWP equilibrium. For example, if the support of b does not depend on p, first-best efficiency is only attainable if $\bar{b}$, the highest value of b is below $\underline{p}$, the lowest value of p. If this condition is satisfied we will have first-best efficiency if all wages lie between $\bar{b}$ and $\underline{p}$; but, as the examples below show, there is no guarantee, even in such a case, that the CWP equilibrium will be first-best efficient.

However, it is perhaps unreasonable to expect the CWP equilibrium to be as efficient as the competitive equilibrium when there are some implicit rigidities which prevent the firm tailoring their wage offer to the individual worker. Another question is whether the CWP equilibrium is the efficient wage distribution given that we cannot force employers to hire workers who are unprofitable at the offered wage or force workers to take jobs they do not want ie to ask whether the equilibrium is efficient among the class of CWPs. It is simple to show by example that the CWP equilibrium is generally not efficient in this sense either.

Consider a case analyzed by Burdett and Mortensen (1989) in which there is no heterogeneity in worker quality but in which there is heterogeneity in b. One efficient CWP is for all firms to offer a wage equal to p as this ensures that all jobs are attractive to all workers while pricing no workers out of jobs. But there is no guarantee that this is the CWP equilibrium. Firms will use their monopsony power to lower wages and as a result some efficient matches will not be consummated. In this example the CWP

equilibrium wage distribution is too low (in the sense of first-order stochastic dominance) as compared to the efficient CWP wage distribution.

However, in general it is not possible to say anything about the comparison of the CWP equilibrium distribution with the efficient distribution. Consider the following example in which the equilibrium wages are too high relative to the efficient level. Suppose all workers have a common value of b, but that there is heterogeneity in the quality of workers with the lowest quality level equal to b. The efficient CWP wage distribution has all firms paying b (as this ensures that no workers for whom it would be efficient for them to work are priced out of jobs) but we know this cannot be the equilibrium wage distribution as Proposition 2 tells us that the equilibrium can have no mass points.[8]

The reason that one cannot say anything about the direction of the inefficiency is that there are a number of factors at work in the model tending to cause inefficiency in different directions. First, when the employer cuts wages the saving in labour costs that is a private gain for the firm is not a social gain as it involves the loss of surplus by workers. The labour market frictions mean that labour supply is not perfectly elastic with respect to the wage which gives employers some monopsony power which they tend to use to force wages too low. Secondly, when an employer raises wages some of the extra workers attracted to the firm come from other firms so that the private return to raising wages overstates the social return. This effect tends to make wages too high.

Given that the equilibrium wage distribution is not efficient, one might reasonably ask whether there are any policies which could make the distribution more efficient. Although it is possible to think of specific policies in particular cases eg a minimum wage policy in the heterogeneous reservation wage example given above, no simple policy seems to offer an improvement in all circumstances. For example, in the heterogeneous quality example a maximum wage policy is called for and a minimum wage would only make things worse.

Finding a good policy is also complicated by the fact that the efficient wage distribution may look nothing like the CWP equilibrium. Consider the following example. Suppose that $b \sim U[\underline{b},\bar{b}]$. Assume that there is a one-to-one relationship between p and b with $p = b + a$, $\lambda_0 = \lambda_1$. Assume (for convenience) that $a < (\bar{b}-\underline{b}) < 2a$. Then we can prove the following:

Proposition 4: The wage distribution that maximises total welfare has half the firms offering a wage $(\underline{b} + a)$ and half the firms offering $\bar{b}$.
Proof: See Appendix.

It should be apparent that no simple policy like a continuous wage tax/subsidy could produce this as an equilibrium wage distribution because Proposition 2 would still apply in this case and any CWP equilibrium could not have any mass points in the wage distribution.

It should be noted that if we consider still more general models in which variables like search intensity and investment in human capital are also choice variables then there are going to be additional sources of inefficiencies as the return to search and training do not accrue only to the individual (see below for more discussion of this).

3. An Equivalence Result

In the introduction we discussed the CWP assumption as being very different from the process of wage-setting under perfect competition. In this section we show that as the labour market becomes frictionless in the sense that the job offer arrival rates become infinite the equilibrium in a labour market with a CWP approximates the perfectly competitive equilibrium so that the outcomes may not be that different. This type of result has been derived for the case of workers of homogeneous quality by Burdett and Mortensen (1989) when the perfectly competitive equilibrium is a single wage so that wage dispersion disappears in the limit. In contrast, with differences in worker quality, the perfectly competitive equilibrium has wage dispersion but we show that this is still the limit of the CWP labour market. The implication of this result is that observing that firms follow CWPs does not necessarily imply that labour market outcomes are very different from what one would expect to find in a competitive labour market.

First let us consider the perfectly competitive equilibrium. With our assumption of constant returns to scale all workers for whom $p>b$ get employment at a wage equal to p while all those with $p<b$ are unemployed. Because of constant returns, equilibrium profits are zero and the equilibrium size of firms is indeterminate. There is also an indeterminacy in the allocation of workers to firms as who works for whom is not specified.[9] This second indeterminacy will be important in understanding the result presented below.

Now consider what happens in the CWP markets as $(\lambda_0,\lambda_1) \to \infty$. For simplicity, let us assume that $(\lambda_1/\lambda_0) \to k$ where k is strictly positive and finite. We can prove the following:

Proposition 5: As $\lambda_0,\lambda_1 \to \infty$ with $(\lambda_1/\lambda_0) \to k>0$ the equilibrium distribution of wages across workers converges in distribution to the perfectly competitive one.
Proof: See Appendix.

The intuition for this result is the following. As discussed above, there is a degree of freedom in the perfectly competitive equilibrium in the allocation of workers to firms. One can use this degree of freedom to ensure that all workers working for a particular employer have the same quality in which case each employer will pay a common wage to all its workers so that this is consistent with the CWP assumptions.[10] This demonstrates that, for example, even if workers care so much about equality that they refuse to work in firms in which there is any inequality at all (which could be one justification for the extreme CWP assumption used here) outcomes are not necessarily very different from the competitive outcomes. Hence, those who believe in the importance of fairness in understanding labour market outcomes need to demonstrate more than the simple existence of concerns about fairness.

If, in reality, labour market frictions are so small that the perfectly competitive model is a good approximation to the CWP equilibrium, the case for using the competitive model as an approximation would be strong as it is simpler to work with[11]. But, in general, the implications of the CWP model if there are nonnegligible frictions are very different from those of the competitive model.

4. Implications of the Company Wage Policy Model

Even if the CWP equilibrium was very different from the competitive one, the model adopted would not make any substantive difference if the predictions of the CWP model were the same as the predictions of the competitive model. In this section we aim to consider how a CWP model leads to a view of the labour market that is substantively different from that given by the competitive model.

a. Wage Dispersion

In a perfectly competitive labour market the distribution of wages would be perfectly explained by the distribution of ability (absent any need for compensating wage differentials). A perfect measure of ability should be able to perfectly explain wages. In the CWP model, ability is still relevant for wage determination but it is no longer the sole determinant of wages. It should be fairly obvious that not all workers with quality p earn the same wage in the CWP equilibrium. But, as the following proposition shows, one can prove the stronger result that the average level of wages is also not uniquely determined by p.

Proposition 6: The expected wage given p and r, denoted EW(p,r), is given by:

$$EW(p,r) = p - \frac{\int_r^p \frac{q[F(w)-F(r)]dw}{q+\lambda_1[F(p)-F(w)]}}{F(p)-F(r)} \qquad (7)$$

a. The expected wage is strictly less than the worker's marginal product.
b. The expected wage is increasing in p, *ceteris paribus*.
c. The expected wage is increasing in the reservation wage, *ceteris paribus*.
d. The expected wage is increasing in (λ_1/q), *ceteris paribus*.

Proof: See Appendix.

The explanation for these results is very simple. Average wages are below marginal product, essentially because the labour market frictions mean that the elasticity of the labour supply curve facing the firm is not infinite and they use this monopsony power to pay workers less than their marginal product. On average, high ability individuals get higher wages, not because they get paid differently from low ability workers working in the same firm but because they are more likely to be in the high wage jobs. The last result says that, for a given distribution of wages, workers do better if their job offer arrival rate is higher relative to their quit rate. This type of result could be used to explain the existence of labour market discrimination even where overt discrimination in paying different wages is not allowed. For example, it is quite plausible to assume that women with dependent children have more restrictions on the jobs they can take because they may be constrained to work part-time and then the time and money costs of going to work become more important or because the hours they can work are restricted. One could model this by assuming they have a low job offer arrival rate. If in addition, they have a relatively high rate of leaving the labour force (a high q) Proposition 6d predicts that on average they will have lower wages.

The above discussion suggests that the CWP model produces predictions that are consistent with those empirical studies of the labour market that find the existence of wage dispersion that cannot be explained by ability alone (for example, Slichter, 1950, or, more recently Krueger and Summers, 1988, and Gibbons and Katz, 1992)[12].

This literature also emphasizes that employer characteristics matter. The CWP model in the form presented above cannot explain the importance of these variables for the simple reason that there is no employer heterogeneity.[13] But, it is possible (if very messy in the present model) to modify the model so that firms are heterogeneous. Burdett and Mortensen (1989) present one example of this type. Suppose that employers differ in their marginal revenue product of labour curves. It seems plausible that 'good' employers have a higher marginal product of labour and perhaps that they also value high ability individuals relatively more. Hence they would like to hire more and better quality workers. As all firms face the same supply curve of labour, the only way they can do this is to pay higher wages, producing a correlation of wages with employer characteristics as found in the empirical evidence.

But, there are also ways in which the CWP model does not support ideas that have been associated with this literature on equilibrium wage dispersion. First, the papers on the importance of employer characteristics often present their findings as positive evidence for rent-sharing which conveys the impression that wages are above what they would be in the competitive labour market. Such a conclusion can not be supported by the CWP model as all workers are being paid less than their marginal product (although the gap is larger for some workers than others).

Secondly, the empirical literature gives the impression that it is employer heterogeneity that is the cause of wage dispersion, emphasizing, for example, the different sorts of technology in different firms. But, while employer heterogeneity does affect wage dispersion in the CWP model it is not the fundamental cause as the model presented above has wage dispersion but homogeneous employers. Rather, it is labour market frictions that are the fundamental cause of wage dispersion.

Finally, the empirical literature often gives the impression that their findings imply that there is more wage dispersion than one would expect to find in a competitive labour market. But, while there is more wage dispersion for workers of a given quality, the CWP model also implies that there is less variation within firms than there would be in a competitive market so that the overall comparison of wage dispersion is ambiguous.

There are other empirical aspects of the process of wage determination which are consistent with the model presented here. For example, Gibbons and Katz (1991) find that for workers changing jobs, wages are highest for those quitting voluntarily, and higher for those displaced as a result of plant closures rather than other reasons. They propose an asymmetric information explanation but the CWP model is also consistent with these findings. In the CWP model those workers leaving voluntarily are doing so because they have a better

wage offer. And, if all workers lose their jobs as a result of a plant closure, the average quality of those workers will be higher than those who lose their jobs when the firm lays-off part of its workforce as it will then choose to lay-off the lowest quality workers.

This is not to say that all aspects of wage determination can be explained by the CWP model in its present form. Because of the extreme assumption that there is no wage variation whatsoever within firms, one cannot explain the positive correlation between wages and job tenure that does seem to be a feature of the data even after one has taken account of potentially spurious correlations between wages and job tenure introduced by the type of search model considered here (see, for example, Altonji and Shakotko, 1985 and Topel, 1991). An obvious extension of the model is to consider the effect of allowing less restrictive wage contracts eg allowing the use of returns to seniority to reduce labour turnover, and this we hope to do in future work.

We have argued that the CWP model can be used as a theoretical foundation for the empirical findings on wage dispersion that ability alone cannot fully explain wages. But, it also suggests modifications of views about the causes of wage dispersion. It suggests that the fundamental cause of wage dispersion is labour market frictions, that wages are on average below marginal products and that wage dispersion is not necessarily greater than it would be in a perfectly competitive labour market.

b. Unemployment

There are several sources of unemployment in the CWP model presented above. First, there is frictional unemployment which is the result of the fact that it takes time to match workers with firms. But, even when a match does occur, employment does not necessarily result. There are essentially three reasons why a match may not be consummated. First, the marginal product of the worker may be less than their reservation wage. In this case, there is no wage at which employment could occur and it is efficient for the worker and firm to part.[14] But, with the CWP assumption there are two other reasons why employment may not result from a match and these are both sources of inefficient unemployment. First, at the wage offered by the firm, the firm may want the worker but the worker does not want the firm. The result is what, in the traditional search literature, is thought of as voluntary unemployment. But, it is also possible that, at the wage offered, the worker wants the job but the firm does not want the worker. It is natural to describe this as involuntary unemployment as this is normally used to describe a situation where workers want work at the wage (or a slightly lower wage) but the employer will not hire them.[15]

The ability of the CWP model to have unemployment that is both voluntary and involuntary is one of its attractive features as real world unemployment is not as simple as many theoretical models would seem to pretend. For example, it is perhaps true that it is always relatively easy to get a low wage job but this does not mean that we should class all unemployment as voluntary because it is likely that there are higher wage jobs in the market which the worker would like and in which they could profitably be employed but these jobs are hard to find. Because of the heterogeneity in both workers and jobs in our model it does not make much sense to talk about an individual being voluntarily or involuntarily unemployed. Each worker is voluntarily unemployed with respect to some jobs and involuntarily unemployed with respect to others. The relative importance of voluntary and involuntary unemployment also differs across individuals. As a measure of the relative importance of involuntary unemployment one could use the fraction of unconsummated efficient job matches that are unconsummated because the employer does not want the worker. For a worker whose ability is p and whose reservation wage is r this would be given by $[1-F(p)]/[1-F(p)+F(r)]$. Manning, Thomas and Wadsworth (1993) present a way of trying to estimate this proportion. One might think that the distinction between voluntary and involuntary unemployment becomes less useful as it becomes blurred but, as we shall see below, the distinction remains useful in thinking about the likely effects of various policies on unemployment. The analysis of the effect of various policies on unemployment is an issue which we consider later.

The CWP model also predicts that unemployment rates will vary systematically across different types of workers. As the inflow rate into unemployment is q and the outflow rate $\lambda_0[F(p)-F(r)]$, the steady-

state unemployment rate for a (p,r) individual which we will denote by u(p,r) will be:

$$u(p,r) = \frac{q}{q+\lambda_0[F(p)-F(r)]} \qquad (8)$$

so that, other things equal, the unemployment rate is lower for high ability individuals, higher for high reservation wage individuals, and higher for those individuals with low job offer arrival rates. This is broadly consistent with the observed facts.

One might also be interested in the matching process from the point of view of firms. In the present model, two sorts of firms will have particular difficulties in recruiting workers: high wage firms who have strict hiring rules and low wage firms who find it difficult to attract workers. This is again broadly consistent with the evidence eg see Holzer (1990) for US evidence on this and IFF (1993) for British evidence.

c. Incentives for Human Capital Acquisition

In the model presented above we have assumed that the ability of workers, p, is exogenously given. Here, we consider informally what might happen if p is, to some extent, a choice variable that can be altered by investment in education and training. As p is, by assumption, a general skill, the analysis of Becker (1975) would predict that, in a perfectly competitive market, workers will pay for the acquisition of skills and that, with perfect capital markets, investment will be at the efficient level. The implications of the CWP model are rather different.

Suppose that the cost of obtaining ability level p is c(p) (which might differ across individuals). In a competitive market a worker will earn p with probability 1 so that the lifetime expected utility is (p/q) and p will be chosen to maximise (p/q)-c(p) leading to the first-order condition qc'(p)=1. Note that, if the individual works, the optimal level of investment in human capital is independent of b.

Now consider the incentives for workers to invest in skill acquisition in a CWP model. Assume that education is a full-time activity so that acquiring skills is incompatible with having a job.

Then it is efficient to undertake all investment at the beginning of one's life.[16] p will be chosen to maximise $V^u(p,b)-c(p)$. The following result is useful.

Proposition 7: For an individual with (p,b) and reservation wage r, V^u can be written as:

$$V^u = \frac{1}{q}[u(p,r).b + (1-u(p,r)).EW(p,r)] \tag{9}$$

where EW is as given in (7) and u is as given in (8).
Proof: See Appendix.

Proposition 7 is very simple. It says that the expected lifetime utility of a worker is a weighted average of utility when unemployed and wage when employed, with the weight on the former option being the unemployment rate. As $EW<p$, and $u<1$, $V^u<(p/q)$ for a worker for whom $p>b$ so that workers do not get the return to human capital investment that they would in a competitive labour market. Given this, one might think that there are too few incentives for workers to invest in skill acquisition. But this is too simple. Workers will invest to the point where $\partial V^u/\partial p=c'(p)$. Differentiating (9) and recognising that r will be chosen to maximise V^u we obtain:

$$\frac{\partial V^u}{\partial p} = \frac{1}{q}\left[-\frac{\partial u}{\partial p}.(EW-b) + (1-u).\frac{\partial EW}{\partial p}\right] \tag{10}$$

(10) shows that one can break down the effect of increased p into two parts, the improved employment opportunities and the higher expected wage. By differentiating (7) and (8) one can readily check that there is no reason why (10) should be less than (1/q) for all individuals and hence no reason why there should be under-investment in p for all workers. But there are some types of workers for whom we know that there will be under-investment. First consider a worker with a value of p at or above the highest wage being offered in the market. Then there is no way that increasing p can bring any benefits and they will not undertake any further investment. Secondly, consider a worker for

whom p is equal to b. Then, from (10), the marginal incentive to invest in skill augmentation is zero (although V^u can be a convex function of p so one needs to be careful about making generalisations). This suggests that the under-investment problem may be more serious for those workers on the margins of the labour market.

The above discussion has focused on the incentives for individuals to acquire skills given the wage distribution F which, by virtue of the CWP assumption, is unaffected by the choice of p by the individual. But, the equilibrium distribution of wages is itself affected by the investment decisions made as a whole. Taking account of this, one can generate some fairly extreme results, for example:

Proposition 8: Suppose that only workers can make investment in skills, that in the absence of any education all workers have marginal product p_0, and that the cost of acquiring $p>p_0$ is strictly positive. Then the only possible equilibrium is one in which no workers acquire any education.
Proof: If there are any labour market frictions, the highest wage offered in the economy must be strictly below the marginal product of the highest ability individual. But then these individuals have no incentive to acquire this ability as it costs them something and they get nothing in return. So no individual will pay anything to acquire a level of productivity above the highest wage offered. Putting these two facts together leads to the conclusion that no worker will make any human capital investment.■

The inefficiency that results from this can obviously be enormous. Of course, this extreme result is the consequence of the extreme assumption that wage policies are not individualistic at all and the inefficiency would be mitigated to the extent that there are individualistic wage policies. But, it does suggest that there may be a very substantial inefficiency in the free market provision of general skills, which might explain why there is such substantial intervention in education by governments in all countries.

However, matters may not be so bad once one recognises that firms as well as workers have incentives to invest in training. In a competitive market employers have no incentive to pay for general skill acquisition as they are forced to pay workers their new marginal product. But, in the CWP model, the existence of labour market frictions means that the returns for training a worker can be positive and, so, the CWP model can explain the empirical puzzle that firms do provide general training (see, for example, Bishop, 1991)[17]. To see this denote by $\pi(p,w)$ the expected profit to be made from employing a worker of quality p in a firm paying wage w. As the worker leaves the firm at a rate $(q+\lambda_1[F(p)-F(w)])$, we have:

$$\pi(p,w) = \frac{p-w}{q+\lambda_1[F(p)-F(w)]} \qquad (11)$$

Firms will invest up to the point where $(\partial\pi/\partial p)=c'(p)$. From (11) we have:

$$\frac{\partial\pi(p,w)}{\partial p} = \frac{1}{q+\lambda_1[F(p)-F(w)]} - \frac{\lambda_1 f(p)(p-w)}{(q+\lambda_1[F(p)-F(w)])^2} \qquad (12)$$

(12) makes it clear that there are two opposing effects. On the one hand increasing p increases the profit to be made from the worker for the period for which they remain with the firm. On the other hand, increasing p also improves the outside employment opportunities of the worker and makes them more likely to leave. From (12) it should be apparent that the incentive for firms to train workers differs across firms with different wages, and differs for workers within firms. How these incentives vary with p and w depends in a complicated way on F, so we will content ourselves with discussing some plausible outcomes. For workers of a given quality higher wage firms tend to have more incentives to train them as their quit rate is lower and the profit per worker is also lower. So we would expect that high wage firms would be doing more general training than low wage firms. A firm with a given w is likely to have high incentives to train the lowest quality workers because (p-w) is close to zero and hence F(p)-F(w) is close to zero. But there may also be high incentives to train high quality workers particularly in high wage firms as raising their productivity further will not further improve their employment prospects and, at least in high wage firms, their quit rate will be rather

low. So the CWP model produces some predictions about which sort of firms will provide general training for which sort of workers which are potentially testable.

In this section we have argued that the CWP model provides a different description of the process of general human capital acquisition from the competitive model. As compared to the competitive model, workers' incentives are likely to be dulled, but firms now have positive incentives to train. However, there is no reason to believe that the outcome will be efficient as part of the gains from general training will always accrue to the future employers of workers and it is likely to be difficult to internalise this effect.[18]

d. Unemployment Benefits and Unemployment

There is a large literature, both theoretical and empirical, on the effects of unemployment benefits on unemployment. The most common approach[19] emphasizes how raising unemployment benefits raises the reservation wage and decreases the exit rate from unemployment, which lengthens unemployment durations and raises the steady-state unemployment rate. This is backed up by evidence that is largely cross-sectional that finds that those individuals that are receiving high unemployment benefits have lower exit rates (see Devine and Kiefer, 1990, for a survey of this literature). But, even accepting this evidence (which is not uncontroversial), it is dangerous to jump from these findings to the conclusion that cutting unemployment benefits will reduce unemployment. With a perfectly competitive model of the labour market one is relatively safe in drawing this conclusion because the wage is thought to be equal to the marginal product which should not be affected by unemployment benefits (unless there is decreasing returns **and** aggregate employment decreases).

In the CWP model it is also true that individuals with higher benefits will, other things equal, have higher reservation wages and lower probabilities of leaving unemployment (see (8) above) so that it is consistent with the cross-section evidence. But, it is important to remember that wages deviate from marginal products, and that the distribution of wages observed is, in part, influenced by the reservation wage of workers so that cutting benefits will generally lead to a fall in wages, which means that the net effect on unemployment will be less than what one would have inferred given the cross-section evidence. One might think that as benefits are raised wages rise but not by enough to off-set the effect on exit rates of the higher benefits.

But, even this is not necessarily true. The easiest way to show this is by example. Assume all workers have the same ability p, and that $\lambda_0=\lambda_1$. Suppose that, in the absence of benefits, there is a distribution of reservation wages but all reservation wages are strictly below p. Now the lowest wage in equilibrium may be below the highest reservation wage so that there is inefficient unemployment. One can eliminate this by paying unemployment benefits to everyone but targeting benefits to ensure that reservation wages are equalised at a level below p. This would then be a floor to the wage distribution and there would be no inefficient unemployment.

What this type of example suggests is that the variation in as well as the level of reservation wages induced by the benefit system will be important in determining unemployment. There are a number of ways in which, for example, the UK tax and benefit system makes some people have low reservation wages and others have high reservation wages. For example, young people (who have no entitlement to benefit) and women married to an employed man (who are likely to have no access to means-tested benefits) are likely to have low reservation wages while those eligible for benefits are likely to have higher reservation wages. The existence of groups of workers with low reservation wages simply encourages firms to pay low wages designed to attract these workers causing unemployment among groups of workers with higher reservation wages. A benefit system to reduce unemployment should be designed to even up reservation wages across the population. Hence, again, the use of a CWP model alters ones views of the likely effect of the unemployment benefit system on unemployment.

e. Minimum Wages and Unemployment

The perfectly competitive model has an unambiguous prediction about the effect of a binding minimum wage: it will reduce employment. As the wage is equal to the marginal product there is no scope for increasing the wage of workers without jeopardizing the

employment of at least some of them. In the competitive version of the model analyzed in this paper the effect of a minimum wage would be very simple; the wage distribution would be truncated at the minimum and those earning more than the minimum would find their wages unaffected (this being a result of the assumption of constant returns to scale). It should not be surprising that the effect of a minimum wage is not so simple in the CWP model as wages are below marginal products on average so that there is scope for raising wages without jeopardizing employment.

It is simple to prove the following:

Proposition 9:

a. Under the assumptions of Proposition 3, an equilibrium exists if a minimum wage of w^* is introduced.

b. Under the assumptions of Proposition 4, equilibrium is unique if a minimum wage of w^* is introduced.

Proof: See Appendix.

Of some interest is the effect of the a rise in the minimum wage from w_1^* to w_2^* on the equilibrium wage distribution (this could be thought of as the introduction of a minimum wage if w_1^* is sufficiently low). Denote the two equilibrium wage distributions by F_1 and F_2. We can prove the following result:

Proposition 10: Assume $\lambda_1=\lambda_0$ so that equilibrium is unique. Suppose the new minimum binds ie that $F_1(w_2^*)>0$. Then $F_2(w)<F_1(w)$ for all w where $F_2(w)<1$.

Proof: See Appendix.

Proposition 10 shows that a binding minimum wage has a very pervasive effect on the wage distribution causing the new wage distribution to strictly dominate the old wage distribution in the sense of first-order stochastic dominance. This means that the minimum wage affects not just those directly affected but also those further up the wage distribution. This might be contrasted with competitive models where in the absence of any effects of a minimum wage on an individual's marginal product of labour (which will be the case here with our assumption of constant returns to scale), those with wages above the minimum are unaffected by the minimum.[20]

Now, let us consider the effects of the minimum wage on employment. It is straightforward to give examples in which a minimum wage can raise employment in a CWP model. Both Albrecht and Axell and Burdett and Mortensen give examples where all workers are of quality p but there is variation in reservation wages. Then employment can be maximised by setting a minimum wage equal to p. One should not be surprised by this as the CWP model is, in some ways a monopsony model, and it is well-known that minimum wages can raise employment in this case.

But while in the textbook monopsony model, wages being below marginal products and the ability to raise employment by use of a minimum wage are two sides of the same coin, these issues can be separated here. In the CWP model, it is possible that a minimum wage reduces employment even though all workers (except a set of measure zero) are being paid below their marginal product. The simplest example of this is where there is no heterogeneity in worker reservation wages but there is sufficient variation in worker quality. Then a minimum wage can only price low quality workers out of jobs and cannot attract more workers into work, so can only reduce employment. This is one area where the Burdett-Mortensen (1989) model with no heterogeneity in worker quality may give potentially misleading conclusions.[21]

So the effect of a minimum wage on employment is ambiguous in the CWP model. Given this, one would like to have some way of identifying what is the likely effect. Whether a minimum wage is likely to reduce or increase unemployment depends on whether employment is largely voluntary or involuntary. If unemployment is largely voluntary then this implies that workers are rejecting jobs because the wage is too low so that an increase in the wage would be likely to reduce unemployment. On the other hand, if unemployment is largely involuntary then a rise in the wage is likely to price more workers out of jobs so that unemployment would rise as a result of a minimum wage.

One aspect of the effect of minimum wages that the present model seems to have problems in explaining is the commonly

observed spike in the wage distribution at the minimum wage. The CWP model predicts that there will be no spikes in the equilibrium wage distribution. This prediction is a result of the fact that there are no job mobility costs in the current model; all workers are prepared to change jobs for an infinitesimal gain in wages. One way of obtaining the possibility of spikes is to relax this assumption and assume that there are costs of changing jobs. This also has the effect of giving firms more monopsony power. But, while such a model might be more realistic, its analysis is more complicated and we leave that to another paper.

The CWP model suggests that the effect of minimum wages on employment should be an empirical matter that cannot be settled by simple inspection of theoretical models. Recent papers by Card (1992a,b), Katz and Krueger (1992), Card and Krueger (1993), Machin and Manning (1994) and Dickens, Machin and Manning (1993) have suggested that it is by no means universal to find a negative effect of minimum wages on employment and Card, Katz and Krueger (1993) suggest that many economists have been blinkered in their approach by a preoccupation with the competitive model.

f. The Effect of Trade Unions

The model presented above has assumed that employers have unilateral power to set wages. In some sectors of some economies that is the appropriate assumption but there are also labour markets where the power of employers to set wages is limited by the activities of trade unions. If one introduces trade unions into the type of model estimated above there are two broad issues in which one might be interested.

First, how does the existence of labour market frictions and CWPs affect our conclusions about the impact of unions on the economy (see Farber, 1986, and Oswald, 1985, for surveys of the conventional views)? For example, in the most popular model of trade unions (the so-called 'right-to-manage' model) unions push up wages and this leads to a reduction in employment. It should be fairly clear that this is not inevitably the case in the CWP model as we have already shown that raising wages can increase employment. But a proper analysis of the consequences of the CWP assumption for the theory of union behaviour requires close attention to the specification of union preferences and the process of collective bargaining eg the issues negotiated by union (just wages or wages and employment) and the level of negotiation (eg firm or industry). We do not really have the space here to do that properly.

Consequently, we consider here the effect of unions pushing up wages in one part of the market on wages in the sector that remains non-union. The way in which we do this is the following. Suppose that a fraction μ of firms are unionised. Denote by $F^u(w)$ the distribution of wages in the union sector. In this sector, wages are not chosen to maximise profits alone and we will treat this distribution as exogenously given. However, in the non-union sector, wages are still chosen to maximise profits; denote the equilibrium wage distribution there by $F^n(w)$. Obviously the wage distribution in the whole economy is given by $F(w)=[(1-\mu).F^n(w)+\mu.F^u(w)]$.

Minimum wages and trade unions are often supposed to have very similar effects on the economy. Indeed, in the UK the system of minimum wage legislation introduced in 1909 and abolished in 1993 was meant to be an explicit replica of collective bargaining and the idea was that minimum wage legislation should be abolished once collective bargaining took root (see Craig et al, 1982 for details of this). But, in the CWP model it is not so obvious that trade unions and minimum wages are close substitutes as minimum wages push the wage distribution from below while trade unions pull it from above. Proposition 10 above showed that minimum wages have very pervasive effects on the wage distribution so we might be interested if altering the top end of the wage distribution has similar effects. The following Proposition shows, by example, that we have some reason to believe that trade unions are likely to have a less pervasive effect on the wage distribution. Denote by $F^*(w)$ the equilibrium wage distribution in the absence of unions. For simplicity we restrict attention to the plausible case where $F^*(w)\geq\mu F^u(w)$ so that, for every wage, there are always less firms in the union sector paying less than that wage than there are in the non-union equilibrium.

Proposition 11: Assume that $\lambda_1=\lambda_0$, and that all workers have ability p. Then if $F^*(w)$ is the equilibrium wage distribution in the absence

of unions and $F^*(w)\geq\mu F^u(w)$ for all w, the equilibrium wage distribution in the non-union sector in the presence of unions is given by:

$$(1-\mu).F^n(w) = \min\left(\min_{v\geq w}[F^*(v) - \mu.F^u(v)],\ 1-\mu \right) \tag{13}$$

Proof: See Appendix.

(13) may seem rather complicated but can best be understood by considering some special cases. First, consider the case where all wages in the union sector are above the highest wage offered in the absence of unions. This means that whenever $F^*(w)<1$ it is the case that $F^u(w)=0$, and that $F^u(w)>0$ implies $F^*(w)=1$. Applying (13) in this case we get the result that $(1-\mu)F^n(w)=\min[F^*(w),1-\mu]$ which implies that $F(w)=\min[F^*(w),1-\mu+\mu F^u(w)]$. What this implies is that unions simply slice off the top of the wage distribution while leaving the lower part of the wage distribution unaltered ie the effect is as drawn in Figure 2 where the solid line represents the equilibrium wage distribution in the absence of unions and the thick line the wage distribution when there are unions.

Another extreme case occurs when $F^*(w)-\mu F^u(w)$ is increasing in w. This implies that for every wage the density of firms paying that wage in the non-union equilibrium is larger than the density of firms paying that wage in the union sector. Applying (13) in this case we obtain $(1-\mu)F^n(w)=F^*(w)-\mu F^u(w)$ which implies that $F(w)=F^*(w)$ ie the distribution of wages is completely unaffected by unions. What happens in this case is that unions simply influence which particular firms pay high wages, an issue that is indeterminate in the usual equilibrium.

Of course, this type of very strong conclusion about the limited effect of unionisation on the wage distribution depends on the strong assumptions made so let us consider how we would expect this conclusion to be altered by relaxing those assumptions.

First, consider what is likely to happen if $\lambda_1 \neq \lambda_0$. If $\lambda_1 > \lambda_0$, then as on-the-job search is more effective than off-the-job search, workers will be more ready to take non-union jobs in the hope of gaining access to the high-paying union jobs ie the reservation wages of workers will be reduced. This will tend to drive down wages in the non-union sector. But if $\lambda_1 < \lambda_0$, workers have a better chance of getting employment in the union sector if they remain unemployed (so the model comes to resemble those labour market models in which it is necessary to queue for good jobs); this raises reservation wages and tends to raise wages in the non-union sector.

Secondly, consider what happens if there is heterogeneity in worker quality. In this case, raising wages in the union sector prices the relatively low ability individuals out of those jobs (this is the way in the current model in which unions reduce employment). This alters the distribution of abilities in the labour supply to the non-union sector. But, from the point of view of the non-union firms who are lower wage firms the displaced workers are relatively high quality and one can show that the distribution of abilities among the labour supply to a non-union firm shifts up. This will tend to raise wages in the non-union sector. This conclusion contrasts with that of Pettengill (1980) whose obsession seems to have been to argue, in the context of a competitive model, that unions raising wages in some firms leads to a fall in the relative demand for low-skilled workers and hence a fall in wages in the non-union sector.

This section has modelled the effect of raising wages through unions in one part of the economy on wage determination in the rest of the economy. It has shown how the effect may be more complicated than one would have expected given the competitive model.

g. Selective Employment Policies

Most economic models have a result that the effect and formal incidence of a tax or subsidy does not depend on the nominal incidence. The CWP model has this feature if we consider tax/subsidy schemes that affect all workers, but it does not share it for policies that affect only some workers. This means that it can potentially explain empirical findings like those of Woodbury and Spiegelman

(1987) who examined the effect of the Illinois bonus schemes and who found that formal incidence does appear to matter.

Suppose the government introduces an employment subsidy that applies only to a group of workers. In a perfectly competitive model the effect of the policy would be the same irrespective of whether the worker or the employer received the subsidy as, with individualistic wages, the wages for the workers affected by the policy can alter independently of the wages of workers who are not affected. But, in a CWP model wages cannot vary independently so that who receives the subsidy will matter.

As an example consider the Workstart scheme that was introduced in the UK in 1993 which provides a subsidy for the employment of certain workers who have been unemployed for a long period. If we assume that the group affected is of measure zero (sadly, probably not a bad assumption) then, in a CWP model, the wage distribution as a whole will be unaffected Suppose that the total subsidy is s with s_1 paid to the employer; the remainder being received by the worker. If, for simplicity, we assume that $\lambda_0 = \lambda_1$ so that the reservation wage of a worker is $(b-s+s_1)$, employment will result from a match if $[p+s_1] > w > [b-(s-s_1)]$ which happens with probability $F[p+s_1]-F[b-(s-s_1)]$. It should be apparent that the effect on the exit rate depends not just on the level of the subsidy but also on who receives it.

Let us consider the efficient allocation of the subsidy between worker and employer. Suppose that the affected group does not suffer from involuntary unemployment ie $F(p)=1$. Then it is efficient to pay the subsidy to the worker as at prevailing wages the jobs are not attractive enough to them. However, if all the unemployment is involuntary then it is efficient to pay all the subsidy to the employer. This is the way in which the Workstart scheme operates so the implicit assumption is that involuntary unemployment is more serious than voluntary unemployment for the target group. It should be noted that Woodbury and Spiegelman (1987) found that subsidies to employers were more effective in increasing the outflow rate from unemployment suggesting that most unemployment is voluntary.

From the discussion above, one might think that it is the proportions of voluntary and involuntary unemployment that determines the optimal allocation of the subsidy. But that conclusion is too simplistic. If F is differentiable and we have an interior solution then the first-order condition for s_1 is $f[p+s_1]=f[b-(s-s_1)]$ so that the optimal allocation depends on the relative marginal effects on the rates of voluntary and involuntary unemployment.

5. Justifying the Company Wage Policy Assumption

So far, we have discussed only the consequences of assuming that firms use CWPs and have not considered at all why they should use such policies in determining wages. In this section we make some attempt to remedy this although the ideas here are rather more speculative than the earlier parts of the paper.

In the model there are essentially three crucial assumptions. First, that there are frictions in the labour market; this seems completely reasonable. Secondly, that firms set wages. Although there are obviously segments of the labour market where workers have some say in the negotiation of their wages either individually or through trade unions, there are large parts of the labour market where assuming that firms unilaterally set wages would seem to be a good assumption. Finally, the model assumes that the firm has information about worker characteristics that is not used in wage determination. In the paper presented here this assumption took the extreme form that there is no wage variation at all within the firm and that all workers in the firm are paid the same wage but results with a similar flavour could have been obtained as long as we assumed that not all individual information is used in wage-setting. It is this assumption which needs the most discussion as it seems to imply that firms are not exploiting all the profit opportunities available to them.

Of course, in reality many firms have some wage variation for workers in the same job. Often firms have some kind of graduated wage structure and allocation to different job titles is often used as a way to obtain variation in wages. But, it is plausible to argue that there is not as much wage variation within firms as we would expect to see if the labour market was perfectly competitive. It probably makes sense to think of a continuum with individualistic wage policies at one extreme and the CWPs analyzed here at the other. Different labour markets are at different points on this line. For example, one

might argue that the labour market for top executives or US academics corresponds more closely to the individualistic case, while the market for unskilled labour corresponds more closely to the CWP model.

Let us consider what would happen if firms did start taking advantage of information about worker characteristics in setting wages. First, for workers who are being hired from unemployment employers would want to try to estimate their reservation wage and would want to set wages accordingly. Secondly, for workers who receive better offers from elsewhere and are about to leave, the employer would like to match their wage offer. And, thirdly it would try to lure workers away from other firms by offering them slightly higher wages. There would obviously be considerable administrative costs in pursuing such a policy while the CWP has the virtue of simplicity but such a policy should be able to increase profits. So, why do firms not pursue such policies more often?

First, problems may be caused if notions of fairness are important in the labour market. The result of firms pursuing the policy described above would be firms with each worker paid a different wage, and the wage paid to each worker not necessarily being tied closely to ability but to whether the workers had been lucky enough to get a good offer from elsewhere or whether they had convinced the employer that they have a high reservation wage. Many researchers (eg Akerlof and Yellen, 1980; Solow, 1990, and Bewley, 1993) have suggested that morale of workers suffers if the wage policy is felt to be unjust. One interpretation of the extreme CWP model analyzed here is that it is the labour market outcome when workers become so obsessed by fairness that intra-firm wage variation becomes zero.

Although the recent literature has primarily emphasized concerns for fairness among workers, concerns for fairness among employers may also be important. Some older work (eg Reynolds, 1951) argued that employers see other employers who actively poach workers as being engaged in unfair competition to some extent and this could also act to preserve CWPs.[22] This requires at least some implicit collusion among employers, and we lack any study of the extent of such collusion in modern labour markets, although most economists probably think it rather limited. And, the evidence of Freeman and

Medoff (1984) that intra-firm wage dispersion is reduced by the activities of unions suggests that the preferences of workers is important.

Another problem with having a very active individualistic wage policy is that once workers realise their employer is using such a policy they are likely to actively take steps to raise their wages. For example, they may threaten to leave if they do not receive a raise either because their reservation wage has risen or they have got a better offer from elsewhere. In a world of perfect information this would not matter because the employer knows whether the worker is serious. But, in the real world where asymmetric information is important, it may be very difficult to verify whether workers do have the outside offers they claim, particularly in segments of the labour market where there are many employers. If workers are able to invent imaginary outside offers very easily then the only incentive compatible wage policy may be a common wage and the instruction to the worker to "leave if you do not like it".

Once wages become individualistic, workers may also realise they have some bargaining power because of labour market frictions and use this to obtain higher wages for themselves. This is the assumption usually made in the matching literature (eg Diamond, 1982a,b; Pissarides, 1985). Peters (1991) has shown that firms may be better off if they could post wages in advance; the problem with this being whether this is credible. CWPs would seem one way of sustaining credibility. Firms want to get a reputation for not responding to worker attempts to use their bargaining power to get higher wages. Because an employer typically has more than one worker there is an incentive to build such a reputation while in many labour markets where workers are essentially anonymous there is little incentive for workers to build a reputation for not accepting company dictated wage policies. According, to this line of argument, CWPs should be seen as a way for employers to ensure that they retain control over wage-setting.[23]

In this section, we have briefly described some arguments as to why CWPs or something like them might exist in the labour market. We have considered a number of possibilities but all of them ultimately rely on some kind of externality; that if the employer started

paying different wages to one worker this would adversely affect their position vis-a-vis other workers either by encouraging those workers to bargain for higher wages or reducing the morale of those workers.

6. Conclusions

Many economists have felt that the perfectly competitive model does not provide a very good description of the working of actual labour markets. But, the development of alternatives has been piecemeal and it is probably fair to say that the perfectly competitive model remains the only model capable of analysing a full list of labour market issues. In this paper, we have demonstrated how assuming that labour markets are characterised by CWPs can lead to an alternative coherent view of the operation of labour markets and one that, we would argue, is more in line with what we observe. In many ways, the individual components are not new. For example, the CWP model contains features of most of the main varieties of efficiency wage models. The fairness component (Akerlof and Yellen, 1990) is embodied in the feature that all workers in the firm receive the same wage; the turnover model (Salop, 1979) in that higher wages reduce quits and ease recruitment, and the adverse selection model (Weiss, 1980) in that paying higher wages means that average worker quality is higher[24]. Manning (1993) also shows how it can be modified to introduce shirking (Shapiro and Stiglitz, 1984). But, what is perhaps new, is to have aspects of all these ideas in a single, relatively simple model.

In some ways the CWP model is less satisfying than the competitive model as it has few of the unambiguous predictions of the competitive model. If one believes in the competitive model, one can "prove" that minimum wages reduce employment with no more than a pencil and paper; that easy option is not open to someone who believes in the CWP model. Many of the issues about the effect of minimum wages, benefits etc can only be resolved by empirical work.

There are a number of important extensions to the model that need to be considered. First, the reasons for the existence of CWPs need more attention than they have been given here. And, secondly, we have analyzed only the effects of an extreme CWP assumption, namely that there is no wage variation within firms at all. It is possible to relax that assumption while still not allowing individualistic wage-setting, for example by allowing seniority wage schedules. The robustness of the results to this type of generalisation needs to be explored, and this we hope to do in later work. But, it is likely to remain the case that such models will be different in interesting and potentially important ways from the perfectly competitive model.

ENDNOTES

1. Matters are more complicated if skills are firm-specific, an issue which we do not deal with in what follows.

2. This should even be the case if there are monitoring problems as, unless the damage inflicted by a shirker on the firm is infinite, it will always be profitable to employ a worker at some negative wage.

3. This is obviously unrealistic as imperfect information is very important in reality. But, assuming imperfect information rapidly causes considerable analytical complexity. For example, see Lockwood (1991) for a model in which employers use workers' experience of unemployment to try to infer worker quality.

4. It would be possible to allow firms to have a strictly concave revenue function but the cost of allowing this is a considerable increase in notation while adding very little to the qualitative results.

5. It should be noted that the choice between the assumptions of a fixed number of firms and free entry can affect the predictions of the model, for example the effects of a minimum wage.

6. It is simple to show, by example, the possible existence of multiple equilibria in the Albrecht and Axell model in which $\lambda_1=0$.

7. It might be thought that if $\lambda_1 \neq \lambda_0$ then this is not necessarily the efficient rule as taking a job alters future job prospects. But as it is optimal for all firms to follow the same employment rule there is never any job-to-job mobility in the first-best so that λ_1 is irrelevant.

8. This is a case where the insight of the CWP model presented here with heterogeneous p is rather different from the models with no variation in p as in Burdett and Mortensen, wages are always too low.

9. This is the one point in the paper where allowing decreasing returns to labour would be helpful. Then, the equilibrium size of firms is determinate but the allocation of workers to firms is still not unique; the only restriction imposed by the competitive equilibrium is that all

firms should employ the same (equilibrium) number of efficiency units of labour.

10. This intuition for the equivalence result also suggests when this type of equivalence result will fail. For example, suppose there are two types of labour which are not perfect substitutes (as in Akerlof and Yellen, 1990). If the CWP assumption is applied across labour types so that a firm must pay the same wage to both types of labour then, in general, the equivalence result will fail.

11. If one believes there is decreasing returns to labour, there is a strong piece of evidence that we are not close to a competitive outcome. In the limiting CWP equilibrium there will be an equilibrium price for an efficiency unit of labour and all firms will employ labour until the marginal product of an extra efficiency unit equals this price. As all firms are identical, this means that total employment in efficiency units must be the same in all firms. As a firm paying a high wage w is employing higher quality workers this means that there should be a negative relationship between firm size and wages. As, in reality, there is a very robust positive relationship between these variables (see Brown and Medoff, 1989; Green, Machin and Manning, 1992) this suggests that actual labour market outcomes are rather different from the competitive ones.

12. It should be noted that this evidence is controversial; see Murphy and Topel (1987) for an argument that these empirical findings can be explained by the competitive model.

13. An exception is the positive correlation of wages with employer size which the model can explain very easily, this being the original motivation of Burdett and Mortensen (1989).

14. This is efficiency in a partial equilibrium sense as the reservation wage of the worker will generally be affected by what is happening in the rest of the labour market. This type of failure to consummate a match does not occur in the present model as all match characteristics are general but would assume more importance in a model where match-specific factors are present.

15. It is more conventional to think of involuntary unemployment in the context of a model with some kind of real wage rigidity. One can think of the CWP assumption as producing this wage rigidity from the point of view of the individual, although from the point of view of the aggregate labour market wages are fully flexible.

16. If one can acquire education and hold down a job and on-the-job search is substantially more effective than off-the-job search, it is possible in the CWP model for it to be optimal to undertake investment once one is in a job, a prediction that is also different from that of the competitive model.

17. To some extent, this is recognised in Becker (1975, p.36) where he argues that general skills in monopsonistic labour markets are, to some extent, specific. See Stevens (1993) for a fuller analysis of this.

18. As Stevens (1993) has suggested the inefficiency may be worse in labour markets with intermediate amounts of frictions. In frictionless labour markets, workers have the full incentive to acquire skills whereas in labour markets with no worker mobility between firms, firms have full incentives.

19. The exact effects may be sensitive to the details of the operation of the benefit system. For a survey of these issues, see Atkinson and Micklewright (1991).

20. This also has implications for certain methods of estimating the effects of minimum wages on employment through use of wage distributions (see Meyer and Wise, 1983) as these methods crucially rely on the assumption that workers with wages above the minimum are unaffected. See Dickens, Machin and Manning (1993) for more details of this argument.

21. Eckstein and Wolpin (1990) have presented a version of the Albrecht and Axell (1984) model where, even though there is no variation in worker quality, a minimum wage can reduce employment as it reduces profits and causes some firms to exit the market.

22. Consider the following quotes from Reynolds (1951): "each personnel manager knows that, if he steals a worker today, someone else will steal from him tomorrow, and all have an interest in playing by the game" (p.51), and "the more significant meaning of competition is impersonal rivalry in which each employer establishes terms of employment designed to attract the number and types of workers he wants" (p.216). This sounds exactly like the CWP model.

23. Ellingsen and Rosen (1993) analyze a model in which some firms decide to post wages and others to negotiate wages with their workers, both forms co-existing in equilibrium.

24. The mechanism used to explain the relationship between wages and average worker quality is different in the Weiss model to that used here but the effect is much the same.

APPENDIX

Proof of Proposition 1

i) The Reservation Wage Rule

Denote by $V^u(p,b)$ the value of being unemployed of a worker with characteristics (p,b) and wage distribution F. Denote by V(w;p,b) the value function of such a worker if employed in a firm paying w. These value functions will also depend on the wage distribution F but this is suppressed in the interests of economy of notation. The highest wage obtainable by a worker of quality p is obviously p. We must have:

$$qV^u(p,b) = b + \lambda_0 \int_{\underline{w}}^{p} \max[V(x;p,b)) - V^u(p,b), 0]\, dF(x) \quad \text{(a1)}$$

$$qV(w;p,b) = w + \lambda_1 \int_{w}^{p} [V(x;p,b) - V(w;p,b)]\, dF(x) \quad \text{(a2)}$$

It is well-known that these value functions exist and are unique, and that it is optimal for an unemployed worker to accept any wage greater than r where $V(r;p,b) = V^u(p,b)$. From (a2), we have:

$$\frac{\partial V(w;p,b)}{\partial w} = \frac{1}{q + \lambda_1[F(p) - F(w)]} \quad \text{(a3)}$$

Evaluating (a2) at w = r and subtracting this equation from (a1) leads to:

$$r(p,b;F) + (\lambda_1 - \lambda_0) \int_{r(p,b;F)}^{p} [V(x;p,b) - V(r;p,b)]dF(x) = b \tag{a4}$$

Integrating the second term on the right-hand side of (a4) by parts and using (a3) leads to:

$$r(p,b;F) + (\lambda_1 - \lambda_0) \int_{r(p,b;F)}^{p} \frac{[F(p) - F(x)]dx}{q + \lambda_1[F(p) - F(x)]} = b \tag{a5}$$

This uniquely defines r as the left-hand side of (a5) is increasing in r. Note that r is continuous in F and a strictly increasing differentiable function of b.

ii) Derivation of Labour Supply

Suppose that workers are using the reservation wage rule r(p,b;F). We will now work out the labour supply to a firm paying wage w.

Consider a worker with characteristics (p,b). Suppose that the steady-state unemployment rate among these workers is u(p,b;F). These workers leave employment at a rate q and leave unemployment at a rate λ_0[F(p)-F(r(p,b;F))] so we must have:

$$u(p,b;F) = \frac{q}{q + \lambda_0[F(p) - F(r(p,b;F))]} \tag{a6}$$

Denote by J(w;p,b;F) the number of workers with characteristics (p,b) in jobs paying a wage w or less. Obviously J(w;p,b;F) = 0 if w < r(p,b;F) and J(w;p,b;F)=J(p;p,b;F) if w>p. Now consider a wage for

which p≥w≥r(p,b;F). In a steady-state, we must have:

$$\left[q + \lambda_1(F(p) - F(w))\right]J(w;p,b;F) = \lambda_0[F(w) - F(r(p,b;F))]\,u(p,b;F)\,M\phi(p,b) \tag{a7}$$

The left-hand side are total quits; the right-hand side recruits. From (a8) it is simple to derive:

$$J(w;p,b,F) = \frac{\lambda_0.u(p,b;F).\phi(p,b).M.[F(w) - F(r(p,b;F))]}{q + \lambda_1[F(p) - F(w)]} \tag{a8}$$

We want to derive the labour supply to an individual firm paying wage w. In the interval [w-ε,w] there are J(w;p,b,F)-J(w-ε;p,b,F) workers and F(w)-F(w-ε) firms. So we can find the labour supply to an individual firm by considering the following limit:

$$L(w;p,b;F) = \lim_{\epsilon \to 0_+} \frac{J(w;p,b,F) - J(w-\epsilon;p,b,F)}{F(w) - F(w-\epsilon)} \tag{a9}$$

Using (a8) this gives (2). As discussed in Burdett and Mortensen, it is necessary to take the limit from below as labour supply will be left continuous in w but not necessarily right continuous, as a firm that pays a wage slightly above a mass of firms will have a labour supply that is discontinuously higher. This will be important in deriving certain characteristics of the equilibrium below.

iii) Derivation of the Profit Function

In steady state, the firm will contain workers for whom r(p,b;F)≤w. As r is strictly increasing in b we can invert this to say that a firm will consist of workers with $b \leq \rho(w,p;F)$ where $\rho(w,p;F)$ is obtained from inverting (1) and hence is given by (5). Also the firm will only employ workers for whom $p \geq w$. The number of workers with different characteristics employed is given by (2). The profit generated by each worker is given by (p-w). Hence the total profits are given by (3). One can then derive (4) by using the definition that $\phi(p,b)=h(b|p)g(p)$, putting (2) in (3), differentiating (1) to derive:

$$\frac{\partial r}{\partial b} = \frac{q+\lambda_1[F(p)-F(r)]}{q+\lambda_0[F(p)-F(r)]}$$

and then changing the variable of integration from b to r.■

Proof of Proposition 2

In proving the existence of equilibrium we use a strategy commonly applied in finding equilibria in infinite dimensional spaces, namely to consider the limit of a sequence of finite dimensional spaces. The proof proceeds in the following way. We present the outline and prove the detailed results later.

Step 1. Define a bounded wage interval W in which we know all wages offered in equilibrium must lie.

Step 2. Show that an equilibrium exists when employers are restricted to offering wages in a finite subset of W, which we denote by W_n.

Step 3. Consider a sequence of partitions of W, W_n where $W_n \subset W_{n+1}$ and $\lim W_n = W$, and show that the equilibrium wage distributions tend to a limit $F^*(w)$.

Step 4. Show that $F^*(w)$ is an equilibrium.

Step 1: Bounding the Equilibrium Wage Offers

Obviously wage offers can be bounded above by $\bar{p}$, the highest quality worker in the market. And no firm will offer a wage below

the lowest reservation wage. As $\lambda_0 \geq 0$, we have, from (a5):

$$b = r(p,b;F) + (\lambda_1 - \lambda_0) \int_{r(p,b;F)}^{p} \frac{[F(p)) - F(x)]dx}{q + \lambda_1[F(p) - F(x)]}$$

$$\leq r(p,b;F) + \int_{r(p,b;F)}^{p} \frac{\lambda_1[F(p)) - F(x)]dx}{q + \lambda_1[F(p) - F(x)]}$$

$$\leq r(p,b;F) + \frac{\lambda_1}{\lambda_1+q}.(p-r(p,b;F))$$

which implies that:

$$r(p,b;F) \geq \frac{b}{q} - \frac{\lambda_1 p}{q} \quad \text{(a10)}$$

which can be used to provide a lower bound for reservation wages independent of F as b and p are both bounded. Denote the upper and lower bounds of W by $\underline{w}$ and $\bar{w}$.■

Step 2: The Existence of Equilibrium for Restricted Wage Offers

Suppose that firms are restricted to offering wages which are in a finite subset of W, which we will denote by W_n. We will restrict attention to partitions in which all the elements of the partition are evenly spaced and which always contain a particular wage to be defined below (which guarantees that firms can make strictly positive profits). As $n \rightarrow \infty$ the distance between elements of the partition goes to zero. Denote the elements of W_n by $w_1,...,w_{N(n)}$ where N(n) is the number of wages in partition n and, without loss of generality, we assume that $w_i > w_{i-1}$. The equilibrium definitions of (6) then only apply to wages in this subset. As W_n has a finite number of points, we can represent the proportion of firms paying w_i by f_i. Denote $\{f_1,...,f_{N(n)}\}$ by **f**. From **f** we can derive the distribution function F(w) as:

$$F(w) = \sum_{\{i:w_i \leq w\}} f_i \qquad \text{(a11)}$$

Hence, we can write labour supply to a firm paying w_i, which we will denote by $L_i(p,b;f)$, using (2) as:

$$L_i(p,b;f) = \frac{q\lambda_0 M\phi(p,b)}{[q+\lambda_1[F(p)-F(w_i)]].[q+\lambda_1[F(p)-F(w_{i-1})]]} \cdot \frac{[q+\lambda_1(F(p)-F(r(p,b;F))}{[q+\lambda_0(F(p)-F(r(p,b;F))} \qquad \text{(a12)}$$

As F(w) is continuous in **f**, L_i iAs F(w) is continuous in **f**, L_i is continuous in f and hence, from (3) $\Pi_i(f)$ the profits earned by a firm paying w_i if the distribution of wages is f is also continuous in f. We want to construct a mapping, a fixed point of which is an equilibrium. The following result will be useful.

Result 1: The condition:

$$\Pi_i(f) \leq \bar{\Pi}(f) \quad where \quad \bar{\Pi}(f) = \sum_{i=1}^{n} f_i.\Pi_i(f) \qquad \text{(a13)}$$

is necessary and sufficient for equilibrium.

Proof: Necessity: Clearly the definition of equilibrium (6) implies (a13) if $\Pi^*=\bar{\Pi}(f)$. This is must be the case as if $\Pi^*<\bar{\Pi}(f)$, then $\Pi_i(f)>\Pi^*$ for some i which violates 6(i). And if $\Pi^*>\bar{\Pi}(f)$ then $\Pi_i(f)<\Pi^*$ for some i with $f_i>0$ which violates 6(ii).

Sufficiency: Suppose that (a13) is true but (6) is not satisfied for any Π^*. Set $\Pi^*=\bar{\Pi}(f)$. Then 6(i) follows from (a13). Suppose 6(ii) is violated so that $\Pi_i<\bar{\Pi}(f)$ for some i with $f_i>0$. This is not possible as it implies that $\Pi_j(f)>\bar{\Pi}(f)$ for some j which violates (a13).■

Now, consider the following mapping T:

$$Tf_i = \frac{f_i + \max[0, \Pi_i(f) - \bar{\Pi}(f)]}{1 + \sum_{j=1}^{N(n)} \max[0, \Pi_j(f) - \bar{\Pi}(f)]} \qquad \text{(a14)}$$

Result 2: A fixed point of T is an equilibrium.
Proof: At any fixed point of T, rearrangement of (a14) gives:

$$f_i.\sum_{j=1}^{n} \max[0, \Pi_j(f) - \bar{\Pi}(f)] = \max[0, \Pi_i(f) - \bar{\Pi}(f)] \qquad \text{(a15)}$$

We will show that (a13) must be satisfied at a fixed point. Suppose not, and that for some j, $\Pi_j(f) > \bar{\Pi}(f)$. Then, by the definition of $\bar{\Pi}(f)$,it must be the case that for some k with $f_k>0$, we have $\Pi_k(f) < \bar{\Pi}(f)$. But this is a contradiction as (a15) then implies that $f_k=0$. So, at any fixed point (a13) is satisfied and it is an equilibrium. ■

We now need to prove existence of a fixed point. This is a straightforward application of Brouwer's fixed point theorem. T is a continuous mapping of the N(n) dimensional unit simplex into itself so must have at least one fixed point. Denote an equilibrium density function for the partition W_n by f^*_{in} and the corresponding equilibrium distribution function by $F^*_n(w)$.■

Step 3: Take finer and finer partitions of W and consider the limit of the equilibrium sequence.
The main result that we are going to use here is Lemma 8 of Mas-Colell (1975) which for our purposes here can be used in the following form:

Lemma 8 (Mas-Colell, 1975): Consider a sequence of partitions of W, W_n, where $W_n \subset W_{n+1}$ and $\lim W_n = W$. Then if $F^*_n(w)$ is equicontinuous for all w in W_n, there is a subsequence for which $F^*_n(w)$ converges to $F^*(w)$.

Given this lemma, we need to show that the equilibrium for any partition is equicontinuous. Our proof of this proceeds in a number of steps.

Result 3: If the partition consists of wages ε apart then we can find an ε^* and a w^* such that if $\varepsilon<\varepsilon^*$, and the partition includes w^*, the equilibrium distribution function is equicontinuous ie there exists a finite K independent of ε such that:

$$|F_n^*(w_i) - F_n^*(w_j)| \leq K|w_i - w_j| \qquad \text{(a16)}$$

for all $w_i, w_j \varepsilon W_n$.
Proof: First, we will prove the following result.

Result 3a: If the equilibrium wage distribution is equicontinuous for all neighbouring wages in the partition, it is equicontinuous for all wages in the partition.

Proof: Assume that (a16) is satisfied if j=i-1 for all i. Now assume that i<N(n). Then:

$$|F_n^*(w_{i+1}) - F_n^*(w_{i-1})|$$

$$= |F_n^*(w_{i+1}) - F_n^*(w_i)| + |F_n^*(w_i) - F_n^*(w_{i-1}|$$

$$\leq K.|w_{i+1} - w_i| + K.|w_i - w_{i-1}| = K.|w_{i+1} - w_{i-1}|$$

(a17)

so that (a16) is satisfied for the pair (w_{i+1}, w_{i-1}). Similar arguments by induction then straightforwardly show that (a16) is satisfied for all wages in the partition.■

Result 3a holds because F is non-decreasing. Given Result 3a we need only show that equicontinuity is satisfied for neighbouring wages. Given (a11), one can rewrite (a16) as:

$$f_i \leq K|w_i - w_{i-1}| \qquad \text{(a18)}$$

Obviously (a18) is satisfied if w_i is not offered in equilibrium as then $f_i=0$. So we need only show that (a18) is satisfied for wages that are offered in equilibrium. It is most convenient to do this by comparing the profit level of w_i with the profits offered by the next highest wage. Consider the profits Π_{i+1} and Π_i. As, by assumption, w_i is offered in equilibrium we must have $\Pi_{i+1} \leq \Pi_i$. Now, from (a12) we have that:

$$L_{i+1}(p,b;f) = L_i(p,b;f).\frac{q+\lambda_1[F(p)-F(w_{i-1})]}{q+\lambda_1[F(p)-F(w_{i+1})]}$$

$$\geq L_i(p,b;f).\frac{q+\lambda_1[F(p)-F(w_{i-1})]}{q+\lambda_1[F(p)-F(w_i)]} = L_i(p,b;f).\left(1+\frac{\lambda_1 f_i}{q+\lambda_1[F(p)-F(w_i)]}\right)$$

$$\geq L_i(p,b;f).\left(1 + \frac{\lambda_1}{q+\lambda_1}.f_i\right) \tag{a19}$$

Now, using (3) we have that:

$$1 \geq \frac{\Pi_{i+1}}{\Pi_i} = \frac{\int_{w_{i+1}}^{\bar{p}} \int_{\underline{b}}^{\rho_{i+1}(p;f)} (p-w_{i+1}).L_{i+1}(p,b)\,db\,dp}{\int_{w_i}^{\bar{p}} \int_{\underline{b}}^{\rho_i(p;f)} (p-w_i).L_i(p,b)\,db\,dp} \tag{a20}$$

$$\geq \left(1+\frac{\lambda_1}{q+\lambda_1}.f_i\right).\frac{\int_{w_{i+1}}^{\bar{p}} \int_{\underline{b}}^{\rho_{i+1}(p;f)} (p-w_{i+1}).L_i(p,b)\,db\,dp}{\int_{w_i}^{\bar{p}} \int_{\underline{b}}^{\rho_i(p;f)} (p-w_i).L_i(p,b)\,db\,dp}$$

where $\rho_i(p;f)=\rho(w_i,p;F)$. Re-arranging (a20) yields:

$$\frac{\frac{\lambda_1}{q+\lambda_1}.f_i}{1+\frac{\lambda_1}{q+\lambda_1}.f_i}$$

$$\leq \frac{\int_{w_i}^{\bar{p}} \int_{\underline{b}}^{\rho_i(p;f)} (p-w_i).L_i(p,b)\,db\,dp - \int_{w_{i+1}}^{\bar{p}} \int_{\underline{b}}^{\rho_{i+1}(p;f)} (p-w_{i+1}).L_i(p,b)\,db\,dp}{\Pi_i} \tag{a21}$$

Using the fact that $f_i \leq 1$, one can re-arrange (a21) to yield:

$$f_i \leq \left(\frac{2+\frac{q}{\lambda_1}}{\Pi_i}\right).$$

$$\left(\int_{w_i}^{\bar{p}} \int_{\underline{b}}^{\rho_i(p;f)} (p-w_i).L_i(p,b)\,db\,dp - \int_{w_{i+1}}^{\bar{p}} \int_{\underline{b}}^{\rho_{i+1}(p;f)} (p-w_{i+1}).L_i(p,b)\,db\,dp\right) \tag{a22}$$

Now, consider how we can use (a22) to prove (a18). First consider the second term (which contains the integrals) in (a22). One can write this as:

$$\int_{w_i}^{\bar{p}}\int_{\underline{b}}^{\rho_i(p;f)} (p-w_i).L_i(p,b)\,db\,dp - \int_{w_{i+1}}^{\bar{p}}\int_{\underline{b}}^{\rho_{i+1}(p;f)} (p-w_{i+1}).L_i(p,b)\,db\,dp$$

$$= \int_{w_i}^{\bar{p}}\int_{\underline{b}}^{\rho_i(p;f)} (w_{i+1}-w_i).L_i(p,b)\,db\,dp + \int_{w_i}^{w_{i+1}}\int_{\underline{b}}^{\rho_i(p;f)} (p-w_{i+1}).L_i(p,b)\,db\,dp$$

$$- \int_{w_{i+1}}^{\bar{p}}\int_{\rho_i(p;f)}^{\rho_{i+1}(p;f)} (p-w_{i+1}).L_{i+1}(p,b)\,db\,dp$$

(a23)

We will now provide bounds for all the elements in (a23). The following results will be useful.

Result 3b: L(w;p,b;F) is bounded above.
Proof: The minimum possible quit rate is q; the maximum possible number of recruits is $\max(\lambda_0,\lambda_1)M\phi(p,b)$. Hence $L(w;p,b;F) \le \max(\lambda_0,\lambda_1)M\phi(p,b)/q$ which is bounded by assumption (A1). Denote this upper bound by L^+.■

Result 3c: The following condition is satisfied for all F:

$$|\rho_{i+1} - \rho_i| \le \frac{1 + |\lambda_1 - \lambda_0|}{q + \lambda_1}.|w_{i+1} - w_i| = K_1.|w_{i+1} - w_i|$$

(a24)

Proof: From (3) we have that:

$$\rho_{i+1} - \rho_i = w_{i+1} - w_i - (\lambda_1-\lambda_0).\int_{w_i}^{w_{i+1}} \frac{[F(p)-F(x)]dx}{q+\lambda_1[F(p)-F(x)]}$$

(a25)

Noting that the term under the integral has a maximum value of $(w_{i+1}-w_i)/(q+\lambda_1)$ this straightforwardly yields (a24).■

Now consider bounding the terms in (a23). We have:

$$\int_{w_i}^{w_{i+1}}\int_{\underline{b}}^{\rho_i(p)} (p-w_{i+1}).L_i(p,b)\,db\,dp \le L^+.(\bar{b}-\underline{b}).(\bar{p}-\underline{w}).|w_{i+1} - w_i|$$

$$= K_2.|w_{i+1} - w_i|$$

(a26)

$$\int_{w_{i+1}}^{\bar{p}}\int_{\underline{b}}^{\rho_{i+1}(p)} (w_{i+1}-w_i).L_i(p,b)\,db\,dp \le L^+.(\bar{b}-\underline{b}).(\bar{p}-\underline{p}).|w_{i+1} - w_i|$$

$$= K_3.|w_{i+1} - w_i|$$

(a27)

$$\int_{w_{i+1}}^{\bar{p}} \int_{\rho_i(p)}^{\rho_{i+1}(p)} (p-w_{i+1}).L_i(p,b)\,db\,dp \leq L^+.(\bar{p}-\underline{p}).(\bar{p}-\underline{w}).|\rho_{i+1} - \rho_i|$$

$$\leq K_4.|w_{i+1} - w_i| \qquad \text{(a28)}$$

Now consider how we can bound the first term in (a22) (ie the term in brackets that does not contain the integrals). As w_i is offered in equilibrium Π_i must equal equilibrium profits so we need to show that equilibrium profits are bounded away from zero. That this is the case is proved in the following result.

Result 3d: We can find a wage w^* such that equilibrium profits are bounded away from zero for all partitions containing w^*.
Proof: From (2), we know that:

$$L_i(p,b;F) \geq \frac{q^2\lambda_0 M\phi(p,b)}{(q+\lambda_1)^2(q+\lambda_0)} = \mu\phi(p,b) \qquad \text{(a29)}$$

Hence from (3):

$$\Pi(w;F) \geq \mu.\int_w^{\bar{p}} \int_{\underline{b}}^{\rho(w,p;F)} (p-w)\phi(p,b)\,db\,dp$$

$$= \mu.\int_w^{\bar{p}} (p-w)H(\rho(w,p;F)|p)g(p)\,dp \qquad \text{(a30)}$$

Now consider how we can bound ρ(w,p;F). From (5) we can derive:

$$\rho(w,p;F) \leq w - \frac{\lambda_0}{q}.(p-w) \qquad \text{(a31)}$$

Using this in (a30) yields:

$$\Pi(w;F) \geq \mu.\int_w^{\bar{p}} (p-w)H\left(w-\frac{\lambda_0}{q}.(p-w)\,|p\right)g(p)\,dp \qquad \text{(a32)}$$

which is a lower bound for profits independent of F. We will show that there exists a wage which guarantees a strictly positive level of profits. From assumption (A1) there exists a w such that H(w|w)>0 where g(w)>0. Consider offering this wage. Then by the continuity and boundedness assumptions in (A1) there is some neighbourhood [w,w+δ] where δ>0 where for p in this neighbourhood $H(w-(\lambda_0/q)(p-w)|p)>0$ and g(p)>0. So the firm will have a non-zero measure of workers in the neighbourhood (w,w+δ) and will be making positive profits from these workers. Hence, profits as a whole must be strictly positive. We can then ensure that for any partition, equilibrium profits are positive by ensuring that all partitions contain this wage.■

Putting together Results 3a-3d, we have shown that, as long as the partition is fine enough and contains a certain wage, $f_i \leq K.|w_{i+1}-w_i|$ for some K which can be chosen independent of the partition. As wages are assumed to be equally spaced in the partition (a18) now follows for all wages except the highest wage. Now we need to show that (a18) also holds for the highest wage. This follows for a fine enough partition because as the partition becomes fine enough the highest wage tends to $\bar{p}$ and hence, from (3), the profits available from paying the highest wage tend to zero and hence there must come a point at which the profits obtainable from paying the highest wage must be lower than equilibrium profits in which case $f_{N(n)}=0$. Then (a18) is automatically satisfied.■

Step 4: Show that the limit of the partitioned equilibria is an equilibrium of the continuous economy.

Proof: We have shown that the sequence of equilibrium distribution functions converges to some continuous distribution function $F^*(w)$. As profits are bounded it must be the case that the sequence of equilibrium profit levels Π_n^* converges to some level Π^*. We want to show that $\Pi(w,F^*)\leq\Pi^*$ for all w so that $F^*(w)$ is an equilibrium of the limiting economy. To show that this is the case, consider the following argument.

For any partition W_n and distribution function F_n^* one can compute the level of profits obtainable by a firm offering any wage (not necessarily in W_n). Define $\omega_n(w)$ to be the wage in W_n which is above w but closest to it. By (2) we have that $L(w,p,b;F_n^*) = L(\omega_n(w),p,b;F_n^*)$. Now, using (3), we can find a finite K such that:

$$\begin{aligned}\Pi(w;F_n^*) &\leq \Pi(\omega_n,F_n^*) + K.(\omega_n-w)\\ &\leq \Pi_n^* + K(\omega_n-w)\end{aligned} \qquad \text{(a33)}$$

Now, take limits and using (a22) we have that $\omega_n \rightarrow w$ and that $\Pi(w;F_n^*) \rightarrow \Pi(w;F^*)$ and hence $\lim \Pi(w;F^*)\leq\Pi^*$ which is what we wanted to show.■

That $F^*(w)$ satisfies a Lipschitz condition follows directly from equicontinuity.■

Proof of Proposition 3

Suppose there are two equilibrium distribution functions $F_1(w)$ and $F_2(w)$. Denote by Π_1 and Π_2 the associated equilibrium levels of profit. Define w' to be the smallest wage such that the distribution functions are identical for all higher wages ie:

$$w' = \min\{w : F_1(x) = F_2(x) \text{ for all } x \geq w\} \qquad \text{(a34)}$$

w' is denoted in Figure 1. From (5), if $\lambda_0=\lambda_1$ we must have $\rho(w,p;F) = w$ and hence $\Pi(w',p;F_1) = \Pi(w',p;F_2)$. Suppose, without loss of generality that F_1 and F_2 diverge with F_1 being below F_2 (as drawn in Figure 1). Then F_1 cannot be flat at w' (which means that w' or a wage arbitrarily close to it must be offered in equilibrium) so that $\Pi(w';F_1) = \Pi_1$. F_2 could be flat over a neighbourhood of w' (ie it is not offered by any firm in equilibrium) so that $\Pi(w';F_2) \leq \Pi_2$. Combining gives $\Pi_1 \leq \Pi_2$.

Now define w" to be the highest wage below w' at which F_1 and F_2 are equal ie:

$$w'' = \max\{w : w < w' \text{ and } F_1(w) = F_2(w)\} \qquad \text{(a35)}$$

w" is also drawn on Figure 1. w" must exist as $F_1(\underline{w}) = F_2(\underline{w}) = 0$. For all $w \in (w'',w')$, $F_1(w) < F_2(w)$. Using this information in (4) yields $\Pi(w'';F_1) > \Pi(w'';F_2)$. Now F_1 could be flat at w" so that $\Pi_1 \geq \Pi(w'';F_1)$. But, F_2 cannot be flat in a neighbourhood of w" because of its definition in (a35) so that $\Pi(w'';F_2) = \Pi_2$. Combining gives $\Pi_1 > \Pi_2$ which is a contradiction. Hence equilibrium will be unique.■

Proof of Proposition 4

Under the assumptions made the surplus generated by the employment of each worker is a. Hence surplus will be maximised if employment is maximised. An unemployed worker with reservation wage b receives an acceptable wage offer with probability F(b+a)-F(b) so that their employment rate e(b) equals:

$$e(b) = \frac{\lambda [F(b+a) - F(b)]}{q + \lambda [F(b+a) - F(b)]} \qquad \text{(a36)}$$

so that total surplus, S, is given by:

$$S = \int_{\underline{b}}^{\bar{b}} e(b)\,db\,. \qquad \text{(a37)}$$

This must be maximised subject to the condition that F(b) is non-decreasing and between 0 and 1. Differentiating (a37) with respect to F(b) leads to the following first-order condition:

$$\frac{\partial S}{\partial F(b)} = \frac{-q\lambda I(b)}{\{q + \lambda[F(b+a) - F(b)]\}^2} + \frac{q\lambda I(b-a)}{\{q + \lambda[F(b-a) - F(b)]\}^2} \qquad \text{(a38)}$$

where I(b) is an indicator function equal to one if b ∈ $(\underline{b},\bar{b}]$ and zero otherwise. If b > $\bar{b}$ then I(b) = 0 so $\frac{\partial S}{\partial F(b)} > 0$. It is then optimal to have F(b) = 1 ie no wage above $\bar{b}$ will be offered in equilibrium. This is the case as a wage above $\bar{b}$ only serves to make some workers unprofitable while being attractive to all workers. For b < $\underline{b}$+a, I(b-a) = 0 and $\frac{\partial S}{\partial F(b)} < 0$.

It is then optimal to have F(b) = 0 ie no wage below ($\underline{b}$+a) will be offered. This is because all workers are profitable at ($\underline{b}$+a) and a lower wage will only discourage some.

For b ∈ [$\underline{b}$+a,$\bar{b}$] we have I(b) = I(b-a) = 1. (a38) then implies that:

$$F(b+a) - F(b) = F(b-a) - F(b)\,. \qquad \text{(a39)}$$

Now, in this region, as by assumption (b+a) > ($\underline{b}$+2a) > $\bar{b}$ so F(b+a) = 1, and (b-a) < $\bar{b}$-a < ($\underline{b}$+a) so F(b-a) = 0. Then (a39) implies F(b) = ½ for all b in [$\underline{b}$+a,$\bar{b}$]. This is only possible if half the firms pay ($\underline{b}$+a) and half pay $\bar{b}$.■

Proof of Proposition 5

Assume p>b (workers for whom p = b have no effect on the equilibrium as they will only work for p and hence give firms zero profits). Using (a6) and (a8), and taking limits as $\lambda_0,\lambda_1 \to \infty$ we obtain:

$$\lim J(w;p,b;F) = 0 \quad \text{if } F(p)>F(w)$$
$$\lim J(w;p,b,F) = M\phi(p,b) \quad \text{if } F(p)=F(w) \qquad \text{(a40)}$$

which says that in the limit all workers for whom p>b get a job at the highest wage attainable by them in the market ie at the highest value of w for which F(p)=F(w). This is true for any F and not just an equilibrium F.

Now consider the following arguments to show that all values of p for which a non-zero measure of workers have b<p must be offered in equilibrium. Using (5) we can derive:

$$\lim \rho(w,p;F) = k.w + (1-k).p \tag{a41}$$

Using (a41) in (4) and taking limits we obtain:

$$\lim \Pi(w;F) = 0 \textit{ if } F(p)>F(w) \textit{ for all } \bar{p}\geq p>w$$

$$\lim \Pi(w;F) = \infty \textit{ if } F(p)=F(w) \textit{ for some } p>w \tag{a42}$$

Equilibrium profits cannot be infinite as there is only a finite amount of surplus in the economy so equilibrium profits must be zero. But, from (a42), this is only possible if for every p there are firms offering this wage in equilibrium.■

Proof of Proposition 6

qV(w;p,b) from (a2) can be interpreted as the expected average wage over a worker's remaining labour market career given that the current wage is w. Hence for a worker of quality p choosing a reservation wage r, the expected wage when in employment is given by the expected value of qV(w;p,b) given that p≥w≥r which is given by:

$$EW(p,r) = \frac{\int_r^p qV(w;p,b)dF(w)}{F(p)-F(r)} \tag{a43}$$

Integrating by parts, and using (a3) leads to:

$$EW(p,r) = p - \frac{\int_r^p \frac{q[F(w)-F(r)]dw}{q+\lambda_1[F(p)-F(w)]}}{F(p)-F(r)} \tag{a44}$$

a. EW≤p. This is obvious.
b. Differentiation reveals that ∂EW/∂p≥0.
c. Inspection of (a44) shows that ∂EW/∂r≥0.
d. By inspection of (a44) we can see that ∂EW/∂(λ/q)≥0.

Proof of Proposition 7

Rearranging (a1) we can write V^u as:

$$qV^u(p,b) = \frac{qb}{q+\lambda_0[F(p)-F(r)]} + \frac{\lambda_0\int_r^p V(w;p,b)dF(w)}{q+\lambda_0[F(p)-F(r)]} \tag{a45}$$

Using (a43) and (8) in (a45) then yields (9).■

Proof of Proposition 9

If a minimum wage of w^* is imposed the equilibrium conditions will only apply for $[w^*,w]$. One can simply apply the existence proof in Proposiion 2 to this changed domain of the profit function.

One can also apply the argument of Proposition 4 to show that equilibrium must be unique.■

Proof of Proposition 10

By the assumption that the minimum wage is binding we must have $F_2(w)<F_1(w)$ for w close enough to w^*_2. The argument of Proposition 4 can be used to show that the two equilibrium distribution functions cannot cross. So we need only show that they also cannot touch for any wage where $F_2(w)<1$. Denote by w' the highest wage where $F_1(w')=F_2(w')$. As the distribution functions do not cross at this point w' cannot be in the middle of a flat section of either distribution function which implies that w' must offer the equilibrium level of profits in both equilibria. As we have $F_2(w)\leq F_1(w)$ for all $w\geq w'$ with strict inequality for some w, we must have:

$$\Pi_2^* = \int_{w'}^{\bar{p}} \frac{(p-w)H(w|p)g(p)dp}{[q+\lambda_1[F_2(p)-F(_2(w')]^2} \qquad \text{(a46)}$$

$$> \int_{w'}^{\bar{p}} \frac{(p-w)H(w|p)g(p)dp}{[q+\lambda_1[F_1(p)-F(_1(w')]^2} = \Pi_1^*$$

which implies that equilibrium profits must be higher with the higher minimum wage. We will now show (not surprisingly) that this cannot be the case.

Denote by w" the highest wage offered in F_2. As $F_1(w")=1$ we must have $\Pi_1^*\geq\Pi(w",F_1)=\Pi(w",F_2)=\Pi_2^*$ where the first equality sign follows from (5). Hence equilibrium profits cannot be higher with the higher minimum wage.■

Proof of Proposition 11

Using (4) and (5) and the assumptions made, profits will be given by:

$$\Pi(w;F) = \frac{q\lambda M(p-w)H(w)}{[q+\lambda(1-F(w))]^2} \qquad \text{(a47)}$$

What will be important is that profits of a firm paying w are only affected by the proportion of firms paying lower wages.

Consider the lowest wage offered in equilibrium in the absence of unions. We can show that it must be the highest value of w which maximises (p-w)H(w). Denote this solution by w'. To see this, suppose that the lowest wage offered in equilibrium is above w'. For the firm offering the lowest wage F(w)=0. Using this in (a47) implies that, by definition of w', this firm is making lower profits than if it cut wages to w'. Hence this cannot be an equilibrium. Now suppose that the lowest wage offered in equilibrium is some w below w', so that F(w')>0. Then:

$$\Pi(w';F) = \frac{(p-w').q.\lambda M.H(w')}{[q+\lambda(1-F(w'))]^2}$$

$$> \frac{(p-w').q.\lambda M.H(w')}{[q+\lambda]^2} \geq \frac{(p-w).q.\lambda M.H(w)}{[q+\lambda]^2} = \Pi(w;F) \qquad \text{(a48)}$$

so that profits could be increased by offering w'. Given w', substituting it in (a47) with F=0 gives the equilibrium level of profits Π^*. That the equilibrium wage distribution is unique follows from Proposition 4.

Now consider the economy with unions. Applying the same argument as above and using the assumption that $F^*(w) \geq \mu F^u(w)$ it is straightforward to show that the lowest wage is the same in the two economies and hence the equilibrium level of profits in the two economies must be the same. We will now show that $F_n(w)$ as given by (13) is an equilibrium.

First $F_n(w)$ as given by (13) is a legitimate distribution function as it is non-decreasing, confined to the unit interval and attains its bounds. It is clear from (a47) that any wage that is offered both in the non-union equilibrium and by a non-union firm in the union equilibrium must have the same level of F(w) as only this can produce the same level of profits. If some wage w is offered by a non-union firm in the union equilibrium it must be the case that $F^n(w)$ is not flat in that region. From (13) this is possible only if $(1-\mu).F^n(w)=F^*(w)-\mu F^u(w)$ which implies that F(w) is the same in both equilibria. We now need to show that if (13) is satisfied no wage offers a higher level of profits. Note that from (a47) profits are increasing in F. So this will be true if $(1-\mu).F^n(w)+\mu F^u(w)<F^*(w)$ for all w. This follows straightforwardly from (13).

Having shown that (13) defines an equilibrium we need to show that equilibrium is unique. This follows because we can write profits as:

$$\Pi(w;F) = \frac{q\lambda M(p-w)H(w)}{[q+\lambda(1-\mu F^u(w)-(1-\mu)F^n(w))]^2} \qquad \text{(a49)}$$

Given that equilibrium profits are unique there is clearly only one value of $F^n(w)$ which can solve this equation.■

FIGURE 1

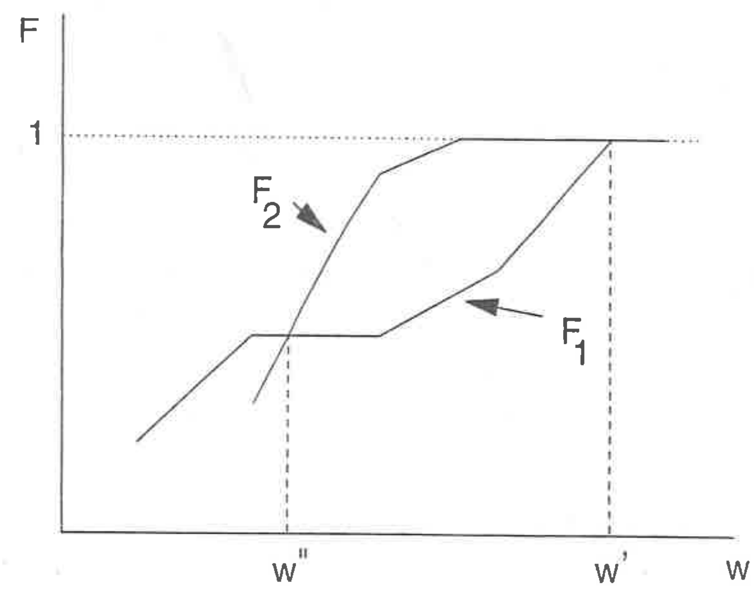
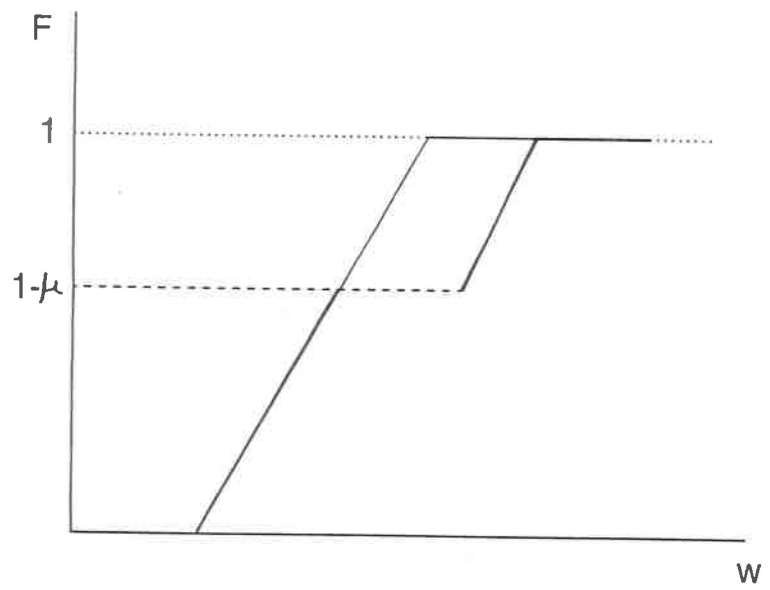


FIGURE 2



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