State dependence, duration dependence and unobserved heterogeneity in the employment transitions of the over-50s

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ABSTRACT

This paper examines employment transitions among men and women in the UK aged between 50 and the state pension age. We begin by examining the issue of duration dependence, using standard duration models. We then use a fourth order Markov model to estimate quarterly transitions while allowing for potential endogeneity of initial conditions. The results reject exogeneity of initial conditions and show the importance of both duration dependence and state dependence. This implies there is the potential for any individual to become trapped in non-employment and, ideally, policy should intervene as soon as an individual begins a period of non-employment.

JEL Classification: J14, J21, J64
Keywords: Labour market participation, Transitions, Over-50s

NON-TECHNICAL SUMMARY

In common with many developed countries, the population of the UK is ageing. By 2020, it is expected that a third of the population will be over the age of 50. The increased pressure that an older population places on the workforce means that there is growing policy interest in encouraging older individuals to remain in paid employment. This was most recently acknowledged in the UK government's consultation document which announced the policy objective of increasing by one million the number of older workers – that is, those aged 50 or over – in employment. Similar concerns are shared across OECD countries

In this paper we study the employment behaviour of older workers by modelling employment transitions of men and women in the UK aged between 50 and the state pension age. We do this using two related empirical approaches that allow making a comprehensive characterisation of the employment transitions. The results we find provide a number of interesting insights. These include: First, the type of labour market state that older workers had occupied previously and the length of time they had spent in that state have important bearing on whether older workers transit into employment. Second, there are marked differences between men and women in the patterns of employment transitions observed. For women, being employed in the previous quarter affected the probability of current employment while for men, employment in the previous four quarters was important.

Our findings mean that there is the potential for any individual experiencing a period of out of work to become trapped in non-employment. This may be for a number of reasons such as skill deterioration, reduced morale or the establishment of a pattern of daily life that does not accommodate paid work. The appropriate policy response to curtail the possibility that older workers become trapped in non-employment seems helping individuals avoid experiencing a period of non-employment and, for those who do find themselves out of work, intervening early on to help them find new employment without much delay.

I. Introduction

In common with many developed countries, the population of the UK is ageing. By 2020, it is expected that a third of the population will be over the age of 50 (Dean, 2003). The increased pressure that an older population places on the workforce means that there is growing policy interest in encouraging older individuals to remain in paid employment. This was most recently acknowledged in the UK government's consultation document (DWP, 2006) which announced the policy objective of increasing by one million the number of older workers – that is, those aged 50 or over – in employment. Similar concerns are shared across OECD countries (OECD 2006).

Such an ambitious target highlights the need to understand the nature of the employment decision for older individuals. This is subject to a number of rather specific influences that distinguish it from the employment decision for prime-age workers. Most obviously, older workers may face the decision of whether to retire. They are also more likely to be influenced by health considerations. Meghir and Whitehouse (1997) and Blundell et al. (2002) both showed the important influence of economic incentives on retirement decisions in the UK. More recently, Haardt (2006) used longitudinal data in Britain to show that earnings capacity has little effect on the decision to retire but benefit level is a strong predictor. Haardt (2006) also found that (self-reported) health is correlated with employment decisions and Disney et al. (2006) showed that the importance of health to employment decisions remains after allowing for the possibility that self-reported health may be endogenous.

The analysis in this paper focuses on a different aspect of the employment transitions of older workers. We explore the extent to which the probability of being employed at a point in time depends on employment status at an earlier point in time and also whether the length of time spent in that earlier employment state is important. That is, we focus

explicitly on the related issues of state dependence and duration dependence. We do this by using data from the UK Longitudinal Labour Force Survey and pursuing two alternative and interrelated modelling approaches: survival analysis and (high order) Markovian models of transitions across labour market states. The first approach makes use of the retrospective information on spell duration available in the data to model the probability of spell exhaustion as a function of spell duration, providing estimates of duration dependence. The second approach models transitions by following individuals across labour market states over the five quarters for which they are observed in the data, enabling an assessment of state dependence and its accumulation over quarters.

The importance of these issues to understanding the underlying processes governing the observed persistence in labour market states is clear. Under state dependence, or 'scarring', previous labour market status has a causal effect on later labour market status. For example, it may be that the experience of non-employment may by itself reduce the probability of later working (or searching for work). It is equally possible that state dependence can operate in a virtuous manner; having been employed in the past may increase the chances of being employed later. Under duration dependence, it is the length of time in a particular state that influences the probability of changing state. For example, it may be the case that a short period of non-employment has no adverse consequences on being employed subsequently but a prolonged period of non-employment has a negative impact. Again, it is straightforward to think of a more positive counter-example whereby duration dependence acts to increase attachment to the labour market. Arulampalam et al. (2000) provide a brief discussion of the possible causes of state dependence. It may be that the experience of a state alters preferences or constraints in such a way that later employment is affected. Another possibility is that employers use periods of non-employment as a signal of low productivity. Alternatively, human capital deterioration

during non-employment may reduce the probability of finding work. To the extent that these factors reinforce their effectiveness with unemployment spell duration, we may see them also as determinants of duration dependence.

The existence of state dependence or duration dependence fundamentally alters interpretation of the determinants of employment. Most obviously, it requires that labour market status be viewed, at least partly, as the outcome of a dynamic rather than static process. Appropriate policy interventions to encourage labour market participation have to be developed accordingly. In the presence of state dependence, interventions should aim to prevent the occurrence of an adverse state. In the presence of duration dependence, it would be important to focus help as soon as possible on those entering an adverse state.

The econometric challenge in examining these dynamic issues is to control for the effect of unobserved heterogeneity. If an individual has a fixed (or long-term) characteristic that influences the probability of employment, not controlling for that characteristic will result in biased estimates of state or duration dependence. A related issue is the so-called 'initial conditions problem' which arises when the starting point of the process governing outcomes is not observed. In this case, it is not possible to observe whether the employment status of the individual when first observed (the initial condition) is the result of state dependence or unobserved heterogeneity. The models developed in this paper control for unobserved heterogeneity and the initial conditions issue.

The remainder of this paper is organised as follows. In the next section, the data are described. Section 3 describes the two modelling approaches, the results of which are presented in section 4. Section 5 offers some conclusions.

II. The data

The analysis in this paper is based on the UK Labour Force Survey (LFS). The LFS is a quarterly survey of 60,000 households in the UK with a focus on those characteristics related to the labour market. It is carried out as a rotating panel with one-fifth of the respondents being replaced each quarter. Hence, each (fully-participating) household is interviewed five times over a period spanning 12 months. All adult household members at a given address are interviewed. The Longitudinal LFS (LLFS) links the quarterly surveys in the LFS so that it becomes possible to observe changes over time for households, families and individuals. The data used in this analysis include only those households who respond to interviews in all five quarters – a balanced panel.[1]

To maximise the estimation sample size, the dataset has been built by combining as many LLFSs as possible such that there is no overlap in the periods of time covered by any of the LLFSs.[2] The final dataset used LLFSs from Summer 1993 – Summer 1994 up until Summer 2003-Summer 2004. To identify the required sample, only those individuals aged 50 or over but under state pension age were chosen. In the UK, the state pension age is currently 65 for men and 60 for women so this means that the sample is composed of men who were aged 50-64 when first observed and women who were aged 50-59 when first observed. The number of observations available for analysis in the resulting dataset was 25,664.

Figure 1 below uses these data to show the change in the employment rate over the period 1993-2003 for men and women aged 50 or over but less than the state pension age. It is clear that over the period there has been an increase in the employment rate for both men and women. The increase for women is especially noticeable.

[1] The sample is provided with weights that address the issue of non-response and attrition in the data; these weights are applied in all the analyses in this paper.

[2] Overlaps were avoided in order to prevent double-counting of individuals and complicating the survey weights.

<FIGURE 1>

Table 1 describes the economic status of individuals when first interviewed. To concentrate on the main groups, only those accounting for at least a half of one per cent of cases are included in the Table. It can be seen that about half the men and slightly more of the women were employed when first interviewed. Self-employment is much more common among men than women with the result that overall about two-thirds of men and slightly fewer women can be viewed as working. Unemployment is low in this population. More significant is economic inactivity; this accounts for about 28 per cent of men and 35 per cent of women.[3]

<TABLE 1>

Inactive people who would like to work are less common than those who would not like to work. For the former, the reason for inactivity is health-related in 69 per cent of all cases for men and about half of all cases for women. For inactive individuals who do not want to work, health problems are cited as the reason by 51 per cent of men and 34 per cent of women. However, whereas women often state that they do not want to work since they are looking after the family or the home (this accounts for 35 per cent of inactive women who do not want to work), very few men give this reason. Another important group is made up of those who are retired. Of the sample as a whole, 8 per cent of men and 4 per cent of women are retired. Clearly, these are people who have retired before the state pension age.

[3] Note that the figures in the text do not exactly match those in the Table 1. The reason for this is that the table only presents those categories accounting for at least a half of one per cent of all cases. The sum of these excluded categories fully accounts for the differences between the figures quoted and those apparent from the Table.

Of those not working but who have worked in the 8 years prior to interview, the experience of employment is often distant. Table 2 shows that for nearly half the men and more than 60 per cent of the women their last experience of employment was more than 5 years before the time of interview.

<TABLE 2>

In view of this, it is not surprising that transitions between employment and non-employment are relatively infrequent. Table 3 compares the labour market state at the start of the survey year with that at the end of the survey year. About 9 per cent of employed men and 10 per cent of employed women were not employed one year later. In the other direction, about 6-7 per cent of non-employed men and women were employed a year later.

<TABLE 3>

Further description of the data is given in Table 4, which reports mean values of the characteristics, including spell duration, used in the estimation. The duration information is based on retrospective information on when respondents entered the state they were in at the time of the first interview. We report the mean values separately for men and women according to their employment status when first observed.

<TABLE 4>

III. The econometric models

In this section, the econometric models used for the analysis are presented. We begin with a standard duration model. The purpose of this is to provide an initial insight into the nature of duration dependence in transitions out of (or into) employment, together with an appreciation of the extent to which these transitions are influenced by observed characteristics, having controlled for unobserved heterogeneity. Next, we move to a high-order Markov model for transition probabilities over the five quarters spanned by the LLFS, which will allow us to look at the issue of state dependence and its accumulation over quarters, while accounting for the endogeneity of initial conditions.

3.1 A model of time to exit employment or non-employment

Given the characteristics of the data, and specifically the fact that we do not have information on multiple spells, we assess duration dependence by modelling the time it takes older workers to exit employment or non-employment using a discrete time[4] mixed proportional hazards (MPH) model in a single-spell framework (see van den Berg, 2001). This implies that we identify unobserved heterogeneity within single spells, not across spells. We do not consider endogenous selection into the initial labour market state at this stage, but will tackle the issue using an alternative modeling approach.[5] Given this set-up, the hazard for individual *i* of exiting in period *j* can be written

$$h_{ij}(t_j, \mathrm{x}_i \mid v_i) = 1 - \exp(-\exp(D(j) + \mathrm{x}_i\beta + u_i))$$

[4] Discrete rather than continuous time is a natural choice since the duration variables are measured to the nearest quarter.

[5] See Meghir and Whitehouse (1997) for a model with multiple spells and endogenous starting state.

where $D(j)$ characterises the baseline hazard, v_i is the unobserved heterogeneity term such that $u_i \equiv \log(v_i)$ and x_i is a vector of covariates for individual i. Essentially, this is a model of transitions in which the identity of the departure and arrival labour market states plays no role, while the time it takes to exit from the departure state matters (Lancaster, 1990). This complementary log-log specification results in the discrete time version of the proportional hazards model. We follow the example of numerous empirical analyses and assume that v_i is Gamma-distributed with unit mean and finite variance. This has the advantage of providing a closed form solution for the likelihood function (Lancaster 1990). We mitigate against possible bias arising from the assumption of a Gamma mixing distribution by specifying the baseline hazard flexibly. Han and Hausman (1990) and Seuyoshi (1992) show that this approach can reduce the bias resulting from unobserved heterogeneity.[6]

In writing the likelihood function, it is important to take account of the structure of the data. As described in section 2, individuals in the dataset were observed five times over the course of a year, with each of the observations separated by about 3 months. This means that most individuals are not observed at the start of their spell but instead have already been in their initial state (employment or nonemployment) for some time when first observed. In other words, the spell data are left-truncated ('delayed entry') and the likelihood function has to condition on survival in the initial state up to the time of first entering the dataset. Using standard results (see, for example, Jenkins 2005), the log-likelihood function for individual i can be written

$$\log L_i = \sum_{k=d_i+1}^{j} [y_{ik} \log h_{ik} + (1 - y_{ik}) \log(1 - h_{ik})]$$

where y_{ik} is a binary indicator variable such that y_{ik}=1 if the spell for individual i ends in a transition in period k and y_{ik}=0 otherwise and d_i is the duration of the spell at the time of

[6] An alternative to specifying a distribution for the unobserved heterogeneity term is to approximate the distribution using a number of mass-points (Heckman and Singer, 1984). Attempts to estimate models of this kind encountered convergence problems.

entering the dataset. Since d_i varies across individuals, each individual's contribution to the overall log-likelihood function is estimated for only a portion of that individual's spell. Taking all individuals in the dataset together allows us to characterise the hazard function for the full range of observed durations.

3.2 A fourth-order Markov model of quarterly transition probabilities

As discussed in the Introduction, an alternative way to study employment dynamics is to look at state dependence by means of Markovian models of labour market transitions. In these models, transitions are identified by following individuals' movements over time across a given set of labour market states, assuming that the probability of occupying a certain state at a given point in time depends upon the experience of states in the past. A popular example in this class is provided by dynamic random effects models (see, for example, Arulampalam et al., 2000). Unlike MPH models, models in this class do not consider the impact of duration on transition probabilities, but explicitly model the identities of the states crossed during the transition (Lancaster, 1990).

Many models for labour market transitions used by previous research, such as dynamic random effect probits, have focussed on first order dynamics, i.e. have assumed that the process of interest can be adequately described by looking only at the dependence between labour market states at two adjacent points in time. In this paper we depart from these models and explicitly consider fourth order dynamics. There are three reasons for doing so. First of all, higher order models nest lower order ones, so that estimating fourth order dynamics will enable us to test the first order assumption made by previous studies. Second, given that we use quarterly data, by estimating fourth order dynamics we are able to relate individual labour market states in a given quarter to states observed as far back as the same quarter of the previous year, so that we are able to fully model within-year dynamics.

Finally, the fourth order approach enables us to derive measures of cumulated state dependence, generating an intermediate measure of dependence between random effect probits (that look at state dependence) and survival analysis (that studies duration dependence).

Models of labour market dynamics face an initial conditions issue, which emerges when the process of interest is serially correlated and its starting values are not available in the data. Due to serial correlation, the unobserved initial condition will be embedded in current and lagged levels of the process investigated. Given that modelling transitions requires conditioning current labour market states upon the past, the unobserved initial condition generates the endogeneity issue discussed in Heckman (1981). Heckman proposed solving the issue by estimating the model of interest jointly with the distribution of the initial sample observation, and to model the latter as a function of pre-sample information and of the individual-specific error component. Recently, Wooldridge (2005) has proposed an alternative solution, in the context of first order models, in which it is the individual-specific error component to be modelled conditional on the first observation. While computationally attractive, the Wooldridge approach assumes that dynamics are first order. Therefore, we control for initial conditions by applying the Heckman approach to the case of fourth order dynamics.

Let e^*_{it} be the attachment to employment for individual i in quarter t, which depends upon the interaction between labour demand and supply, plus a series of control factors. While e^*_{it} is unobservable, in the data we have information on e_{it}, a dichotomous employment indicator. As customary in this set-up, we assume that the employment event occurs when the latent propensity is large enough, and we fix the thresholds for employability at 0 without losing generality: $e_{it}=I(e^*_{it}>0)$, where $I(.)$ is an indicator function. Since we are interested in within-year transitions, we specify a model for employment

transitions conditional on exogenous regressors x_{it} (that proxy for the potential and reservation wage, plus all other relevant shifters) and on indicators of labour market states occupied in the four preceding quarters:

$$e^*_{it} = \beta' x_{it} + \lambda_1 e_{it-1} + \lambda_2 e_{it-2} + \lambda_3 e_{it-3} + \lambda_4 e_{it-4} + \varepsilon_{it}$$

The error term ε_{it} represents the convolution of all unobservable heterogeneity (either individual-specific or purely volatile) that may influence employment, and is assumed to be independent from x_{it}. The problem of initial conditions emerges if ε_{it} is not independent of the indicators of past labour market states. Since such indicators may themselves be a function of individual specific attributes, independence of ε_{it} will in general be violated, inducing an endogeneity issue. The solution proposed by Heckman (in the case of first order models) consists of estimating the transition equation and the process determining lagged states jointly. Here we extend it to fourth order dynamics. We assume that past states are determined according to the following rule:

$$e^*_{it-s} = \gamma_s' z_{it-s} + u_{it-s} \quad s=1,2,3,4$$

$$e_{it-s} = \mathrm{I}(e^*_{it-s} > 0)$$

and control for the initial conditions issue by letting the unobserved component of these equations freely correlate with unobserved heterogeneity in the transition equation with correlation coefficient ρ_s. In addition, we also allow for free cross-process correlations in the equations for lagged states, with correlation coefficients σ_{hk}, $k<h=3,4,5$.

By making distributional assumptions about the unobserved components of the model, the sample likelihood can be derived and the parameter of interest estimated. Specifically,

we assume that the vector of errors (ε_{it} u_{it-1} u_{it-2} u_{it-3} u_{it-4}) follows a five-variate normal distribution with zero mean and covariance matrix Ω. The matrix Ω has extra-diagonal elements given by the correlation coefficients defined above, and, given the dichotomous nature of the observed dependent variables, diagonal elements equal to unity. The cross-error correlations control for unobserved heterogeneity in the process governing employment transitions.[7]

As discussed in, for example, Arulampalam et al. (2000), lagged labour market states should be modelled as functions of pre-sample information and information on variables predating labour market entry, such as parental backgrounds. Unfortunately, the LFS does not contain information of the latter type. Therefore we use x_{it-s} to form each of the z_{it-s} vectors. This implies that we are assuming strict exogeneity of the regressors in the transition equation. We also exploit knowledge of the year in which the individual entered the state in which s/he is observed at the first interview date, and complete the z_{it-s} vectors with the national GDP growth rate measured in that year, with the idea that initial labour market states, but not transitions, depend upon the macroeconomic conditions prevailing at the time.[8]

Estimation of transition probabilities enables assessment of the issue of state dependence, i.e. of the variation in the probability of employment induced by differences in employment histories, holding individual heterogeneity constant. To the extent that unobserved heterogeneity has been appropriately controlled for, state dependence provides estimates of the causal impact of past history on current outcomes. The measures of state dependence typically derived from dynamic limited dependent variable models is the 'marginal effect' associated with the lagged dependent variable of interest. Given the fourth

[7] The likelihood function involves fifth order normal integrals, which are computed by simulation, using a GHK simulator with 100 random draws.

[8] Meghir and Whitehouse (1997) use unemployment rates at the time a spell is first observed to instrument initial conditions. While they use contemporaneous unemployment rates in the transition equation, we flexibly control for aggregate economic conditions in the transition equation by means of year and quarter dummies.

order set up of this model, we present four such measures, each given by the marginal effect associated with each indicator of lagged states. In general, these measures will take the following form:

$$SD_j = \Phi(b'x+l_j)-\Phi(b'x),\ j = 1,2,3,4$$

where x contains continuous explanatory variables evaluated at their sample mean, and dummy variables set at zero, b and l are the estimates of β and λ, while Φ represents the standard normal cumulative density function.

If the true model were first order, additional quarters spent in employment should not affect current employment probabilities. This provides the basis for formulating a test for the null hypothesis that the correct order of the Markov chain is the first, i.e. H_0: $\lambda_4= \lambda_3= \lambda_2=0$. More generally, one can also test for higher order autoregression, namely the second (H_0: $\lambda_4= \lambda_3= 0$) and the third (H_0: $\lambda_4= 0$).

Observing dependency with different points in the past also enables us to quantify the accumulation of state dependence as the time spent in a spell of employment increases from zero to four quarters, providing an intermediate dependence concept between state and duration dependence. We define cumulated state dependence as

$$CSD_2 = \Phi\ (b'x +l_1 +l_2)- \Phi\ (b'x)$$

$$CSD_3 = \Phi\ (b'x +l_1 + l_2+ l_3)- \Phi\ (b'x)$$

$$CSD_4 = \Phi\ (b'x +l_1 + l_2+ l_3+ l_4)- \Phi\ (b'x)$$

i.e. as the marginal effects on current participation associated with having been participating for two, three or four consecutive quarters, relative to non participation in the past (note: $CSD_1=SD_1$).

IV. Results

In this section, we begin by presenting the results obtained from the MPH model outlined above. This is with a view to providing an insight into the degree of duration dependence characterising the data. Following this, the results obtained controlling for the endogeneity of initial conditions are presented.

4.1 MPH results

Table 5 presents the coefficient estimates resulting from the MPH models of time to employment entry (for those who were not employed when first observed) and time to employment exit (for those who were employed when first observed). The results are presented separately for men and women.

<TABLE 5>

The first set of estimated coefficients represents the baseline hazard. In all cases, there is evidence of negative duration dependence. That is, the longer an individual remains in the initial state, the smaller the hazard of exiting from the state becomes. This is true for both employment entry and employment exit. It is also true for both men and women. The

estimated baseline hazards over the first 10 years (40 quarters) of a spell for men and women are shown graphically in Figure 2.[9]

<FIGURE 2>

This highlights a number of features. First, as already noted, all spells are characterised by negative duration dependence; the hazards are highest towards the beginning of a spell and mostly decline monotonically thereafter. Second, the degree of duration dependence is much more marked when considering employment entry than when considering employment exit. The results suggest that the hazard of finding work soon after starting a non-employment spell is higher than the hazard of leaving employment soon after starting an employment spell. Over time, the hazards of employment entry and exit converge to some extent, particularly for women. Third, duration dependence appears slightly more marked for men than for women, especially when considering exits from employment.

The results in Table 5 show personal characteristics to also be important. Older men have a smaller hazard of employment entry and a larger hazard of employment exit than their younger counterparts. This is particularly the case shortly before state pension age, reflecting the retirement decision. The role of qualifications is less straightforward to interpret. Level of qualification appears unimportant for women's hazards and also for men's employment exit hazard. This is possibly reflecting the fact that qualifications are less important than experience among older workers. However, the employment entry hazard is higher for men with mid level qualifications than it is for those with no qualifications. Individuals still paying off the mortgage for their accommodation have a higher hazard of employment entry and a lower hazard of employment exit than individuals

[9] These hazard rates are calculated for an individual having observed characteristics represented by the base categories in Table 5. They are not conditional on unobserved heterogeneity. That is, they are averaged over the unobserved heterogeneity distribution.

who own their property outright. This is true for both men and women, perhaps signalling the need to have a job in order to keep up with mortgage repayments. With regard to household composition, the presence of dependent children in the household has no effect on the hazards for men but increases the hazard of employment entry for women (but not the hazard of employment exit for women). This may be explained by the possibility that the children of women in this age group are likely to have reached – or be reaching – an age at which their mothers are able to consider re-entering the workforce following a period of time devoted primarily to childcare. Having a partner does not affect the employment entry hazard for men or women but does reduce the hazard of employment exit for men (but not for women). This may be capturing the increased need to work for those men partnered with non-earning women. It is difficult to discern much pattern in the effects of occupation or industry on employment entry and exit hazards but when considering regional variation there is some evidence of employment entry hazard being lower and employment exit hazards being higher in the northern regions of the country and, for women, also in London. Finally, there is little evidence of consistent (i.e. across men and women) seasonality in the hazards of employment entry or exit for men or women. There is no trend over time in the hazards of employment entry or exit.

At the bottom of Table 5, the estimated unobserved heterogeneity term is presented. This is significant at the 5 per cent level in all the hazards with the exception of the hazard of employment entry for men. The employment exit hazards are characterised by greater (and more significant) unobserved heterogeneity than employment entry hazards. For both types of transitions, unobserved heterogeneity appears more important for women than for men. This perhaps reflects the possibility that the participation decision is relatively straightforward for men while that of women may more often have to take into account other commitments such as child-raising and caring responsibilities. In any event, the test

statistics presented in Table 5 point to the importance of accounting for unobserved heterogeneity.

4.2 Markov model results

The fourth order Markov model laid out in Section 3 has been estimated on the longitudinal component of the LFS for the years 1993-2004, separately for women and men, using the same set of control variables as in the MPH model.

<TABLE 6>

Table 6 reports the estimated covariance structure of unobservables for men and women. Estimated coefficients in the first four lines refer to correlations between unobservables in the transition and initial condition equations. For both men and women, these coefficients are statistically significant at usual confidence levels, implying that initial conditions exogeneity can be rejected. The formal test of exogeneity reported at the bottom of the Table emphatically confirms this. The positive sign of the coefficients means that the unobserved factors that are associated with being in employment at a point in time also play a role in keeping individuals employed over time. One example of such factors could be unobserved labour market attachment. For women, unobserved heterogeneity appears to be more relevant than it is for men, since all the relevant correlations are larger. This evidence is consistent with the MPH results and could be given an analogous interpretation.

The other estimated coefficients in the Table refer to 'reduced form' correlations across initial condition equations. These are larger than the estimates in the top part of the table, since they are unconditional on lagged indicators of labour market states. They appear similar for men and women. Overall, the estimated correlation structure indicates that there

is some heterogeneity that is not captured by the regressors included in the model, justifying the adoption of the multi-equation set-up.

<TABLE 7>

<TABLE 8>

Table 7 reports the estimates of the measures of state dependence defined in the previous section, together with tests for the order of the Markov model. For men, it appears that dynamics are of an order higher than one, since the estimated maximum simulated likelihood coefficients on lagged employment indicators (see Table 8) are all statistically significant at conventional level of confidence, with the exception of the third order lag. This finding is reflected in the estimated measures of state dependence and cumulated state dependence. While the marginal effect associated with the employment indicator lagged one quarter is sizeable (75 per cent) and significant, the other marginal effects on employment dummies lagged two and four quarters significantly shift the probability of current employment, by approximately 6 percent each. As a consequence, there is an accumulation of state dependence over quarters within a year, a pattern that would not be captured by a first order model. Formal tests for the order of the Markov chain cannot reject the null that the process is fourth order at the 5 percent level of confidence.

For women, on the other hand, the tests reported in Table 7 suggest a first-order model is sufficient. What matters for women's current employment is the labour market status of the previous quarter, with no role played by preceding employment history. This suggests that older women's trajectories in the labour market are different relative to those of older men, which appear to be characterised by more dependence on the past. Such an impression is confirmed also by looking at the size of the cumulated state dependence effects: over the

four quarters, the effect for men is almost double that for women; 88 percent vs. 48 percent. As was the case with unobserved heterogeneity, such a result is consistent with the findings from the MPH analysis that duration dependence was larger for men than for women. From the standpoint of economic interpretation, such evidence suggests that the factors that can trigger a virtuous circle of employability, such as human capital accumulation on the job or signalling effects, are less relevant for women, possibly due to the fact that in their case there are more alternatives to labour market participation, which may weaken the positive effects of continuous employment. In turn, this implies that policies that prevent episodes of non-employment, irrespective to some extent of individual attributes, may have a more lasting impact on male labour market trajectories relative to female ones. On the other hand, the prevalence of heterogeneity for women as an explanatory factor for overall persistence, suggests that in their case policies should aim to endow individuals with those attributes that increase employability.

Table 8 reports estimated coefficients for the transition equations of the model. For both men and women there are few factors that significantly influence employment transitions. For men, there are evident age effects, older individuals experiencing a lower likelihood of remaining employed over quarters relative to younger ones. Also, characteristics like the presence of dependent children, the presence of a partner or the type of living arrangements attract significant estimates in the employment transition equation. On the other hand, qualifications do not seem to matter much. Similar remarks apply in the case of women, but here qualifications display more significant effects compared to men.

The Appendix Tables report estimates of the initial condition equations. We can note that here personal attributes retain more explanatory power than they do in the transition equation, reflecting the fact that these equations are unconditional on lagged labour market states. Also, these equations contain indicators of the GDP growth rate at the start of the

spell, i.e. our "instrument" for initial conditions, which is generally significant in explaining the probability of the initial conditions. Formal tests of joint significant of the GDP growth indicators in the initial condition equations reject the null hypothesis at the 0.001% and 10% level of significance for men and women respectively.

V. Summary and conclusions

In this paper we have modelled employment transitions for men and women in the UK aged between 50 and the state pension age. Using two related approaches, we have explored the existence of both duration dependence and state dependence, while addressing the econometrically important issue of endogenous initial conditions.

The results provide a number of interesting insights. From an econometric point of view, the importance of controlling for the endogeneity of initial conditions was evident. Furthermore, the results showed the advantage of allowing for a fourth order Markov model in that the restriction implied by the common approach of working with a first order model was rejected when considering men's transitions. There were also some more substantive findings. First, transitions were characterised by both duration dependence and state dependence. Second, marked differences between men and women were apparent. For women, being employed in the previous quarter affected the probability of current employment while for men, employment in the previous four quarters was important. This translates into duration dependence having a greater influence on employment probability for men than for women. Conversely, unobserved heterogeneity was more important for women than for men.

The combination of state dependence and duration dependence means that there is the potential for any individual experiencing a period of out of work to become trapped in non-employment. This may be for a number of reasons such as skill deterioration, reduced

morale or the establishment of a pattern of daily life that does not accommodate paid work. The appropriate policy response is to help individuals avoid experiencing a period of non-employment and, for those who do find themselves out of work, to intervene early to help them find new employment. This policy response is particularly relevant for men, given the stronger effect of state and duration dependence. For women, the greater importance of unobserved heterogeneity suggests that the appropriate policy to encourage employment would be one which focuses on developing those attributes and skills linked to employability.

Appendix

Appendix Table 1: Initial conditions equations, men

	Employed t -1		Employed t -2		Employed t -3		Employed t -4	
Age category (base: [50-53])								
- (53-56]	-0.150	(5.11)	-0.141	(5.01)	-0.176	(6.21)	-0.201	(6.92)
- (56-60]	-0.427	(13.10)	-0.403	(12.89)	-0.400	(13.02)	-0.447	(13.89)
- (60-63]	-0.786	(22.13)	-0.757	(21.62)	-0.774	(22.50)	-0.793	(22.44)
- (63-65]	-1.024	(23.84)	-0.982	(23.81)	-0.973	(22.66)	-0.861	(19.18)
number of dependent children	0.095	(2.63)	0.089	(2.52)	0.088	(2.53)	0.111	(3.09)
Has partner	0.283	(8.41)	0.265	(8.03)	0.288	(8.77)	0.283	(8.50)
Housing tenure (base: owned outright)								
- mortgaged	0.353	(12.16)	0.378	(13.44)	0.376	(13.63)	0.367	(13.40)
- rented/ rent-free	-0.264	(6.97)	-0.251	(6.68)	-0.260	(7.11)	-0.249	(6.77)
Highest qualification (base: none)								
- nvq5/6	0.062	(1.99)	0.090	(3.17)	0.023	(0.78)	0.069	(2.32)
- nvq4	0.083	(2.13)	0.064	(1.80)	0.054	(1.50)	0.053	(1.33)
- nvq3	0.089	(3.11)	0.112	(4.07)	0.097	(3.68)	0.097	(3.42)
- nvq1/2	-0.010	(0.21)	0.032	(0.68)	0.074	(1.60)	0.068	(1.41)
- other	-0.197	(4.80)	-0.186	(4.77)	-0.126	(3.26)	-0.125	(2.98)
Region (base: SE excl. London)								
- North	-0.524	(8.94)	-0.548	(9.44)	-0.550	(9.74)	-0.524	(9.17)
- Yorkshire & Humberside	-0.355	(7.33)	-0.341	(7.08)	-0.331	(6.89)	-0.306	(6.28)
- East Midlands	-0.141	(2.63)	-0.111	(2.08)	-0.137	(2.54)	-0.133	(2.42)
- East Anglia	-0.064	(0.92)	-0.065	(0.95)	-0.033	(0.49)	-0.069	(1.02)
- London	-0.171	(3.24)	-0.152	(2.94)	-0.188	(3.64)	-0.204	(3.95)
- South West	-0.088	(1.72)	-0.091	(1.82)	-0.112	(2.21)	-0.086	(1.72)
- West Midlands	-0.100	(2.01)	-0.102	(2.06)	-0.146	(2.97)	-0.139	(2.79)
- North West	-0.375	(7.92)	-0.379	(8.09)	-0.427	(9.12)	-0.392	(8.21)
- Wales	-0.442	(7.35)	-0.448	(7.64)	-0.469	(7.54)	-0.427	(6.88)
- Scotland	-0.313	(6.39)	-0.291	(6.11)	-0.308	(6.39)	-0.295	(6.05)
- Northern Ireland	-0.364	(4.44)	-0.364	(4.55)	-0.350	(4.34)	-0.292	(3.55)
Industry (base: manufacturing)								
- primary	0.339	(4.67)	0.294	(4.12)	0.292	(3.88)	0.219	(2.78)
- energy	-0.504	(5.51)	-0.381	(4.55)	-0.344	(3.88)	-0.348	(3.82)
- construction	0.118	(2.87)	0.105	(2.53)	0.100	(2.35)	0.085	(1.89)
- wholesale, retail & motor trade	0.249	(5.43)	0.230	(5.14)	0.233	(4.88)	0.291	(5.94)
- hotels & restaurants	0.056	(0.69)	0.067	(0.89)	0.107	(1.30)	0.052	(0.62)
- transport, storage & communication	0.019	(0.41)	-0.024	(0.51)	-0.002	(0.04)	0.055	(1.10)
- financial intermediation	-0.284	(3.20)	-0.297	(3.73)	-0.344	(4.27)	-0.305	(3.72)
- real estate, renting & business activities	0.339	(7.15)	0.311	(6.84)	0.328	(6.41)	0.412	(7.41)
- public administration & defence	-0.052	(0.77)	-0.118	(1.93)	-0.137	(2.20)	-0.086	(1.36)
- education	0.152	(2.43)	0.116	(1.90)	0.099	(1.53)	0.149	(2.01)
- health & social work	0.269	(4.05)	0.252	(3.82)	0.331	(4.80)	0.341	(4.68)
- other	-0.473	(8.22)	-0.484	(8.53)	-0.540	(9.63)	-0.596	(11.17)
Occupation (base: manager/admin.)								
- professional	0.212	(4.01)	0.196	(3.73)	0.164	(3.03)	0.131	(2.46)
- associated, professional & technical	0.204	(3.88)	0.156	(3.21)	0.176	(3.50)	0.138	(2.61)
- clerical, secretarial	0.165	(3.00)	0.174	(3.11)	0.192	(3.49)	0.153	(2.57)

- craft and related	0.069	(1.63)	0.043	(1.04)	0.038	(0.91)	0.084	(2.03)
- personal, protective	0.105	(1.63)	0.103	(1.65)	0.127	(2.06)	0.136	(2.12)
- sales	0.197	(2.77)	0.120	(1.65)	0.163	(2.16)	0.176	(2.56)
- plant and machine operatives	0.098	(2.21)	0.082	(1.87)	0.114	(2.59)	0.113	(2.52)
- other	-0.174	(3.45)	-0.191	(4.03)	-0.166	(3.55)	-0.194	(4.15)
Calendar year (base: 1993)								
- 1994	-0.166	(3.19)	-0.164	(3.11)	-0.535	(6.41)	-0.599	(7.70)
- 1995	-0.043	(0.73)	-0.030	(0.53)	-0.653	(7.54)	-0.555	(6.09)
- 1996	-0.060	(0.90)	0.003	(0.05)	-0.649	(7.85)	-0.738	(8.48)
- 1997	-0.017	(0.23)	0.062	(1.12)	-0.561	(7.86)	-0.709	(10.03)
- 1998	-0.168	(2.57)	0.144	(2.46)	-0.468	(6.63)	-0.596	(8.76)
- 1999	-0.028	(0.52)	-0.067	(1.25)	-0.483	(6.02)	-0.563	(7.24)
- 2000	-0.018	(0.31)	-0.025	(0.45)	-0.617	(7.20)	-0.570	(5.99)
- 2001	0.064	(0.92)	0.118	(1.92)	-0.517	(6.16)	-0.652	(7.58)
- 2002	0.078	(1.05)	0.197	(3.49)	-0.453	(6.07)	-0.590	(8.01)
-2003	-0.020	(0.31)	0.277	(4.97)	-0.424	(6.22)	-0.533	(7.98)
Calendar quarter (base: Oct-Dec)								
- Q1: Jan-Mar	0.078	(1.14)	0.161	(2.85)	0.071	(1.02)	0.148	(1.98)
- Q2: Apr-Jun	0.043	(0.69)	0.042	(0.72)	0.050	(0.82)	0.101	(1.61)
- Q3: Jul-Sep	-0.046	(0.95)	0.040	(0.85)	0.029	(0.68)	0.053	(1.07)
GDP growth at spell start	1.169	(2.60)	1.576	(3.91)	2.344	(5.70)	3.561	(8.88)
Constant	0.579	(6.35)	0.453	(6.10)	1.057	(11.32)	1.097	(10.52)
Wald test of joint significance of GDP indicator in all initial conditions equations		d.o.f.=4		χ^2=80.17		p-value=	0.0000	

Appendix Table2: Initial conditions equations, women

	Employed t -1		Employed t -2		Employed t -3		Employed t -4	
Age category (base: [50-53])								
- (53-56]	-0.114	(3.96)	-0.150	(5.31)	-0.135	(4.64)	-0.154	(5.23)
- (56-60]	-0.338	(10.48)	-0.354	(11.10)	-0.309	(9.51)	-0.300	(9.18)
number of dependent children	0.024	(0.51)	-0.023	(0.56)	-0.061	(1.54)	-0.022	(0.55)
Has partner	0.017	(0.51)	0.052	(1.60)	0.029	(0.86)	0.047	(1.34)
Housing tenure (base: owned outright)								
- mortgaged	0.263	(8.77)	0.280	(9.61)	0.290	(10.25)	0.241	(8.33)
- rented/ rent-free	-0.209	(4.77)	-0.155	(3.63)	-0.192	(4.31)	-0.232	(5.19)
Highest qualification (base: none)								
- nvq5/6	0.127	(3.61)	0.088	(2.58)	0.109	(3.25)	0.102	(2.58)
- nvq4	0.076	(2.20)	0.051	(1.63)	0.055	(1.68)	0.023	(0.69)
- nvq3	0.052	(1.30)	0.038	(0.98)	0.047	(1.21)	0.040	(0.90)
- nvq1/2	-0.008	(0.15)	-0.012	(0.23)	-0.006	(0.10)	-0.003	(0.06)
- other	-0.372	(7.51)	-0.329	(6.92)	-0.273	(5.33)	-0.209	(2.90)
Region (base: SE excl. London)								
- North	-0.343	(5.24)	-0.324	(5.07)	-0.246	(3.70)	-0.268	(4.08)
- Yorkshire & Humberside	-0.160	(2.83)	-0.121	(2.11)	-0.154	(2.72)	-0.109	(1.92)
- East Midlands	-0.159	(2.60)	-0.175	(2.86)	-0.188	(2.95)	-0.158	(2.48)
- East Anglia	-0.146	(1.92)	-0.088	(1.17)	-0.041	(0.54)	-0.096	(1.25)
- London	-0.148	(2.49)	-0.177	(3.08)	-0.158	(2.69)	-0.116	(1.98)
- South West	-0.067	(1.13)	-0.070	(1.22)	-0.047	(0.81)	-0.051	(0.89)
- West Midlands	-0.123	(2.22)	-0.098	(1.68)	-0.106	(1.87)	-0.099	(1.66)
- North West	-0.258	(4.86)	-0.262	(5.02)	-0.196	(3.74)	-0.188	(3.57)
- Wales	-0.358	(5.11)	-0.426	(6.12)	-0.396	(5.77)	-0.384	(5.65)
- Scotland	-0.199	(3.61)	-0.209	(3.81)	-0.172	(3.11)	-0.134	(2.38)
- Northern Ireland	-0.477	(5.11)	-0.387	(4.38)	-0.368	(4.10)	-0.362	(3.89)
Industry (base: manufacturing)								
- primary	0.596	(3.63)	0.333	(1.73)	0.610	(3.06)	0.474	(2.68)
- energy	-0.675	(2.94)	-0.724	(3.14)	-0.727	(3.16)	-0.552	(2.58)
- construction	0.315	(2.63)	0.316	(2.53)	0.389	(2.89)	0.362	(2.61)
- wholesale, retail & motor trade	0.156	(2.27)	0.142	(2.03)	0.157	(2.18)	0.177	(2.54)
- hotels & restaurants	0.157	(1.87)	0.094	(1.15)	0.277	(3.18)	0.349	(4.04)
- transport, storage & communication	0.067	(0.73)	0.083	(0.93)	0.153	(1.60)	0.183	(1.92)
- financial intermediation	0.037	(0.35)	0.079	(0.75)	0.132	(1.17)	0.185	(1.64)
- real estate, renting & business activities	0.137	(1.82)	0.164	(2.16)	0.224	(2.66)	0.280	(3.39)
- public administration & defence	0.096	(1.10)	0.135	(1.47)	0.210	(2.31)	0.275	(3.05)
- education	0.222	(2.96)	0.168	(2.31)	0.204	(2.44)	0.307	(3.89)
- health & social work	0.276	(3.81)	0.244	(3.44)	0.310	(4.16)	0.339	(4.60)
- other	-0.597	(7.31)	-0.625	(7.51)	-0.602	(7.12)	-0.636	(7.84)
Occupation (base: manager/admin.)								
- professional	-0.025	(0.32)	0.011	(0.14)	-0.009	(0.10)	-0.101	(1.23)
- associated, professional & technical	0.077	(0.96)	0.103	(1.25)	0.097	(1.19)	0.031	(0.40)
- clerical, secretarial	0.069	(1.16)	0.135	(2.18)	0.097	(1.64)	0.011	(0.20)
- craft and related	-0.367	(2.99)	-0.329	(2.48)	-0.234	(1.75)	-0.217	(1.69)
- personal, protective	-0.087	(1.08)	0.001	(0.01)	-0.068	(0.87)	-0.135	(1.80)

- sales	-0.100	(1.29)	-0.058	(0.74)	-0.067	(0.90)	-0.075	(1.00)
- plant and machine operatives	-0.237	(2.34)	-0.140	(1.40)	-0.176	(1.75)	-0.178	(1.80)
- other	-0.608	(8.68)	-0.539	(7.36)	-0.594	(8.63)	-0.665	(9.65)
Calendar year (base: 1993)								
- 1994	-0.219	(3.65)	-0.307	(4.78)	-0.483	(5.29)	-0.577	(6.53)
- 1995	0.040	(0.60)	0.017	(0.26)	-0.632	(6.01)	-0.606	(5.60)
- 1996	0.009	(0.11)	-0.044	(0.60)	-0.697	(7.26)	-0.685	(6.68)
- 1997	0.057	(0.65)	0.031	(0.44)	-0.645	(7.56)	-0.725	(8.09)
- 1998	-0.123	(1.66)	0.020	(0.27)	-0.634	(8.00)	-0.678	(8.69)
- 1999	-0.109	(1.82)	-0.114	(1.81)	-0.457	(4.99)	-0.622	(7.15)
- 2000	0.058	(0.85)	-0.001	(0.02)	-0.747	(7.37)	-0.513	(4.61)
- 2001	0.183	(2.20)	0.115	(1.52)	-0.554	(5.70)	-0.684	(6.62)
- 2002	0.157	(1.82)	0.130	(1.85)	-0.526	(6.16)	-0.612	(6.99)
-2003	-0.031	(0.41)	0.116	(1.51)	-0.447	(5.64)	-0.450	(5.63)
Calendar quarter (base: Oct-Dec)								
- Q1: Jan-Mar	0.223	(2.76)	0.134	(1.89)	0.115	(1.42)	0.143	(1.63)
- Q2: Apr-Jun	0.165	(2.16)	-0.010	(0.15)	0.120	(1.66)	0.117	(1.57)
- Q3: Jul-Sep	0.008	(0.13)	-0.047	(0.87)	0.069	(1.37)	0.062	(1.04)
GDP growth at spell start	-0.402	(0.89)	0.001	(0.03)	-0.048	(0.12)	0.996	(2.07)
Constant	0.588	(5.11)	0.617	(5.72)	1.162	(9.84)	1.227	(9.66)
Wald test of joint significance of GDP indicator in all initial conditions equations		d.o.f.=4		χ^2=7.85		p-value=	0.0973	

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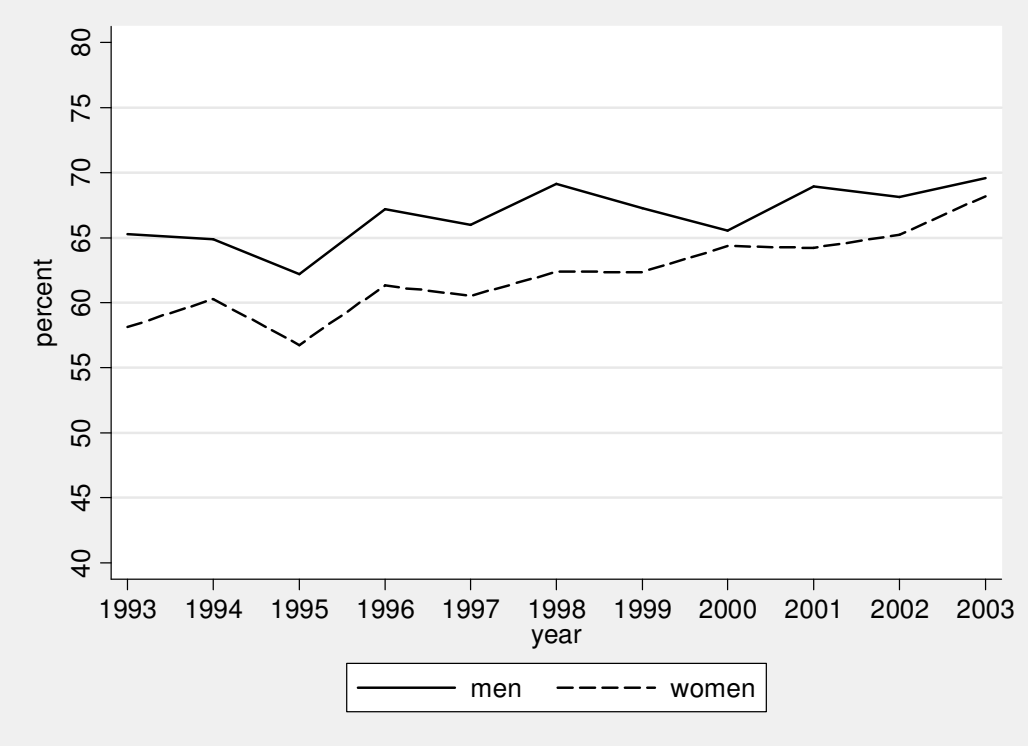
Figure 1: Employment rates among men and women aged between 50 and the state pension age, 1993-2003



Source: Longitudinal Labour Force Survey, 1993-2003

Figure 2: Estimated hazard rates of employment entry and exit over first 10 years (40 quarters) of spell, by sex

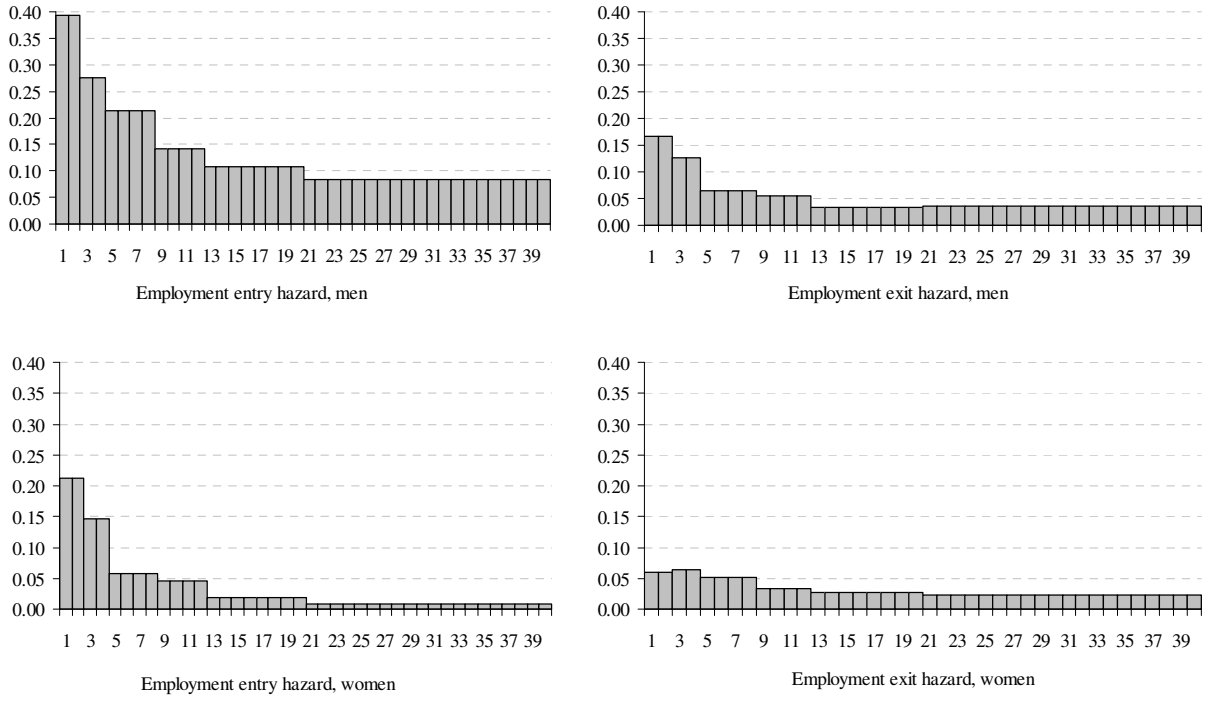


Table 1: Economic status when first observed by sex (col %)

	Men	Women
Employee	51.3	56.5
Self-employed	15.6	5.6
ILO unemployed	4.7	2.9
Inactive, not seeking but would like work		
- looking after family/ home	0.3	1.2
- long term sick or disabled	4.2	2.7
- believes no job available	0.7	0.6
- not looked	0.5	0.5
Inactive, not seeking and would not like work		
- looking after family, home	0.9	10.1
- long-term sick or disabled	10.7	9.4
- not need or want job	1.0	2.9
- retired	7.9	4.4
- other reason	0.5	1.3
Base	14,653	11,011

Note: Column percentages do not sum to 100 since, for presentational purposes, categories accounting for less than 0.5 per cent have not been shown.

Table 2: Length of time out of work for those not working but who have previously worked (col %)

	Men	Women
less than 3 months	2.4	1.5
3 months but less than 6 months	3.5	3.1
6 months but less than 12 months	6.4	5.4
1 year but less than 2 years	12.2	7.7
2 years but less than 3 years	10.1	6.9
3 years but less than 4 years	9.2	7.0
4 years but less than 5 years	7.3	5.7
5 years or more	49.0	62.8
Base	4,634	3,993

Table 3: Transitions between employment and non-employment (row %)

	When last interviewed (one year later):		
When first interviewed:	Employed	Non-employed	Base
Men			
- Employed	91.1	8.9	10,019
- Non-employed	6.6	93.4	4,634
Women			
- Employed	90.2	9.9	7,018
- Non-employed	6.3	93.7	3,993

Table 4: Mean characteristics by sex and employment status when first observed (Col %)

	Men		Women	
	Non-employed	Employed	Non-employed	Employed
Duration of spell, quarters (base: >20)				
- 1-2	5.8	5.2	4.5	4.3
- 3-4	6.3	3.6	5.4	3.8
- 5-8	12.2	6.0	7.7	5.8
- 9-12	10.1	5.3	6.9	5.3
- 13-20	16.5	8.5	12.7	10.2
Age category (base: [50-53])				
- (53-56]	17.2	23.5	31.4	29.7
- (56-60]	27.0	23.2	34.5	21.5
- (60-63]	28.2	12.4	0.0	0.0
- (63-65]	11.4	2.9	0.0	0.0
Highest qualification (base: none)*				
- nvq5/6	12.4	13.0	9.6	11.7
- nvq4	8.1	10.5	18.6	24.8
- nvq3	27.5	32.9	8.0	10.3
- nvq1/2	5.7	7.9	8.0	12.6
- other	9.2	14.6	4.3	8.8
Housing tenure (base: owned outright)				
- mortgaged	22.5	51.8	27.7	50.4
- rented/ rent-free	35.7	15.7	32.5	14.7
no. of dependent children (base: none)	8.3	16.7	10.3	10.5
Partner (base: no partner)	73.6	86.5	73.6	79.4
Occupation (base: manager/admin.)				
- professional	7.1	12.3	4.0	9.6
- associated, professional & technical	5.3	8.5	3.5	10.1
- clerical, secretarial	4.2	5.7	11.1	25.3
- craft and related	14.5	19.8	1.8	2.5
- personal, protective	3.3	4.1	7.9	13.7
- sales	2.0	3.3	6.3	10.0
- plant & machine operatives	12.9	16.0	3.1	4.2
- other	36.8	8.4	57.9	13.4
Industry (base: manufacturing)				
- primary	2.3	3.2	0.6	1.1
- energy	1.9	0.9	0.3	0.2
- construction	7.9	11.0	0.7	1.4
- wholesale, retail & motor trade	5.6	11.1	8.6	15.1
- hotels & restaurants	1.6	1.5	2.7	3.8
- transport, storage & communication	6.6	8.9	1.2	2.6

- financial intermediation	2.6	2.1	1.3	2.9
- real estate, renting & business act.	3.5	10.4	3.2	8.3
- public administration & defence	4.5	5.3	2.5	6.0
- education	3.3	5.7	6.4	14.3
- health & social work	1.9	3.9	9.0	20.5
- other	40.4	14.2	57.4	14.5
Region (base: SE excl. London)				
- North	7.2	4.3	6.2	4.7
- Yorkshire & Humberside	9.6	8.4	8.7	8.5
- East Midlands	6.8	7.7	7.4	7.1
- East Anglia	2.9	4.2	3.7	4.0
- London	11.7	10.3	11.3	10.8
- South West	6.9	9.0	6.9	8.6
- West Midlands	8.8	9.8	9.2	9.4
- North West	12.9	9.5	11.3	10.0
- Wales	6.5	4.3	6.4	4.2
- Scotland	9.9	8.1	9.5	8.3
- Northern Ireland	2.4	1.9	2.7	1.6
Calendar quarter (base: Oct-Dec)				
- Q1: Jan-Mar	22.9	23.1	23.5	23.5
- Q2: Apr-Jun	26.2	27.4	25.9	27.2
- Q3: Jul-Sep	28.2	28.2	28.3	28.2
Calendar year (base: 1993)				
- 1994	10.9	9.9	10.6	9.6
- 1995	4.5	3.6	4.3	3.3
- 1996	6.7	6.8	6.9	6.5
- 1997	11.3	10.7	11.4	10.5
- 1998	10.6	11.6	11.4	11.3
- 1999	11.7	11.8	11.7	11.6
- 2000	4.3	4.0	4.0	4.3
- 2001	7.3	8.0	7.6	8.1
- 2002	11.6	12.1	11.6	13.0
- 2003	11.1	12.4	10.3	13.3
No. of observations (persons)	4,634	10,019	3,993	7,018

* All qualifications are converted to approximate National Vocational Qualification (NVQ) equivalents. The rough academic equivalents are: NVQ1 - low-level qualification, age 16; NVQ2 – qualification, age 16; NVQ3 – qualification, age 18 ; NVQ4 – degree; NVQ5/6 – higher degree.

Table 5: MPH estimates of time to enter or exit employment, by sex.

	Men				Women			
	Employment entry		Employment exit		Employment entry		Employment exit	
Duration of spell, quarters	coeff.	(t-stat)	coeff.	(t-stat)	coeff.	(t-stat)	coeff.	(t-stat)
(base: >20)								
- 1-2	3.55	(16.30)	1.65	(10.05)	3.33	(10.46)	1.05	(4.18)
- 3-4	2.67	(12.24)	1.33	(8.46)	2.92	(9.83)	1.10	(4.98)
- 5-8	2.06	(9.93)	0.64	(4.42)	1.93	(6.54)	0.88	(4.64)
- 9-12	1.12	(4.77)	0.43	(2.78)	1.68	(5.70)	0.41	(2.06)
- 13-20	0.56	(2.42)	-0.04	(0.30)	0.80	(2.91)	0.24	(1.42)
Age category								
(base: [50-53])								
- (53-56]	-0.34	(2.19)	0.003	(0.02)	-0.54	(2.88)	0.25	(2.05)
- (56-60]	-0.67	(4.23)	0.48	(4.42)	-0.89	(4.55)	0.97	(7.25)
- (60-63]	-1.35	(7.24)	1.02	(7.88)				
- (63-65]	-2.23	(7.02)	2.51	(15.38)				
Highest qualification								
(base: none)								
- nvq5/6	0.21	(1.03)	-0.06	(0.44)	0.06	(0.23)	-0.25	(1.46)
- nvq4	0.41	(1.87)	-0.19	(1.22)	0.48	(2.24)	-0.17	(1.11)
- nvq3	0.44	(2.60)	-0.05	(0.43)	0.47	(1.69)	0.06	(0.31)
- nvq1/2	0.36	(1.44)	-0.01	(0.06)	-0.35	(1.03)	0.16	(0.77)
- other	0.42	(1.79)	-0.17	(1.00)	0.12	(0.38)	-0.01	(0.05)
Housing tenure								
(base: owned outright)								
- mortgaged	0.49	(3.68)	-0.37	(4.14)	0.50	(2.75)	-0.49	(4.20)
- rented/ rent-free	-0.05	(0.33)	-0.16	(1.34)	-0.12	(0.57)	-0.21	(1.22)
no. of dep. children (base: none)	0.10	(0.55)	-0.03	(0.23)	0.53	(2.13)	-0.03	(0.16)
Partner (base: no partner)	-0.10	(0.66)	-0.36	(3.16)	0.22	(1.12)	0.06	(0.42)
Occupation								
(base: manager/admin.)								
- professional	0.06	(0.25)	0.04	(0.22)	1.44	(2.74)	0.35	(1.21)
- associated, professional & tech.	0.06	(0.28)	-0.12	(0.74)	0.75	(1.49)	-0.22	(0.84)
- clerical, secretarial	-0.13	(0.47)	0.16	(0.93)	0.33	(0.86)	-0.01	(0.02)
- craft and related	-0.22	(1.06)	0.02	(0.13)	-0.002	(0.00)	1.02	(2.78)
- personal, protective	-0.24	(0.74)	-0.10	(0.45)	0.24	(0.53)	0.20	(0.82)
- sales	0.26	(0.77)	-0.13	(0.54)	-0.52	(1.12)	0.46	(1.79)
- plant & machine operatives	-0.35	(1.53)	-0.01	(0.06)	0.05	(0.10)	0.26	(0.80)
- other	-0.25	(1.04)	0.18	(1.13)	0.12	(0.30)	0.20	(0.86)
Industry (base: manufacturing)								
- primary	0.48	(1.44)	-1.09	(3.98)	-0.47	(0.45)	-1.34	(2.05)
- energy	-1.70	(2.12)	0.65	(1.95)	0.04	(0.04)	3.04	(2.16)
- construction	0.24	(1.12)	-0.19	(1.34)	-0.85	(0.94)	-0.09	(0.18)
- wholesale, retail & motor trade	-0.35	(1.34)	-0.10	(0.68)	-0.003	(0.01)	-0.45	(1.75)
- hotels & restaurants	0.37	(1.05)	0.34	(1.18)	-0.25	(0.48)	0.68	(2.14)
- transport, storage &	-0.22	(0.89)	-0.11	(0.72)	-0.49	(0.70)	-0.03	(0.07)

communication								
- financial intermediation	-0.06	(0.21)	0.39	(1.41)	-0.59	(0.86)	0.02	(0.05)
- real estate, renting & business act.	0.38	(1.51)	-0.15	(0.99)	-0.29	(0.63)	0.09	(0.32)
- public administration & defence	-0.07	(0.28)	0.13	(0.72)	-0.32	(0.60)	-0.31	(1.03)
- education	-0.03	(0.11)	0.04	(0.19)	-0.48	(1.05)	0.02	(0.07)
- health & social work	0.29	(0.80)	-0.09	(0.41)	-0.30	(0.71)	-0.21	(0.84)
- other	0.01	(0.03)	0.05	(0.30)	-0.08	(0.21)	0.25	(0.96)
Region (base: SE excl. London)								
- North	-0.25	(0.96)	0.63	(3.28)	-0.68	(1.70)	0.66	(2.56)
- Yorkshire & Humberside	-0.25	(1.05)	0.38	(2.49)	0.07	(0.23)	0.13	(0.60)
- East Midlands	0.11	(0.45)	0.07	(0.44)	-0.35	(1.07)	0.06	(0.23)
- East Anglia	-0.13	(0.39)	0.04	(0.19)	-0.53	(1.25)	-0.25	(0.86)
- London	0.17	(0.86)	0.01	(0.08)	-0.44	(1.48)	0.57	(2.90)
- South West	-0.03	(0.12)	0.08	(0.51)	0.41	(1.35)	0.28	(1.32)
- West Midlands	-0.12	(0.54)	-0.20	(1.28)	-0.14	(0.48)	0.03	(0.14)
- North West	-0.56	(2.53)	0.124	(0.82)	-0.767	(2.49)	0.236	(1.15)
- Wales	-0.50	(1.60)	0.27	(1.32)	-1.02	(2.44)	0.28	(0.90)
- Scotland	-0.12	(0.52)	0.34	(2.17)	-0.51	(1.62)	0.41	(1.88)
- Northern Ireland	-1.01	(2.05)	0.23	(0.79)	-2.13	(2.34)	0.04	(0.09)
Calendar quarter (base: Oct-Dec)								
- Q1: Jan-Mar	0.26	(1.70)	0.01	(0.16)	0.24	(1.41)	0.17	(1.58)
- Q2: Apr-Jun	0.22	(1.43)	-0.15	(1.72)	-0.29	(1.50)	0.05	(0.48)
- Q3: Jul-Sep	0.30	(1.95)	-0.12	(1.37)	0.26	(1.54)	0.16	(1.55)
Calendar year (base: 1993)								
- 1994	0.25	(0.88)	-0.10	(0.62)	0.44	(1.38)	0.002	(0.01)
- 1995	0.02	(0.06)	-0.01	(0.03)	-0.15	(0.39)	0.11	(0.48)
- 1996	0.55	(1.93)	0.23	(1.39)	0.39	(1.12)	0.73	(3.18)
- 1997	0.36	(1.30)	-0.22	(1.29)	0.76	(2.37)	-0.08	(0.36)
- 1998	0.42	(1.50)	-0.25	(1.49)	0.10	(0.28)	-0.14	(0.62)
- 1999	0.33	(1.14)	-0.08	(0.50)	0.29	(0.86)	0.35	(1.68)
- 2000	0.48	(1.71)	-0.34	(1.92)	0.59	(1.75)	0.06	(0.25)
- 2001	0.53	(1.85)	0.06	(0.34)	0.25	(0.71)	0.01	(0.04)
- 2002	0.29	(1.02)	-0.33	(2.00)	-0.18	(0.50)	-0.28	(1.30)
- 2003	0.62	(2.32)	-0.32	(2.15)	-0.00	(0.00)	-0.03	(0.16)
Constant	-4.97	(11.09)	-3.39	(13.31)	-4.77	(7.54)	-3.82	(10.13)
σ^2	0.68 (1.51)		3.91 (5.85)		4.48 (3.60)		7.65 (8.03)	
LR test statistic of $\sigma^2=0$ ($\sim \chi^2_{(1)}$)	2.9		59.1		27.0		105.6	
Log-likelihood	-1591.71		-5092.15		-1376.08		-3807.19	
Observations	4634		10019		3993		7018	

Absolute value of z statistics in parentheses

Table 6: Correlation structure of unobservables of the fourth order Markov model and tests for exogeneity of initial conditions

	Men		Women	
	coeff.	t-stat	coeff.	t-stat
ρ_1	0.271	(2.32)	0.808	(6.50)
ρ_2	0.314	(2.88)	0.801	(6.57)
ρ_3	0.335	(3.22)	0.773	(6.06)
ρ_4	0.308	(2.87)	0.733	(5.38)
σ_{32}	0.981	(586.68)	0.979	(394.32)
σ_{42}	0.956	(329.01)	0.954	(214.59)
σ_{52}	0.933	(240.15)	0.922	(154.16)
σ_{43}	0.980	(197.05)	0.976	(320.25)
σ_{53}	0.954	(213.78)	0.945	(201.77)
σ_{54}	0.977	(496.33)	0.971	(285.87)
	$\chi^2_{(4)}$	p-value	$\chi^2_{(4)}$	p-value
Wald test of exogenous initial conditions (H_0: $\rho_1=\rho_2=\rho_3=\rho_3$)	28.25	0.0000	118.9	0.0000

Table 7: Estimated measures of state dependence, cumulated state dependence, and Wald tests for the order of the Markov model

	Men		Women	
	coeff.	t-stat	coeff.	t-stat
SD_1	0.755	(13.68)	0.404	(2.32)
SD_2	0.060	(1.71)	0.015	(0.28)
SD_3	0.012	(0.53)	0.055	(1.09)
SD_4	0.057	(1.77)	0.051	(0.87)
CSD_2	0.828	(18.41)	0.414	(2.18)
CSD_3	0.842	(20.89)	0.450	(2.17)
CSD_4	0.882	(21.75)	0.480	(2.15)
	χ^2(df)	p-value	χ^2(df)	p-value
Third order H_0: $\lambda_4= 0$	4.23 (1)	(0.0396)	0.70 (1)	(0.4034)
Second order H_0: $\lambda_4= \lambda_3=0$	5.38 (2)	(0.0679)	1.59 (2)	(0.4516)
First order H_0: $\lambda_4= \lambda_3= \lambda_2=0$	12.91 (3)	(0.0048)	1.59 (3)	(0.6605)
Static H_0: $\lambda_4= \lambda_3= \lambda_2= \lambda_1=0$	109.01 (4)	(0.0000)	8.61 (4)	(0.0716)

Table 8: Estimates of the employment transition equation from the fourth order Markov model

	Men		Women	
	coeff.	t-stat	coeff.	t-stat
Employed t-1	2.399	(9.04)	1.104	(2.37)
Employed t-2	0.343	(2.23)	0.038	(0.28)
Employed t-3	0.083	(0.57)	0.141	(1.04)
Employed t-4	0.326	(2.06)	0.131	(0.84)
Age category (base: [50-53])				
- (53-56]	-0.204	(2.79)	-0.141	(2.92)
- (56-60]	-0.332	(4.49)	-0.415	(7.92)
- (60-63]	-0.568	(5.92)		
- (63-65]	-0.967	(8.80)		
number of dependent children	0.126	(1.60)	0.174	(2.05)
Has partner	0.109	(1.65)	0.050	(1.01)
Housing tenure (base: owned outright)				
- mortgaged	0.216	(3.85)	0.218	(4.59)
- rented/ rent-free	-0.164	(2.50)	-0.184	(2.83)
Highest qualification (base: none)				
- nvq5/6	0.072	(0.93)	0.210	(2.84)
- nvq4	0.098	(1.08)	0.107	(1.89)
- nvq3	0.098	(1.57)	0.086	(1.29)
- nvq1/2	0.075	(0.72)	-0.049	(0.55)
- other	-0.179	(1.88)	-0.522	(5.36)
Region (base: SE excl. London)				
- North	-0.415	(3.82)	-0.274	(2.78)
- Yorkshire & Humberside	-0.217	(2.37)	-0.040	(0.46)
- East Midlands	-0.059	(0.58)	-0.173	(1.96)
- East Anglia	0.047	(0.41)	-0.104	(0.99)
- London	-0.100	(1.04)	-0.161	(1.97)
- South West	-0.112	(1.27)	0.046	(0.51)
- West Midlands	-0.022	(0.24)	-0.063	(0.81)
- North West	-0.284	(3.12)	-0.218	(2.72)
- Wales	-0.449	(4.31)	-0.335	(3.13)
- Scotland	-0.169	(1.85)	-0.168	(2.07)
- Northern Ireland	-0.418	(2.54)	-0.430	(3.53)
Industry (base: manufacturing)				
- primary	0.372	(2.97)	0.912	(4.55)
- energy	-0.305	(1.80)	-0.808	(2.68)
- construction	0.111	(1.46)	0.547	(2.38)
- wholesale, retail & motor trade	0.220	(2.53)	0.233	(2.04)
- hotels & restaurants	0.112	(0.65)	0.113	(0.86)
- transport, storage & communication	0.133	(1.61)	0.087	(0.60)
- financial intermediation	-0.238	(1.63)	0.102	(0.58)
- real estate, renting & business activities	0.481	(4.62)	0.177	(1.61)
- public administration & defence	-0.048	(0.45)	0.197	(1.51)

- education	0.199	(1.66)	0.188	(1.64)
- health & social work	0.209	(1.70)	0.274	(2.54)
- other	-0.091	(0.89)	-0.570	(4.95)
Occupation (base: manager/admin.)				
- professional	-0.030	(0.30)	0.190	(1.48)
- associated, professional & technical	-0.032	(0.32)	0.175	(1.52)
- clerical, secretarial	-0.025	(0.22)	0.029	(0.34)
- craft and related	-0.057	(0.77)	-0.122	(0.74)
- personal, protective	0.353	(2.36)	-0.030	(0.29)
- sales	0.258	(1.65)	-0.195	(1.68)
- plant and machine operatives	-0.061	(0.71)	-0.265	(1.83)
- other	-0.289	(3.51)	-0.455	(4.48)
Calendar year (base: 1993)				
- 1994	-0.084	(0.84)	-0.191	(1.97)
- 1995	0.029	(0.25)	-0.079	(0.72)
- 1996	0.169	(1.10)	0.110	(0.79)
- 1997	-0.018	(0.11)	-0.254	(1.89)
- 1998	0.045	(0.40)	-0.257	(2.50)
- 1999	0.083	(0.83)	-0.053	(0.58)
- 2000	0.209	(1.70)	-0.045	(0.42)
- 2001	0.033	(0.21)	0.108	(0.76)
- 2002	0.115	(0.77)	-0.180	(1.34)
-2003	0.088	(0.77)	-0.171	(1.65)
Calendar quarter (base: Oct-Dec)				
- Q1: Jan-Mar	0.114	(0.72)	0.217	(1.58)
- Q2: Apr-Jun	0.163	(1.30)	0.172	(1.47)
- Q3: Jul-Sep	0.136	(1.42)	0.012	(0.13)
Constant	-1.453	(5.28)	-0.266	(0.60)
Log likelihood	-15234.7		-11419.7	
Model chi2 (p-value)	1614.59	(0.00)	949.370	(0.00)
Number of observations	14653		11011	