Structural analyses of duration dependence and persistence in job-o¤er arrival rates and wages

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Executive summary

The aim of this report is to …nd out whether being without a job affects people's future labour market prospects in Australia. That is, do the unemployed lose the ability to …nd jobs and would they have to accept lower-paying jobs over time? The method used to investigate this question is an econometric analysis of the Survey of Employment and Unemployment Patterns, which contains labour market data for the period between September 1994 and September 1997 tracking the same individuals over 36 months.

In order to answer these questions, a naive approach would be to look at the labour market success of those who have been unemployed for long versus those who have been unemployed only shortly. However, these two groups are not comparable. The long-term unemployed are to some extent those who are less likely to obtain well-paid jobs in the …rst place. Thus they are a selective subgroup of all those who ‡ow into unemployment. This selectivity makes any simple comparison of average numbers an invalid approach. To overcome this fundamental problem, we develop a model of how the labour market works and use this model to correct for the selectivity of the longer-term non-employed.

The …rst main …nding is that there is no evidence that being without a job negatively a¤ects the level of wage o¤ers or the level of future lifetime earnings. This …nding is driven by two pieces of information in the data. The …rst is that individuals themselves do not substantially reduce the estimated value of their future income stream if they are unemployed for longer. An exception are those above 50 years of age whose value of future earnings is 4 per cent less per extra jobless year. The relative stability of future labour market prospects means that many of those who are long-term unemployed already had low expectations of their lifetime earnings at the outset of their unemployment period. The second piece of information is that when we look at the wages of individuals who have been unemployed between two jobs, then the wage changes of those who have been unemployed for longer are not lower than those who have been unemployed for a shorter period of time. The wage subsidies paid to employers of the long-term unemployed in the period 1994-1997 may be partly responsible for this. However, even if we discount the speci…c circumstances of the time, the basic wage changes do not suggest that those who are unemployed for longer get o¤ered substantially lower-paying jobs.

The second main …nding is that people in unemployment receive fewer job o¤ers than people in employment (conditional on both groups searching

for work), indicating that full-time search while not employed is less effective than the part-time search of people in employment. The finding that unemployment is an inefficient way to search for a job is obtained by comparing the probability of being offered a new job when unemployed as compared to the probability of a job offer for the same individual when employed. In unemployment, the representative person obtains about one job offer every 4 months, whereas the same person would obtain a job offer every 2 months in employment. This is interpreted as direct evidence that the best way to find a new job is to search while employed.

The implication of this second finding is that, in Australia, there is no efficiency gain for the economy as a whole in terms of a better matching of vacancies and job searchers as a result of searching while in unemployment. At least not in a period of relatively high unemployment as experienced by Australia at the time of the survey. In this respect the Australian labour market is like that of Northern Europe[1], where the unemployed are also less likely to obtain job offers than the employed, and not like the US where the unemployed seem better or at least equally able to search for new jobs compared to the employed.[2] Hence, unemployment in the US can be argued to improve the matching function of the labour market, which cannot be claimed for unemployment in Australia. For Australia at the time of the survey there is no reason to see a little unemployment as making the matching between workers and jobs better, which means unemployment can be seen as a sheer production loss. These differences between countries could be caused by the state of the aggregate labour market or by institutional differences, such as for example, the easier dismissal procedures in the US which might make employers less reluctant to employ people who are currently unemployed.

A third, more minor, finding is that those who report having a (mild and often temporary) disability, which impedes their work performance, are estimated to lose a minor amount of labour market potential only. The loss

[1] Some evidence for this is found by Boeri (1999). He shows that an increase of workers on short-term jobs, who are likely to be on-the-job searchers, reduces the flow from unemployment to employment using information from a number of countries. Pissarides and Wadsworth (1994) show that twice as many workers in the UK choose on-the-job search rather than quitting into full-time search, which indicates many workers see a relative benefit in searching on the job. In a macro economic study for the UK, Jackman et al. (1989) show that the efficiency of job search by the unemployed has decreased relative to the job search of the employed in the last decades up to 1989.

[2] See an overview of a few articles in Devine and Kiefer (1991: pp. 254-255).

in potential wages associated with such a disability is around 3 per cent, whilst there is no reduction in the number of job o¤ers.

Overall, the main determinants of labour market success seem to lie in the initial characteristics of individuals entering the labour market. Inequality in wage outcomes is mainly due to inequality in characteristics that were already present when individuals started their working careers. Hence, if the aim is to reduce inequality, making initial characteristics (such as schooling) more equal seems a good option.

This report has applied state-of-the art labour econometrics and has dealt with many data issues. To achieve this, a theoretical model, in which rational individuals search optimally for jobs in an ever changing labour market, was set up and solved. The latest econometric techniques have been used to estimate the determinants of how often people get job o¤ers and which wages they get o¤ered. We allow for a myriad of important issues, such as measurement errors in wages and interpretation errors by respondents; the in‡uence of many important unobserved characteristics; and we combine information from wages, job o¤ers and self-reported estimates of future wage streams (in the form of reservation wages) into one framework. In short, we have incorporated the main aspects of the job search process into a coherent framework.

The disadvantage of these structural techniques is that they necessarily presume a much simpler labour market than is realistic. One has to make many speci…c assumptions to implement a causal framework and one has to assume away some important real-life issues that cannot be dealt with. A few items that could not be incorporated, and that so far have not been coherently integrated in the academic literature, can be mentioned. For example, we know that the behaviour of the partner matters for the behaviour of individuals, but we have not allowed for it in this framework (…rstly, because of the theoretical di¢culty in allowing for behaviour of the partner and secondly because of the lack of detailed information on the partner's behaviour); we know that individuals are not always rational, that is, they could sometimes do better than they do, yet we have to assume in the model that individuals roughly make the best decisions they can; we know that labour market policies in the 1994-1997 period could have a¤ected both wages and job o¤ers, yet we assume they have only a¤ected wages; we know that individuals change their labour market behaviour long before a new child arrives in the household, yet we assume in the model that children only alter behaviour once they arrive; we know that some people have used labour market

programs in this period and others have not, yet we lack the data to say who has been a¤ected and hence have to assume everyone was a¤ected equally; and we know that individuals look for a combination of hours and wages (and possibly other features) in jobs, yet our method requires the assumption that the number of hours wanted is no restriction. In short, several things need to be assumed that are more or less plausible and on which our interpretation rests. However, by dealing with the most salient features of the job search process, we hope to have obtained a better understanding of the way in which the Australian labour market works.

1 Introduction

The aim of this project is to use up-to-date methods to investigate whether being without a job decreases people's future labour market prospects. That is, would the unemployed, over time, lose the ability to …nd jobs and/or would they have to accept lower paying jobs? This issue has been the topic of a long international debate on the causes of changes in human capital. Human capital changes can be re‡ected in changes in the probability of …nding a job and in the expected wages once a job is found. Job-…nding probabilities may decrease because of stigma e¤ects, running out of potential jobs to apply for, or decreased ability or motivation to …nd jobs. Similarly, individuals may lose or gain skills, which leads to lower or higher wage o¤ers after a prolonged period without a job. Decreases in human capital are obviously a main concern for policy makers. As a result, there is a large empirical literature analysing these negative changes. Accordingly, various names for negative human capital changes during unemployment (these can be either true or perceived changes) have been used, including 'scarring' (Clark et al., 2001), 'discouragement' (Calmfors and Lang, 1995), 'loss-of-skill' (Ljungqvist and Sargent, 1998), or 'stigma' (Omori, 1997; Piore, 1971).

The answer to the question of whether human capital changes for those without jobs has important distributional implications (see Machin and Manning, 1999). If there are strong decreases in human capital, people in long-term unemployment risk being permanently out of the labour force or on substantially lower wages as a result of their long spell out of employment. Then, initial 'bad luck' in …nding jobs may translate into a lifetime spent in poverty. If there are no major changes in human capital, then 'bad luck' with respect to …nding a job is likely to be transitory. Lifetime inequality may then have been caused by the inequality in initial characteristics such as schooling.

From the Survey of Employment and Unemployment Patterns data used in this report, transition probabilities of respondents in di¤erent age groups can be calculated. These calculations show major di¤erences in the probability of employment for respondents of di¤erent ages who were in unemployment one year ago. There is a remarkable drop in the probability for people between 50 and 59 compared to the younger age groups. The probability of regaining employment between wave 1 and wave 2 is 41.5 per cent for the younger age group versus 17.3 per cent for the older age group and the probability of regaining employment between wave 2 and wave 3 is 27.9 per cent

versus 13.4 per cent. The probability also decreases with age for younger respondents, but to a much smaller extent (similar differences are found for respondents who were non-participants one year ago).

It takes roughly 140 days on average until unemployed workers who look for jobs obtain their first job offer[3]. This is fairly constant in the three years of the survey, with the second year having waiting periods that are around 20 days shorter than in the first or third year. It takes older respondents above 50 years of age more than twice as long to get a job offer than those aged between 20 and 34 years. This longer waiting time until a job offer indicates that their job-finding probabilities are lower. One of the aims of this paper is to see whether the lower job-offer probabilities of older respondents are due to longer unemployment durations or whether it is their age, education or other characteristics at the outset of the search period which make them obtain fewer job offers. The detailed information over three years for each individual in the Survey of Employment and Unemployment Patterns (SEUP) on employment, job search, reservation wages and wages helps us to identify these factors.

The structure of the report is as follows. The second section provides a brief review of the literature on which this paper builds. In the third section, we present the theoretical framework in a descriptive way and leave a more formal description to the appendices. A separate (technical) subsection outlines the estimation strategy followed in this paper, which allows for random measurement errors in reservation wages and actual wages. The fourth section provides a description of the data we use.

The fifth section contains the results. First the results on the first-difference models for accepted wages and reservation wages are presented. These provide information on the changes in these wages over time, with changes in other characteristics and with elapsed time in employment and non-employment. The change in accepted wage and reservation wage reflect the individual's human capital as perceived by the employer and by the individuals themselves. Second we examine the timing of job offers. The analysis explores what characteristics are most likely to increase the job-offer rate. These results inform us about the job-finding skills, which include all characteristics and perceived characteristics (including 'stigma')

[3] This is calculated by using the relationship between the hazard rate of an event and the duration until an event takes place. For a constant hazard rate, the expected duration is $\frac{1}{hazard}$. In this case $\frac{1}{0.007} = 142.9$.

of an individual that make a job o¤er more likely to occur. Third, we look at the determinants of o¤ered wages. Combining the information on accepted wages, reservation wages and job o¤ers in a structural model, we examine the wage-o¤er distribution (including information on accepted and rejected wage o¤ers).

The …nal two sections summarize and discuss the results. Readers who are not interested in the methodology and/or data issues could skip the second to fourth sections.

2 Literature review

This section gives an overview of the literature on human capital changes and discusses the way in which this paper builds on this literature.

So far, individual level empirical evidence on the possible causes for changes in job-…nding probabilities has come from three main sources. First, there have been studies looking at single-spell non-employment durations. Such studies have typically found negative duration dependence, that is the transition probability of …nding employment decreases with the duration of being without employment. The di¢culty has been to disentangle the possibility that those who remain unemployed are those most unlikely to …nd a job anyway (unobserved heterogeneity) from the possibility of genuine changes in human capital. While some claim to have found changes in job-…nding probabilities (for example, Omori 1997), others report no changes in human capital (Heckman and Borjas, 1980; Lynch, 1989). This ambiguity occurs mainly because model speci…cations for the popular models used (Mixed Proportional Hazard or logit) are found to be extremely sensitive to the choice of the unobserved heterogeneity distribution (see Baker and Melino, 2000). Therefore Van den Berg (2001) concludes that these popular models cannot convincingly reveal changes in human capital using single spell data.

The second source of evidence for changes in human capital at the individual level is the repeated observation of job-search periods for the same individual (for example, Frijters et al., 2001; the feature papers in volume 111 number 475 of the Economic Journal, 2001; or the earlier survey by Wolpin, 1995). These studies include …rst di¤erence estimates[4] of the logarithm

[4] First di¤erence estimates analyse the di¤erence between the wage at time t and time t-1 of the same individual. This di¤erence is explained by the individual's changed personal circumstances. The e¤ect of all time-invariant characteristics on wages is di¤erenced out

of wages depending on variables such as the length and incidence of non-employment. First-difference estimates of the duration of non-employment are so far non-existent. None of these studies convincingly manage to separate the effect of changes in human capital from initial differences in human capital.

The third approach is to model the job-search process structurally and use individual-level information to see whether changes in human capital are reflected in reservation wage behavior (for a survey see for example, Van den Berg, 1999; Wolpin, 1995; Frijters and Van der Klaauw, 2001). It is difficult to calculate the optimal reservation wage strategy in these structural models, when the job-search process is allowed to become more realistic and thus more complex. In the structural models used so far, authors have therefore had to make restrictive assumptions about possible mechanisms. The most popular model, introduced by Flinn and Heckman (1982), for instance, introduces employment as an absorbing state, which means that once individuals enter employment, they will never become unemployed again. Thus, in their model the only human capital changes take place during a single unemployment spell. Using German data, Frijters and Van der Klaauw (2001) extended this model to allow for endogenous non-participation. They found modest reductions in job-finding probabilities and somewhat larger reductions in expected wages as functions of the duration of non-employment.

Following the third approach in this report the literature is extended by using a large unique Australian panel data set. Its first major advantage is that it contains information on all the job offers that a person has had over a period of 3 years. This allows for a direct identification of changes in the job-offer arrival rate. These changes are identified by using a fixed-effect estimator for the logit hazard rate model, which is an extension of the Chamberlain (1980) model. This model allows us to obtain estimates of the determinants of job-offer arrival rates without the need to make parametric assumptions on the distribution of individual heterogeneity. By using a fixed effects approach and only including those individuals who actively searched, the analyses are also not affected by the selectivity of the search decision, which is a major problem in studies that lack information on job search activities.

Another strong point of the job-offer data is that it is available for indi-

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of the model. In this way one can control for person-specific unobserved heterogeneity by simply differencing it out of the model.

viduals both in employment and unemployment. Following the same individuals over time, we can ascertain whether job-o¤er arrival rates are higher or lower in employment compared to the rates in non-employment. This is an important variable for labour market policy: the relative job-o¤er arrival rate in employment determines the attractiveness of employment versus non-employment. Marimon and Zilibotti (1999) and Acemoglu and Shimer (1999), for instance, advocate subsidising unemployment as an e¢cient search channel. If however the job-o¤er arrival rate is higher during employment, then unemployment bene…ts are subsidising ine¢cient search for jobs. Indeed, in many theoretical models assumptions are made about this job-o¤er arrival rate. For example, Burdett and Mortensen (1998), Bontemps et al. (2000), and Ljungqvist and Sargent (1998) in their search models allow the arrival rates to be the same in employment and unemployment, whereas Van den Berg (1990), Frijters and Van der Klaauw (2001), and Flinn and Heckman (1982) assume that the job-o¤er arrival rate for the employed is zero. The …ndings in this paper indicate that the job-o¤er arrival rate during employment is higher than during unemployment. This supports the theoretical models that allow for job o¤ers during employment.

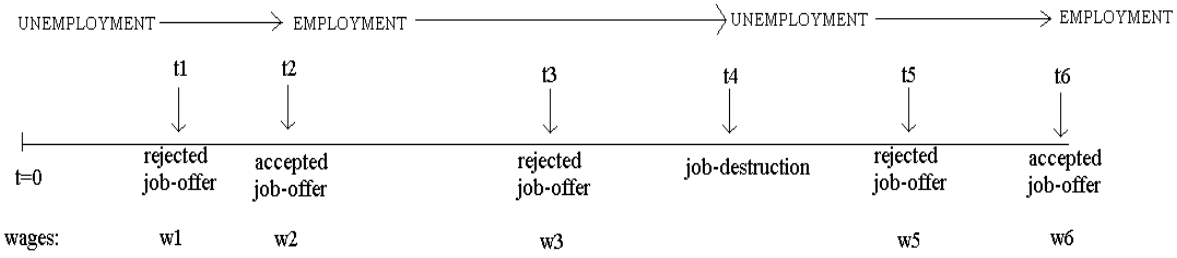
The third advantage of the data is that it contains successive observations of reservation wages for individuals, as well as information on accepted wages. Making the standard assumption that accepted wages are those offered wages that are higher than the reservation wage, we can use this data to trace the changes in the wage-o¤er distribution. Using reported reservation wages means that we do not need to calculate reservation wages in the structural model and hence allows us to estimate a much richer structural model than used hitherto. We present estimates of how wage o¤ers change with previous incomes, with current durations of employment and non-employment, and with cumulative durations of employment and non-employment. Such estimates could not be obtained if we had to calculate reservation wages analytically because the computational complexities would have been too great.

3 Methodology

3.1 The theoretical model in words

This subsection presents the ideas underlying the theoretical model on which the analysis in this paper is based.[5] The abstract representation of the labour market in this paper is one of individuals who either search for jobs or not. Figure 1 shows a particular hypothetical labour market history to make our framework as concrete as possible in terms of a speci…c example. This person enters the labour market at time 0. She receives a job o¤er at time t1 worth a wage w1, but rejects this o¤er. She accepts the job o¤er of w2 at time t2, after which she works till time t4, in the meantime rejecting wage o¤er w3 at time t3. Becoming unemployed again at t4, she again rejects a job o¤er w5 at time t5, but accepts the job o¤er of w6 at time t6. Thus, this individual is unemployed for a cumulative length of t2+(t6-t4), and is employed for a period of (t4-t2). Of the …ve wage rates o¤ered to her, we only observe w2 and w6 as actual wage earnings.

Figure 1: an example of a particular labour market history.



What we would ideally want to know are the determinants of all the o¤ered wages, independent of whether these o¤ers were rejected or not; all the determinants of the wage demands (reservation wages) that lead to some o¤ers being rejected; and all the determinants of the probability of getting

[5] Appendix B describes the model in more detail and presents the mathematical derivation of the model.

jobs o¤ers. These three functions characterise the entire future labour market prospects. As potential determinants of these functions we think not only of individual characteristics, but especially of labour market history itself. The main relations we are interested in can be formulated as:

1. Do the previous wages (a proxy for the quality of the previous job) a¤ect future outcomes? For instance, does the actual wage w2 a¤ect the length of the next unemployment spell (t6-t4) through the probability of job o¤ers at t5 and t6?

2. Do …xed unobserved individual characteristics (a proxy for relevant tastes and ability) a¤ect wages and durations, that is, are there unobserved factors that a¤ect the wage o¤ers and durations? Also, are there unobserved factors in‡uencing the timing of job o¤ers, that is, the probabilities of getting job o¤ers at any point in time?

3. Does the cumulative time spent in non-employment (a proxy for habituation and lost-time e¤ects) a¤ect wages and duration, that is, does the duration t2+(t6-t4) a¤ect w6 or the probability of a job o¤er at t6?

4. Does the cumulative time spent in employment (a proxy for networks and experience gained) a¤ect wages and durations, that is, does (t4-t2) a¤ect w5 or (t6-t4)?

5. Does the current length of unemployment a¤ect o¤ered wages, that is, does t2 a¤ect w2 or does (t5-t4) a¤ect w5? Does the current length of unemployment a¤ect job-o¤er-arrival rates, that is, does the duration t2 a¤ect the probability of a job o¤er at t2?

6. Does being employed a¤ect wage o¤ers or the duration until a job o¤er, that is, is the wage o¤ered during employment (w3) higher than a wage o¤ered during unemployment (such as w1)? Also, is the probability of getting job o¤ers higher between t2 and t4 (in employment) than between t0 and t2?

In this example, previous wages and all the duration variables are partly the result of search behaviour, because the length of employment and unemployment are directly related to the refusal of job o¤ers at particular times. They are also related to the probability of getting job o¤ers at particular

times. Each of the wages and durations in this example are therefore not only relevant variables for the functions we aim to estimate, but they are choices that are simultaneously determined by these functions. We hence allow for many lock-in effects of current behaviour on future outcomes. Allowing for such rich dynamic effects is at the forefront of the current literature. At best, the literature manages to take account of the effect of current (un)employment length on search behaviour (see Frijters and Van der Klaauw (2001) for an example or Petrongolo and Pissarides (2001) for an overview of the empirical structural studies). Difficulties arise when we try to calculate what an individual should do, since the possible number of life-paths quickly becomes too numerous to be manageable when we allow for dynamic effects. When it is impossible to compute what individuals should do, the functions of interest cannot be inferred from indirect evidence. Having only limited data, previous structural analyses have had to make strong assumptions in order to be able to calculate optimal behaviour and use indirect evidence. Lacking the ability to compute what individuals should do in complicated circumstances has therefore limited the current literature to consider only some of the relations listed above.

We include all these six relations without the need to calculate what individuals should do. This is possible because the data is unusually rich and includes direct observations on the job-offer arrival rate and the reservation wage. In the vast majority of the literature, the t1, t3, and t5 of our example in Figure 1 would be unobserved, that is, we would not have known about rejected job offers. In the data used in this paper, on the other hand, we know all the job offers and we know the upper limit of all the rejected wage offers. This allows us to look at complicated dynamics. However, this comes at a cost, in that we cannot convincingly answer 'what if' questions, because we cannot calculate what individuals in the data should do in different circumstances. This is a result of using the observed reservation wage in the structural model, instead of estimating a reservation wage path, which could then be made dependent on various characteristics of the job searcher and the labour market. Thus we cannot simulate the effect of characteristics on the reservation wage path and the consequent changes on the unemployment duration. Policy questions are invariably 'what if' questions. In this paper, we choose for maximum understanding of the mechanisms in the labour market, whilst paying the price that we cannot say very much about the magnitude of policy effects (although we can reasonably gauge their direction).

By confronting the model with data, we obtain estimates of how the values

of various choices (accepting a job o¤er or staying unemployed) change over time. Decreasing wage o¤ers over time would inform us about reductions in marginal productivity, whereas decreasing job-o¤er arrival rates would inform us about reductions in job-…nding skills and/or increasing stigma e¤ects. Tracking the same individual over time provides information about the importance of observed and unobserved characteristics a¤ecting human capital, giving an insight into the unemployed individual's human capital over time.

The …rst step is to estimate how the job-o¤er arrival rate and reservation wages move over time. For this, we use …rst-di¤erence models for reservation wages and job o¤ers that exploit the fact that we observe individuals more than once and the rather unique fact that we actually observe job o¤ers, whether accepted or not. Using …rst di¤erence models means we take account of time-invariant characteristics, irrespective of whether they are observed or unobserved. By taking the initial characteristics into account we do not have to worry too much about the selectivity of the sample.

With the knowledge of how job-o¤er probabilities and the reservation wage change over time, we can identify how wage o¤ers change over time because it is known that wage o¤ers are lower than reservation wages for all unaccepted job o¤ers and higher than reservation wages for accepted wage o¤ers. Furthermore, actual wages are equal to o¤ered wages for those that …nd an acceptable job. This information is su¢cient to estimate what happens to wage o¤ers, even for those that have not accepted a job o¤er during the survey period.

3.2 Empirical estimation strategy

This subsection discusses the practical approach taken in this paper. The data allows us to estimate some components of the structural model separately which simpli…es the estimation procedure.

Reservation wages, wages and job o¤ers are observed over a three-year period. Changes in the …rst two variables are estimated by relatively simple …rst di¤erence models which are outlined in the following subsection. The advantage of …rst di¤erencing is that only the e¤ects of time-varying factors are estimated. Unobserved factors which are constant over time do not in‡uence outcomes. Thus, this approach in principle controls for a large proportion of unobserved heterogeneity. That is, the e¤ects are estimated

by looking at the effect of observed changes in situation for an individual rather than the effect of observed differences between individuals. The latter method of estimating the effect of an observed difference could be influenced by unobserved differences between individuals.

The probability of a job offer in a particular month is estimated by conditioning this probability on the total number of months in which job offers have been received and then consider the relative probability of job offers in particular months to the probability of any other possible combination. Thus, given the total number of months with a job offer, the method determines which of the months in which job search was undertaken were most likely to have generated the job offer(s) given the characteristics of the job searcher in these months. The approach is described in the second subsection. It again has the great advantage that it allows us to ignore any time-invariant characteristic of the individual, such as her unobserved innate talents or her observed education level. These factors simply drop out.

To estimate wage offers, use is made of the observed reservation wages, the observed actual wages (which are a selection of all wage offers) and job-offer arrival rates. A structural model is estimated for wage offers so inferences can be made over the full wage offer distribution, using all the observed components, instead of having to restrict ourselves to a truncated wage offer distribution. The methodology for this is described in the third subsection.

3.2.1 Reservation wages

For several individuals in the data, reservation wages are observed at more than one point in time. This means a first difference model can be estimated, by creating a dependent variable which is equal to the log(reservation wage) at time t minus the log(reservation wage) at time 0 (the first reservation wage which is observed in the survey):

$$\Delta \ln \phi_{it} = \ln \phi_{it} - \ln \phi_{i0} = (X'_{it} - X'_{i0})\beta + \mu_{it} - \mu_{i0}$$

where X_{it} contains the time-variant characteristics and $\mu_{it} - \mu_{i0}$ is a normally distributed error term, given that μ_{it} and μ_{i0} are each normally distributed error terms as well. β is only identified for characteristics which display sufficient changes over time.

The above model explains how changes in characteristics (over time) affect the reservation wage, whilst controlling for fixed effects and thus for

unobserved heterogeneity (assuming this is constant over time). The latter is a major advantage of such a model since it allows one to identify the true effect of a change in an individual's characteristic rather than a comparison between individuals with different characteristics. However this also means that we can only examine the effect of characteristics that change over time. For example, we cannot determine the effect of gender on the change in reservation wages because gender is a characteristic that is constant over time.

A similar model can be estimated for accepted wages as well, in order to explore patterns in the accepted wages. However it should be noted that accepted wages are not equivalent to the wage offers, the estimation of which is more complicated and which is discussed in Section 3.2.3.

3.2.2 Job-offer arrival rates

First we discuss how the data on job offers can be used to estimate the job-offer arrival rate. The probability of obtaining a job offer is modelled as a logit model in the following way:

$$P(O_i(t) = 1) = \frac{e^{I_{it}^e \delta + X_{it}^0 \beta^\lambda + v_i^\lambda}}{1 + e^{I_{it}^e \delta + X_{it}^0 \beta^\lambda + v_i^\lambda}}$$

where $O_i(t)$ is an indicator variable of whether an individual i who searches for jobs obtains a job offer in period t (here we look at monthly job offers: $O_i(t) = 1$ if at least one job offer was received in month t, $O_i(t) = 0$ if no job offers were received in month t); I_{it}^e is an indicator function of being employed in period t which means that the parameter δ captures the difference between job-offer arrival rates for the employed and the unemployed; v_i^λ is an individual fixed effect that may include, apart from human capital variables, an individual's interpretation of what a job offer means; X_{it} is a vector of individual characteristics in period t that include history variables, functions of time spent in the current state, etc. $X_{it}^0 \beta^\lambda$ incorporates baseline functions of current durations and calendar time. We use the logit formulation instead of the more standard Mixed Proportional Hazard (MPH) because the logit model restricts the job-offer arrival probabilities to be smaller than 1 in each month which is important in the discrete-time set-up that we have chosen. The model allows for complex history effects, complex baseline effects, and fixed individual traits that can be correlated with observables, so it is

very ‡exible and it incorporates the MPH as a special case (that is, when $(I_{it}^{e}\delta + X_{it}^{0}\beta^{\lambda} + v_i^{\lambda})$ approaches minus in…nity).

For most individuals we only have a few observations with $O_i(t) = 1$, which is not enough to enable direct estimation of the …xed e¤ect v_i^{λ}. The large errors in the estimates for v_i^{λ} would bias the estimates of the other variables (see for example, Chamberlain 1980). We therefore extend Chamberlain (1980) by using a conditioning statistic through which the …xed e¤ects are eliminated. We use the following estimator:

$$L(O_i | \sum_t \{O_i(t)\}, \delta, \beta) = \frac{e^{\sum_t O_i(t)\{I_{it}^{e}\delta + X_{it}^{0}\beta^{\lambda}\}}}{\sum_{S_i} e^{\sum_{t<d_{ij}} O_i(t)\{I_{it}^{e}\delta + X_{it}^{0}\beta^{\lambda}\}}}$$

where O_i denotes the set $\{O_i(1), .., O_i(T)\}$, $O_i(t)$ denotes the random variable and S_i denotes the total possible set of vectors that O_i can attain that lead to the same $\sum_t \{O_i(t)\}$. That is, we condition the probability of having job o¤ers in the observed months on the total number of months in which job o¤ers were received. As a result of this conditioning the …xed e¤ect drops out of the likelihood function and no longer needs to be estimated.

Therefore, maximising this conditional likelihood no longer involves estimating the individual e¤ects and leads to unbiased estimates of the other parameters. However, this estimator only works for individuals who have a positive number of job o¤ers and have fewer job o¤ers than months in which they could receive a job o¤er. Otherwise, the conditioning set only contains one element, equal to the observed outcome, in which case the likelihood is 1 for any parameter choice and the parameters are unidenti…ed.

The great advantage of this method is that it makes use of all searching individuals, even if they only have one spell. Because even a single spell contains information. For example, if an individual has had one job o¤er then the timing of the job o¤er is informative about the baseline functions (that is, when are individuals most likely to receive a job o¤er), however nothing can be said about spell-varying characteristics. From individuals with multiple spells, we have spell-varying information on X_{it}^{0} that identi…es β^{λ} and δ. The estimator thus uses all the information that is available in both single and multiple spells.

The practical problem with this method is that the conditioning set S_i can become quite large for individuals with many job o¤ers who search for many months. For instance, the number of possibilities in S for someone who has

had 6 job offers in 36 months of searching is $\binom{36}{6} = 1947\,792$[6]. A conditioning set of this size is too big to handle for current computers. Whenever the set S_i becomes too big for an individual, the innovation in this paper is to split the observation on the individual into two observations and randomly allocate the monthly data over these two artificially created individuals such that we can do fixed-effect analyses on the two new individuals. This only leads to a loss of efficiency (by not accounting for the fact that the two observations are on the same individual) and was necessary in about 10 per cent of the cases.

3.2.3 The wage-offer distribution

When an individual starts a new employment spell at time t, the actual starting wage of an individual is denoted by w_{it}. This is an accepted wage offer, so it represents a value from the truncated wage-offer distribution, that is w_{it} has to be larger than ϕ_{it}, the actual reservation wage at time t. The standard approach is to select a parametric form for the wage-offer distribution $F(w_{it}^o)$ depending on observable factors, in addition to requiring that the observed wage is higher than the observed reservation wage. In this report, we follow a more elaborate approach in order to allow for measurement errors in both wages and reservation wages and for fixed unobserved traits that could be correlated with observables. We assume the following relation to hold for the (unobserved) wage offer w_{it}^o and the reservation wage ϕ_{it} :

$$\ln w_{it}^o = X_{it}'\beta^o + v_i + \eta_{it}^o \tag{1}$$

and

$$\ln \phi_{it} = X_{it}'\beta^\phi + v_i \tag{2}$$

where w_{it}^o is the wage offer of individual i at time t; η_{it}^o is white noise with variance σ_w^2. Thus the wage-offer distribution is assumed to be normally distributed with an individual-specific mean (depending on the personal characteristics) and population-specific variance σ_w^2. X_{it}' is a vector including time-varying and time-invariant characteristics; v_i is a individual fixed term, representing the time-invariant characteristics of individual i, that can be interpreted as an individual-specific wage floor. Such an individual-specific

[6] The number of possible combinations we can make by selecting 6 months to have a job offer out of 36 possible months is equal to $\binom{36}{6} = \frac{36!}{30!6!} = \frac{36.35.34...2.1}{(30.29...1)(6.5.4.3.2.1)} = \frac{36.35.34.33.32.31}{6.5.4.3.2.} = 1,947,792$.

term is necessary because the theoretical model shows that individuals sort themselves into non-participation over time according to their reservation wage and the value of non-participation time. Once the reservation wage falls below the value that corresponds to the value of non-participation time, the individual withdraws from the labour force, since being in non-participation is valued higher then employment at the reservation wage level would be. Hence, if we would not take account of some speci…c wage ‡oor, the potential endogeneity between v_i and the initial characteristics X_{i0}^{0} would create a bias in the coe¢cients β^o. Note that such a bias cannot be purged by …rst-di¤erencing accepted wages, because accepted wages are only observed when they are larger than ϕ_{it},which is also dependent on the individual-speci…c wage ‡oor, and thus changes in accepted wages still involve v_i. The framework above allows for rich dynamics in reservation wages and wage o¤ers.

It seems likely that there are random di¤erences in the interpretation of reservation wages, which could be accounted for through inclusion of measurement error in reservation wages. It is assumed that the log of observed reservation wages $\ln \tilde{\phi}_{it}$ are equal to the log of actual reservation wages $\ln \phi_{it}$ plus a normal error term: $\ln \tilde{\phi}_{it} = \ln \phi_{it} + m_{it}^{\phi}$ where $m_{it}^{\phi} \sim N(0, \sigma_{m,\phi}^2)$. This measurement error also allows for the possibility that reservation wages are a¤ected by transient random shocks. Similarly, we allow for measurement error in wages by taking the log of observed wages ($\ln \tilde{w}_{it}$) equal to the log of actual wages plus a random measurement error term: $\ln \tilde{w}_{it} = \ln w_{it} + m_{it}^{w}$ where $m_{it}^{w} \sim N(0, \sigma_{m,w}^2)$. The size of these measurement error terms provides a measure of the …t of the model (Ridder and Van den Berg, 1998).

From the theoretical model it follows:

$$\begin{aligned} \ln w_{it}^{o} &< \ln \phi_{it} \text{ i¤ } d_{it} = 0 \\ \ln w_{it}^{o} &= \ln w_{it} \text{ , } \ln \phi_{it} \text{ i¤ } d_{it} = 1 \end{aligned} \tag{3}$$

where $d_{it} = 1$ for accepted job o¤ers at time t and $d_{it} = 0$ otherwise. Wages are only observed when $d_{it} = 1$. The likelihood of the observed information on wages, reservation wages and acceptance of job o¤ers equals

$$L(\tilde{w}_{it}, \tilde{\phi}_{it}, d_{it} | \beta^o, O_i(t)) = \prod_{O_i(t)=1 \wedge d_{it}=0} P(\ln w_{it}^{o} < \ln \phi_{it}) \text{¤}$$

$$\prod_{O_i(t)=1 \wedge d_{it}=1} P(\ln w_{it}^{o} = \ln w_{it}, \ln w_{it}^{o} \text{ , } \ln \phi_{it}) \tag{4}$$

whereby $O_i(t)$ = 1 and d_{it} = 0 denotes those job o¤ers that are rejected and $O_i(t)$ = 1 and d_{it} = 1 the job o¤ers that got accepted. The …rst term in equation 4 represents the probability of an observation on a rejected job o¤er and the second term represents the probability of an observation on an accepted job o¤er. The parameters of the model are estimated by maximising this likelihood function. Further details can be found in appendix D.

3.3 Testing for validity of the …xed-e¤ect approach

We want to test whether the approach in the previous subsection, which accounts for a …xed e¤ect in reservation and actual wages, is valid. The null hypothesis is that the …xed e¤ect approach is valid, which means that v_i should include the contribution of all time-invariant characteristics on w_{it}^o :

$$H0 : \beta_Z^o = 0 \text{ where } Z_{it} \text{ ½ } X_{it} \text{ subject to } Z_{it} \text{ being time-invariant}$$

The idea underlying the test is that v_i is meant to control for all observed and unobserved …xed characteristics that a¤ect wages. An empirical test of whether this is achieved is to see whether time-invariant elements in X_{it} have coe¢cients equal to 0. For example, educational attainment variables are included in Z_{it} because these variables normally are of major importance to wage o¤ers and do not vary over time. For these variables we hence have under $H0$ that

$$2\{\ln L(\beta_Z^o \text{ unrestricted}) \text{ ¡ } \ln L(\beta_Z^o = 0)\} \text{ » } \chi^2(k)$$

where k is the number of variables in Z_{it}.

We simply report the result of this test here. The relevant …xed variables we use in the test are indicator variables for whether an individual had successfully followed tertiary, vocational, or secondary school education. The relevant $\chi^2(3)$ critical value is about 11.3, whilst our test statistic was about 9.8. This indicates that at the 1 per cent level we could not reject our null hypothesis of the …xed e¤ect approach being valid.

4 Data

The data analysed were derived from the Australian Bureau of Statistics' Survey of Employment and Unemployment Patterns 1994-1997 (SEUP). This is

the …rst longitudinal data set to detail the working and job-seeking experiences of the Australian population in general on a continuous basis (for more information on the data set see Australian Bureau of Statistics (ABS), 1997 and 1998). Although the three-year time span of the survey is still relatively short for a panel, this length of observation period allows us to observe transitions in and out of work, particularly because those at risk of unemployment have been oversampled.

The SEUP consists of three samples from the population aged 15 to 59, residing in private dwellings: Jobseekers[7], Population Reference Group (a random sample of the population) and Labour Market Programme participants. The SEUP Con…dential Unit Record File, which is used, only contains the …rst two samples which adds up to information on 7572 respondents and information on labour market program episodes and bene…t receipt episodes is excluded.[8] The total sample overrepresents Jobseekers, which is a relatively disadvantaged group at risk of unemployment. Full-time students[9], contributing family workers and the self-employed[10] were excluded. In the …rst-di¤erences analyses, all respondents who have not had a change in employment status and have not been searching during the survey period (that is, people who have been employed without searching on the job or people who have been a non-participant for the full three years) are excluded, because no …rst di¤erences can be calculated for them. In the individual analyses, additional respondents may be excluded for whom less than two observations are available on the relevant dependent variable. The SEUP had an attrition rate of 11.6 per cent after the …rst year and an additional 8.4 per cent after the second year. In the analyses we included all information available on each individual up to the moment of dropping out.

[7] The Jobseeker group comprises those who, at the time of recruitment (April-July 1995), were: unemployed, underemployed (working less than ten hours per week and looking for a job with more hours), discouraged from job search or not in the labour force but likely to enter the labour force in the near future (ABS, undated). Thus they are selected to be more disadvantaged than the average person entering unemployment.

[8] This exclusion involves both the detailed information at the episode level and the summary information by wave for each respondent.

[9] Full-time students are excluded because for them the choice between work and non-work or searching or not searching is less relevant given their choice for an alternative (that is full-time study).

[10] The self-employed and family workers are excluded because the concept of participation based on the relative values of reservation wages and market wages is not relevant for them in the same way as it is for wage and salary earners.

This study follows the experiences of individuals over the three years of the survey, recording people's reservation wages when they are looking for work (independent of whether they are working at that time or not), o¤ered wages (wage rates at the start of a job after a non-working spell) and the number of accepted and rejected job o¤ers (for those who are searching). Unfortunately, reservation wages are recorded net of taxes and o¤ered wages are recorded with taxes included. Heath (1999) mentions that from a cross tabulation of the reservation wage and previous wage it appears that some confusion may have arisen and some respondents seem to have provided wages and reservation wages according to the same measure.

A comparison between reservation wages and wages for those who are searching while working reveals that the reservation wage is on average lower than the wage in the current job, which would be consistent with the reservation wage being a net amount and the o¤ered wage a gross amount. However, there are also several cases where the two amounts are fairly close to each other indicating both amounts are net amounts or gross amounts. In our analysis, we estimate a structural model in which information on wages and reservation wages needs to be combined. Therefore, we decided to correct the raw wage o¤ers by approximating the amount of tax to be paid and deducting this amount from the observed wage o¤ers. This should make the wages more comparable to the recorded net reservation wages. However, the results obtained from this speci…cation are close to the results from the speci…cation where just the raw wages and raw reservation wages are combined.

For the period before 1994, the respondents were asked about the length and wage of their last employment spell as well as about the cumulative length of time spent in employment and unemployment. Wages that were recorded for spells less than two years before the start of the survey are used in the analysis as is the spell duration information on spells that took place less than 1200 days ago. To go further back in time may demand too much from the respondent's recollection ability.

The episodes for each respondent in the SEUP are combined to form sequences of work and non-work spells. Additionally, for each respondent searching spells are recorded so that for each spell at all points in time a time-variant search indicator can be constructed. For each of the work spells, information on the job, such as earnings, hours of work, occupation or industry, is collected. For the searching spells, the reservation wage is collected for each wave in which the spell was current. Hence we have a maximum of

three observed reservation wages per search spell.[11] Throughout the survey period the month in which a job o¤er is made is registered together with the acceptance or rejection of the o¤er.

In this analysis, we make use of the information on all reservation wages observed throughout the survey, on wage o¤ers (…rst wage after non-working spell) and on whether or not at least one job o¤er was made in each month of the searching spells.

Initial socio-demographic data were collected between April and July 1995. The panel was revisited in September 1995, 1996, and 1997 to collect information on the di¤erent labour market episodes in the preceding year. At the end of each wave, information on household and individual characteristics was collected. This repeated collection of background information is important in the estimation of …rst di¤erence models. The e¤ect of characteristics can only be measured by observing the correlation between the change in characteristics and the dependent variable of interest.

Table 1 reports the summary statistics on individual and household characteristics on all spells (thus including some individuals more than once) in the …rst column. The second column presents the characteristics of the individuals included in the sample and the last column looks at a subgroup of respondents, who were not employed at the end of the survey.

From this table we observe that those who end up without work at the end of the survey period: are more likely to be somewhat older or female; have been looking for work for a longer time in the past; are less likely to have been born in Australia; are less likely to be pro…cient in English (that is, they are from a non-English speaking background, speak English less well, speak another language at home than English and are recent immigrants); are more likely to live in urban areas outside the capital cities, have lower education levels, have less work experience, have or have had a partner, and to have a disability; and are less likely to be a part-time student.

Summary statistics for the dependent variables are given in Table 2 by employment status, gender, search status and disability. From the raw data

[11] Reservation wages and market wages are derived from weekly (reservation) earnings and number of hours of work. The reservation and market wages are in categories as a result of the categorized observation of earnings. Weekly earnings of the employed and weekly reservation wages of the searchers are self-reported in 29 and 30 categories respectively, which we use as the basis for imputation of continuous wage values for each respondent in the analyses.

Table 1: Summary statistics for the total sample and subsamples

	all spells		all individuals		no work at end	
Variable	Mean	St. d.	Mean	St. d.	Mean	St. d.
number of spells			3.589	2.903	3.455	2.836
employment spell	0.439	0.496				
woman	0.503	0.500	0.502	0.500	0.522	0.500
age	35.776	10.756	37.208	10.978	38.779	11.784
years of job search since school	2.266	2.944	2.178	3.033	3.052	3.441
Australian born	0.729	0.444	0.706	0.456	0.680	0.467
Eur./N.-Am. migr.: non-English	0.064	0.245	0.076	0.265	0.094	0.292
Eur./N.-Am. migr.: English	0.085	0.279	0.083	0.277	0.078	0.269
other migrants : non-English	0.095	0.293	0.109	0.312	0.124	0.329
other migrant: English	0.026	0.160	0.026	0.158	0.024	0.154
migrated after 1990	0.045	0.207	0.046	0.209	0.045	0.208
migrated after 1980	0.115	0.319	0.124	0.330	0.133	0.340
non-Engl. speaking background	0.177	0.382	0.200	0.400	0.231	0.422
english pro...ciency is very well	0.905	0.294	0.882	0.323	0.845	0.362
english pro...ciency is well	0.072	0.259	0.085	0.279	0.100	0.301
english pro...ciency is not well	0.023	0.150	0.033	0.178	0.054	0.227
lives in capital city	0.529	0.499	0.562	0.496	0.529	0.499
lives in urban area	0.320	0.467	0.296	0.456	0.329	0.470
lives in rural area	0.151	0.358	0.143	0.350	0.142	0.349
youngest child is aged 0	0.052	0.222	0.052	0.221	0.056	0.231
youngest child is aged 1 to 2	0.087	0.282	0.088	0.284	0.097	0.296
youngest child is aged 3 to 5	0.097	0.296	0.096	0.295	0.096	0.295
youngest child is aged over 5	0.131	0.338	0.129	0.335	0.126	0.332
english is spoken at home	0.904	0.295	0.883	0.322	0.854	0.354
higher degree/post-doctoral	0.024	0.152	0.025	0.155	0.013	0.112
bachelors degree	0.078	0.267	0.076	0.264	0.037	0.188
undergraduate diploma	0.068	0.252	0.069	0.254	0.048	0.213
skilled vocational quali...cation	0.168	0.374	0.164	0.370	0.148	0.355
basic vocational quali...cation	0.066	0.248	0.061	0.239	0.058	0.235
...nished secondary school	0.167	0.373	0.158	0.365	0.156	0.362
left secondary aged 16-18	0.193	0.395	0.192	0.394	0.207	0.405
left secondary aged less than 15	0.237	0.425	0.256	0.436	0.335	0.472
work experience in years	13.422	10.843	14.492	11.242	14.439	12.090
rec. wrk exp. in days (in last yr)	146.184	128.519	133.166	148.623	52.063	96.431
number of children	0.804	1.099	0.801	1.114	0.811	1.138
partnered	0.573	0.495	0.626	0.484	0.645	0.479
separated/widowed	0.156	0.363	0.154	0.361	0.174	0.379
never married	0.328	0.470	0.298	0.458	0.277	0.447
disabled	0.312	0.463	0.322	0.467	0.419	0.493
disability impeding employment	0.260	0.439	0.272	0.445	0.397	0.489
part-time student	0.075	0.264	0.073	0.260	0.054	0.225
number of observations	18257		5223		2501	

there is only a slight di¤erence in job-o¤er arrival rates between individuals in and out of employment who are searching. Women seem to have a slightly higher job-o¤er arrival rate than men and those with a disability appear to have fewer job o¤ers. The reservation wages of those in employment are slightly higher than for those without employment. Men have higher reservation wages than women. Generally those with a disability demand slightly lower reservation wages than those without a disability. Similar e¤ects are seen for market wages, that is women and those with a disability have lower wages than others. Interestingly, there is little di¤erence in wages for those who continue searching while in employment and those who do not. As discussed in the introduction, there are clear di¤erences by age groups. Older respondents have fewer job o¤ers per day of looking for work. In addition, respondents between 40 and 54 years of age have lower wages and reservation wages than the younger age group and those aged between 55 and 59 years. The highest average wages and reservation wages are observed for individuals between 35 and 39 years old.

Comparing reservation wages observed in the three waves, there appears to be a dip in the second wave (except for respondents between 45 and 59 years old). However, further investigation revealed that this is not observed over time when following one individual, but only re‡ects the di¤erence in the sample for which reservation wages are recorded. Unfortunately, a sequencing problem has occurred while the data was collected, which meant that for all those who were looking for work at the time of the recruitment or before the recruitment interview no reservation wage was collected in wave 1. The reservation wage in the …rst wave is only collected for those who started to look for work after the recruitment interview. This is evident from the observed number of cases with a reservation wage in wave 1 in Table 2. A similar problem, although on a smaller scale, occurs for reservation wages in the second wave for a subgroup of those who have not had their reservation wage in wave 1 collected. Of those who were looking for work before the recruitment interview and who were still looking for work during the second wave, only for those who were looking for work until the end of wave 2 was the reservation wage collected. For individuals who started looking for work before the recruitment interview and who stopped looking for work before the end of wave 2, no second wave reservation wage was collected.[12]

[12] This explanation was received from the ABS.

Table 2: Summary statistics for the dependent variables

	wage	res.wage 1	res.wage 2	res. wage 3	job o¤./day
number of obs.	7852	1102	2740	2493	18257
not in employment		11.06	10.82	11.15	0.0058
out of the labour force					0.0032
unemployed		11.06	10.82	11.15	0.0071
by gender					
man		11.54	10.82	11.35	0.0062[a]
woman		10.60	10.82	10.90	0.0083[a]
by disability					
yes		11.09	10.94	11.06	0.0058[a]
no		11.04	10.77	11.21	0.0078[a]
in employment	13.73	11.39	11.33	11.97	0.0038
work, no search	13.69				0.0026
work and search	13.85	11.39	11.33	11.97	0.0066
by gender					
man	13.99	12.34	11.64	12.49	0.0061[a]
woman	13.46	10.50	10.99	11.41	0.0071[a]
by disability					
yes	13.52	11.43	11.20	11.77	0.0043[a]
no	13.81	11.37	11.38	12.06	0.0075[a]
By age					
20-24	10.76	9.08	9.58	9.95	0.0080[a]
25-29	11.80	10.27	9.82	10.35	0.0081[a]
30-34	12.44	10.94	10.36	11.03	0.0086[a]
35-39	14.16	12.41	11.46	11.53	0.0058[a]
40-44	13.66	11.13	10.55	10.91	0.0065[a]
45-49	13.96	10.59	11.18	11.40	0.0066[a]
50-54	12.98	10.87	11.16	11.36	0.0047[a]
55-59	14.03	11.63	12.00	11.91	0.0035[a]

Note a: This is the average number of job o¤ers per day for search spells only

These missing values on the reservation wage for some of the respondents (including those who seem most disadvantaged in the labour market) could lead to misleading results in simple analyses. However, the approach taken here uses multiple observations on each respondent and identi…es the e¤ect of changes in variables by comparing reservation wages over time for one individual rather than by comparing di¤erent individuals. Thus, unobserved di¤erences in the individuals for whom reservation wages are recorded do not a¤ect the analysis in this report.

Table 3 provides an overview of the value of wages and hours in the current spell versus reservation wages and preferred hours in a previous search spell for those who are working in the current spell. For those who are searching and not working in the current spell it provides reservation wages and preferred hours versus wages and hours in the previous work spell.

Wages are on average higher than reservation wages. However, it should be remembered that wages are gross values and reservation wages are net values. Comparing wages and reservation wages on an individual level for those who are currently working, we …nd that 87 to 96 per cent of wages is higher than the previous reservation wage (allowing for a 20-cent di¤erence). Comparing preferred hours with actual hours it appears that on average the unemployed end up in jobs with fewer hours than they would like to work. However, this could be because the samples for these two measures do not completely coincide[13]. This seems con…rmed if we compare the hours worked with preferred hours in the previous spell at the individual level for workers, the table shows that 94 per cent work no more than 4 hours less than they would like to work in the …rst wave. In the second and third waves, larger proportions seem underemployed when comparing their working hours with previous preferred hours. In these two waves, 22 and 26 per cent respectively work more than 4 hours less than they would prefer to work.

5 Results

The results are divided into two parts. The …rst part deals with the reduced-form results and the second part discusses the results from the structural approach. The reduced-form …rst di¤erence models of accepted wages and

[13] With reservation wages, preferred hours are not observed for every search spell as explained earlier and some respondents may not have had a preceding search spell.

Table 3: Spell characteristics and previous spell characteristics by starting wave

spell starts in:	wave 1		wave 2		wave 3	
Variable	Mean	St. d.	Mean	St. d.	Mean	St. d.
if working in this spell						
wage	12.67	9.65	12.21	7.67	13.10	6.65
previous reservation wage1	10.82	4.42	10.92	6.02	10.36	2.90
previous reservation wage2			10.80	4.38	10.41	3.60
previous reservation wage3					10.95	3.92
if searching for a job						
reservation wage in wave 1	10.58	4.60				
reservation wage in wave 2	10.63	4.21	10.49	3.50		
reservation wage in wave 3	10.74	3.80	10.65	3.83	11.08	4.19
if not working this spell						
wage in previous spell	11.95	13.29	11.34	5.69	12.13	7.76
if working this spell						
wage>reservation wage+0.20	96%		88%		87%	
wage<reservation wage-0.20	3%		10%		11%	
wage=reservation wage+/-0.20	1%		2%		2%	
hours	31.61	14.39	30.73	13.69	30.03	14.31
previous preferred hours1	34.89	8.52	34.90	8.53	37.09	6.51
previous preferred hours2			35.91	7.69	35.93	7.42
previous preferred hours3					35.46	8.19
if searching for a job						
job o¤ers per day	0.007	0.025	0.008	0.031	0.007	0.038
preferred hours in wave 1	34.56	8.63				
preferred hours in wave 2	34.89	8.40	35.67	7.67		
preferred hours in wave 3	34.05	8.72	35.10	8.14	34.53	8.87
if not working this spell						
hours in previous spell	31.75	13.92	30.12	13.61	31.40	14.07
if working this spell						
hours>preferred hours+4	87%		59%		47%	
hours<preferred hours-4	6%		22%		26%	
hours=preferred hours+/-4	7%		19%		27%	
number of observations	11465		4122		2670	

reservation wages and the conditional model of job offers are presented in section 5.1 and the structural wage-offer model is presented in section 5.2.

5.1 The reduced-form results

5.1.1 Accepted wages and reservation wages

Table 4 presents the reduced-form fixed-effect analyses of wages and reservation wages. These first difference models provide an idea of the patterns of wages and reservation wages with time and changes in characteristics. The R^2 measure shows that little of the variation in reservation and accepted wages is explained by the characteristics. Furthermore, the t-values are generally fairly small. Only variables with a t-value of 2 or higher would represent effects that are significantly different from zero at the 5-percent confidence level.

The effects of changes in total employment and non-employment duration on wages can be derived from the rows with elapsed calender time and the rows with cumulative non-employment duration. Non-employment can consist of either unemployment or non-participation, assuming the duration of either spell has the same effect. The current situation, however, has to be employment or unemployment. Elapsed calender time is by definition equal to the change in cumulative employment and the change in cumulative non-employment. One extra year of cumulative employment and no change in cumulative non-employment translates into elapsed time being 365 (days) and cumulative non-employment being 0 days. Thus the effect of one extra year (or 365 days) of cumulative employment and no change in the cumulative non-employment duration on starting wages is calculated to be about 4 per cent (=100%£[exp(0.00011£365)-1]), as can be seen in the fourth column of Table 4.

The effect of longer cumulative non-employment is ambiguous, that is, it depends on age. One extra year of cumulative non-employment and no change in cumulative employment translates into elapsed time being 365 (days) and cumulative non-employment also being 365. The net effect of the two coefficients is positive for respondents under 30 years of age[14] and

[14] The under 30 age group is the reference group for the age dummies, included in the cumulative unemployment duration variable, which means the coefficient for this age group is implicitly set to zero.

Table 4: Fixed-effect analyses of starting wages and reservation wages on the Australian SEUP data.

	$\Delta \ln w_{it}$			$\Delta \ln \tilde{\phi}_{it}$		
Variables	coef.	t-val	effect of one unit[a] change	coef.	t-val	effect of one unit[a] change
Individual characteristics						
intercept	0.022	1.4	n.a.	-0.011	0.9	n.a.
Δ t (elapsed time)	0.00011	2.8	4.1%	0.00015	3.8	5.6%
no labour market history				-0.07	0.6	-6.8%
currently employed				0.035	1.8	3.6%
Δ (current unemployment duration)				-0.000023	1.2	-0.8%
Δ (cumulative non-employment duration)	0.00013	2.5	4.9%	-0.000011	0.4	-0.4%
Δ (current employment duration)	0.00007	4.1	2.6%	0.000035	0.9	1.3%
Δ (cum. non-em.dur.)*(30 $\cdot$ age$<$40)	-0.00014	3.0	-5.0%	-0.00011	2.1	-3.9%
Δ (cum. non-em.dur.)*(40 $\cdot$ age$<$50)	-0.00015	2.7	-5.3%	-0.000002	0.0	-0.1%
Δ (cum. non-em.dur.)*(50 $\cdot$ age$<$60)	-0.00016	2.2	-5.7%	-0.00012	1.9	-4.3%
$\sigma_{m,\phi}$				0.039		
Number of observations	5267			3713		
Number of individuals	1892			1576		
R^2	0.02			0.02		

note a: for durations (measured in days), one unit changes are changes with one year (=365 days)

The other available time-varying regressors were: previous wage, duration of last employment/non-employment spell, part-time studying, # children, have a partner, disability, hours of work, education levels, and urban housing. The shown specification includes the most relevant and significant variables: none of the other variables added significantly to the explained variance.

negative for respondents older than 30 years. That is, the contribution of the cumulative non-employment duration and the cumulative non-employment duration interacted with age is positive and negative respectively for these age groups.[15] For older individuals, wages increase faster with the duration of employment than with non-employment. For example a 60-year old individual may expect a 1.1 per cent lower increase in wage after one year spent in non-employment rather than employment. Given that one year of cumulative employment delivers a 4.1 per cent wage increase, this would actually mean a 3.0 per cent increase in the nominal wage after one year in non-employment. However for younger individuals (between 20 and 30 years old), wages may increase faster with non-employment than employment. For example a 20-year old respondent has a 4.9 per cent higher increase in accepted wages if one year of elapsed time is spent in non-employment rather than in employment. If the additional days of employment occur in a current spell the di¤erence between the two scenarios is smaller at about 2.3 per cent. This suggests that the loss of skills is not an important factor for younger individuals, the e¤ect being positive or small, but may be relevant to some extent for older individuals. An explanation for this may be that people under 30 years of age are at the start of their career and it is perhaps more accepted for them to have a non-employment spell (perhaps to travel or to study and in that way gain additional human capital) whereas for older groups it is more likely to cause a break in their career path which needs to be explained to prospective employers. Using a …xed e¤ects model, Gray (2000) …nds that unemployment generally has a negative e¤ect on the hourly wage of young Australians, although this e¤ect is mostly insigni…cant (except for durations of unemployment of more than one year). A possible explanation for the di¤erent result found in this report is that the non-employment spells can include non-participation spells as well as unemployment spells and we compare accepted wages over time for the same individual, whereas Gray compares between individuals.

For individuals who remain employed, we see that the tenure e¤ect, as measured by the e¤ect of increases in current employment, is about 2.6 per cent per year (100£[exp(365£0.00007) ¡ 1]). This wage gain is lost when individuals become unemployed and hence is likely to be related to …rm-

[15] The breakeven point, where the net e¤ect of an extra year of cumulative unemployment on starting wages is the same as an extra year of employment, when age is speci…ed as a continuous variable (see the draft version of this report) occurs at age 35. Thus the continuous and discrete age speci…cation of the model seem to lead to similar results.

speci…c human capital investments. Compared to the consensus estimates in the literature (as reported in, for example, Borjas 2000) this is a rather high number which may re‡ect the fact that during the sample period the economy was moving upwards through the business cycle.

From the second column in Table 4, we see that reservation wages are about 3.6 per cent higher for the employed than for the unemployed with similar characteristics, which is as expected. As to the e¤ect of durations a more complex picture arises, with the most signi…cant negative e¤ects observed for the 30 to 40 age group and the 50 to 60 age group. In this equation, a clear di¤erence with the continuous speci…cation of age is obvious, since this pattern could not have been adequately represented by a linear age e¤ect. The e¤ect of extra cumulative non-employment is negative for everyone.[16] The e¤ect is not signi…cant for everyone, given that the cumulative non-employment variable by itself is highly insigni…cant and the interaction term is only signi…cant for the 30 to 40 age group and the 50 to 60 age group. However the e¤ect is as expected, with a somewhat larger negative e¤ect of non-employment duration for older individuals than for younger individuals. This points to a possibly more serious decrease in human capital with longer non-employment spells for older individuals than for younger unemployed, although there is a counterintuitive lower decrease for 40 to 50 year old persons. From the coe¢cients it can be calculated that a 20 year old individual is expected to have -0.4 per cent lower reservation wages after one year of non-employment than would otherwise be the case, whereas for a 40 year old person the expected decrease is -4.3 per cent and for a 60 year old person this is -4.7 per cent.

Examining the e¤ect of current durations, we see that current unemployment (which may also include non-participation spells if they occurred previous to the unemployment spell without an intervening employment spell) has a slightly negative e¤ect on the reservation wage (about 0.8 per cent per year), whilst an extra year of current employment increases reservation wages by about 1.3 per cent a year (these two e¤ects are insigni…cant however). Overall, the results suggest that reservation wages, which re‡ect expected lifetime values, do not seem to decrease much with time spent in non-employment for young unemployed. Thus, no serious loss of skills seems to occur in young individuals when they are unemployed. However, this does not necessarily

[16] In the linear age speci…cation it was negative for everyone over 13 years of age (see draft version of this report), which was everyone in this sample.

mean that job-…nding rates or wage o¤ers do not change over time. To be more conclusive on this, we need the results of the structurally estimated elements of the model including the wage o¤ers (instead of only the accepted wages).

Finally, the dummy variable "no labour market history" indicates those respondents who claim not to have had any employment spells before the start of the survey. Not having had any employment spells is plausible for young individuals who just left school, however to account for the missing information in the (majority of) other cases, the "no labour market history" variable is included. It is clear from the table that this variable has no signi…cant e¤ect.

5.1.2 Job-o¤er arrival rate

In Table 5, we present the results of the conditional …xed-e¤ect logit model for the job-o¤er arrival rate. The easiest interpretation of the numbers in this model is a relative marginal e¤ect interpretation: view them in the context of an individual who has had 1 job o¤er in the entire period. For such an individual, the coe¢cients correspond directly to the relative probabilities. If we take the point estimate of 0.06 for those with a partner, this would mean that in a month with a partner, the probability that this individual receives a job o¤er is $(e^{0.06} - 1) \times 100\% = 6.2\ per\ cent$ higher than in a period without a partner. However, this estimate is insigni…cant and we cannot rely on the value too much.

An important e¤ect apparent from the table is that job-o¤er arrival rates are much higher for the employed than for the unemployed, whereby the rates are signi…cantly higher for those with higher wages. For example, the point estimate for an individual with a mean log-wage, which is about 3 corresponding to a wage level of about $20 per hour, is 0.72[17]. Thus the probability of getting a job o¤er is about twice as high in employment as in unemployment for this particular person (calculated by $(e^{0.77} - 1)100\% =$ 116 per cent increase in relative probability) .

As to the baseline e¤ects, we see that there are strong business cycle e¤ects. That is, in the second year, job o¤ers are about 57 per cent more likely than in the …rst year, whilst job o¤ers become nearly three times more

[17] This can be calculated from table 5 using all the coe¢cients relating to current employment and previous wages: $0.51 + 3 \times 0.085 = 0.77$.

Table 5: Fixed-e¤ect analyses of job-o¤er arrival rates in the Australian SEUP data.

	λ_{it}		
Variables	coef.	t-value	e¤ect of one unit[a] change
elapsed time	0.0001	0.5	3.7%
no labour market history	-0.076	0.7	-7.3%
currently employed	0.51	11.9	67.0%
(currently employed)*ln(wages)	0.085	1.1	8.9%
¢ ($current$ unemployment duration)	-0.0002	2.7	-7.0%
¢ ($cumulative$ non-employment duration)	-0.0028	15.4	-64.0%
¢ ($current$ employment duration)	-0.0016	9.8	-44.2%
ln(previous wages)	-0.014	0.3	-4.1%
part-time study	-0.0086	0.1	-0.9%
number of children	-0.054	0.8	-5.3%
disability	0.10	1.3	10.5%
partnered	0.06	0.4	6.2%
t>365	0.45	6.7	
t>730	0.60	8.6	82.2%
Number of observations	2508		
Number of individuals	2266		
Average Likelihood	-5.33516		

note a: Relative marginal e¤ects in the context of an individual with one job o¤er in the entire period. Durations are measured in days, one unit changes in durations are changes with one year (=365 days)

There were 242 individuals for whom S contained more than 40000 entries and who were split up.

likely in the third year compared to the …rst year. This e¤ect is consistent with the upwards trend in the economy over the survey period.

Apart from these baseline e¤ects, we see strong negative e¤ects of increasing cumulative non-employment: an extra year of non-employment translates to a reduction in the probability of getting a job o¤er of about 64 per cent, which is a large decrease. Current employment and unemployment duration also have strong negative e¤ects. Combined, the results on durations suggest strong decreases in job-o¤er arrival rates with employment and unemployment durations. Note that these results are obtained by looking only at the periods when individuals report to be searching and include …xed e¤ects, which means they should not be tainted by selectivity problems.

The e¤ects of the duration of unemployment are stronger than those of employment, not only are the job-o¤er arrival rates lower to start with in unemployment, but they decrease faster over time as well. The structural interpretation would be that there is a large loss of job-…nding skills. The e¤ects are so strong however, that we suspect it is also possible that the unemployed become more selective in the types of jobs they search for over time.

The e¤ect of individual characteristics is very small, which re‡ects the fact that all relevant time-invariant characteristics are di¤erenced out. From the weak e¤ects of having a partner, having a disability (which against expectations is positive although insigni…cant), the number of children, and whether individuals study part time, we surmise that the …xed e¤ects take account of the majority of individual factors.

5.2 Structural model results

The advantage of using the structural model is that it combines several pieces of information to reconstruct the unobserved wage o¤ers, since we only observe wages for accepted job o¤ers. The actual wages associated with these accepted o¤ers are only a selection of all o¤ered wages. Those for whom wage o¤ers decrease over time are for instance more likely to stop searching for jobs and become non-participants. Rejected wage o¤ers are not observed in the data, which is why actual changes in wages underestimate the e¤ect of unemployment on wage o¤ers. The structural framework allows us to use the information on rejected job o¤ers, that is, it informs us that the rejected job o¤ers o¤ered a wage below the reported reservation wage. Combining

the information on reservation wages, rejected job offers and observed wages for accepted job offers, allows us to determine the complete wage-offer distribution.

In Table 6, we present the estimates for the determinants of the wage-offer distribution. The first column contains the preferred final specification. The results are directly interpretable as marginal effects. For instance, the coefficient of 0.036 on whether one has a partner means that those with a partner obtain about 100£(0.036) = 3.6 per cent higher wage offers than those without a partner. Such an effect of being partnered is often found for wages of married men, the so-called marriage premium.

The measurement errors in wages appear to be of nearly equal importance in this model as unobserved transient 'true' wage errors. This seems reasonable, given the large problems in measuring wages in this data set and given the fact that there is more to jobs than wages alone. Compared to the results in other structural models with wage measurement errors (for example, Ridder and Van de Berg 1998), the relative contribution of measurement error is low, indicating a reasonable fit of the model to observed wages. We attribute this fit to the fact that the fixed-effect method accounts for most of the unobserved heterogeneity.

Previous wages do not affect current wage offers very much. A change from about \$7.38 to \$20.09 in previous wage (which is a change from 2 to 3 in the logarithm of the previous wage) is necessary to produce a 1.7 per cent increase in the expected wage offer. Combined with the finding in Table 5 that previous wages have no significant effect on job-finding rates, we cannot reject the assumption that higher wages have a negligible effect on future labour market outcomes.[18] The mere fact that previous wages have little effect on current wages again indicates that the fixed-effect method captures most of the relevant time-invariant characteristics and that the included time-varying characteristics capture the most important time-varying mechanisms.

The effect of time-varying individual characteristics is not large, but confirms expectations. Individuals who become disabled receive about 3.3 per cent lower wage offers. Recalling that disability had no negative effect on job-offer arrival rates, we conclude that the effect of disability is minor. Those

[18] This assumption was necessary for the existence of a reservation-wage strategy on which this model is based. From these findings on previous wages it seems a reservation wage strategy is indeed the optimal strategy.

Table 6: Fixed-e¤ect analyses of the wage-o¤er distribution

	mean log wage o¤er	
Variables	coef.[a]	t-val
intercept	0.092	3.6
calender time in survey (t)	0.00035	6.9
no labour market history	0.054	2.6
currently employed	-0.090	5.4
¢(cumulative non-employment duration)	0.00015	7.0
¢(current unemployment duration)	0.000063	4.5
¢(cum. non-em.dur.)*(30 · age<40)	0.000069	12.5
¢(cum. non-em.dur.)*(40 · age<50)	0.000037	7.0
¢(cum. non-em.dur.)*(50 · age<60)	-0.000049	7.4
urban	0.023	2.6
ln(previous wage)	0.017	2.0
part-time study	-0.011	0.7
number of children	-0.022	4.5
30 · age<40	-0.055	3.7
40 · age<50	0.0031	0.2
50 · age<60	0.28	16.8
disabled	-0.033	3.5
partnered	0.036	3.6
tertiary education	-0.053	4.0
vocational education	-0.056	5.1
…nished secondary school	-0.038	3.0
in second wave (t>365)	0.0091	0.5
in third wave (t>730)	-0.12	6.1
$\sigma_{m,w}$	0.25	139.9
σ_w	0.29	100.7
Number of observations	4553	
Number of individuals	1624	
Average Likelihood	-1.19151	

# of rejected job-o¤ers: 2713; # accepted job-o¤ers: 1841. The reference individual is single, no extra education, non-urban, healthy, aged between 20 and 30, just unemployed, in 1994.

note a: marginal e¤ect of one unit change is simply 100%£(estimated coe¢cient)

who have a partner are o¤ered 3.6 per cent higher wages, whilst those with one extra child are o¤ered 2.2 per cent less. The premium for living in an urban area is about 2.3 per cent. Studying part-time reduces wage o¤ers by 1.1 per cent. Combining these wage-o¤er results with the job-o¤er arrival rate results, it seems that only the presence of children has a clear negative e¤ect on human capital, which is however insigni…cant for the job-o¤er arrival rate.

The age-e¤ects, which indicate that the older earn more (with the exception of the youngest age group), are likely to pick up the e¤ects of accumulated human capital relevant to the labour market. They closely re‡ect what is usually found in the literature.

The strongest results are the e¤ects of durations. The e¤ect of elapsed time, which is by design equal to the e¤ect of increasing cumulative employment duration, is to increase wage o¤ers by about 13 per cent a year in the …rst two years. In the third year, wage o¤ers decrease relative to the second year and return to nearly the same level as those in the …rst year (this is the result of the estimated e¤ect of the indicator variable for the current wave).

Increases in cumulative non-employment have a large positive impact on wage o¤ers. An extra year of non-employment increases wage o¤ers by an average of 5.6 per cent over and above the e¤ect of time. For those aged between 30 and 40, this increase is even bigger, that is, about 8.3 per cent a year. For those above 50, the increase is smaller, that is, about 3.8 per cent a year. An increase in the duration of current unemployment further increases wage o¤ers by over 2 per cent a year. Adding these together, a young individual who is unemployed for a whole year obtains 8.1 per cent higher wage o¤ers after this year of unemployment compared to a similar individual who was employed during that whole year.

This total e¤ect of unemployment is large and counter-intuitive, although there is some evidence from Le and Miller (1999), which indicates a similar effect on earnings in a cross-sectional analysis of the SEUP[19]. However, the non-employment duration e¤ect is consistent with the reduced-form analyses on wages and reservation wages in Table 4, where cumulative non-employment had a negligible negative e¤ect on 'raw' starting wages and reservation wages for most respondents. Yet, job-o¤er arrival rates decrease strongly with longer cumulative non-employment. This only …ts the structural model if

[19] Le and Miller …nd a 1 per cent increase in earnings per year of looking for work since leaving full-time education for the sample of Jobseekers in the 1995 wave of the SEUP. The e¤ect is stronger when only looking at men.

the mean wage o¤er increases sharply with cumulative non-employment.

There is a possibly straightforward explanation for this large increase in wage o¤ers with non-employment. The time period of the survey is one where there was an active policy of providing large wage subsidies to the longer-term unemployed. Those who were unemployed for about 6 months obtained wage subsidies of about 120 dollars per week, rising to about 220 dollars per week extra for those unemployed longer than 18 months. As the median wage for the longer-term unemployed in this period is about 300 dollars per week, this wage subsidy amounted to roughly 50 per cent of the wage per year of unemployment (because 100%£220/(1.5*300)¼50%). Although not all the unemployed in our sample who obtained a job will have received these wage subsidies, it is clear that these large subsidies may provide an explanation for the large increase in wage o¤ers seen in this period. In fact, the results may be an indication of the e¤ect of those policies.

The CURF version of the data, used in this analysis, unfortunately lacks information on subsidy recipiency. Furthermore, we use self-reported unemployment in the analysis, which is likely to diverge from the administrative de…nition of unemployment used by the implementers of the wage subsidy program. Therefore, we can do little more than roughly approximate what the e¤ect of unemployment on wage o¤ers would have been without these wage subsidies. Consider the case in which the wage subsidies have maximum e¤ect and assume that in our sample the take-up rate of these subsidies is about 50 per cent, which would be quite high. Let us also, for the sake of this exposition, assume that half of these wage subsidies (which were paid to the employer) were passed on to workers in the form of higher wages, which is also a high estimate. These wage subsidies would then, for the median person, account for a wage increase of 12.5 per cent per year of unemployment. This would more than explain the e¤ect of cumulative and current unemployment on wage o¤ers found in this section. Depending on the market wage of the unemployed individual, the 'wage-subsidy-free' e¤ect of unemployment would seem to be around zero and maybe slightly positive.

Hence, the …ndings do not support the idea that the unemployed are receiving substantially lower wage o¤ers over time, even if we account for the wage subsidy programs in this period.

6 Summary and conclusions

In this paper, we have used a unique Australian panel data set to analyse the changes in reservation wages, the job-o¤er arrival rate and the wage-o¤er distribution. The …rst main …nding is that the job-o¤er arrival rate decreases strongly with longer non-employment but that wage o¤ers do not decrease with non-employment duration. This result not only arises from the structural model, but it is also consistent with the raw data. These …ndings are identi…ed by observed job o¤ers which decline in frequency with (un)employment duration, whilst accepted wages increase with non-employment for individuals under 30 years of age and only decrease slightly for those over 30 years, and reservation wages decrease with non-employment duration.

The increasing wage o¤ers with non-employment duration can to a large extent (if not fully) be explained by the introduction of labour market programs in 1994, which provided employers of long-term unemployed with substantial wage subsidies. The SEUP CURF does not allow us to identify respondents for whom a wage subsidy was paid. A rough calculation of the average wage subsidy, however, seems to be at least of a similar size as the wage increase for longer-term unemployed. This interpretation would indicate that the wage subsidies work, that is, unemployed obtain jobs under the wage subsidy scheme and the wage the employer needs to o¤er is the wage paid to the employee minus the subsidy. This means the true unobserved wage-o¤er distribution increases much less or perhaps even decreases with unemployment duration.

An alternative interpretation, if the above is not believed to be a su¢cient explanation of the positive e¤ect of non-employment duration, is the 'productivity' interpretation of these …ndings. In this interpretation, there is no loss of production skills due to non-employment, though there is a loss of job-…nding skills. From a distributional point of view, it means this paper does not support the necessity of continuous employment, since there seems to be no signi…cant lock-in e¤ect of being unemployed or a non-participant in terms of future wage outcomes. However, it may become more di¢cult to receive a job o¤er once the duration of unemployment becomes longer. This explanation however seems implausible, since it would imply that the unemployed gather new skills at a higher rate than the employed

Another alternative explanation of the main …nding is that individuals who are unemployed become more selective over time in the type of job o¤ers

they solicit. That is, the unemployed seem to experience a fast decrease of lower-paying job o¤ers, yet do not become less productive while unemployed. From the fact that reservation wages decrease with unemployment, in particular for older unemployed individuals, it follows that lower-paid jobs are not necessarily rejected, rather that they no longer …nd or search for them after a longer time of unemployment. It could be the case that those who have been unemployed for a long period of time get discouraged with looking for lower-paid jobs and want to move on to other types of jobs. Alternatively, long-term unemployed have uno¢cial and unobserved low-paid jobs (including home production) which means they no longer consider searching for low-paid jobs in the o¢cial labour market.[20] Finally, the employment of individuals, who search for a job, may be of an "inferior" quality and the work experience in it may not contribute to the wage level in the same way other employment would do.

From the relatively small decrease in reservation wages for most individuals, we can conclude that the net e¤ect of unemployment is not large in the sense that this would lead to a large decrease in the value of being unemployed. For older individuals the decrease in reservation wage indicates some loss of skills due to unemployment and this loss in skill seems mainly re‡ected in a decreasing ability to …nd jobs with an increase in the unemployment duration.

A second main …nding in the paper is that job-o¤er arrival rates are much higher for the employed than for the unemployed. This holds especially for individuals in higher paid employment. Taken at face value, this would imply that unemployment bene…ts as a search subsidy are counterproductive. The best way to …nd a new job according to the results here is to keep the old job (if that is an option of course), especially when one is paid well. Possible explanations for this are that the employed have access to employment networks and that they may have signalling advantages. The fact that they are already employed is likely to in‡uence a prospective employer's decision

[20] We note that the 'search-selectivity' interpretation of the results does have support in the current theoretical and empirical literature. Coles and Smith (1998) argue that the large drop in exit rates from unemployment to employment is a sign that the unemployed consciously search for di¤erent jobs over time. They term this 'stock-‡ow matching'. Their best evidence is that the hazard of leaving unemployment for the long-term unemployed does not depend on the number of available vacancies, but does depend on the number of new vacancies. They argue this indicates that the longer unemployed only search for new jobs and do not use the current stock of available vacancies.

positively.

Other …ndings are that the presence of a self-reported minor disability seems to have little e¤ect on labour market outcomes; that those who stop searching for jobs are a selective subset of all individuals; and that serious job o¤ers in this period arrive fairly infrequently, that is, about once every four months for the typical unemployed person and once every two months in employment for this same person.

The policy implications from this paper are threefold:

1. Unemployment bene…ts as a search subsidy are counter-productive, because job o¤ers arrive faster in employment than in unemployment, even for low-paid jobs. Hence, ensuring a good match between workers and jobs is best achieved by encouraging search in employment. It does not seem to be the case that unemployed individuals can search more e¢ciently than employed individuals.

2. There is no evidence for a large loss of production skills of the unemployed, which means that from a distributional point of view there is no aggravation over time in the position of the unemployed. No evidence is found for a 'slide to the bottom' in terms of wages for those unlucky enough to have become unemployed. Conversely, this means that the main determinants for low expected wage o¤ers are initial individual characteristics, which are unknown for some part. The cause of the inequality in these initial characteristics was not the focus of this paper.

3. The e¤ects of disability on labour market opportunities seem limited. That is, wage o¤ers go down with 3.3 per cent for those that become disabled, but job-o¤er arrival rates do not decrease signi…cantly. These e¤ects are identi…ed by the behaviour of individuals whose disability status changed over the three survey years. These transient disabilities are likely to be milder forms of disability which means their e¤ect cannot be extrapolated to the e¤ects of severe and more permanent disabilities.

7 Discussion of caveats and alternative specifications

The results in the paper need to be qualified by the following two caveats:

1. It would be tempting to conclude from the analysis that unemployed individuals increasingly refuse lower-paid jobs over time. This would fit the increases in observed wage offers and the decrease in job-offer arrival rates for longer-term unemployed. However this interpretation of the results is rejected on internal consistency and theoretical grounds, since it would not be consistent with the observed reservation wages because these actually decline with unemployment duration for older individuals (and to a lesser extent also for younger individuals). Thus the reservation wages show that the unemployed are not more reluctant to accept jobs. Together with the other results, a more consistent interpretation of the results is that the long-term unemployed no longer actively search for low-paid jobs, partly because of the wage subsidies in this period. The difference in these two interpretations may seem subtle, but is quite important when we think of policies that rely on individuals accepting proposed jobs. In the case that individuals refuse to accept low-paid jobs, the setting up of programs that create more low-paid jobs makes little sense, whereas such programs could be helpful in the case where individuals would not refuse such jobs although they are not actively searching for them. This example illustrates that the interpretation of the results is not straightforward and requires care. The strong emphasis we place in the interpretation on the joint consistency of the outcomes for the three main variables (wages, reservation wages and job offers) aids the interpretation, since it is based on theory.

2. As in all empirical work, making the data suitable for analysis required a substantial amount of attention. Data cleaning involves a number of debatable decisions that could potentially affect the outcomes. We have done our best to make the most plausible assumptions, which we outline below. The three most important data issues were the imputation of incomes, dealing with the number of hours worked, and the definition of the durations. Dealing with these issues in order:

    [2] Wages were not reported as the exact amounts, but were reported in 29 categories for the accepted wages and 30 categories for the

reservation wages. These categories run from 1-79 dollars per week, 80-119 dollars per week, 120-159 dollars per week up to 1120-1159 dollars per week and …nally over 1160 dollars per week. The only di¤erence between the categories for reservation and accepted wages is that the reservation wages have one additional category for the lowest range which is subdivided into 1-39 and 40-79 dollars per week. For the analyses, we needed a continuous measure. Hence we used an interval-regression technique to replace the observed income category with the expected income (within the stated category) given nearly all available observable characteristics. We used over 30 variables for this prediction. In this case, the more endogenous with income, the better it is for the purposes of prediction. Apart from the close …t in the imputation models for the wages, the structural model, which uses the imputed values, actually allows for measurement errors, which means we have covered the income-category problem to the best of our ability.

[2] The model uses hourly wages as the relevant income concept. We found out however that stated hourly incomes were higher (given all other characteristics) for lower number of hours worked[21]. This is an unexpected e¤ect. After conditioning on occupation, tenure, gender, education, and industry, one would not expect any (negative) e¤ect from working more hours. The most likely explanation for this is that people with a low number of hours are more likely to be casual workers and thus do not get fringe bene…ts, such as paid leave, superannuation, Christmas bonuses and the like. Essentially, the stated hourly income for low-hours workers probably re‡ects total hourly wages. This is unlikely to be the case for those that work more hours, their incomes are unlikely to include fringe bene…ts. An under-reporting of incomes for full-time workers is actually a recurring phenomenon in survey data (individuals on average report up to 10 per cent lower total incomes than that their employer reports for them or than the amount which ap-

[21] In the logarithm of the wage equation, the coe¢cient for hours worked is equal to -0.009. This corresponds to results found in the 1994/1995 to 1997/1998 Income Distribution Surveys, where the "hours worked" coe¢cient ranges from -0.003 for sole parents, to -0.007 for single women, and -0.0166 for married men.

pears on their tax records. See on this issue for instance various chapters in Blundell et al. 1994). We however needed comparable hourly incomes because individuals sometimes change their number of hours over time. Therefore, we interpreted the e¤ect of hours worked on hourly wages as under-reporting and corrected for this by increasing hourly wages according to the number of hours worked, using the coe¢cient estimated for hours worked in the wage equation. Through this procedure, hourly incomes for full-time earners were increased by about 9 per cent. We feel this is the most plausible interpretation of the hours of work phenomenon and that correcting for this by in‡ating hourly incomes for high-hour workers is the best possible response. Leaving the data as it is, would in our opinion have led to serious distortions.

- Wages are measured before tax, whereas reservation wages are measured after tax. Heath (1999) observes that this may have confused respondents, making measurement errors more likely. When comparing the reservation wages with the wages of working individuals who are also searching for a job, we …nd that the reservation wage is on average lower than the wage. In about 35 per cent of all the cases, where both a reservation and an accepted wage are observed at the same time, is the reservation wage at least 20 per cent lower than the accepted wage (this is around 55 per cent when reservation wages are only required to be 5 per cent lower). This is as expected if reservation wages are measured as a net amount and wages as a gross amount. However on the other hand, we …nd that in many cases the values are comparable indicating that respondents may have used the same measure for the two types of wages. In about 14 per cent of all the cases where both a reservation and an accepted wage are observed at the same time are they within 5 per cent of each other. This leaves around 30 per cent of the reservation wages which are more than 5 per cent higher than the accepted wages.

- When looking at the e¤ect of the duration of spells on wages, job-o¤er arrival rates and reservation wages, an important question is which type of spells need to be considered. One can think of the duration of search spells, the duration of employment/non-employment spells, or the duration of some other de…ned state.

The essential question here is the de…nition of the state space. We choose, largely on the basis of convention in the literature, to de…ne only two states, that is, employment and non-employment, and to derive the durations accordingly. The current duration of employment is then for instance the time spent since the last non-employment spell until the point in time of interest. This point in time is the moment the endogenous variable is measured, which could be the job o¤er, the wage, or the reservation wage. The cumulative durations are de…ned in a similar manner. Implicitly this means we make no distinction between the e¤ects of non-participation versus unemployment on wages and job-o¤er arrival rates. Although being a non-participant or being unemployed is allowed to be selective and endogenous, the e¤ect of being in either state on wage o¤ers, reservation wages and job o¤ers is assumed to be the same. This can be defended by pointing out that job o¤ers and wage o¤ers must depend on the veri…able information available to the employer. Because the employer will have di¢-culties verifying the actual way in which time out of employment is spent, it seems reasonable to assume that the employer treats all time out of employment the same. A similar argument can be made for assuming that the e¤ects of employment duration are the same, independent of whether an individual searched for a job during employment or not. Non-participation is hence a state we allow as an endogenous state to which individuals can ‡ow, but its e¤ect on the endogenous variables is assumed to be the same as unemployment. These are important debatable choices because they de…ne what durations are examined and hence the applicability of the results. The interest of the results depends on what the reader sees as reasonable states to look at.

2 There are an in…nite number of di¤erent possible model speci…-cations and there is only limited time to try them[22]. This means that not all avenues have been completely explored and that it remains possible that we are missing some important elements. The way in which we tried to minimise this possibility was to

[22] It costs about a day of computing time to calculate a di¤erent speci…cation for the wage-o¤er distribution and another day to try a di¤erent speci…cation for the job-o¤er arrival rate.

use very simple reduced-form analyses at …rst (cross-tabulations; simple least-square analyses; using only a subsample of the data; etc.). After this exploration, those variables that seemed most important from a theoretical and statistical point of view were used in the structural analyses. After observing that the duration variables were most important in the results, several di¤erent speci…cations with these durations were tried (we tried using previous durations; we tried normalising durations to some number at the start of the sample to make sure we were not picking up some e¤ect of things that happened before the sample).

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Appendices

A Glossary of technical terms

baseline e¤ects: the relation between calendar time and the variable of interest (the job-o¤er arrival rate in this case).

disability: a self-reported physical or mental ailment that a¤ects work performance.

duration: the time period between two states.

employment: self-reported state in which one has paid employment.

endogenous variable: the variable that is to be explained.

exogenous variable: a variable that is used to explain outcomes.

…xed e¤ects: individual characteristics that do not change over the labour market life of an individual.

human capital: the set of individual characteristics that in‡uence lifetime employment and wages.

job-o¤er arrival rate: the probability of receiving a job o¤er in a given month.

non-employment: the self-reported state of being without a paid job, thus it includes non-participation and unemployment.

non-participation: the self-reported state of being without and not searching for a paid job.

reservation wage: the hourly wage an individual minimally wants before accepting a job o¤er.

unobserved heterogeneity: individual unobserved characteristics, which are believed to be of importance for the variable of interest (for example, the e¤ect of motivation on the wage level).

unemployment: the state of being without a paid job but (self-reportedly) searching for one.

wage-o¤er distribution: the set of probabilities attached to a range of hourly wages, which an individual could possibly be o¤ered.

truncated wage-o¤er distribution: when only wage o¤ers above or under a particular wage level can be observed (in this case above the reservation wage) so only part of the wage-o¤er distribution is observed.

B A more formal presentation of the theoretical model

In many instances only a reduced form equation of exit from employment or unemployment can be estimated because there is no separate information on job search intensity, job o¤ers, acceptance of job o¤ers or reservation wages. In these cases the separate components of the hazard rate can not be disentangled. Here however we have job-o¤er information and we observe reservation wages and wages. As a result we can decompose the hazard rate out of unemployment θ into two components, the job-o¤er arrival rate $\lambda(h(t))$ and the wage-o¤er acceptance rate 1-$F_t(\phi_t|h(t))$:

$$\theta = \lambda(h(t)) * (1 - F_t(\phi_t|h(t)))$$

Here, $h(t)$ is a function of previous labour market outcomes where an individual is of age t. The history of an individual includes the current state of employment or unemployment, which means the job-o¤er arrival rate can di¤er for the same individual over states. Furthermore, it is assumed that only individuals who search obtain job o¤ers at a rate $\lambda(h(t))$. Job o¤ers are accompanied by a wage o¤er w, which is drawn from the wage-o¤er distribution $F_t(.|h(t))$. ϕ_t is the reservation wage which is the minimum wage level an individual is willing to accept.

Individuals have to decide whether or not to accept a wage o¤er and can at any time decide to go into non-participation. Unemployed individuals obtain a bene…t level b which includes the disutility of searching. Individuals face a common discount rate ρ (so all future income can be expressed in the present value) and they are assumed to be rational expected-income maximisers. A necessary assumption for the existence of an equilibrium is that there is some age T after which the job-o¤er and wage-o¤er functions λ and F_t are known constants. This could be, for example, a compulsory retirement date after which λ and F_t are zero.

It is useful to note that only for the purposes of the model are $\lambda(h(t))$ and $F_t(.|h(t))$ taken as given. In reality there is no reason to think that $\lambda(h(t))$ and $F_t(.|h(t))$ are purely exogenous from the point of view of the individual. It may well be the case that that they themselves are the optimal choices amongst a set of λ and F_t. It does seem likely that job-o¤er arrival rates and wage o¤ers are to some extent in‡uenced by the type of jobs that individuals apply for. A job searcher can either spend time searching high-wage jobs, which presumably arrive only infrequently, or search for low-wage jobs, which presumably arrive more frequently. This possibility is called endogenous search selectivity (also known as stock-‡ow matching by Petrongolo and Pissarides 2001). It is beyond the present state of the art to solve a model allowing for endogenous search selectivity. However, we allow in the interpretation of the results that $\lambda(h(t))$ and $F_t(.|h(t))$ are a chosen optimal combination. This means that changes in observed $\lambda(h(t))$ and $F_t(.|h(t))$ do not only re‡ect changes in job-…nding skills and marginal productivities but could also re‡ect changes in search selectivity.

The model is based on the assumption that individuals maximise their lifetime utility, which depends on wages, reservation wages, bene…t levels, and employment history. The formal model, which is an extension of the Van den Berg (1990) non-stationary job-search model, is described and solved in appendix C. The solution equation is fairly intractable. The main computational problem is that the number of possible reservation wage paths explodes over time, with all the possible combinations of employment and unemployment spells over time. Such a di¤erentiable dynamic problem has not been solved anywhere yet in the literature and all current models have had to reduce the state-space somehow to ensure computational tractability (see for example, Rust and Phelan, 1997; or Keane and Wolpin, 1997).

Fortunately, with the available data set the two main underlying functions we are interested in, λ_t and F_t, can be estimated without a closed-form solution to the structural model. Other authors (for example, Bontemps et al., 2000) have followed a similar approach of presenting estimations of underlying functions without providing closed-form solutions to the structural model.

By directly observing whether an individual, who is searching for a job, obtains a job o¤er, the determinants and changes in the job-o¤er function λ_t can be directly analysed without solving other aspects of the model. In this approach, it is crucial to know whether an individual engages in active job search, that is, is not in non-participation, because the choice to go into

non-participation is endogenous and highly selective (as shown empirically by Frijters and Van der Klaauw, 2001). Therefore, if it were unknown whether someone actually searches, empirical data on job o¤ers would be tainted by selectivity problems.

We can identify F_t indirectly, because rejected wage o¤ers w_t^{rej}must be lower than the reservation wage ($w_t^{rej} < \phi_t$) and accepted wage o¤ers w_t^{acc}must be higher or equal to the reservation wage (w_t^{acc} ¸ ϕ_t). By directly observing reservation wages and accepted wages, we hence have some information with which to identify changes in the wage-o¤er function F_t that do not require the calculation of the reservation wage path. However, not everything about F_t is identi…ed, because the left-hand tail of F_t (containing the lower wage o¤ers) could have any arbitrary shape without being in con‡ict with the observed reservation wages or accepted wages. Only the part of F_t corresponding with values larger than ϕ_t can be identi…ed, which means some functional form assumptions on the distribution function F_t are indispensable in the actual estimation of F_t.

C Background model

In this appendix, the extended version of the non-stationary job-search model of Van den Berg (1990) used in this paper is described and solved formally. The Van den Berg model itself can be understood as an extension of the structural model of Flinn and Heckman (1982).

First, we de…ne the main components of the model. Suppose individuals can be in three labour market states; employment (e), unemployment (u), or non-participation (n). Non-participation is an absorbing state (that is, individuals cannot exit this state once they have entered it) in which individuals no longer search for jobs. This state pays a constant ‡ow utility of u_{np} for the rest of an individual's life time. Individuals who search obtain job o¤ers at a rate $\lambda(h(t))$. Here, $h(t)$ is a function of previous labour market outcomes where an individual is of age t. The history of an individual includes the current state of employment or unemployment, which means the job-o¤er arrival rate can di¤er for the same individual over states. Job o¤ers are accompanied by a wage o¤er w, which is drawn from the wage-o¤er distribution $F_t(.|h(t))$. Individuals have to decide whether or not to accept a wage o¤er and can at

any time decide to go into non-participation. Unemployed individuals obtain a bene…t level b which includes the disutility of searching. Individuals face a common discount rate ρ (so all future income can be expressed in the present value) and they are assumed to be rational expected-income maximisers. A necessary assumption for the existence of an equilibrium is that there is some age T after which the job-o¤er and wage-o¤er functions λ and F_t are known constants. This could be, for example, a compulsory retirement date after which λ and F_t are zero.

The structural model is characterized by the following assumptions:

1. For each $t \geq 0$, the wage o¤er distribution has the following properties: (i) $F_t(w|h)$ is a continuous function, which is strictly monotonically increasing on the support $h\alpha(t), \beta(t)$i (with $0 \leq \alpha(t) < \beta(t) \leq 1$), (ii) $F_t(\alpha(t)) = 0$, (iii) $\lim_{w \uparrow \beta(t)} F_t(w|h_w) = 1$, and (iv) the mean is bounded. h_w is a known function of previous wages and previous job and unemployment durations.

2. For each $t \geq 0$, the job o¤er arrival rate $\lambda(t|h_\lambda)$ satis…es $0 \leq \lambda(t|h_\lambda) \leq K$ for a …xed $K < 1$. Also, the bene…ts level while being unemployed, $b(t)$, satis…es $0 \leq b(t) \leq K$.

3. At each $t \geq 0$ an unemployed worker has the option of moving into the absorbing state of nonparticipation, where the utility value equals u_{np} from then on.

4. Except for only a …nite number of points (possibly 0), $F_t(w|h_w)$, $\alpha(t)$, $b(t)$ and $\lambda(t|h_\lambda)$ are continuous functions of t. If a function is discontinuous in a point, say at $t^¤$, then it is right-continuous and the left-hand limit of this function at $t^¤$ exists.

5. (death) On $[T, 1$i for some positive T, the exogenous functions $F_t(w|h_w)$, $b(t)$, $np(t)$, and $\lambda(h_\lambda)$ are constant and no longer depend on h_w or h_λ.

6. The discount rate ρ satis…es $0 < \rho < 1$.

7. At each $t \geq 0$ an employed worker can be hit by unemployment at a constant rate δ.

The functions h_w and h_λ are de…ned such that $\lambda(t|h^¤) \geq \lambda(t|h)$ for any $h < h^¤$. Analogue, $F_t(w|h^¤)$ …rst order stochastically dominates $F_t(w|h)$ for any $h_w < h_w^¤$. A subtle di¤erence with previous models is that t does not

denote duration but calendar time (=age). Durations are determined by t and elements in h.

Given $\lambda(h(t))$ and $F_t(.|h(t))$, the existence of an optimal reservation wage strategy is guaranteed if higher wages are always better. That is, higher wages do not decrease future job-…nding probabilities or future expected wage o¤ers. If this condition does not hold, then the reservation wage property may not hold since it may be optimal to accept lower wages now in exchange for some future gain. This would complicate the analyses considerably and the data on reported reservation wages could no longer be interpreted. Thus the following condition turns out to be crucial:

Condition 1 (higher wages are better) $h_w(W_{¤}^{i}) > h_w(W^{i})$ and $h_\lambda(W_{¤}^{i}) > h_\lambda(W^{i})$ when all elements in $W_{¤}^{i}$ are at least as big as all elements in W^{i} where W^{i} is the set of previous wages.

The following theorem establishes the su¢ciency of this condition for the reservation wage property to hold.

Theorem 2 Condition 1 is su¢cient such that the model characterised by assumption 1-7, leads to an optimal strategy of an unemployed individual characterised by an optimal time to go into non-participation $\bar{t}$ if no acceptable job has arrived before that time and an optimal reservation wage $\phi(t|\bar{t})$ for the time before $\bar{t}$, given $\bar{t}$.

Proof: let R_t^u denote the expected present value of searching if the elapsed unemployment duration equals t. Let the expected present value of being employed at wage w and history h_w be denoted as $R^e(w, h_w)$. Here, h_w^+ denotes the labour market history after being hit by an employment shock. The Bellman equations for R_t^u and R^e satis…es

$$R_t^u(h_w) = \max\{\frac{u_{np}}{\rho}, \mathbf{M}\, t ¤ [b(t) + \lambda_t(h_w)\mathsf{E}_{F_t}[\max\{R_t^e(w, h_w), 0\}] + (1 ¡ \rho\, \mathbf{M}\, t)R^u_{t+\mathbf{M}t}\}$$

$$R_t^e(w, h_w) = \mathbf{M}\, t ¤ [w + \delta(R_t^u(h_w^+) ¡ R_t^e(w, h_w))] + (1 ¡ \rho\, \mathbf{M}\, t)R^e_{t+\mathbf{M}t}$$

Now, there holds that $R_t^u(h_w)$ is non-decreasing in h_w when $R_t^e(w, h_w)$ and $\lambda_t(h_w)$ are non-decreasing in h_w and when $F_t(h_w)$ …rst order stochastically

dominates any $F_t(w|h)$ with $h < h_w$. These hold by de…nition of h_w. From the de…nition of $R_t^e(w, h_w)$ we can see that a su¢cient condition for it to be strictly increasing in w is if h_w^+ is non-decreasing in w. Should an individual decide to search for a job, this establishes that at any moment he is best o¤ with a reservation wage strategy, which we denote as $\phi_t(h_w)$. The reservation wage path follows from the end-period condition: after T all functions are known and constant, and hence ϕ_T is unique. For any period and any history before that, this allows one to trace $\phi_t(h_w)$ backwards.

The inclusion of non-participation is analogue to having at any time t a job available with certainty that will pay the constant wage u_{np}. As in Frijters and Van der Klaauw (2001), this leads to an optimal stopping time $\hat{t}$ that solves the maximization problem

$$\max_{\hat{t} \geq 0} \phi_0 | \phi_{\hat{t}} = u_{np}$$

The di¤erential equations for the value equations given $\hat{t}$ become

$$\begin{aligned} \frac{\partial R_t^u(h_w)}{\partial t} &= \rho R_t^u(h_w) - [b(t) + \lambda_t(h_w)(E_{F_t}[\max\{R_t^e(w, h_w), 0\}]] \\ \frac{\partial R_t^e(w, h_w)}{\partial t} &= (\rho + \delta) R_t^e(w, h_w) - [w + \delta R_t^u(h_w^+)] \end{aligned}$$

The reservation wage ϕ_t at each point in time should be that wage at which $R_t^e(w^*, h_w) = R_t^u(h_w)$. This means $\phi_t = w^*$ solves

$$\frac{\frac{\partial R_t^e(w^*, h_w)}{\partial t} + [w^* + \delta R_t^u(h_w^+)]}{(\rho + \delta)} = \frac{\frac{\partial R_t^u(h_w)}{\partial t} + [b(t) + \lambda_t(h_w)(E_{F_t}[\max\{R_t^e(w^*, h_w), 0\}]]}{\rho}$$

This means that the reservation wage path can be characterised by the solution to

$$\begin{aligned} \phi_t = (\rho + \delta) & \frac{\frac{\partial R_t^u(h_w)}{\partial t} + [b(t) + \lambda_t(h_w)(E_{F_t}[\max\{R_t^e(\phi_t, h_w), 0\}]]}{\rho} - \\ & \delta R_t^u(h_w^+) - \frac{\partial R_t^e(\phi_t, h_w)}{\partial t} \end{aligned}$$

Here, δ is the job-destruction rate, R_t^e is the discounted value of lifetime earnings in employment depending on wages and history, R_t^u is the discounted

lifetime earnings when unemployed, and h_w^+ denotes the history that would emerge if the accepted job were to be destroyed. This yields a continuous (di¤erentiable) reservation wage path for all points where each of the elements on the right hand side are continuous (di¤erentiable). In turn this is guaranteed for the continuous (di¤erentiable) points of $b(t)$, $\lambda_t(h_w)$ and F_t.

Reservation wages in this model are hard to calculate: one in principle has to calculated backwards from T by looking at what the reservation wage path of someone with employment history h_w would be like if he remained unemployed till T. For points where the individual would prefer to be in non-participation, $\frac{u_{np}}{\rho}$ can be imputed as the value of being unemployed. A complication is that for all points backwards, $R_t^e(w, h_w)$ also has to be calculated, which involves all the possible future history paths till time T (the moment the job-o¤er and wage-o¤er function become constant) for every wage. This very quickly becomes computationally infeasible when there are a lot of elements in h_w and when one wants to allow for observed and unobserved characteristics. Such a di¤erentiable dynamic problem has not been solved anywhere yet in the literature and all current models have had to reduce the state-space somehow to ensure computational tractability (see for example, Rust and Phelan 1997, Keane and Wolpin 1997). An option is to turn to simulation methods in the vein of Keane and Wolpin (1997), but that carries no guarantee that the solution will be correct. The method chosen in the text has the advantage of allowing for very complicated e¤ects of history on λ_t and F_t in a structural framework without the need to calculate ϕ_t . What we lose by following this approach is an ability to look at policy changes which require calculating ϕ_t for ranges outside the observed values in the data.

D Speci…cation of the likelihood function of the structural model

Starting from the likelihood function in equation 4 in Section 2.3 we derive:

$$L(w_{it}, \tilde{\phi}_{it}, d_{it} | \beta^o, O_i(t)) = \prod_{O_i(t)=1 \wedge d_{it}=0} P(\ln w_{it}^o < \ln \phi_{it}) \times \prod_{O_i(t)=1 \wedge d_{it}=1} P(\ln w_{it}^o = \ln w_{it}, \ln w_{it}^o \geq \ln \phi_{it})$$

$$= \prod_{O_i(t)=1 \wedge d_{it}=0} P(X_{it}'\beta^o + v_i + \eta_{it}^o < \ln \phi_{it}) \cdot \prod_{O_i(t)=1 \wedge d_{it}=1} P(X_{it}'\beta^o + v_i + \eta_{it}^o = \ln w_{it}, \ln w_{it}^o \geq \ln \phi_{it})$$

whereby $O_i(t) = 1$ and $d_{it} = 0$ denotes those job offers that are rejected and $O_i(t) = 1$ and $d_{it} = 1$ the job offers that got accepted.

There are several complications in calculating the likelihood. These complications arise from the generality of the model. The main complication involves the unknown individual-specific v_i. The estimation procedure would be straightforward without this factor and would not need any structure on the observed reservation wages. To estimate the factor v_i, information on the successive reservation wages of individuals is used:

$$\ln \tilde{\phi}_{it} - \ln \tilde{\phi}_{i0} = (X_{it}' - X_{i0}')\beta^\phi + m_{it}^\phi - m_{i0}^\phi$$

which means we can get an unbiased estimate of β^ϕ and of σ_m^2 by estimating simple OLS analyses on the successive reservation wages of individuals. As the number of individuals goes to infinity we get arbitrarily close to the true β^ϕ and we can thus write

$$\hat{V}_i \equiv \frac{1}{T} \sum_{t=1}^{T} \{\tilde{\phi}_{it} - X_{it}'\hat{\beta}^\phi\} \rightarrow v_i + \hat{M}_i$$

where $\hat{M}_i \equiv \frac{1}{T} \sum_{t=1}^{T} m_{it}^\phi \sim N(0, \frac{1}{T}\sigma_{m,\phi}^2)$. Now use $\hat{V}_i$ and $\hat{M}_i$ to obtain a calculable likelihood that uses the information on observed wages, reservation wages and job offers:

$$L(w_{it}, \tilde{\phi}_{it}, d_{it} | \beta^o, O_i(t)) = \prod_{O_i(t)=1 \wedge d_{it}=0} P(\eta_{it}^o < X_{it}'\hat{\beta}^\phi - X_{it}'\beta^o) \cdot \prod_{O_i(t)=1 \wedge d_{it}=1} P(\eta_{it}^o - \hat{M}_i + m_{it}^w = \ln w_{it} - X_{it}'\beta^o - \hat{V}_i, \eta_{it}^o \geq X_{it}'\hat{\beta}^\phi - X_{it}'\beta^o)$$

which becomes

$$\prod_{O_i(t)=1 \wedge d_{it}=0} \Phi(X_{it}'\hat{\beta}^{\phi} - X_{it}'\beta^{o} \mid 0, \sigma_w^2) \cdot$$

$$\prod_{O_i(t)=1 \wedge d_{it}=1} \int_{X_{it}'\hat{\beta}^{\phi} - X_{it}'\beta^{o}}^{1} \phi(\eta_{it}^{o} \mid 0, \sigma_w^2) \cdot \phi(\ln \varpi_{it} - X_{it}'\beta^{o} - \hat{V}_i - \eta_{it}^{o} \mid 0, \sigma_{m,w}^2 + \frac{1}{T}\sigma_{m,\phi}^2) d\eta_{it}^{o}$$

where $\Phi(.)$ denotes the cumulative normal distribution and $\phi(.)$ the density of the normal distribution.

The …nal likelihood function used in the estimation procedure is computationally demanding because it involves integrating over the unknown wage component for all accepted job o¤ers.