# A matching model of non-employment and wage pressure

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**Contents**

**Abstract**

In this paper a matching model with variable search intensity that incorporates the inactive is developed and calibrated. The model is used to look at possible explanations for the recent sharp decline in the UK working-age unemployment rate, which has been accompanied by only a moderate reduction in the working-age inactivity rate. From the range of different shocks considered, the most plausible combination consists of a significant reduction in unemployment benefits, perhaps reflecting reduced coverage, coupled with an increase in the student population. According to the model, these shocks would not have produced an increase in aggregate wage pressure.

Key words: Unemployment, inactivity, wage pressure, matching.

JEL classification: E24, J41.

**Summary**

In contrast to previous cyclical upswings where both the unemployment and inactivity rates have declined in tandem, the fall in the total non-employment since the mid-1990s has been almost completely accounted for by a decrease in the unemployment rate, while the inactivity rate has remained broadly flat.

The monetary policy implications of these developments are unclear. It is possible that the relatively stable inactivity rate has helped to moderate any extra wage pressure arising from the decline in unemployment. However, it is equally plausible to argue that the inactive are so detached from the labour market that they have no impact on wage bargaining.

In order to address these issues, this paper develops a model of the labour market that explicitly distinguishes between the unemployed and the inactive, rather than treating all those who are out of work as unemployed. The key difference between the groups is the value that they place on non-work related activities such as leisure. It is assumed that unemployed people have a relatively low valuation on such uses of their time. Consequently, they search harder for jobs, are prepared to accept lower pay, and therefore enter employment more readily.

We then use the model to examine the behaviour of inactivity, unemployment and wage growth over 1994-2000. Specifically, we attempt to identify the underlying shocks that can explain the observed trends in unemployment and inactivity over this period. We consider shocks to the benefits received by the unemployed and the inactive, the costs incurred by the firm when hiring and firing workers, and the share of individuals with low search effort in the working-age population. The most plausible impulses involve a rise in the fraction of individuals with low search effort, and a reduction in benefits to the unemployed. The rise in the proportion of students in the working-age population over the 1990s could have raised the share of individuals with low search effort correspondingly, while the stricter benefit regime since the mid-1990s could have increased the attractiveness of working compared with being unemployed. Both these shocks imply movements in unemployment and inactivity that would not be accompanied by a rise in wage pressure.

## 1. Introduction

Recent developments in the joint behaviour of unemployment and inactivity in the United Kingdom have attracted increasing attention (Gregg and Wadsworth (1999), Nickell (2001), Brittan (2001)). One reason for this interest is that the fall in the UK unemployment rate over the current upswing has been accompanied by a comparatively stable inactivity rate. Indeed, Chart 1.1 shows that the decline in inactivity compared to that of unemployment over the latest recovery has been much more muted than in the past. Consequently the ratio of the inactivity rate to the unemployment rate, which had been stable at around 3 during 1981-93, has since risen steadily to over 5 (Chart 1.2).

**Chart 1.1: Unemployment and inactivity as a % of working-age population**

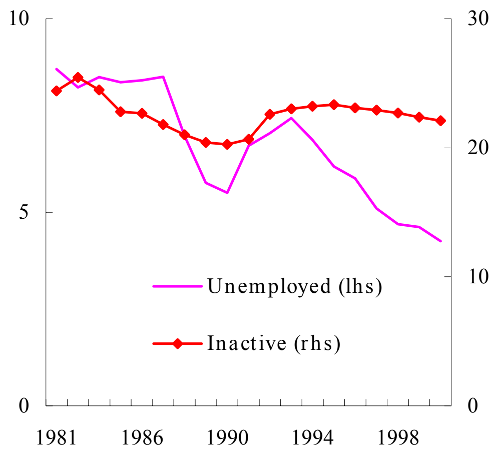
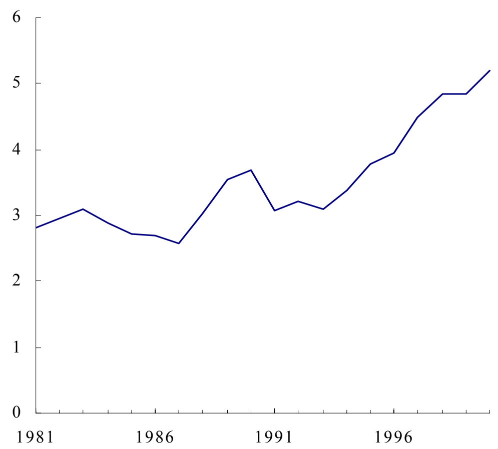



**Chart 1.2: Ratio of the inactivity rate to the unemployment rate**




What are the implications of these developments for monetary policy? Nickell (2001) focuses on the role of a relatively high inactivity rate on restraining the growth of potential output. However, it might also have implications for aggregate wage pressure. One possibility is that a relatively high inactivity rate has helped to moderate any extra wage pressure arising from the sharp decline in unemployment. On the other hand, it is arguable that the inactive are so detached from the labour market that they have no moderating impact on wage bargaining.

Unfortunately, standard labour market models cannot address such issues because they do not distinguish between the inactive and the unemployed. To address this deficiency, we develop a simple matching model of the labour market with two types of non-employed workers according to their levels of job search. Individuals with low levels of search effort ($L$-types), who can loosely be interpreted as inactive, adopt this strategy because they attach a higher value to home production or to leisure than their counterparts with high search effort ($H$-types) who can loosely be interpreted as the unemployed. In addition to lower search effort, the higher value that *L*-types place on home production or leisure means that they set higher reservation wages.[1]

The key feature of the model is that wage offers made to the unemployed and inactive are interdependent. This co-dependency flows from the fact that an employer can match with either type of job seeker. One consequence is that the impact of a given shock on wage pressure depends on the mix of each type in the non-employed population. For example, a reduction in the benefits available to *L*-types puts downward pressure on *L*-type wages and raises their search effort as might be expected. However, it also puts upward pressure on *H*-type wages. This is because firms are now more likely to match with a more expensive *L*-type, which increases the leverage of *H*-types. We illustrate the properties of the model via simulating the steady-state impacts of several exogenous shocks, including a permanent increase in the productivity of a job match, and a reduction in hiring costs. These simulations demonstrate that the relationship between unemployment, inactivity and wage pressure, which are all endogenous, depends critically on the source of the underlying exogenous shock. For example, unemployment and wage pressure are unrelated in the face of a productivity disturbance, while a cut in hiring costs leads to lower unemployment and higher wage pressure.

We then use the model to examine the behaviour of inactivity, unemployment and wage growth over 1994-2000. Specifically, we attempt to identify the underlying shocks that can explain the observed declines in unemployment and inactivity over this period. We consider shocks to benefits, hiring costs, firing costs, and the share of low search effort individuals in the working-age population. The most plausible impulses involve a rise in the fraction of low search effort individuals, and a reduction in benefits to *H*-type non-employed. A larger *L*-type share could reflect the rise in the proportion of students among the working-age population, while the reduction in benefits could reflect the stricter benefit regime since the mid-1990s. Under these shocks the 1994-2000 movements of unemployment and inactivity would not be associated with a rise in wage pressure.

The layout of the paper is as follows. Section 2 develops the matching model and derives the steady-state equilibrium conditions. In Section 3 we calibrate the model and simulate a variety of shocks to illustrate its key properties. Section 4 explores the relationship between unemployment, inactivity and wage pressure. A final section concludes.

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(1) This suggests that the inactive (*L*-types) have lower transition rates into employment. But this mapping may not be exact because some categories of self-reported inactive workers have higher flow rates into work than the self-reported unemployed (Schweitzer (2003)). It is possible for the inactive to search less than the unemployed yet have higher transition rates because they have higher job offer probabilities. Our empirical work uses differences in realised transition rates to identify high and low-effort searchers.

## 2. The model

We start our description of the model by considering the job-matching process. In particular, we shall use a matching function that relates the number of job matches formed to the search activity of unemployed and inactive workers. One might believe that inactive workers do not take part in the matching process. However, according to the UK Labour Force Survey some positive fraction of those non-employed people classified as inactive at the beginning of a three-month period, will find work before the end of the period. Some of these people will have been waiting for the results of job applications. But some of them will claim that at the beginning of the period they were not actively seeking work, while others will claim that they did not want to work at all.(2)

Why is it that people who are not looking for work, and even people who say they do not want to work, find work three months later? One perspective, which we call the 'missing data' view, is that inactive people do not enter work directly. All transitions that appear to be from *I* to *E* actually involve a short period in *U* that we do not observe owing to the discrete nature of many labour market surveys. Consider an individual who is temporarily sick in month one, and hence classified as inactive. He or she then recovers in month two and starts searching again. In month four the individual finds a job. If, like the UK Labour Force Survey (LFS), the survey is run quarterly and this individual happens to be interviewed only in months one and four, he or she will appear to have entered employment directly from inactivity. In reality, this was not the case.(3) An alternative possibility which we call the 'right place, right time' view, is that occasionally non-employed people who are supplying little or no search effort will receive job offers simply by virtue of being in the right place at the right time. They might, for example, meet the proverbial 'man in the pub' who just happens to have a suitable vacancy.(4) In this instance simply signalling that one is out of work can be enough to obtain a viable job offer. Although these two explanations for observed transitions from *I* to *E* are not mutually exclusive, they do have differing implications for modelling purposes.

Under the missing data view, inactive people do not enter a standard continuous time-matching function.(5) Non-employed individuals choose whether or not to participate in the labour market as a function of the net returns to participation. If the labour market is tight, and these returns are high, they are likely to participate. If the labour market is loose, and these returns are low, they are likely not to participate. In that sense, the stock of inactive people is a function of labour

(2) A detailed analysis of the transition rates into employment of many different categories of the non-employed is contained in Schweitzer (2003).
(3) Under ILO definitions it is also possible to search for and find a job before one becomes available for work. This might be particularly relevant for students moving from college into employment.
(4) We thank Stephen Nickell for giving us this idea.
(5) Chris Pissarides has pointed out that the inactive may play a role in a discrete time framework where both the inactive and unemployed have the same intensity conditional upon searching. However, the unemployed are more likely to be searching in any given period.

market tightness, rather than a determinant. In this example, the stock of inactive people does not tell us anything about market tightness that we could not already have known from inspection of (say) the vacancy to unemployment ratio. A recent paper that implicitly adopts this approach is Garibaldi and Wasmer (2000). In their model, individuals are either employed, unemployed and searching for work, or inactive and engaging in home production. The returns to home production vary across individuals and across time, and it is this that causes individuals to switch from one non-employment state to another and hence contributes to the economic cycle.
This paper leans towards the 'right place, right time' view of the observed transitions from *I* to *E*. We believe that certain categories of the inactive can enter employment directly, if the right opportunity comes their way, with little or no job search. These categories might include, among others, students who say they would like to work but are not searching, those individuals who are at home looking after their family, and the discouraged (those who say they are not searching because they believe no work is available).

Our approach is based on a model outlined in Chapter 5 of Pissarides (2000). In his model the number of matches per period ($m$) is a function of (i) the product of the average search intensity of the unemployed and the number of unemployed people ($su$), and (ii) the product of the average advertising effort per vacancy and the number of vacancies ($av$). The key extension we make is to substitute all non-employed people ($n$) for the unemployed ($u$). Search intensity is now averaged across all non-employed people. For simplicity, we drop the assumption that firms can vary advertising effort per vacancy. Hence, the matching function we use is of the form:

$$m = m(sn, v) \qquad \textbf{(2.1)}$$

We assume there are two types of individual: $L$-types, who comprise a fraction $\phi^L$ of the population; and $H$-types who comprise a fraction (1- $\phi^L$) of the population. The size of the total population is $P$. $L$-types are either employed or non-employed. While non-employed, they choose to supply a low level of search effort ($s^L$). $H$-types are either employed or non-employed. While non-employed they choose to supply a high level of search effort ($s^H$). Both types of individual choose these search intensities optimally as a function of their characteristics.

The economy proceeds in the following way. Each period, firms that want to recruit post vacancies. To do so, they must pay a fixed amount $pc$ per period ($p$ is the output of a filled job, so advertising costs are assumed proportional to the output of a filled job). The per-period probability that any given firm matches with a non-employed person, which we denote by $q^F$ is equal to the number of matches divided by the number of vacancies. Hence:

$$q^F = \frac{m(sn, v)}{v} \qquad \textbf{(2.2)}$$

Total search effort is a weighted sum of the search of high and low-effort searchers, thus $sn = s^L n^L + s^H n^H$, where $n^L$ and $n^H$ are the number of low and high-effort searchers respectively. While firms are posting vacancies, non-employed individuals are receiving state benefits. *L*-types receive $b^L$ and *H*-types receive $b^H$. Differences in these benefits reflect the possibility that *H*-types are formally claiming unemployment-related benefits, for which *L*-types are ineligible. Non-workers also receive utility from not working that is diminishing in the amount of search effort supplied. This utility may arise through home production, through enjoyment of leisure time, or through some combination of the two. If they supply no search effort at all, non-employed *L*-types receive a baseline amount $l^L$ and non-employed *H*-types receive a baseline amount $l^H$. We assume that $l^L > l^H$ and it is this that causes high-effort searchers to search harder and thus enter employment more quickly than low-effort searchers.[(6)] So the flow utility to non-employed *L*-types ($z^L$) and *H*-types ($z^H$) has two components: a fixed component (representing state benefits) and a variable component (representing the value of home production and/or leisure time). We write these flow utilities as:

$$z^L = b^L + \sigma\left(s^L, l^L\right) \quad \textbf{(2.3)}$$

$$z^H = b^H + \sigma\left(s^H, l^H\right) \quad \textbf{(2.4)}$$

where the function $\sigma(s, l)$ has the following properties:

$$\sigma_s(s,l) < 0$$
$$\sigma_{ss}(s,l) < 0$$
$$\sigma_l(s,l) > 0$$

Utility from home production and/or leisure time is decreasing in the time spent searching, and increasingly so.

Again following Chapter 5 of Pissarides (2000), we assume that the per-period probability that any given non-employed person matches with a vacancy is proportional to the fraction of total search effort that he or she has supplied. Hence these probabilities, denoted by $q^L$ for an *L*-type and $q^H$ for an *H*-type, can be written as:

$$q^L = \frac{s^L}{sn} m(sn, v) \quad \textbf{(2.5)}$$

$$q^H = \frac{s^H}{sn} m(sn, v) \quad \textbf{(2.6)}$$

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(6) The assumption that $l^L > l^H$ may reflect a higher taste for non-market activities among *L*-types.

When a non-employed person matches with a firm posting a vacancy they will agree on a wage rate. We denote the wage for *L*-types by $w^L$, and the wage for *H*-types by $w^H$. Once this wage has been agreed, firms must also pay a fixed hiring cost, ($h^L$ for *L*-types and $h^H$ for *H*-types).(7) This is analytically equivalent to a training cost. $h^L$ and $h^H$ are paid only once, in the first period of a new hire. In this respect, they differ from advertising costs, *pc*, which are paid each period that a vacancy is open.

An interesting point to consider is whether a non-employed person and a firm that have just met can always agree on some division of output that is acceptable to both parties. In particular, will it always make sense for a firm to hire an *L*-type it has just met, given that, in equilibrium, *L*-types tend to have a higher wage than *H*-types (reflecting the increased value of their outside option)? We return to this issue later on.

Finally, we turn to filled jobs. Each period, a filled job produces a fixed amount, *p*. This is shared between firm and worker according to the wage rates $w^L$ and $w^H$. These wage rates are continuously renegotiated, and will change in response to economic shocks. In addition, a job that has been filled faces an exogenous probability $\lambda$ of being destroyed each period.(8) If the job is destroyed, the firm must pay a fixed firing cost ($f^L$ for *L*-types, and $f^H$ for *H*-types).(9) (10) The employed person then becomes non-employed and must start searching for work again. The firm can no longer produce and must decide whether to post another vacancy.

We are now in a position to write down the seven value functions that together describe the present discounted value of expected future utility available to: employed *L*-types, employed *H*-types, non-employed *L*-types, non-employed *H*-types, firms employing an *L*-type, firms employing an *H*-type and firms currently posting a vacancy. These are written out in full below.(11)

$$rW^L = w^L + \lambda\left(N^L - W^L\right) \qquad \textbf{(2.7)}$$

$$rW^H = w^H + \lambda\left(N^H - W^H\right) \qquad \textbf{(2.8)}$$

(7) It is assumed that the firm can always identify *L* and *H*-types from the method by which both parties meet, and possibly their labour market histories. For example, *H*-types use formal job search channels and tend to have shorter spells of non-employment. Consequently both types can be paid different wages for doing the same job, and have different training costs.
(8) This assumption of a fixed and exogenous rate of job destruction means that shifts in hiring and firing costs will only affect non-employment through their impact on job creation. With endogenous job destruction, such movements will affect both job creation and job destruction (Mortensen and Pissarides (1999), Pissarides (2000)). This means that our findings concerning the impacts of shifts in hiring and firing costs may not generalise to the case where job destruction is endogenous.
(9) In principle, firing costs can differ between *L*-types, and *H*-types for several reasons, including differences in their pay rates during any period of notice.
(10) It is assumed that new hires are governed by the same wage structure as those workers already employed by the firm. In particular, hiring and firing costs do not form part of the negotiations when the worker and firm first meet about the possibility of forming a match.
(11) All the value functions describe the steady state since it is assumed that the various asset values are constant over time.

$$rN^L = b^L + \sigma(s^L, l^L) + q^L(W^L - N^L) \quad \textbf{(2.9)}$$

$$rN^H = b^H + \sigma(s^H, l^H) + q^H(W^H - N^H) \quad \textbf{(2.10)}$$

$$rJ^L = p - w^L + \lambda(V - J^L - f^L) \quad \textbf{(2.11)}$$

$$rJ^H = p - w^H + \lambda(V - J^H - f^H) \quad \textbf{(2.12)}$$

$$rV = -pc + q^F\left[\rho^L(J^L - V - h^L) + (1 - \rho^L)(J^H - V - h^H)\right] \quad \textbf{(2.13)}$$

**(2.7)** says the rental value of a job to an *L*-type ($W^L$ is the capital value, and *r* the real rate of interest) is equal to his or her per-period wage plus the capital loss that would occur if the job were destroyed, times the per-period probability that the job is destroyed. **(2.8)** gives the rental value of a job to an *H*-type.

**(2.9)** says the rental value of non-employment to an *L*-type is equal to state benefits received, plus the value of home production and/or leisure time, plus the capital gain that would occur if he or she were to enter employment, times the probability that he or she does enter employment. **(2.10)** gives the rental value of non-employment to an *H*-type.

**(2.11)** says the rental value to the firm of a job that is filled by an *L*-type is equal to per-period profits net of the wage ($p$- $w^L$), plus the capital loss that would occur if the job were destroyed, times the per-period probability that the job is destroyed. **(2.12)** gives the rental value to the firm of a job that is filled by an *H*-type.

Finally, **(2.13)** says the rental value to the firm of a vacancy is equal to the (negative of) the per-period cost of advertising a vacancy (*pc*) plus the expected capital gain that would occur if the vacancy were filled times the probability that the vacancy is filled. This capital gain is uncertain because the employer does not know whether he will meet an *L*-type or an *H*-type. The expected capital gain is the weighted average of the asset value of a job filled by an *L*-type (net of *V* and hiring costs), and the asset value of a job filled by an *H*-type (net of *V* and hiring costs). The weights depend on $\rho^L$, which we use to denote the conditional probability that a firm meets with an *L*-type, given that it meets with someone. $\rho^L$ is simply the fraction of all non-employed people who match in a given period that are *L*-types. Hence:

$$\rho^L = \frac{n^L q^L}{n^L q^L + n^H q^H} \quad \textbf{(2.14)}$$

Using **(2.5)** and **(2.6)** in **(2.14)** we obtain:

$$\rho^L = \frac{s^L n^L}{sn} \qquad \textbf{(2.15)}$$

Our model has seven endogenous variables: two wage rates ($w^L$ and $w^H$); two optimally chosen search efforts ($s^L$ and $s^H$); two non-employment stocks ($n^L$ and $n^H$); and a stock of vacancies ($v$). To solve the model we need seven equilibrium conditions. The conditions we use, which are a natural extension of those in Pissarides (2000), are as follows. The two wage rates ($w^L$ and $w^H$) are determined by a Nash Bargaining process, such that a fraction $\beta$ of the total surplus generated from each match goes to the worker (whether *L*-type or *H*-type), and a fraction (1-$\beta$) goes to the firm. The two search efforts ($s^L$ and $s^H$) are chosen to maximise the value of non-employment ($N^L$ for an *L*-type and $N^H$ for an *H*-type). Firms post vacancies until the asset value of a vacancy is zero. This is effectively a free entry condition. Finally, $n^L$ and $n^H$ evolve according to the processes governing matching and job destruction described above. The conditions are written out in full below:

$$\left(W^L - N^L\right) = \beta\left[\left(J^L - V\right) + \left(W^L - N^L\right)\right] \qquad \textbf{(2.16)}$$

$$\left(W^H - N^H\right) = \beta\left[\left(J^H - V\right) + \left(W^H - N^H\right)\right] \qquad \textbf{(2.17)}$$

$$\frac{\partial N_i^L}{\partial s_i^L} = 0 \qquad \textbf{(2.18)}$$

$$\frac{\partial N_i^H}{\partial s_i^H} = 0 \qquad \textbf{(2.19)}$$

$$V = 0 \qquad \textbf{(2.20)}$$

$$\frac{\partial n^L}{\partial t} = \lambda\left(\phi^L P - n^L\right) - q^L n^L \qquad \textbf{(2.21)}$$

$$\frac{\partial n^H}{\partial t} = \lambda\left[\left(1-\phi^L\right)P - n^H\right] - q^H n^H \qquad \textbf{(2.22)}$$

In the conditions for optimal search effort, **(2.18)** and **(2.19)**, each individual is indexed by *i*. It is necessary to retain these subscripts until the calculus has been performed, since each individual *i* must take the actions of others as given when choosing $s_i$. Since all *L*-types are identical to all other *L*-types and all *H*-types are identical to all other *H*-types we shall find that, in equilibrium, there are only two search efforts: $s^L$ and $s^H$. Equation **(2.21)** says that the change in *L*-type non-employment is equal to the number of inflows (the constant job destruction rate times the number of *L*-types in employment) minus the number of outflows (the probability that an *L*-type matches times the number of *L*-types who are non-employed). There is an equivalent expression for then change in *H*-type non-employment **(2.22)**.

By setting **(2.21)** and **(2.22)** to zero, we derive steady-state conditions for employment:

$$n^L = \frac{\lambda\phi^L P}{\lambda + q^L} \qquad \textbf{(2.23)}$$

$$n^H = \frac{\lambda(1-\phi^L)P}{\lambda + q^H} \qquad \textbf{(2.24)}$$

We can now use the equilibrium conditions **(2.16)** to **(2.20)**, together with the value functions **(2.7)** to **(2.13)**, to derive expressions for the remaining endogenous variables ($w^L$, $w^H$, $s^L$, $s^H$, and $v$). These are reported below (the full workings are available upon request).

$$w^L = (1-\beta)[b^L + \sigma(s^L, l^L)] + \beta\left\{p - \lambda f^L + \theta^L\left[pc + q^F\rho^L h^L - q^F(1-\rho^L)\left(\left[\frac{p - w^H - \lambda f^H}{r+\lambda}\right] - h^H\right)\right]\right\} \qquad \textbf{(2.25)}$$

$$w^H = (1-\beta)[b^H + \sigma(s^H, l^H)] + \beta\left\{p - \lambda f^H + \theta^H\left[pc + q^F(1-\rho^L)h^H - q^F(\rho^L)\left(\left[\frac{p - w^L - \lambda f^L}{r+\lambda}\right] - h^L\right)\right]\right\} \qquad \textbf{(2.26)}$$

$$\sigma_s(s^L, l^L) = \frac{m(sn, v)}{sn}\left(\frac{w^L - b^L - \sigma(s^L, l^L)}{r + \lambda + q^L}\right) \qquad \textbf{(2.27)}$$

$$\sigma_s(s^H, l^H) = \frac{m(sn, v)}{sn}\left(\frac{w^H - b^H - \sigma(s^H, l^H)}{r + \lambda + q^H}\right) \qquad \textbf{(2.28)}$$

$$\frac{pc}{q^F} = \left(\frac{1}{r+\lambda}\right)\left(\begin{array}{l} p - \rho^L[w^L + \lambda f^L + h^L(r+\lambda)] \\ -(1-\rho^L)[w^H + \lambda f^H + h^H(r+\lambda)] \end{array}\right) \qquad \textbf{(2.29)}$$

**(2.25)** and **(2.26)** are the wage equations for *L*-types and *H*-types respectively. While they may look cumbersome, they do have intuitive appeal. **(2.25)** says that an *L*-type's wage is a weighted average of his or her reservation wage (the term in brackets, pre-multiplied by 1-$\beta$) and the potential gain from the match (the term in braces, pre-multiplied by $\beta$). The weights are (1-$\beta$) and $\beta$. If the worker has no bargaining power ($\beta = 0$), he gets his reservation wage, which is equal to the sum of state benefits and the value of leisure time adjusted for search effort. If the firm has no bargaining power ($\beta = 1$) the worker gets the entire potential gain from the match.

The 'potential gain from the match' needs some elaboration. If the match goes ahead, an amount $p$ will be produced, out of which an amount $f^L$ must be paid in firing costs with fixed probability $\lambda$ per period. But in addition to producing, the match saves on advertising costs. To see how large these costs might be, imagine the case where the worker refuses the match and the firm is forced to hire another $L$-type. The $L$-type who walks away is likely to have to wait $1/q^L$ periods until he finds another firm. The firm he finds is likely to have spent, in total, an amount $pc/(\rho^L q^F)$ hiring him. Hence, the expected cost of advertising for an $L$-type per period that the $L$-type would be non-employed is given by $(pc/\rho^L q^F)/(1/q^L)$. This simplifies to $pc$ times $v/n^L$, the ratio of vacancies to non-employed $L$-types, which we label $\theta^L$ for convenience.[12] Unfortunately, this is not the end of the story. In addition to the $pc$ advertising costs that must be paid each period that the firm is searching for another $L$-type, $L$-type hiring costs equal to $h^L$ are also paid with probability $q^F \rho^L$. One further wrinkle, unique to our model, is that the firm is not forced to recruit another $L$-type. It may find an $H$-type instead. This occurs with probability $q^F(1 - \rho^L)$ per period. The capitalised value of matching with an $H$-type is equal to $(1/(r + \lambda))(p - w^H - \lambda f^H)$ $+h^H$ which must be subtracted from the other cost items.

We can see from **(2.25)** and **(2.26)** that the two wage rates are interdependent. One interesting implication is that changes in state benefits available to $L$-types (the inactive) have implications for the wage rate open to $H$-types (the unemployed) and hence for the steady-state non-employment rate of $H$-types. We shall return to this issue in Section 4.

The remaining equations are more straightforward. The optimal search equations, **(2.27)** and **(2.28)**, say that a non-employed worker will supply search effort until the marginal cost of doing so (in terms of leisure time forgone), just equals the expected gain from doing so (in terms of the probability adjusted mark-up of the wage over the reservation wage). To see this, note that the first term on the right-hand side is the probability that a given unit of search effort results in a match, while the second term is the capitalised value of the mark-up of the wage rate over the reservation wage. **(2.29)** is the job creation condition. It says that firms will post vacancies until the expected total advertising cost is just equal to the present discounted value of expected future profits (this term reflects the fact that the firm does not know whether it will meet an $L$-type and pay $w^L$, or an $H$-type and pay $w^H$).

[12] A numerical example might help. Imagine that I threaten to resign from my company. If I do this, I know that it will take me just two weeks to find another job. I also know that my company will have to advertise my job at a cost of £50 per week for four weeks before finding a replacement. That means each week that I am in employment, rather than non-employed, I save society a total of 4*£50/2 = £100 per week. This £100 surplus is then shared out according to my bargaining strength, $\beta$, and added to my weekly wage.

## 3. Model calibration and properties

We do not attempt to solve the model analytically. Instead, we aim to find plausible parameter values that will allow us to obtain numerical solutions of the initial steady state and the new steady state following a shock. We turn first to the calibration.

### *3.1 Calibration*

The first step is to specify appropriate functional forms, both for the matching function **(2.1)** and for the value of leisure function used in **(2.2)** and **(2.3)**. In common with most authors, we specify a Cobb-Douglas matching function:

$$m(sn, v) = \mu(sn)^{\gamma} v^{1-\gamma} \qquad \textbf{(3.1)}$$

In a recent survey of the empirical literature, Petrongolo and Pissarides (2001) argue that Cobb-Douglas matching functions have tended to fit the data well, in most countries and in most studies. Recall from the discussion in Section 2 that we want to find a value of leisure function such that the value of leisure is decreasing in the amount of search effort supplied, and increasingly so. One function that delivers this result is shown below:

$$\sigma(s, l) = l\left(1 - \alpha(s)^2\right) \qquad \textbf{(3.2)}$$

The parameter $\alpha$ determines the sensitivity of the value of leisure time to changes in search effort. We set $\alpha = 1$. In this case $s$ can be viewed as the fraction of time spent searching. For $s = 0$, the non-employed person enjoys his or her maximum value of leisure time, $l$. For $s = 1$, the non-employed person gets no utility from leisure time at all. By construction, the marginal disutility from extra search time is increasing in the amount of search being undertaken. That means that it would cost an $H$-type more to raise his or her search time by (say) 30 minutes than it would cost an $L$-type. This aspect of the cost of search function turns out to have important implications for model properties.

Counting up across the seven equations of our model, and the two functions outlined above, we have a total of 18 exogenous parameters. These 18 parameters are listed in Table 3.1 below, together with the benchmark values we assign to them.

**Table 3.1**

**Values of the exogenous parameters in the benchmark case**

| Parameter | Description | Quarterly value |
|---|---|---|
| $P$ | Population size | **1.000** |
| $p$ | Output of a filled job | **1.000** |
| $\alpha$ | Parameter in value of leisure function | **1.000** |
| $\beta$ | Fraction of total surplus that goes to the worker | **0.500** |
| $\lambda$ | Job destruction rate | **0.035** |
| $h^L$, $h^H$ | Training costs for *L* and *H*-types | **0.333** |
| $f^L$, $f^H$ | Firing costs for *L* and *H*-types | **1.000** |
| $\gamma$ | Elasticity of job matches with respect to total search effort | **0.500** |
| $r$ | Real discount rate | **0.010** |
| $\mu$ | Parameter of the matching function | *1.094* |
| $b^L$ | State benefits paid to non-employed *L*-types | *0.121* |
| $b^H$ | State benefits paid to non-employed *H*-types | *0.242* |
| $l^L$ | Maximum value of leisure time / home production available to *L*-types | *0.771* |
| $l^H$ | Maximum value of leisure time / home production available to *H*-types | *0.537* |
| $pc$ | Per-period cost of posting a vacancy | *0.601* |
| $\phi^L$ | Fraction of population that are *L*-types | *0.378* |

There is a distinction between the way in which values were assigned to the first eleven parameters (shown in bold in the third column), and the way in which values were assigned to the last seven parameters (shown in italics in the third column). Parameter values shown in bold are either convenient normalisations or were assigned by direct observation. The estimate of training costs, for example, comes from a paper by Bentolila and Bertola (1990). But some parameter values, such as the maximum value of leisure time available to *L*-types ($l^L$), or the fraction of *L*-types in the whole population ($\phi^L$), are much less tangible. These parameter values, shown in italics, were chosen so that a number of steady-state conditions hold in the benchmark case. We now deal with the selection of each parameter in turn.

The first two parameter values listed in Table 3.1 ($P$ = 1.000, and $p$ = 1.000) are convenient normalisations. The selection of $\alpha$ ($\alpha$ = 1.000) has already been discussed. In common with Pissarides (1998), we set the worker's share of the total surplus ($\beta$) equal to 0.500. This is slightly lower than the value chosen by Millard and Mortensen (1997), who set $\beta$ = 0.584 on the grounds that it yields a steady-state unemployment rate equal to the UK average over the period 1983-92. Our results are not that sensitive to small variations in $\beta$. We set the quarterly rate of job destruction ($\lambda$) equal to 0.035, on the grounds that this is the average transition rate from employment into non-employment across successive waves of the UK Labour Force Survey from 1993 to 1999.[(13)]

We take our estimates of training costs ($h^L$ and $h^H$) from US survey information reported in Hammermesh (1993). This suggests that average training costs were $2,500 per worker in 1990. In the same year, average US wages plus benefits were equal to $31,200. With parameters set to their benchmark values, the steady-state wage in our model is around 93% of output. That suggests we set our training cost parameters equal to around one third of quarterly output (ie $h^L = h^H = 0.333$).[(14)]

We take estimates of firing costs ($f^L, f^H$) from a cross-country study by Bentolila and Bertola (1990). They suggest the following specification for expected firing costs ($F$)

$$F = N + (1 - P_a)SP + P_a[(1 - P_u)(SP + LC) + P_u(UP + LC)] \qquad \textbf{(3.3)}$$

where $N$ is pay for the notice period, $P_a$ is the probability that the dismissal is appealed to the courts, $P_u$ is the probability that the dismissal is ruled unfair by the courts, $SP$ is the severance payment, $LC$ represents the employer's legal costs from going to court, and $UP$ is the payment for unfair dismissal. They use the following parameter values for the UK: $N = 1.5$ months' pay, $SP = 1.5$ months' pay, $P_a = 0.0923$, $P_u = 0.11$, $LC = 2$ months' pay, and $UP = 2$ months' pay. Working through the arithmetic, we get an expected figure equal to 3.2 months' pay. We round down and set both $f^L$ and $f^H$ equal to output in one quarter. Consequently, $f^L = f^H = 1.000$.

The parameter $\gamma$ captures the elasticity of job matches with respect to total search effort, $sn$ (see equation **(3.1)**). More conventional matching functions use the unemployment rate in place of $sn$. Empirical estimates of the elasticity of job matches with respect to the unemployment rate tend to be close to one half, (Petrongolo and Pissarides (2001)). We choose to set $\gamma = 0.5$ also.[(15)] Following the literature (Millard and Mortensen (1997) and Neiss and Nelson (2001)) and empirical evidence we set the real discount rate, $r$, to 1% per quarter.[(16)]

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[(13)] It is arguable that this is a lower bound on the true job destruction rate given the nature of the LFS which will not capture many transitions between quarterly surveys.

[(14)] This is derived as (2500/(31200/4))*(100/93). It might be thought that training costs for $L$-types might be a little higher than training costs for $H$-types since $L$-types tend to have longer non-employment durations. This is something we could consider at a later date, though we do not believe it would have any material impact on the properties of our model.

[(15)] The partial effect of an increase in $n$ is to lower search intensity (with more non-employed people, the returns to search are reduced, see **(2.27)** and **(2.28)**). That might suggest that we shade $\gamma$ up above 0.5. But, in general equilibrium, the impact on $s$ of a change in $n$ will depend on what has caused $n$ to change in the first place. For that reason, we see no reason to move away from $\gamma = 0.5$.

[(16)] The ten-year spot real interest rate derived from UK government index-linked gilts has averaged 3.5% since they were first introduced. This implies a real rate of 0.88% per quarter.

We have directly assigned values to eleven of our eighteen parameters. Benchmark values are chosen for the remaining seven parameters such that seven conditions hold in steady state. These conditions are as follows:

$$n^L = 0.080 \quad \textbf{(3.4)}$$

$$n^H = 0.064 \quad \textbf{(3.5)}$$

$$\frac{s^H}{s^L} = 2.343 \quad \textbf{(3.6)}$$

$$\frac{v}{m(sn, v)} = 0.549 \quad \textbf{(3.7)}$$

$$\frac{b^H}{w^H} = 0.260 \quad \textbf{(3.8)}$$

$$b^L = 0.5 * b^H \quad \textbf{(3.9)}$$

$$\frac{v}{m(sn, v)} c = 0.333 \quad \textbf{(3.10)}$$

**(3.4)** and **(3.5)** put restrictions on the fraction of the population that are non-employed *L*-types and *H*-types in steady state. **(3.6)** puts a restriction on the probability that an *H*-type enters employment in a given period, relative to the probability that an *L*-type enters employment in a given period.[17]

Restrictions **(3.4)** to **(3.6)** were all derived from Labour Force Survey (LFS) data. From the LFS, it is possible to obtain a 26-group breakdown of the non-employed population. The unemployed can be categorised according to the current duration of their unemployment spell (less than six months and greater than six months); while the inactive can be categorised according to the stated reason for their inactivity (with up to 24 different reasons available). The categories are shown in Table 3.2, together with the average quarterly transition rate into employment, and the average fraction of the working-age population that each category represented during the period 1993 to 1999 (Schweitzer (2003)).

[17] From equations **(2.3)** and **(2.4)** it is clear that the relative probabilities of entering employment simplifies to the relative search effort supplied.

**Table 3.2**
**Average transition rates and average stocks of 26 categories of non-employment (1993-99)**

| Status | Average quarterly transition rate into employment (%) | Average stock (as percentage of working-age population) | Type |
|---|---|---|---|
| **Unemployed** | | | |
| <6 months | 34.1 | 3.0 | *H* |
| >=6 months | 14.2 | 2.8 | *H* |
| **Seeking work, but unavailable to start** | | | |
| Student | 27.5 | 0.3 | *H* |
| Looking after family | 16.4 | 0.1 | *L* |
| Sick (temporary) | 11.8 | 0.0 | *L* |
| Sick (long-term) | 3.9 | 0.0 | – |
| Other reason | 35.2 | 0.1 | *H* |
| No reason | 25.9 | 0.0 | *H* |
| **Not seeking work, and would like to work** | | | |
| Waiting on application | 25.2 | 0.0 | *H* |
| Student | 16.4 | 0.7 | *L* |
| Looking after family | 5.6 | 2.0 | *L* |
| Sick (temporary) | 7.6 | 0.3 | *L* |
| Sick (long-term) | 1.3 | 1.8 | – |
| Discouraged | 4.3 | 0.2 | *L* |
| Not started looking | 16.4 | 0.3 | *L* |
| Other reason | 12.4 | 0.5 | *L* |
| No reason | 19.0 | 0.0 | *L* |
| **Not seeking work, and would not like to work** | | | |
| Waiting on application | 29.5 | 0.0 | *H* |
| Student | 13.4 | 3.1 | *L* |
| Looking after family | 3.5 | 5.0 | – |
| Sick (temporary) | 4.8 | 0.2 | *L* |
| Sick (long-term) | 0.7 | 4.0 | – |
| Job not needed | 3.4 | 0.5 | – |
| Retired | 1.9 | 1.4 | – |
| Other reason | 8.8 | 0.5 | *L* |
| No reason | 45.6 | 0.2 | *H* |

After ranking each of the 26 categories of the non-employed listed in Table 3.2 according to the rate at which they transition into employment, we define a cut-off point and label those above this point high-effort searchers (*H*-types), and those below low-effort searchers (*L*-types). We aim, so far as possible, to label as *H*-types all those who transition at a rate close to the rate of the short-term unemployed (34.1% per quarter). Most of the remainder we label as *L*-types. There is one exception to this rule: we count the long-term unemployed (at least six months) as *H*-types despite the fact that a few *L*-types have higher transition rates. Finally, six categories, marked with a dash in the 'Type' column are excluded from our model on the grounds that they have very low transition rates. These individuals are mainly either long-term sick or early retirees.

It is now reasonably straightforward to see how we obtained restrictions **(3.4)** to **(3.6)**. From Table 3.2, non-employed *L*-types represent, on average, 8.0% of the working-age population.[18] Non-employed *H*-types represent, on average, 6.4% of the working-age population. Moreover, *L*-types transition at a weighted average rate of 10.8% per quarter, while *H*-types transition at a weighted average rate of 25.3% per quarter. Taken together, this means we would like our model to generate steady-state non-employment rates of $n^L = 0.080$, and $n^H = 0.064$. We would also like *H*-types to enter employment 25.3/10.8 (=2.343) times more frequently than *L*-types, which in turn means they must search with 2.343 times more effort than *L*-types.

Restriction **(3.7)** says that, in steady state, the expected duration of a vacancy should be equal to 0.549 of a quarter, or a little over seven weeks. This is the average expected duration of UK Jobcentre vacancies over the period 1993 to 1999, where the expected duration is defined as the inverse of the probability that a vacancy is filled, ie the inverse of the number of placings divided by the previous period stock of unfilled vacancies.[19]

Restriction **(3.8)** says that, in steady state, the replacement ratio (state benefits available to high-effort searchers, divided by the high-effort searcher's wage conditional on receiving benefits) equals 0.26 as suggested by Millard and Mortensen (1997). We believe that state benefits available to low-effort searchers should be less than those available to high-effort searchers (ie $b^H > b^L$).[20] However, we have little or no idea on the relative magnitudes. For simplicity, we arbitrarily set *L*-type benefits equal to one half of *H*-type benefits (see restriction **(3.9)**).

Survey information reported in Hammermesh (1993) for the United States suggests that the total cost of advertising a vacancy is equal to around one month's output. This restriction is imposed by **(3.10)**.

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(18) Of course this 8% figure is much lower than the actual inactivity.
(19) It has been suggested that only around one third of all vacancies in the economy are advertised at Jobcentres. By calibrating our model in this way, we are implicitly assuming that non-Jobcentre vacancies are filled at broadly similar rates to Jobcentre vacancies.
(20) Particularly since we have excluded the long-term sick, who may be on more generous benefits, from our definition of *L*-types.

Table 3.3 shows the steady-state values of the endogenous variables in the model. Notice that the $w^L > w^H$ in the steady state. This result, which may seem counter-intuitive, flows from the fact that *L*-types must be compensated for their higher value of home production/leisure while both types of worker are equally productive. One way of reversing this result would be to allow $h^L > h^H$ so that *L*-types are more expensive to hire.(21) This might reflect the possibility that *L*-types require more training to perform a given task because they are less attached to the labour market. The wage of both *L* and *H*-types is above 90% of output (recall that $p = 1$). That is considerably higher than empirical estimates for the UK labour share of around 70%. This gap largely reflects the fact that capital is not present in this model. The only cost firms face is the cost of posting vacancies. They do not have to pay interest and depreciation on capital.(22) Consequently, it is more sensible to think of $p$ as output net of capital costs. The steady-state vacancy rate ($v = 0.017$) is approximately equal to the number of vacancies per head of working-age population over the period.(23) $s^H/s^L$, $n^H$ and $n^L$ are at their steady-state values by construction.

**Table 3.3**
**Steady-state values of the endogenous variables in the benchmark case**

| Variable | Description | Quarterly value |
|---|---|---|
| $w^L$ | Wage rate of *L*-types | **0.944** |
| $w^H$ | Wage rate of *H*-types | **0.930** |
| $s^L$ | Search effort of *L*-types | **0.199** |
| $s^H$ | Search effort of *H*-types | **0.466** |
| $v$ | Vacancy rate | **0.017** |
| $N^L$ | Non-employment rate of *L*-types | **0.080** |
| $N^H$ | Non-employment rate of *H*-types | **0.064** |

### *3.2 Model properties*

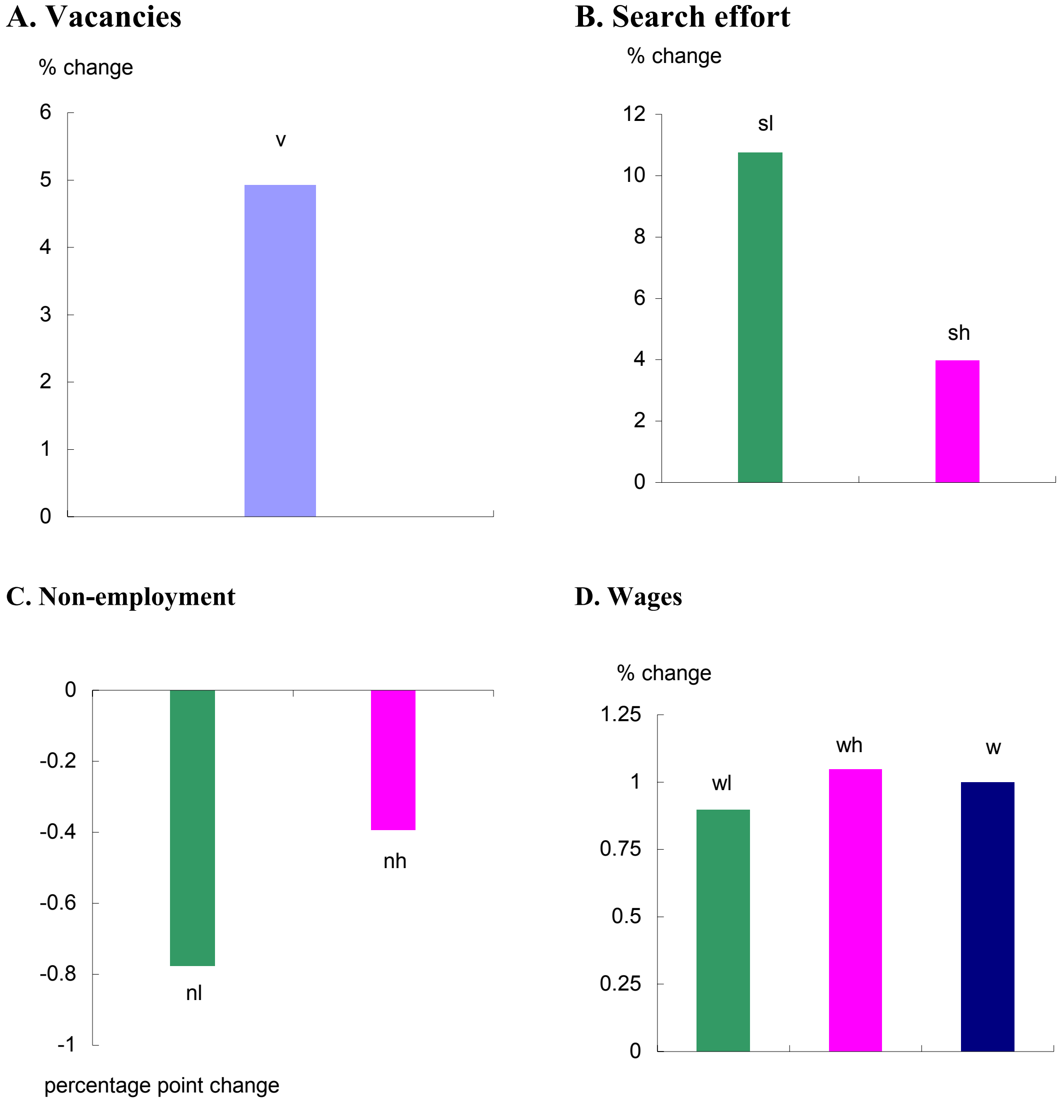
To illustrate the properties of the model we examine the steady-state responses of the seven endogenous variables in the model ($v$, $s^L$, $s^H$, $n^L$, $n^H$, $w^L$, $w^H$) to three permanent exogenous shocks. We consider (i) a permanent 1% increase in worker productivity ($p$), (ii) a 50% cut in benefits to *L*-type non-employed ($b^L$), and (iii) a 50% cut in the hiring costs of both *L* and *H*-types ($h^L$ and $h^H$).

(21) It is also possible to reverse this result if we assumed that *L*-types search less because they have a lower expected return to job search than to *H*-types.
(22) Pissarides (2000) discusses extending the basic matching model to allow for capital.
(23) Assuming that the total number of vacancies is three times those listed with Jobcentres.

### *3.2.1 Impact of a productivity rise*

Our model would be productivity neutral were it not for the fact that a number of important (opportunity) cost parameters are not indexed to productivity. As it is, when productivity rises, employing people becomes more attractive since (i) wages are in part held down by unchanged state benefits, (ii) hiring costs are lower compared to the output of a filled job, and (iii) firing costs are lower compared to the output of a filled job. Taken together, this encourages firms to post more vacancies in steady state (Panel A in Chart 3.1). The increase in vacancies induces greater search effort (when vacancies rise, the marginal return to an extra unit of search is higher). The search effort of *L*-types rises by more than the search effort of *H*-types because, given the nature of the cost of search function, it is cheaper for *L*-types to increase their search effort (Panel B). Because $s^L$ rises by more than $s^H$, $n^L$ falls more quickly than $n^H$ (Panel C).

**Chart 3.1: Responses to 1% productivity rise**



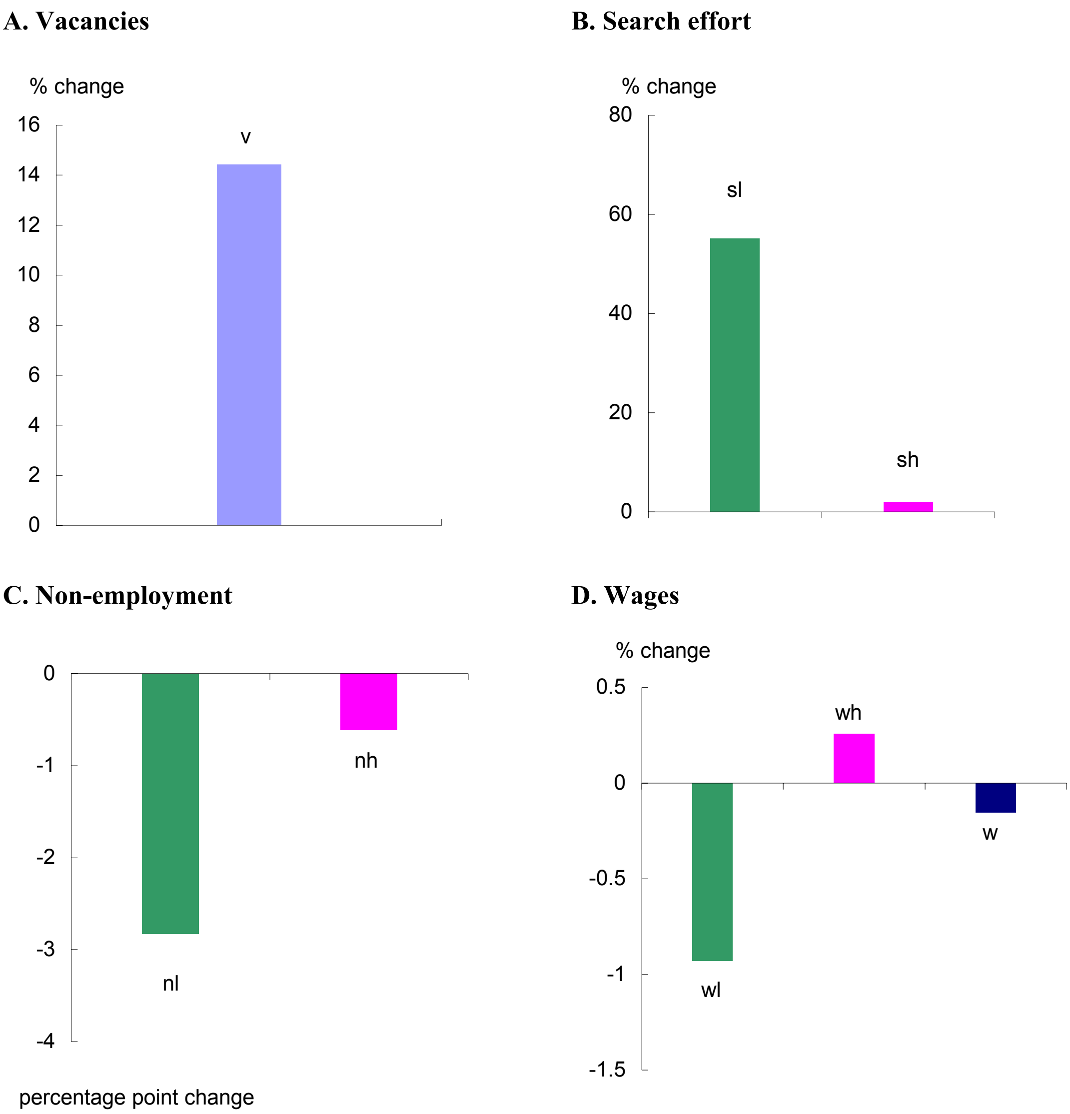

The final panel (Panel D), which plots the two wage rates for each type ($w^L$ and $w^H$) and the aggregate wage rate (*w)*, is a little harder to understand. First, note that both wage rates rise by an amount close to the change in productivity (1%). That is because *p* is a major determinant of the surplus from the match that is split in the same ratio as before (50:50). Second, note that $w^H$ rises by more than $w^L$. With reference to the wage equations, **(2.25)** and **(2.26)**, this is at first glance surprising. The reservation wage of *H*-types declines by proportionately more than the reservation wage of *L*-types (because the value of their home time falls by proportionately more). Moreover, $\theta^L$ rises by proportionately more than $\theta^H$ (because $n^H$ falls by proportionately more than $n^L$). Both of those effects put proportionately more upward pressure on $w^L$ than on $w^H$. But these effects are dominated by the increase in $\rho^L$, which measures the probability that a firm matches with an *L*-type given that it matches with someone. Essentially, the probability that the firm matches with an *L*-type rises by more than the probability that the firm matches with an *H*-type, because the *L*-types increase their search effort by more than the *H*-types. This improves the bargaining power of *H*-type individuals because a higher surplus is generated from a match between *H*-types and firms. Thus high-effort searchers can get a share of this surplus and both parties will still be better off.(24)

### *3.2.2 Impact of a cut in benefits for low-effort searchers*

Chart 3.2 shows the impact of a 50% cut in the benefits paid to *L*-types ($b^L$). Such a cut may embody the recent policies of restricting the availability of student grants. The cut immediately increases the search effort of *L*-types which encourages firms to create more jobs. The extra vacancies induce extra search effort by *H*-types, although their proportional response is much lower since their benefits are unchanged. The extra search of both groups helps to reduce their non-employment rates, but the proportional fall in $n^L$ dominates. Aggregate wages decline as might be expected. But it is interesting to note that the decline in $w^L$, is partly offset by a rise in $w^H$. As before, the increase in $w^H$ reflects the increased likelihood that the firm will run into a more costly *L*-type.

(24) Essentially *H*-types can credibly say 'Well, I think you ought to pay me a little more, because if you don't give me the job, you're likely to run in to an *L*-type next time, and they're more expensive anyway'.

**Chart 3.2: Responses to 50% fall in low-effort benefits**



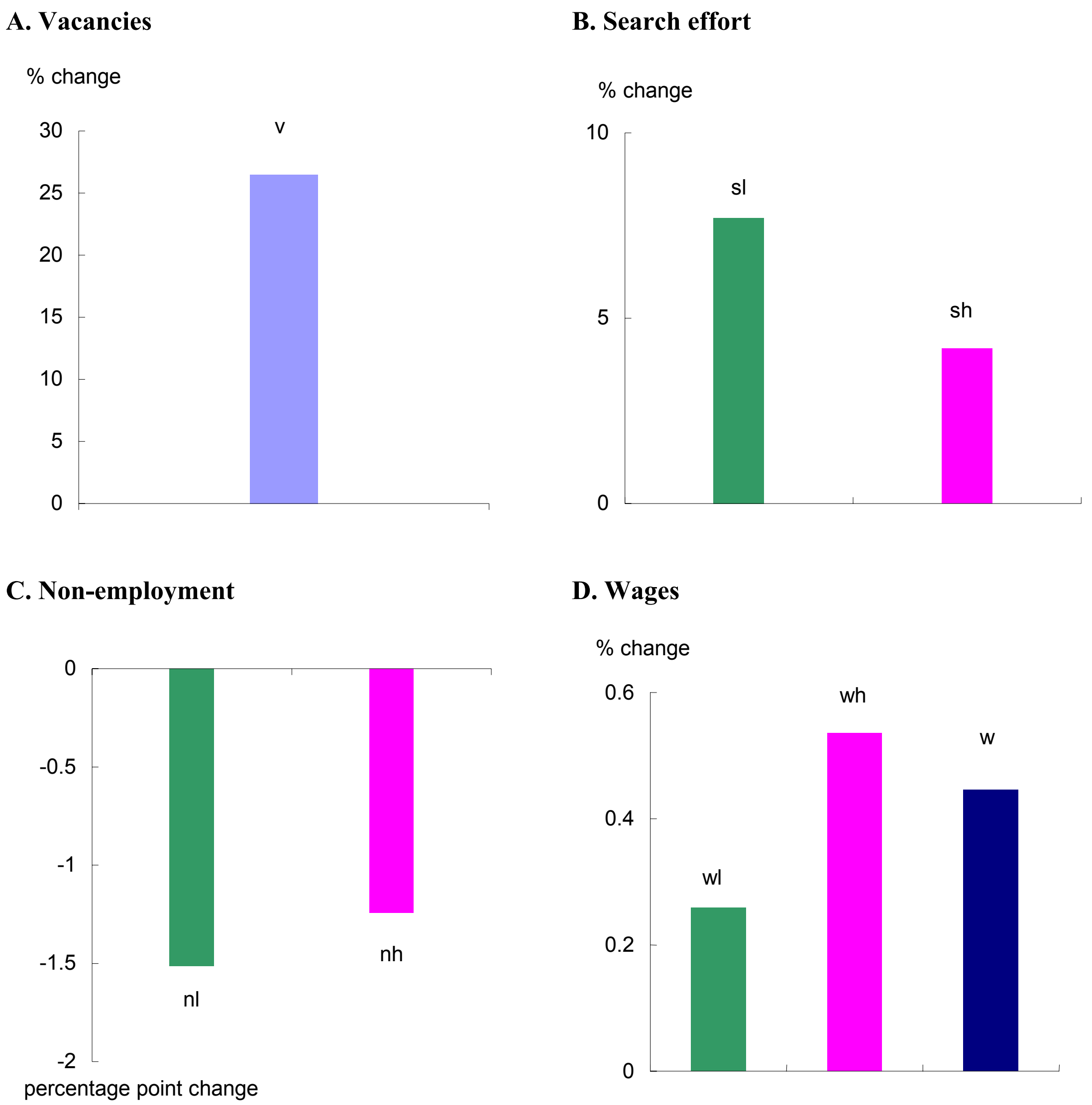

### 3.2.3 *Impact of a hiring subsidy*

Finally, we consider the impact of a hiring subsidy to employers. This is modelled as a 50% cut in both $h^L$ and $h^H$.[25] Chart 3.3 shows that vacancies and search effort rise. $s^L$ rises by proportionately more than $s^H$, which leads to a proportionately larger decline in $n^L$ compared to $n^H$. It is important to note that these falls in non-employment hinge critically upon our assumption of exogenous job destruction so that a hiring subsidy increases job creation but has no impact

[25] Such subsidies form part of many New Deal programmes that are currently available to the non-employed. For example, up to 20% of non-gateway participants on the New Deal for Young People have taken job with a private sector employer for six months where the wage was subsidised by up to £60 per week (see www.dfes.gov.uk/statistics/DB/SFR/s0277/index.html).

upon job destruction. Mortensen and Pissarides (1999) develop a matching model with endogenous job destruction where hiring subsidies can increase unemployment by encouraging firms to cut existing jobs sooner in order to receive the subsidy for creating a new job. This rise in the incidence of unemployment dominates the decline in the duration of average spells. In any case, the reservation wages of both groups decline, which puts downward pressure on $w^L$, $w^H$, and $w$. But this is more than offset by the rise in the vacancy/non-employment ratios $(\theta^L, \theta^H)$ so that all wages rise. Once again $w^H$ increases by proportionately more than $w^L$ because $\rho^L$ increases.

**Chart 3.3: Responses to 50% fall in hiring costs for non-employed**



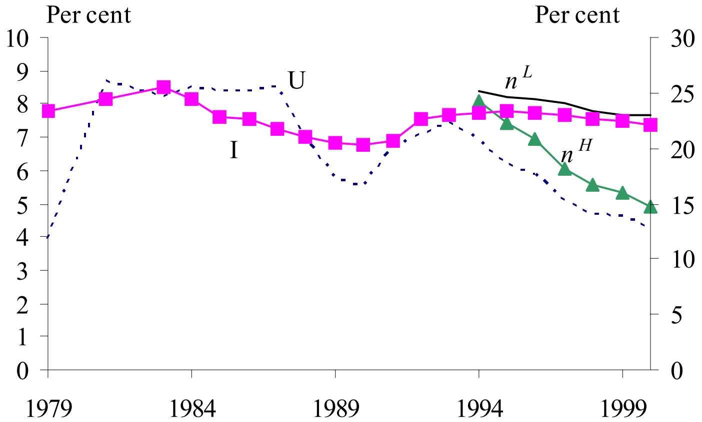

All three exogenous shocks (productivity rise, $L$-type benefit cut, and a hiring subsidy) lead to a larger percentage point decline in $n^L$ compared to $n^H$. This suggests that such shocks are unlikely to account for relative movements in inactivity and unemployment. The next section investigates these issues in more depth.

## 4. Non-employment and wage pressure

In this section we use our model to investigate the relationship between (changes in) unemployment, inactivity and wage pressure. Particular attention is paid to the recent UK experience of a falling unemployment rate coupled with a broadly constant inactivity rate.

Chart 4.1 plots a long-run unemployment rate series and a long-run inactivity rate series alongside $n^H$ (the *H*-type non-employment rate) and $n^L$ (the *L*-type non-employment rate). The denominator in each case is the working-age population and all series are derived from the LFS. As explained in Section 3, the categorisation of individuals into *H* and *L*-types is based on a ranking of the observed transition rates of 26 different categories of non-employment (Table 3.2). Essentially, *H*-types are the unemployed plus one or two others such as inactives who are waiting for the outcome of a job application. *L*-types are a subset of the inactive that excludes those with very low transition rates (principally the long-term sick). While $n^H$ and $n^L$ differ from actual unemployment and inactivity, each constructed series has a similar profile to its 'real world' counterpart. In what follows, the terms $n^H$ and the unemployment rate, and $n^L$ and the inactivity rate, are used interchangeably.

**Chart 4.1: Unemployment, inactivity, $n^H$ and $n^L$ (1)**




(1) Inactivity rate is on the right-hand scale. All other rates are on the left-hand scale.

This framework highlights the well-known fact that there is no reduced-form relationship linking either the unemployment rate or the inactivity rate to wage pressure (by which we mean the productivity-adjusted real wage, or *w/p*).[26] This is because the 'trade-off' between the

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[26] Defined in this way, wage pressure is something distinct from labour market tightness. We believe the latter to be explicitly a disequilibrium phenomenon, see Brigden and Thomas (2003).

unemployment rate and/or the inactivity rate and wage pressure depends on the source of the shock that has caused the unemployment rate and/or the inactivity rate to move. We can illustrate this point with a simple diagram.

**Chart 4.2: Unemployment / wage pressure loci**

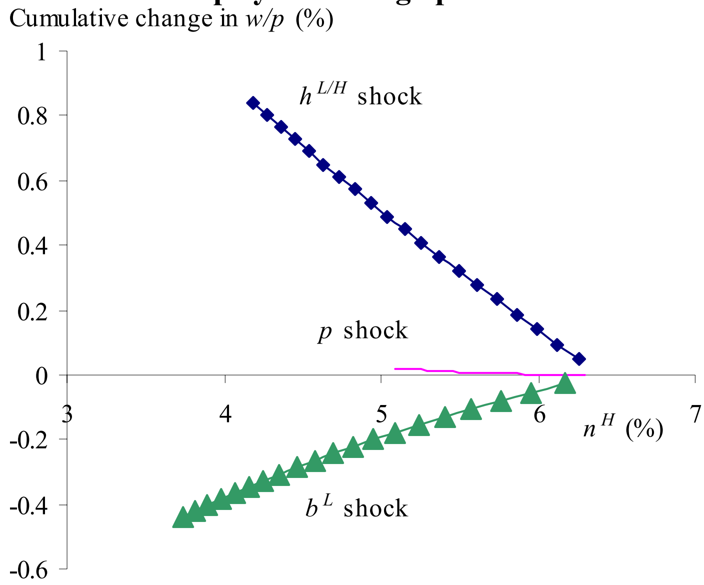


Chart 4.2 plots a sequence of the long-run unemployment rate/wage pressure outcomes following three different types of shock.[27] They are not Phillips curves in the usual sense of the word since they are drawn in real space. The top line represents the sequence of long-run unemployment/wage pressure outcomes as the hiring cost is reduced (by means of a hiring subsidy) first by 5%, then by 10% and so on down to zero. The middle line represents the sequence of long-run unemployment rate/wage pressure outcomes as productivity rises first by 0.25%, then by 0.50% and so on up to 5.00%. Finally, the bottom line represents the sequence of long-run unemployment rate/wage pressure outcomes as state benefits to the inactive are reduced first by 2.5%, then by 5.0% and so on up to 50.0%.[28]

Chart 4.2 indicates that we cannot look at the recent movements in the actual unemployment and inactivity rates apparent in Chart 4.1, and draw reliable inferences on ensuing changes in wage pressure. A more reliable approach, and one that we follow here, is to concentrate instead on finding some combination of plausible shocks that could account for the 3.1 percentage point reduction in $n^H$ and the 0.7 percentage point reduction in $n^L$, that took place during the period 1994 to 2000. Of course, it is (nearly) always possible to generate a 3.1 percentage point reduction in $n^H$ and a 0.7 percentage point reduction in $n^L$ by shocking just two parameters in the model.[29] Moreover, once the two parameters that are to be shocked have been chosen, then the

(27) More precisely, we plot the new steady-state *H*-type non-employment rate, against the percentage difference between the new steady-state and the old steady-state aggregate productivity-adjusted wage rates.
(28) One interpretation of Chart 4.2 is that demand shocks lead to a negative relationship between wage pressure and unemployment while supply shocks lead to a positive relationship.
(29) Strictly, it is not always possible because some parameters may be constrained (for example, the two search effort parameters are bounded by 0 and 1).

shocks to those parameters are uniquely determined. That is to say, if we hypothesised that the 3.1 percentage point reduction in $n^H$ and the 0.7 percentage point reduction in $n^L$ were explained solely by variations in state benefits (ie solely by variations in $b^H$ and $b^L$), then we could solve for that unique change in $b^L$ and that unique change in $b^H$ that would deliver these reductions in $n^H$ and $n^L$.[30]

With 18 exogenous parameters, there are up to 153 different shock pairings that could have caused the observed movements in $n^H$ and $n^L$.[31] In order to narrow the search somewhat, we focus on just 7 of the 18 ($\phi^L$, $b^L$, $b^H$, $f^L$, $f^H$, $h^L$ and $h^H$). Our justification for taking this approach is simply that, with the exception of $\phi^L$ (which measures the fraction of *L*-types in the population), these are the main policy parameters in the model. Moreover, to simplify things further, we assume that any change in hiring or firing costs affects *H* and *L*-types equally. That means we are left with just ten possible shock pairings. These shock pairings, together with the size of each shock necessary to cause the observed reductions in $n^H$ and $n^L$, are presented in Table 4.1.

**Table 4.1**
**Shocks that could have generated the falls in $n^H$ and $n^L$ observed during the period 1994–2000**

| Shock pairing | | Adjustment necessary to generate observed falls in $n^H$ and $n^L$ | Implications for[(a)]: *v* | *w/p* |
|---|---|---|---|---|
| **$\phi^L$, $b^H$** | | **$\phi^L$ ↑ 9.4%, $b^H$ ↓ 40.9%** | **↑ 25.0%** | **↓ 0.3%** |
| $\phi^L$, $b^L$ | | $\phi^L$ ↑ 60.6%, $b^L$ ↓ 62.0% | ↑ 18.8% | ↓ 0.2% |
| $\phi^L$, $f^{L/H}$ | ✗ | $\phi^L$ ↑ 40.6%, $f^{L/H}$ ↓ 124.7% | ↑ 18.8% | ↑ 4.5% |
| $\phi^L$, $h^{L/H}$ | | $\phi^L$ ↑ 29.4%, $h^{L/H}$ ↓ 83.6% | ↑ 43.4% | ↑ 0.8% |
| $b^H$, $b^L$ | | $b^H$ ↓ 47.5%, $b^L$ ↑ 10.7% | ↑ 25.0% | ↓ 1.4% |
| $b^H$, $f^{L/H}$ | | $b^H$ ↓ 52.9%, $f^{L/H}$ ↑ 38.0% | ↑ 25.0% | ↓ 2.8% |
| $b^H$, $h^{L/H}$ | | $b^H$ ↓ 77.3%, $h^{L/H}$ ↓ 100.0%, | ↑ 12.5% | ↓ 2.5% |
| $b^L$, $f^{L/H}$ | ✗ | $b^L$ ↑ 105.8%, $f^{L/H}$ ↓ 327.0% | ↑ 25.0% | ↑ 10.9% |
| $b^L$, $h^{L/H}$ | | $b^L$ ↑ 28.9%, $h^{L/H}$ ↓ 128.8% | ↑ 68.75% | ↑ 0.5% |
| $f^{L/H}$, $h^{L/H}$ | | N/A | N/A | N/A |

(a) Over the period 1994 to 2000, the stock of vacancies at job centres more than doubled, while the labour share rose by around 3%.

The table should be read as follows. If one takes the view that the falls in $n^H$ and $n^L$ observed during the period 1994–2000 were due entirely to changes in state benefits then, looking at the fifth row, unemployment benefits would need almost to have halved while inactive benefits would need to have risen by more than 10%. Reading across to the final two columns we see

[30] An alternative procedure might be to calibrate the model to match the 1994 non-employment rates of both groups and the extent to which changes in all the parameters can account movements in $n^H$ and $n^L$ over 1994-2000. This alternative is ruled out by the fact that we do not have good measures of how several of the parameters have actually evolved over the period.
[31] Calculated as 18!/(16!2!) = 153.

that, if these shocks had occurred, vacancies should have risen by one quarter while the labour share should have fallen slightly. The model would not solve for the final shock pairing. Intuitively, if we impose the restrictions $f^H = f^L$ and $h^H = h^L$, then there is no combination of (common) shocks to *H*-type and *L*-type hiring and firing costs that would deliver such a markedly different response from *H*-type and *L*-type non-employment.

We can rule out some of the shock pairings in Table 4.1 on the grounds that the magnitude of the implied shocks is implausible. For example, if one takes the view that the falls in $n^H$ and $n^L$ were due to a combination of a change in $\phi^L$ and a change in $f^{L/H}$, or that they were due to a change in $b^L$ and a change in $f^{L/H}$, then firing costs would have to fall so much that they turned negative. In other words, the government would be granting a firing subsidy. These pairings are marked with an '✗' in the second column.

The most intuitively appealing pairing involves a negative shock to $b^H$ and a positive shock to $\phi^L$.[32] This pairing, which appears in bold in Table 4.1, also leads to a rise in vacancies and an easing of wage pressure. Although the real value of unemployment benefits has not changed much since the mid-1990s (Nickell and van Ours (2000)), there have been steps to tighten eligibility which helps to reduce the value of being unemployed relative to working. Elements of this increased strictness include the introduction of the Jobseeker's Allowance (JSA) in 1996 which replaced unemployment benefit and income support for the unemployed. JSA tightened eligibility partly by requiring recipients to sign a 'jobseeker's agreement' detailing the steps that the claimant will take in order to find work. This agreement is assessed fortnightly. If the claimant cannot prove that all reasonable steps have been taken to satisfy the agreement, or refuses to accept a reasonable offer of work, then JSA payments can be terminated. The introduction of various welfare-to-work schemes since the late 1990s, such as the New Deal for Young People (NDYP) in 1998, has also made it much harder for the unemployed to receive benefits indefinitely. For example, under the NDYP 18-24 year olds who have been continuously claiming unemployment benefit for six months are required to enter a Gateway program for up to four months, during which they are offered intensive job finding assistance.[33] Those who have not found work by this period are then offered options including subsidised employment and full-time education/training. However, they cannot return to receiving unemployment benefits. We can expect the NDYP to put downward pressure on real wages by reducing the incidence of long-term unemployment, and encouraging job creation. Similar schemes aimed at other target groups, including lone parents, were also introduced in the late 1990s but were initially voluntary.

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(32) On the face of it, the pair of shocks involving a decline $b^H$ and a rise in $b^L$ also seems plausible. However the real level of benefits available to inactive $b^L$ is unlikely to have risen since 1994. Apart from the changes to student maintenance, the disability benefit regime was sharply tightened in 1995.

(33) Blundell, Dias, Meghir and Van Reenen (2001) find that the New Deal for Young People has raised the unemployment-to-employment transition rates for males by around 20%. There is no significant effect for females who comprise around one quarter of the program participants. Riley and Young (2001) provide evidence that the NDYP has reduced wage pressure.

There are also grounds for believing that $\phi^L$, the proportion of the working-age population who are *L*-types, has risen. *L*-types are principally individuals who place a relatively high value on leisure/home production. One factor likely to influence $\phi^L$ is the number of full-time students of working age, which has risen by around 490,000 since 1994 from 7% of the working-age population to 8%. According to the model, a rise in the student share could be expected to moderate the upward pressure on search effort arising from a decline in $b^H$. However, any moderating effect may have been partly offset by the decreasing availability of student grants over the period may have simultaneously encouraged students to look harder for work, especially part-time jobs.[(34)] According to the Labour Force Survey, the share of part-time employees who were still in education rose from 10% in 1984 to 13% in 2000.

The preferred shocks that generate a 3.1 percentage point reduction in the unemployment rate, coupled with a 0.7 percentage point reduction in the inactivity rate, imply a small decrease in wage pressure. But the actual labour share rose (by around 3%) during the period under consideration. One way to address this might be to consider the possibility that more than two types of shock occurred. For example, it seems plausible that recent government incentives have lowered hiring costs. Other things equal, our model predicts that this would put upward pressure on the labour share.

As a sensitivity check on the findings, we conducted an alternative set of simulations where the quarterly firing costs ($f^L$ ,$f^H$ ) were reduced from one unit of output to one-half of one unit. Consequently we set $f^L = f^H = 0.5$. One reason for this reduction is that the parameters used to generate our benchmark values of firing costs in Table 3.1 are based on data from the 1970s and 1980s.[(35)] But the unionised share of the workforce, which is likely to be positively related to the probability that a dismissal is appealed to the courts, has fallen over the 1990s.[(36)] In any case, the finding that shocks to $\phi^L$ and $b^H$, provide the most plausible explanations for the falls in unemployment and inactivity over 1994-2000 continues to hold. However, the movements in both parameters are now more muted. For example, $b^H$ is now required to fall by 28.1% and $\phi^L$ to rise by 5.3% (the shifts in Table 4.1 are -47.5% and +10.7% respectively). One possible explanation for these lower responses is that lower firing costs mean a higher equilibrium rate of job creation so that benefits and the *L*-type share do not have to change as much to achieve a given change in unemployment and inactivity.

We also assumed that *L*-type non-employed receive no state benefits ($b^L = 0$). This immediately rules out an investigation into the effects of changing benefits to non-employed *L* and *H*-types. However, shocks to $\phi^L$ and $b^H$ continue to provide the most plausible explanations for the falls in

(34) For example, since 1998 new entrants into full-time education have generally been expected to contribute around £1,000 towards tuition costs. Between 1991 and 1998 the average student grant fell from around £1,500 to £1,200 per year.
(35) See Bentolila and Bertola (1990).
(36) This share fell from 36% in 1992 to 30% in 1998 (Wadhwani (2000)).

unemployment and inactivity over 1994-2000. In this case, $\phi^L$ rises by 1.3%, and $b^H$ declines by 40.1%.[37]

## 5. Conclusions

Since the mid-1990s, the proportion of unemployed people among the UK working-age population has fallen, while the proportion of inactive people has remained broadly constant. This poses some important questions for policy-makers. Does the reduction in the pool of unemployed people mean that the labour market has necessarily tightened, putting upward pressure on wages, as most macroeconometric models of the UK economy would tell us? Or will any upward pressure on wages be moderated by the stock of inactive people, which is considerably larger than it would normally be at this point in the economic cycle?

In an attempt to shed some light on these issues, we have built and calibrated a theoretical model of the labour market that includes a role for the inactive. Specifically, we have extended the model of variable search intensity described in Chapter 5 of Pissarides (2000) to include two types of non-employed individual: *H*-types and *L*-types. *H*-types (who represent the unemployed) and *L*-types (who represent the inactive) differ only in the value that they attach to leisure time/home production. The *H*-types have a lower value of leisure time/home production than the *L*-types which means that they have a lower reservation wage, choose to search harder for work, and therefore enter employment more readily.

A key feature of our model is that the wage rates available to each type are interdependent. Among other things, that means that if *L*-types are encouraged to search harder by a reduction in state benefits, such as student grants, then that will have implications for the wage rate open to *H*-types, and hence for the steady-state non-employment rate of *H*-types.

One important result is that, in our model, it is impossible to write down a single reduced-form relationship linking either the unemployment rate or the inactivity rate (or some combination of the two) to wage pressure. That is because the relationship depends on the source of the shock that has caused either the unemployment rate or the inactivity rate to move. Consequently, it is not possible to look at a plot of unemployment and inactivity and then draw unambiguous conclusions about the implications for wage pressure.

We then conducted the following exercise. First, we selected a subset of the 18 parameters in our model that, by and large, could have been affected by changes in government policy. Second, we took all possible pairings of this subset of the parameters and calculated the size of the shock to

(37) In an earlier draft of the paper we carried out these simulations in a simpler model without hiring and firing costs. This rules out an analysis of the 7 of the 10 shock pairings shown in Table 4.1 that assess the impacts of changes in hiring and/or firing costs. This framework produced similar results for the shock pairings ($\phi^L$), ($b^H$) and ($\phi^L$), ($b^L$) to those in the first two rows of Table 4.1. The model would not solve for the ($b^H$), ($b^L$) pairing.

each parameter in each pair that would have been necessary to generate the movements in the unemployment rate and the inactivity rate observed since the mid-1990s. Some of the shock pairings were then ruled out on grounds of plausibility. For example, if one hypothesised that the only two shocks were to inactive benefits and firing costs, then the government would need to be offering a substantial firing subsidy in order to generate the observed reductions in unemployment and inactivity. The most intuitively appealing pairing involved a 40% reduction in unemployment benefits, coupled with a 10% increase in the fraction of *L*-types in the population. The decline in unemployed benefits could reflect the introduction of the Jobseeker's Allowance in 1996 and the New Deal for Young People in 1998. The rise in the share of those who place a relatively high value on leisure time / home production could reflect the increase of almost 500,000 in the number of full-time students over the period.

In terms of further work, the model could be extended to include a role for the capital stock. Currently, the implied steady-state labour shares look too high. This is because we are not accounting for the amount that firms have to spend on financing the capital stock and on depreciation.

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