The design of unemployment transfers - Evidence from a dynamic structural life-cycle model*

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Abstract

In this paper we develop and estimate a dynamic structural life-cycle model of labor supply behavior which accounts for endogenous accumulation of human capital and for the effect of the tax and transfer system on work incentives. In addition to income tax, social security contributions and social assistance, we model unemployment insurance benefits which are endogenous with respect to life-cycle employment. For better identification of the structural model we exploit several changes in the fiscal system over time. The structural parameter estimates are used to evaluate the employment and welfare effects induced by the central parameters of the unemployment insurance, namely the entitlement period and the replacement ratio.

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1 Introduction

In this paper we analyze the employment effects induced by unemployment insurance in a dynamic structural life-cycle model. In particular we want to evaluate the behavioral effects related to the two central components of unemployment insurance, namely the entitlement period which is related to previous employment and the replacement ratio. In this sense our analysis complements an important empirical literature about the employment effects of financial incentives exploiting policy reforms in a reduced form framework. A recent example is Lalive et al. (2006) who use regional variation in the design of unemployment insurance to identify the causal effect on the duration of unemployment.

An evaluation of unemployment insurance based on a dynamic structural model has the advantage over the reduced from model that it is directly embedded in a theoretical framework and therefore it is possible to provide a clearer and more general interpretation of the empirical findings. In particular since we model the employment decision over the whole life-cycle our framework captures the complex incentives effects induced by unemployment insurance which are discussed in detail in Mortensen (1977). In a fully dynamic setting employment effects induced by changes in unemployment insurance are ambiguous since entitlement for the insurance is conditional on previous employment.[1] Moreover, within a structural model it is possible to simulate fiscal effects and to derive welfare effects of policy changes. The potential scepticism towards policy evaluations based on structural models is related to identification of the parameters is often not transparent. In this paper we address this problem and propose an identification strategy which exploits variations in the fiscal legislation over time which affected only certain groups.

An analysis of the design of unemployment insurance in a dynamic structural model necessitates a generalization of the existing dynamic structural life-cycle models of labor supply with endogenous human capital accumulation (for example Eckstein and Wolpin, 1989) to incorporate a detailed specification of the tax and transfer system. In particular, along with income tax and social security contributions, we account for transfer payments to non-working individuals. Specifically, a non-working individual receives either means tested social assistance or non means tested unemployment insurance payments, which are tied to the individual's recently employment history and previous earnings. In this sense our life-cycle model incorporates in addition to the endogenous accumulation of human capital which affects the wages, the endogenous accumulation of experience which determines eligibility and entitlement of unemployment insurance.

A small number of papers have included a specification of transfers to the non-working within a dynamic structural life-cycle model of labor supply. Among others, Ferrall (1997) and Wolpin (1992) have included a specification of unemployment insurance benefits, and Adda et al. (2007)

[1] Our study is related to several empirical studies of structural search models that estimate the employment effects of unemployment insurance e.g. van den Berg (1990), Ferrall (1997) or Frijters and van der Klaauw (2006). Common to all theses studies is that they focus exclusively on job transitions of an inflow sample of unemployed or of school drop-outs and therefore these studies do not account for the entitlement effect discussed by Mortensen (1977).

include both unemployment insurance benefits and social assistance, i.e. means-tested minimum income.[2] The analysis undertaken in this study draws on this previous literature and extends it in several aspects. Notably, we utilize a more realistic specification of the household budget constraint than that adopted in the related literature. With respect to the modeling of out-of-work transfers we include both unemployment insurance and means-tested social assistance and, in contrast to Adda et al. (2007) we allow the duration of unemployment insurance payments to depend on the individual's age and working history. Further, we model other features of the tax and transfer system including income tax and social security contributions. We argue that these extensions are necessary to capture correctly labor supply incentives which vary according to wage, age and working experience. Moreover the modelling of income taxation allows us to consider changes in income taxation or social security contributions to finance potential transfer reforms we evaluate using the proposed life-cycle model.

Our modeling approach further includes a number of empirically relevant features which are not simultaneously present in other dynamic structural models of life-cycle labor supply featuring transfers to non-working individuals. First, dependent on age and health status, individuals have a probability to be eligible for early retirement schemes and conditional on eligibility they can decide to retire before the compulsory retirement age of 65 years. Second, we allow for several sources of non-stationarity due to experience and age effects and other changes occurring over the life-cycle. Specifically, our model includes non-stationarity in the job-offer and separation rates, endogenous accumulation of working experience which affects wages, and pensions and transfer rules that vary according to age and working experience. Finally, we allow for heterogeneity in job-offer and separation rates, preferences and wages according to observed characteristics, and permit a flexible structure of unobservables to affect the different processes.

Similar to e.g. French (2005), we use simulated method of moments to estimate the dynamic structural life-cycle model for Germany. The empirical analysis is based on a thirteen year panel of single men and women without dependent children taken from the German Socio Economic Panel (SOEP). This data set contains detailed income and demographic information and follows employment behavior on a monthly basis. For the empirical analysis we account in detail for the German tax and transfer legislation in which the generosity of out of work transfers depends on the previous working history as described above.

As mentioned above, for better identification of the different processes driving the employment behavior we exploit variation in the tax and transfer system over time. During the observed period 1995 - 2007 several major tax reforms have changed the working incentives for different groups in our population by either decreasing marginal tax rates or social security contributions or changing the design of out of work transfers. Most important, several reforms of the eligibility criteria for the unemployment insurance by age and working experience induce exogenous changes over time which can be exploited as identifying variation for the structural parameters.[3]

[2] Additionally, following Rust and Phelan (1997) there exits serval studies which explicitly focus on the retirement decision in a dynamic life-cycle setting and account for the relevant rules for the pension system.

[3] Several papers estimate the employment effects of changes in the entitlement criteria in reduced from models for Germany, e.g. Hunt (1995) or Fitzenberger and Wilke (2009).

This identification strategy is similar to Adda et al. (2009) who argue that regional variation over time increases their identifying power for estimating educational decision and employment behavior over the life-cycle.

The paper proceeds as follows. Section 2 outlines our model of labor supply and retirement over the live-cycle. Section 3 details the adopted empirical specification and presents the estimation method and discusses identification. In Section 4 we describe our sample of single adult households taken from the German Socio-Economic Panel (SOEP). In this section we also provide a descriptive analysis of labor supply and retirement behavior over the life-cycle. Section 5 presents our structural parameter estimates and in Section 6 we use the estimated structural model evaluate the effect of the design of unemployment insurance on life-cycle employment. Finally, Section 7 concludes the paper with a discussion of the broader implications of our results for policy makers.

2 Model

2.1 Overview of the model

In order to analyze the employment effects induced by the design of unemployment insurance we derive and estimate a dynamic structural life-cycle model in which agents choose between three states, namely full-time employment f, non-employment n and retirement r. The model accounts for the endogeneity of human capital accumulation and for the effect of the tax and transfer system on work incentives. In addition to income tax, social security contributions and means-tested social assistance, we model unemployment insurance. Transfers to the unemployed are endogenous with respect to life-cycle employment since eligibility, the amount of benefits and the entitlement period of unemployment insurance are determined by previous earnings and the previous working history. In the proposed framework the labor market transitions of non-employed and employed individuals depend respectively on individual specific job-offer and job-separation rates which evolve over the life-cycle in response to regional and individual specific characteristics. We propose a discrete time, finite horizon model in which choices are made at quarterly intervals. We assume that the maximal life time is $\overline{T} = 78$ years and denote the age of retirement with T^R.

In this analysis, we only model the life-cycle labor supply of single households without dependent children. We focus on individuals aged 40 years and above which justifies assuming that family composition is constant over the agent's future life. Moreover, it is assumed that men and women over 40 have finished their education and all of the analysis is conditional on educational qualifications obtained prior to age of 40 years. Finally, as is common in this literature, for example Rust and Phelan (1997), we make the restrictive assumption that individuals do not save and are credit constrained.[4] Therefore, the estimated employment effects induced by changes in the tax and transfer system should be interpreted as upper bounds. In a more general model, in addition to the tax and transfer system, precautionary savings would

[4]French (2005) is one of the few examples that allows for saving in a structural life-cycle model of retirement.

provide insurance by allowing intertemporal consumption smoothing, e.g. Low et al. (2009). In such a setting households are less dependent on the tax and transfer system and therefore any behavioral effects induced by changes in the tax legislation are likely to be lower.

The selection criteria have been partly chosen to reduce complexity in the empirical analysis. However, our population is of central interest when studying the employment effects of different unemployment programmes. In general, single households are especially dependent on the transfer system as they cannot rely on the income of other household members. Moreover, employment rates of older individuals tend to be fairly low which makes this an important group for labor market policies. Finally, when agents are forward looking, the working incentives induced by unemployment insurance are different for individuals close to retirement than for younger individuals. Specifically, older individuals with long entitlement periods for unemployment insurance may find it optimal to use unemployment as a stepping stone from employment into retirement.

2.2 Labor market transitions

Labor market transitions depend on the one hand on the structure of the labor market, defined by the job-offer and job-separation rates, the distribution of offered wages and the tax and transfers system, and on the other hand on individuals' preferences for consumption and leisure. We simply the search process and assume that all non-employed have a constant search intensity which is denoted with S. This implies that implicitly individuals optimize their reservation wage when deciding about labor market transitions. In the following we describe the structure of the labor market, the state specific financial incentives, expressed in terms of net incomes, and finally the specification of preferences.

Transitions into employment

In each period t, every non-employed individual receives with probability $\Theta_{i,t}(X_{i,t}, \mu_i^\theta)$ an offer for a full-time job. The job offer rate depends on regional and individual characteristics including experience $X_{i,t}$ and on individual specific unobservable effects μ_i^θ. The gross wage associated with this job offer is denoted $w_{i,t}$. Non-employed individuals who receive an offer must decide between rejecting the job offer and remaining non-employed, and accepting the job offer, in which case they make a transition into employment. Non-employed individuals face pecuniary and non-pecuniary costs for making a transitions into employment. These costs include fix costs for starting a job and habit formation and can be described as state dependence effects (Hyslop, 1999). With probability, $1 - \Theta_{i,t}(X_{i,t}, \mu_i^\theta)$, a non-employed individual does not receive a job offer and thus a transition into employment is not possible. Given the limited information in the data we cannot observe job-to-job transitions. Therefore, we assume that there is no on-the-job search which implies that we can not distinguish between general and firm specific human capital accumulation.

Transition into non-employment

Employed individuals face each period a job separation rate $\Gamma_{i,t}(X_{i,t}, \mu_i^\gamma)$ which again depends on regional, and observed and unobserved individual characteristics. If the individual experiences a separation he or she makes a transition into non-employment. With probability, $1-\Gamma_{i,t}(X_{i,t}, \mu_i^\gamma)$, there is no separation and the employed can choose between staying in the job or making a voluntary transition into non-employment. Again, we allow for state dependence in the sense that employed individuals making a transition into non-employment face a cost capturing habit formation as well as potential organizational costs of receiving transfers.

Transition into retirement

Both the employed and the non-employed can make a transition into retirement. Retirement is modeled as an absorbing state. Hence once retired, an individual cannot make a transition back into employment or non-employment. This assumption is in line with the German legislation and is strongly supported by the data. Depending on the year of legislation the official age of retirement lies between 60 and 65, and in general it is not possible to make a transition before the official retirement age. However, there exist various possibilities to enter retirement before the official retirement age which depend mainly on the health status of an individual, the completed working history, age, gender, firm size, and year of legislation. Given the data at hand, it is not possible to model in detail all potential channels of early retirement. Instead we estimate the probability of having the option of entering retirement earlier than the official retirement age based on the above mentioned characteristics. Thus, with probability $\Lambda_{i,t}(X_{i,t}^r)$ an individual has the option of entering retirement and depending on the financial incentives and preferences the individual makes a transition into retirement or decides not to take the option of early retirement. In this case the individual remains either employed or non-employed, yet he or she remains eligible for retirement in all subsequent periods.

2.3 Financial incentives at the different employment states

In contrast to most previous studies of employment behavior over the life-cycle, we model in detail the effect of the tax and transfer system and assume that individuals make their employment and retirement decision based on net income rather than on gross earnings. This study uses the German tax and transfer system as a benchmark. The main features of the German tax and transfer system are noted here while Appendix II provides a more detailed description together with information concerning recent relevant changes to the system.[5] Our estimation procedure includes a tax simulation model that maps the following features of the tax and transfer system and generates for each individual the state specific net income conditional on the individual's demographic characteristics, on the draw from the wage distribution and on other non-labor

[5] As mentioned above, we restrict attention to single households without children. This greatly simplifies the modeling of the tax and transfer system as the family related components of the legislation, such as the joint income taxation of married couples and child related transfers, do not need to be considered.

income.[6]

Net income in full time employment

The individual's net income in full-time employment takes the following form

$$m_{i,f,t} = F_f(w_{i,t}, I_{i,t}; TS_t).$$

Net income in full-time employment depends on the offered gross wage $w_{i,t}$, non-labor income $I_{i,t}$, and the tax and transfer system of the given period TS_t. The tax and transfer system includes social security payments (SSC), income taxation, and, if net income is sufficiently low, a transfer to raise the individual's income to the minimum income.[7]

Net income in non-employment

Net income for a non-employed individual whose last period of employment was at time s is determined as follows:

$$m_{i,n,t} = F_n\left(El_{i,t}, En_{i,t}, I_{i,t}, m_{i,f,s}; TS_t\right).$$

In the above $El_{i,t}$ denotes eligibility to receive unemployment insurance transfers and $En_{i,t}$ denotes the months of unemployment insurance benefits the individual is entitled to at time t. An individual who is not entitled to unemployment insurance receives social assistance (ALG II), which is a permanent minimum income. Individuals who are eligible to benefit from unemployment insurance (ALG I) are provided with a time-limited transfer which depends on their net income in their most recent job $m_{i,f,s}$.[8] Eligibility to receive unemployment insurance depends on the number of months worked in the three, from 2006 on two years prior to the individual entering non-employment. At the point of entering unemployment, the duration of entitlement depends on employment behavior over the last seven years and on age, with entitlement periods being increasing in age. [9]

The non-labor income of the non-employed may be subject to income taxation and minimum income transfers are means-tested against non-labor income. In theory, the employed who voluntarily choose to move into non-employment are in the first three months not eligible for ALG I. However, in reality it is very difficult to distinguish between voluntary and involuntary

[6]We assume that individuals have an initial endowment of assets which remains constant and depending on the year specific rate of return they receive capital income.

[7]Since our sample consists of single individuals, full-time net incomes are always higher than the minimum income and hence none of the sampled individual receive an in-work transfer.

[8]The names of the transfer programs have been changed in course of the transfer reform in 2005. For simplicity we use ALG I to refer to the part of the transfer which is dependent on the previous earnings, and use ALG II to refer to the minimum income component.

[9]In practice, until 2005, eligible individuals who have used their months of entitlement, received unemployment insurance benefits at a reduced rate. Modelling the reduced rate would double the state space for the value function and this would highly complicate the approximation of the value functions, see below. Therefore, we assume that unemployed receive the means-tested transfers once entitlement is exhausted.

separations and therefore, we assume that from the beginning on all non-employed receive ALG I if they full fill the eligibility rules related to previous employment.[10]

Net income in retirement

Similarly to the net income in non-employment, net income in retirement depends strongly on an individual's working history. In reality, individuals have various sources of pension income including state pensions, private pensions and income from firm-specific pension plans. In addition, if an individual is not entitled to any pension or if the sum of income from all pensions is sufficiently low, then he or she receives a means-tested minimum income transfer similar to the ALG II. Given the limited data at hand we cannot model all sources of pension income. Instead we focus on the state pension which in Germany provides the largest share of pension income.

In brief, state pension payments depend on the total number of years in employment over the working life and the associated gross earnings, and on any unemployment insurance payments received when non-employed. In periods where non-employed individuals are ineligible for unemployment insurance they do not accumulate pension entitlement. A fraction of the pension together with all non-labor income is subject to income taxation.

Formally, we approximate the net income in retirement in the following way:

$$m_{i,r,t} = F_r \left(PI_{i,t}, I_{i,t}; TS_{i,t} \right).$$

where $\mathrm{PI}_{i,t}$ denotes the pensionable income of individual i accumulated over the individual's working life up to age t. In any given month, the pensionable income of a working individual consists of the individual's gross earnings, while the pensionable income of a non-employed individual is the value of any unemployment insurance benefits received. We approximate pension income as 60% of the individuals pensionable income averaged over working life, and assume that individuals whose pension income is less than minimum income receive ALG II to raise their income in retirement up to this level. Finally, pension income are capped at 2000 Euros per month, which is in line with the rules governing the accumulation of pension benefits. As mentioned above a fraction of the pension together with all non-labor income is subject to income taxation. [11]

2.4 Optimal Labor Supply over the Life-cycle

By drawing on dynamic programming techniques, our model analyzes optimal employment and retirement behavior over the life-cycle in a forward looking setting where the individual considers the dependence of payoffs occurring in the future on his current labor supply decision. There are several mechanisms linking today's employment and retirement decision with future

[10] Since in our model individuals can change their employment behavior only at a quarterly basis this assumptions affects only the first quarter.

[11] In practice, individuals accumulate pension points over their working life which, together with yearly defined point values, determine the pension payments when entering retirement. Our chosen approximation of the pension system is less complex but since it depends on the employment behavior over the whole working life it captures all features of the pension system relevant for out analysis.

payoffs which we implement in our model. In addition to non-stationarity in the job-arrival and separation rates, full time employment in the current period leads to higher expected future wage offers, assuming positive returns to experience. Additional intertemporal linkages occur through unemployment insurance benefits. First, employment in the current period increases the duration of entitlement to unemployment insurance payments, thus increasing the value of non-employment in the future. Second, wage based rewards due to human capital accumulation mean that current employment leads to higher future unemployment insurance in the case of unemployment. Finally, only in a model with forward looking agents it is possible to capture that non-employment might be used as a stepping stone from employment into retirement. This final unemployment spell is very distinct from unemployment earlier in working life as there is no uncertainty or risk of getting a job offer for employment in the future. In a framework with myopic agents which do not care about their future consumption, this would be meaningless.

An individual's life-cycle utility can be expressed in terms of the state specific value functions $V_t^j(s_{i,t})$ for $j = f, n, r$. The state variables $s_{i,t}$ consist of all variables affecting the contemporaneous utilities, the job-offer rate $\Theta_{i,t}$, job-separations $\Gamma_{i,t}$, the probability of having the option of early retirement $\Lambda_{i,t}$ and the offered wage $w_{i,t}$. At time t, the individual is assumed to know the current value of $s_{i,t}$ but may not know the values of all or some elements of $s_{i,t+k}$ for $k > 0$. However, the distribution of $s_{i,t+1}$ is known to the individual at time t and it is assumed to depend only on $s_{i,t}$. The value function associated with full-time employment is defined as discounted value of the individual's expected life-time utility if he or she works full-time in the current quarter and makes optimal labor supply and retirement decisions in all subsequent quarters. The value function for non-employment is similarly defined. The value function associated with retirement is defined as the discounted value of the individual's expected life-time utility if he or she enters retirement in the current quarter and stays there for the rest of the life. As mentioned above T^R denotes the age for retirement, which is either the compulsory retirement age or the age of early retirement for the eligible. Hence at age $t = T^R - 1$, individuals enjoy with certainty the expected value function of retirement.

The state specific value functions for full-time employment and non-employment are defined recursively as follows

$$\begin{aligned} V_{i,t}^f(s_{i,t}) &= U_{i,f,t}(s_{i,t}) + \Gamma_{i,t}\left\{\Lambda_{i,t}\delta\mathbf{E}_t\left[\max\{V_{i,t+1}^n, V_{i,t+1}^r\}\right] + (1-\Lambda_{i,t})\delta\mathbf{E}_t V_{i,t+1}^n\right\} + \\ &\quad (1-\Gamma_{i,t})\left\{\Lambda_{i,t}\delta\mathbf{E}_t\left[\max\{V_{i,t+1}^f, V_{i,t+1}^n, V_{i,t+1}^r\}\right] + (1-\Lambda_{i,t})\delta\mathbf{E}_t\left[\max\{V_{i,t+1}^f, V_{i,t+1}^n\}\right]\right\} \end{aligned} \tag{1}$$

$$\begin{aligned} V_{i,t}^n(s_{i,t}) &= U_{i,n,t}(s_{i,t}) + (1-\Theta_{i,t})\left\{\Lambda_{i,t}\delta\mathbf{E}_t\left[\max\{V_{i,t+1}^n, V_{i,t+1}^r\}\right] + (1-\Lambda_{i,t})\delta\mathbf{E}_t V_{i,t+1}^n\right\} + \\ &\quad \Theta_{i,t}\left\{\Lambda_{i,t}\delta\mathbf{E}_t\left[\max\{V_{i,t+1}^f, V_{i,t+1}^n, V_{i,t+1}^r\}\right] + (1-\Lambda_{i,t})\delta\mathbf{E}_t\left[\max\{V_{i,t+1}^f, V_{i,t+1}^n\}\right]\right\} \end{aligned} \tag{2}$$

while the value function for retirement is

$$V_t^r(s_{i,t}) = U_{i,r,t} + \delta\mathbf{E}_t V_{i,t+1}^r \tag{3}$$

$U_{i,j,t}$ denotes the individual's flow utility associated with state j at time t and δ denotes the discount factor. This is a crucial parameter in the life-cycle optimization problem as it describes how strongly expected future utility affects the individual's current choice. In the empirical analysis we follow the literature and assume an annualized discount factor of 0.96. As mentioned above, the state specific value functions depend on the job-offer rate $\Theta_{i,t}$, job-separations $\Gamma_{i,t}$ and the probability of having the option of early retirement $\Lambda_{i,t}$. These entities define the individual's choice set for the next period which can be expressed in terms of the value function. For instance an unemployed individual who is not eligible for retirement and who did not receive a job offer can not maximize over different value functions but receives with certainty the expected value of the value function for non-employment $V^n_{i,t+1}$.

Individuals maximizes life-cycle utility subject a budget constraint. Since in our framework individuals neither save nor borrow, the budget for consumption equals state specific net income. Optimizing behavior on the part of an individual without the option of early retirement implies acceptance of the job offer if and only if $V^f_{i,t}(s_{i,t}) \geq V^n_{i,t}(s_{i,t})$. Conversely, if $V^n_{i,t}(s_{i,t}) > V^f_{i,t}(s_{i,t})$ then the individual will choose non-employment. Am individual with the option of early retirement will work full-time if and only if $V^f_{i,t}(s_{i,t}) \geq V^n_{i,t}(s_{i,t})$ and $V^f_{i,t}(s_{i,t}) \geq V^r_{i,t}(s_{i,t})$, will be non-employed if and only if $V^n_{i,t}(s_{i,t}) > V^f_{i,t}(s_{i,t})$ and $V^n_{i,t}(s_{i,t}) \geq V^r_{i,t}(s_{i,t})$, and otherwise the individual will move out of the labor market and into retirement. At age $t = T^R$ all remaining non-retired individuals enter compulsory retirement.

Approximation of Value functions

As common in this literature, we approximate the value functions using an adaptation of the method of Keane and Wolpin (1994). We choose two grids of points g_T and e_T corresponding to respectively values of the state variables s_T that are known to the individual at time $T-1$ and values of $s_{i,T}$ which are not known to the individual at time $T-1$. Using these grid points we construct $V^r(g_T, e_T)$, that is the value of retirement for individuals with time T state variables equal to g_T and e_T. We then run the Ordinary Least Squares (OLS) regression of $V^r(g_T, e_T)$ on $Q(g_T)$, where Q is a matrix formed from elements of g_T. This yields an expression for the expectation of the value function at time T given the time T state variables known to the individual at time $T-1$. For the approximation we construct a grid with XX points.

2.5 The effect of unemployment insurance over the life cycle

Mortensen (1977) theoretically analyzes the employment effects of changes in unemployment insurance in a job search model which has a similar dynamic setting as our framework.[12] Most important, the model is fully dynamic in the sense that both the currently employed and the currently unemployed base their employment decision in the next period on the expected utility in all future periods, i.e. on the state specific value function. Mortensen (1977) shows that in this setting clear theoretical predictions about the sign of the employment effects are not

[12] Cahuc and Zylberberg (2004) show that the central result in Mortensen (1977) holds in a simplified job search model with fixed search effort but optimal reservation wages as presented here.

possible.[13]

Consider a reduction in the generosity of unemployment insurance in terms of a shorter entitlement period or lower replacement ratio. This change affects the value function of the currently employed (Equation 1) in two ways, i) directly through the flow utility in the current period and ii) in expectation through the flow utility in future periods. As discussed above entitlement for unemployment is conditional on previous employment, and thus the current employment decision is directly linked to the generosity of unemployment insurance in the future. Hence the positive employment effect related to the decreasing flow utility of non-employment is counteracted by the *entitlement effect* of employment (Mortensen, 1977). In particular, the value of current employment decreases for future periods since entitlement to unemployment insurance in the future periods is less attractive. In other words the insurance effect of current employment decreases. From the theoretical model it is therefore not clear how a less generous unemployment insurance affects the working behavior of the currently employed.

Similarly for the unemployed (Equation 2). Here it is necessary to distinguish between the unemployed entitled for unemployment insurance and those only receiving means-tested transfers. For the latter group the flow utility in the current period is not affected by a change in the unemployment insurance. Thus, changes in the employment behavior are only related to effects on the expected flow utilities in future periods and the aforementioned opposite effects are present. For the unemployed currently eligible for unemployment insurance a reduction in the generosity, i.e. a change in the replacement ratio has a clear direct positive employment effect related to the flow utility in the current period, however the overall effect is again ambiguous due to the expectations about the flow utilities in future periods.

This discussion underlines that it is impossible to make clear theoretical predictions about the overall employment effects of changes in the unemployment insurance. However, the theoretical model provides insights for which groups the positive or negative effects might be dominating. Mortensen (1977) shows that employment effects are different for unemployed at the end of their entitlement period than for unemployed with long entitlement periods since the entitlement effect of employment is more important for the first group. Moreover the sign and size of the effect differs depending on age. *Ceteris paribus*, for a young individual, future expectations are far more important than for a worker close to retirement. Thus, the entitlement effect is more relevant for a younger worker. A clear prediction of the employment effect is only possible for employed or unemployed who have accumulated an entitlement period that is sufficiently long to cover their remaining working life until retirement. For this group, the entitlement effect of employment is not important. Hence, for this group a reduction in the replacement ratio could only lead to a positive employment effect.

[13]Obviously, for this discussion, the discount factor of future flow utilities is crucial. For a myopic agent, the employment effects would be clear cut as expectations about the future are not important.

3 Estimation of structural model

This section contains a description of chosen empirical specifications of the job-offer and job-separation rate, the probability of having the option of early retirement, the state specific flow utilities, the distribution of offered wages and the stochastic health process. Thereafter, we discuss in detail the estimation method, identification and present the empirical moments we use to jointly estimate all processes driving the life-cycle employment behavior.

3.1 Empirical Specification

Job offer and separation rate

Job-offers and job-separations evolve non-stationary as they depend on individual, and regional characteristics including the accumulated working experience. In particular we model the probability for an individual unemployed in period t of receiving a job offers as:

$$\Theta_{i,t}(X_{i,t}, \mu_i^\theta, \upsilon_{i,t}^\theta) = \theta_x X_{i,t} + \mu_i^\theta + \upsilon_{i,t}^\theta \quad \text{for} \quad t = 1, ..., T. \tag{4}$$

The separation rate for the currently employed is specified as:

$$\Gamma_{i,t}(X_{i,t}, \mu_i^\gamma, \upsilon_{i,t}^\gamma) = \gamma_x X_{i,t} + \mu_i^\gamma + \upsilon_{i,t}^\gamma \quad \text{for} \quad t = 1, ..., T, \tag{5}$$

where $X_{i,t}$ includes age terms, accumulated working experience and the region of residence, i.e. east or west Germany where the labor market situation is very different. μ_i^θ and μ_i^γ are individual specific random effects which are normally distributed with zero mean, variance $\sigma^2_{\mu^\theta}$ and $\sigma^2_{\mu^\gamma}$ and covariance $Cov_{\mu^\theta\mu^\gamma}$. Finally, $\upsilon_{i,t}^\theta$ and $\upsilon_{i,t}^\gamma$ are normally distributed error terms that are independent for all i, and t.

Early Retirement

Specific early retirement programmes make transitions into retirement possible even before the official retirement age. Eligibility for early retirement depends mainly on the health status, gender, age or working history but as well on firm specific circumstance and agreements which are unknown. Moreover the official and firm specific rules were changing over time. Therefore, it is not possible to derive precisely the eligibility for early retirement. Instead, we estimate the individual probability of having the option for early retirement in the following specification:

$$\Lambda_{i,t}(X_{i,t}^R, \upsilon_{i,t}^\lambda) = \lambda_x X_{i,t}^R + \upsilon_{i,t}^\lambda \quad \text{for} \quad t = 1, ..., T, \tag{6}$$

where $X_{i,t}^R$ includes the above mentioned observable characteristics including a measure of experience and time and age effects, $\upsilon_{i,t}^\lambda$ follows again a normal distribution independent for all i, and t.

Flow Utilities

Flow utilities from non-employment, full-time work and retirement are specified as:

$$U_{i,f,t} = \beta \frac{\left[\left(m_{i,f,t} - \gamma_{nf} y_{i,n,t-1}\right) \eta_i\right]^{(1-\rho)} - 1}{1-\rho} + \varepsilon_{i,f,t}, \tag{7}$$

$$U_{i,n,t} = \beta \frac{\left[\left(m_{i,n,t} - \gamma_{fn} y_{i,f,t-1} - s\right)\right]^{(1-\rho)} - 1}{1-\rho} + \varepsilon_{i,n,t}, \tag{8}$$

$$U_{i,r,t} = \beta \frac{(m_{i,r,t})^{1-\rho} - 1}{1-\rho} + \varepsilon_{i,r,t}, \tag{9}$$

We follow the previous literature and assume that individuals are risk averse, and set $\rho = 1.5$.[14] β_y determines the sign and magnitude of the preference for consumption. η_i describes the degree of complementarity between consumption and leisure and thus provides information about the reservation wage or the share of net income necessary to compensate individuals for the disutility of work. We allow for heterogeneity of the complementarity and assume that $\eta_i \sim N(\theta, \sigma_\eta^2)$. To guarantees that all individuals enjoy positive utility from leisure time η_i is truncated from below 0 and above 1.[15] As discussed above unemployed face constant search costs denoted with S, including direct cost for job search or stigma of being unemployed. Finally, we include measures of state dependence, e.g. habit persistence, γ_{nf} and γ_{fn} which make transitions costly. The complementarity, the search costs and the state dependence effects are all affected by the parameter of risk aversion ρ. This allows us to give these effects a direct interpretation in monetary terms. The unobservables $\epsilon_{i,n,t}$, $\epsilon_{i,f,t}$ and $\epsilon_{i,r,t}$ are assumed to be mutually independent and independent over time. Additionally, $\epsilon_{i,j,t}$ for all i, j and t is assumed to have a type I extreme value distribution. At time t individual i knows the current values of $\epsilon_{i,j,t}$ but has no information about the future values of these error terms.

Gross Wages

In the empirical analysis individual i's log offered gross wage is assumed to evolve according to

$$\log(w_{i,t}) = \lambda_z z_{i,t} + \alpha_i^w + \upsilon_{i,t} \quad \text{for} \quad t = \tau_i, ..., T. \tag{10}$$

In the above $z_{i,t}$ are observed individual characteristics that affect wages including education, region of residence and a function of experience in the labor market. The coefficients on experience capture the effect of human capital accumulated via previous employment on wages. $\upsilon_{i,t}$ is a shock to individual i's wages occurring at time t and is assumed to be independent of observed individual characteristics, to occur independently over time and to be normally distributed with zero mean and a variance σ_υ^2. Individual i is assumed to know the current value of $\upsilon_{i,t}$ but does not know the future values of the time varying shocks to wages. α_i^w is a time invariant individual

[14] For a detailed discussion on the difficulties to identify the individuals' risk aversion, see Laibson et al. (2007) .

[15] Assuming a uniform or normal distribution without truncation does not change the results but would complicate a welfare analysis.

specific random effect assumed to be unconditional normally distributed with zero mean and variance variance $\sigma^2_{\alpha^w}$.

Health Process

The health status is known to be an important determinant of labor supply and retirement behavior and may also impact on wages. We measure health with an indicator variable, $H_{i,t}$, which takes value one if the individual reports health problems at time t and zero otherwise. We assume that health status evolves stochastically over the life-cycle according to the following equation:

$$H_{i,t}(H_{i,t-1}, g_{i,t}, \phi_{i,t}) = \pi_1 H_{i,t-1} + \pi_2 g_{i,t} + \phi_{i,t} \quad \text{for} \quad t = 1, ..., T, \tag{11}$$

where $g_{i,t}$ consists of individual characteristics that impact on health, including education and age. The health status in the previous quarter, $H_{i,t-1}$, captures persistence in health status. The unobservable $\phi_{i,t}$ is assumed to occur independently over both individuals and time and to have a standard normal distribution. Given these distributional assumptions, estimation of the parameters in (3.1) can be conducted prior to estimation of the remaining parameters. Appendix I details the estimation methodology and resulting parameter estimates.

Initial Conditions

The dynamic nature of our model implies that we cannot treat the initial sample observations of experience and the initial state observed in the sample as exogenous with respect to the individual's labor supply choices during the sample period. To account for the endogeneity of the initial conditions we follow Heckman (1981) and use a reduced form equation to model the initial observations, and allow the unobservables affecting the initial observations to be correlated with the random effects appearing in the flow utilities and the wage equation. While Heckman (1981) proposed a probit model for the initial state, we generalize this to account for the endogeneity of both the initial state and initial experience, and to allow for individuals to be retired in the initial state. Specifically, we use a reduced form dynamic multinomial probit model to approximate labor supply and retirement behavior between entering the labor marker, assumed to occur at age 20 years, and the time when the individual enters the sample. The data generation process for behavior prior to entering the sample is based on three indices $IE_{i,t}$, $IN_{i,t}$ and $IR_{i,t}$, indicating employment, non-employment or retirement at time t. More precisely, an individual is in employment at time t if $IE_{i,t} \geq IN_{i,t}$ and $IE_{i,t} \geq IR_{i,t}$, is nonemployed if $IN_{i,t} > IE_{i,t}$ and $IN_{i,t} \geq IR_{i,t}$ and otherwise retirement is the initial state. As above, we model retirement as an absorbing state, hence any individual who enters retirement cannot subsequently move into employment or non-employment.

In the empirical implementation, the index $IE_{i,t}$ is a linear function of observed characteristics, including experience, the random effects μ^θ_i, μ^γ_i, α^w_i and η_i, and an error term $\epsilon^I_{i,f,t}$. Inclusion of the random effects permits the initial observations to be correlated with subsequent

labor supply behavior. This is necessary to capture the endogenous nature of the initial conditions. The second index $IR_{i,t}$ is a linear function of age terms and error term $\epsilon^I_{i,r,t}$ while, for identification purposes, $IN_{i,t}$ depends only on error term $\epsilon^I_{i,n,t}$. The three error terms are mutually independent, independent over time and individuals and are drawn from a standard normal distribution.

3.2 Estimation strategy: Method of Simulated Moments

The parameters describing the job arrival and job separation rate, preferences, gross wages and the initial conditions are estimated jointly using the Method of Simulated Moments (MSM): parameters are chosen to minimize the distance between a set of moments pertaining to the values of the endogenous variables, namely wages, employment and retirement outcomes, as observed in the sample and the average values of the same moments in simulated data sets.[16] Similar to, e.g. French (2005), we estimate the health process separately from preference and wages in a first step (see Appendix I).

Method of Simulated Moments

Estimation proceeds as follows. R data sets with the same empirical distribution of exogenous individual characteristics as the sample are constructed. Using a particular vector of model parameters, denoted θ, employment outcomes and wages are simulated for each individuals in each of the R data sets. Relevant moments of the simulated endogenous variables in each data set are computed and denoted $M^r(\theta)$ for $r = 1, ..., R$. The metric $J(\theta)$ is constructed as follows

$$J(\theta) = \left(M^s - \frac{1}{R}\sum_{r=1}^{R} M^r(\theta) \right) \widehat{\Omega} \left(M^s - \frac{1}{R}\sum_{r=1}^{R} M^r(\theta) \right)', \tag{12}$$

where $\widehat{\Omega}$ is the weighting matrix, here $1/N$ times the inverse of the variances of the sample moments. $\widehat{\Omega}$ is estimated using bootstrap resampling of individuals from the original data set. The MSM estimator minimizes the distance between the simulated and the observed moments: $\widehat{\theta} = \text{argmin}_\theta J(\theta)$. The term $\frac{1}{R}\sum_{r=1}^{R} M^r(\theta)$ appearing in $J(\theta)$ is not a continuous function of the parameter vector θ as small changes in θ cause discrete changes in employment behavior for some individuals. Consequently gradient and Hessian based optimization methods are unsuitable methods for minimizing $J(\theta)$. Instead we use Simulated Annealing in the form suggested by Goffe et al. (1994) to solve for the MSM estimates..

Identification and Chosen Moments

Structural models are often criticized on the basis that identification of the parameters is not transparent. Recent contributions by Todd and Wolpin (2006) and Attanasio et al. (2005) propose using randomized or natural experiments to provide clearer identification of the central

[16] In a previous paper Haan and Prowse (2009) we discuss the treatment of missing observations when using MSM.

structural parameters in dynamic life-cycle models. Specifically, estimates from more robust reduced form analysis, such as treatment effects estimated using differences in differences techniques, provide inputs when estimating the structural parameters.

In our application, we observe the sample covariances between wages, transitions between employment states and retirement and labor market outcomes including retirement with demographic characteristics. We also observe the sample correlations between initial employment and retirement and demographic characteristics. Given the coefficient on consumption, this information identifies the parameters appearing in the wage process, arrival and separation rates, initial conditions, the preference for leisure and the cost of non-employment. The coefficient on consumption however is less straight forward to identify. Clean identification of this coefficient requires variation in net income that affects employment or retirement decisions without influencing wages, job-arrivals or separations.

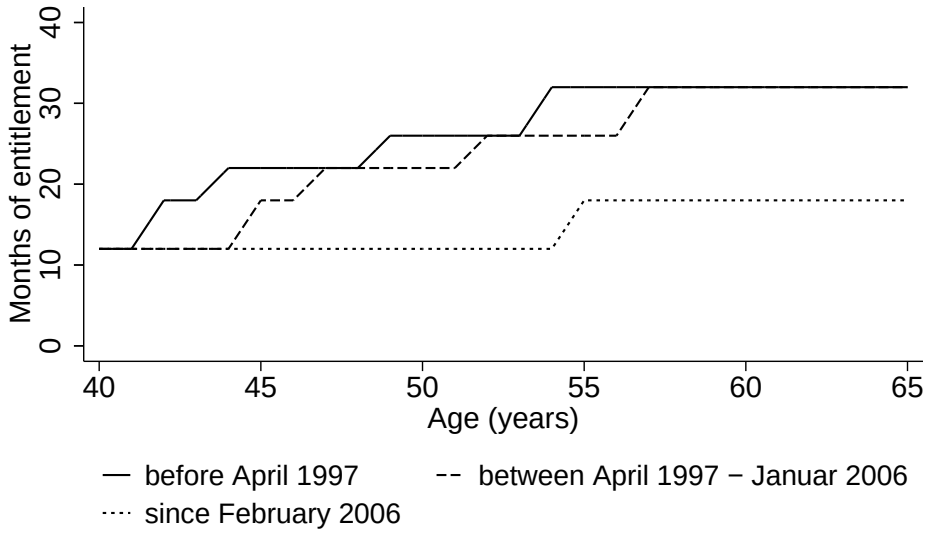
For our application, which focuses on Germany, our identification strategy for the coefficient on consumption relies on nonlinearities and discontinuities in the tax and transfer system and changes and reforms of the tax and transfer system during the sample period. In detail, in addition to moments related to year specific effects, we use the correlation between observed labor market outcomes and the unemployment insurance entitlement period, which we observe in the sample, as the bases for estimating the coefficient on consumption.[17] This correlation is influenced partly by experience, education, unobserved heterogeneity and other individual characteristics appearing in the model, but also depends on the year specific tax and transfer rules; the component of this correlation that is due to the tax and transfer code reflects the dependence of preferences on consumption and therefore this is informative about the coefficient on consumption in the structural model.

More precisely in Germany, the tax and transfer system influences the duration of entitlement to unemployment insurance benefits in two important respects. First, the rules dictate a maximum duration of entitlement, which varies discontinuously according to age. While the duration itself depends on a variety of individual characteristics, this variation by age is exogenous in the sense that it is not driven by variables within the model. Second, during the sample period, there were a number of changes to the system of unemployment benefits. Importantly, these changes where contingent on age. These changes create further, exogenous, variation of the entitlement period. In Figure 1 we present how the entitlement criteria changed over time through reforms introduced in 1997 and 2006. Nearly all age groups were affected either through the 1997 or the 2006 reform which implies that the identifying variation comes from the whole age distribution.

In this sense we use a rather indirect approach to exploiting the exogenous variation in eligibility period for unemployment insurance benefits when estimating our model. Unfortunately, given the nature of our sample, we cannot follow Attanasio et al. (2005) Attanasio, Meghir, and Santiago (2005) and treat the changes to the German system of unemployment insurance as a

[17] In reality, we use a number of correlations between different labor market outcomes and various functions of the unemployment insurance entitlement period as moments. For clarity of discussion, we refer here is a single correlation.

Figure 1: Changes in the maximal entitlement period by age



Note: Figure shows the maximal entitlement periods for eligible individuals for different periods. For more detail, see Schmitz and Steiner (2007).

natural experiment to be exploited via difference in difference methods and to provide identifying information relevant to the structural model. Specifically, we do not have clearly defined treatment and control groups, as the policy changes affected essentially all individuals in the sample, only the magnitudes of the changes varied across individuals.[18] In thus far our identification strategy is similar to Adda et al. (2009) who argue that regional variation over time increases their identifying power for estimating educational decision and employment behavior over the life-cycle.

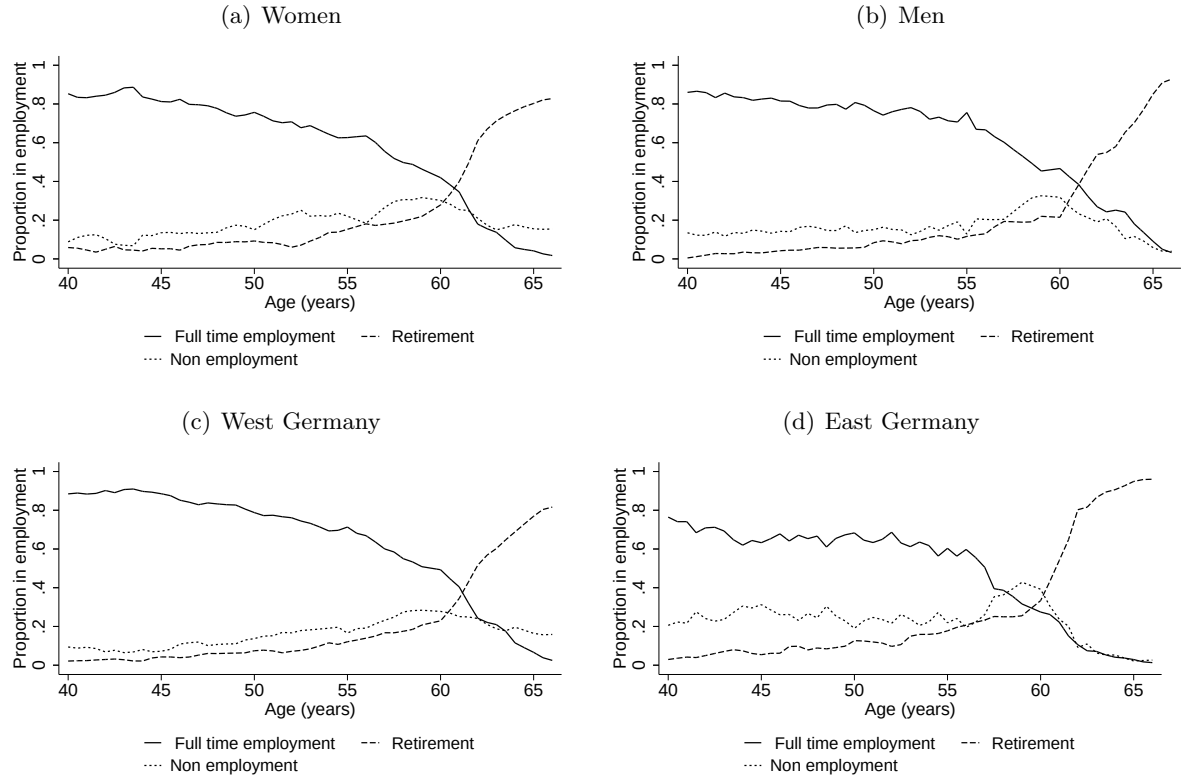
4 Data and Descriptive Evidence

This study draws on data from the SOEP which is an annual representative panel survey of over 11,000 households living in Germany and contains information about working behavior, socio-economic variables and income information from all sources at the individual and household levels.[19] We construct an unbalanced panel of single adult households with consecutive observations in at least two years between 1996 - 2008 inclusive which yields retrospective information for the fiscal years 1995 - 2007. In our analysis we focus on a specific sample of single households

[18] Using changes to the system of unemployment insurance benefits in the late 1980s, Hunt (1995) uses difference in differences techniques to estimate effects of the duration and level of employment insurance benefits. This was possible as Hunt (1995)'s sample covered a wider age rate and therefore a treatment group was readily available.

[19] For a detailed description of the data set, see Haisken De-New and Frick (2005).

Figure 2: Observed life-cycle employment and retirement behavior by gender and region



Source: Authors' calculations on the basis of the SOEP 1996-2008.

for which we assume that their family composition remains constant over their life-cycle. More precisely, we restrict the sample to singles older than 40 and younger than 66 years. We exclude individuals with primary earnings from self-employment as well as those in full-time education as their labor supply behavior differs substantially from that of the rest of the population of interest. These exclusions yield a sample with 2016 different single individuals, consisting of 1095 women and 921 men. The median number of observations per individual is 28 quarters.

Employment behavior

The SOEP includes detailed information about employment and retirement behavior in each month of the year prior to the interview date. For tractability, we group the monthly information for each individual to form quarterly observations. More precisely, the individual's state in the first month of the quarter determines the quarterly outcome. In this analysis we distinguish between employment, assumed to be full-time work, non-employment and retirement.[20] Individuals who report sufficient income from an own pension are classified as retired.

Figure 2 shows the share of employment, non-employment and retirement by age separately for men and women and by region. In general, the behavior of the various subgroups is similar.

[20]For our sample part-time work is only of minor importance, only about 5% of the population works less than 30 hours.

Until the age of 55 years employment rates are fairly high and decline to zero over the last 10 years of the working life. Before age 55 years the majority of the non-work corresponds to non-employment whereas retirement increases markedly after the age of 60 years. Employment rates for men and women are quite similar. This is not surprising since our sample consists only of single individuals without dependent children. A difference by gender only becomes visible at the end of the working life. In particular, women tend to retire earlier than men. By region however we find the expected strong difference: averaged over the whole age distribution, the employment rate is 10 percentage points higher in west Germany, and older east Germans have a higher propensity of retirement than west Germans of the same age. These differences are likely to be related to the worse economic conditions in east Germany.

We find an interesting shape of non-employed rate by age which is consistent with non employment being a stepping stone between employment and retirement. For men and women in both parts of Germany non-employment rates peak around the age of 60 and decline thereafter. In fact, it might be rational for workers to move from employment into non-employment for the period covered by the unemployment insurance and then to move into retirement. This stepping stone is in particular attractive since the period covered by unemployment insurance increases the pension payments when entering retirement. Unemployment in the final period of an individual's working life is very distinct from unemployment experienced at earlier years. When the individual is eligible for retirement with sufficiently high pension claims, there is no risk of a large reduction in the future income when unemployment insurance runs out.[21] This is in contrast to the unemployed not eligible for retirement benefits since the out of work income after the entitlement period run would be simply the minimum income. Hence, when agents are risk averse and forward looking, in the sense that they care about their future income, the combination of unemployment insurance and pension payments provide very different incentives for the employment decision close to retirement.

Gross wages

In addition to the retrospective information on monthly employment states and retirement, the data includes the gross earnings in the month prior to the interview date. Moreover, the corresponding working hours including payed over-time work are given and thus, we can construct an hourly wage measure. For time-consistency we cannot use the retrospective employment information and the current wage information from the same survey wave. Instead, we make use of the panel dimension in the data. Since we observe the exact interview day we can match the wage information collected in one year to the corresponding quarter of the retrospective employment information collected the next year.

[21] In theory, of course older unemployed need to be searching for a job and to be ready to take up this job, however in reality it is very unlikely the workers older then 60 get job offers which they are forced to take up by the employment office.

Demographic characteristics

Given that our sample is very homogenous, we condition the employment process and wages only on a few demographic characteristics. Specifically in addition to gender, education, nationality and region of residence, which are time-invariant, we allow for heterogeneity of age, time-varying health status and experience. A measure of experience at the time the individual enters the sample is constructed from retrospective information concerning the individual's working history. This variable is then updated in accordance with the individual's observed employment behavior.

5 Results

In the following we present preliminary results from a model without education and regional effects. Results of the full model are about to come and will allow to study effect heterogeneity.

Structural parameters

Tables 1, 2 and 3 show the estimates of the parameters of the equation describing log wages, job arrival and separation rates, and the preferences parameters including the access to early retirement.

Table 1: Estimates of Parameters in the Wage Equation

	Coefficient	Standard Error
Intercept	2.000	0.107
West	-	-
Education (years) /10	-	-
Experience (years) /10	0.341	0.038
Experience^2 (years) /1000	-0.522	0.165
Male	-	-
German	-	-
Health Problems	- 0.001	0.071
Age_1	0.054	0.028
Age_2	-0.021	0.071
λ_α	0.331	0.039
σ_υ	0.193	0.020

Note: Age_1 and Age_2 are age terms. Age_1 is zero if the individuals is aged less than 54 years, increases at the rate of 0.25 per quarter between age 54 and age 59 years and takes the value 5 if the individual is aged 59 years or older. Age_2 is zero if the individual is aged less than 59 years and increases at the rate of 0.25 per quarter thereafter. West is an indicator of residing in west Germany, Education is measured in years of formal eduaction. German is an indicator of being a German national. Health Problems is an indicator of having health problems that limit daily activities.

We find a significant effect of experience on wages which underlines the importance of human capital accumulation for the wage process. Moreover, individual specific unobserved effects and

Table 2: Job transitions

Arrival Rate		
	Coefficient	Standard Error
Intercept	-1.975	0.315
A2	-0.109	0.332
A3	-0.553	0.145
A4	-0.796	0.461
Bad health	-0.236	0.284
West	-	-
Experience	-	-
Separation Rate		
	Coefficient	Standard Error
Intercept	-3.877	0.239
A2	0.089	0.142
A3	0.038	0.092
A4	1.170	0.187
Bad health	-1.346	0.256
West	-	-
Experience	-	-
Unobserved Heterogeneity		
Variance Arrival	18.40	
Variance Separation	2.97	
Correlation	0.56	

Note: Age_1 and Age_2 are age terms. West is an indicator of residing in west Germany, Education is a dummy for having a medium school degree or vocational qualification. German is an indicator of being a German national. Health Problems is an indicator of having health problems that limit daily activities.

transitory shocks seem to play an important role. These effects should be reduced in a more complete wage estimation including education, regional and gender effects.

There exists a clear age pattern in the job arrival and separation rate. Older individuals are less likely to get a job offer and more likely to face a separation. The interpretation of the health effect is not meaningful in the simplified model since health status is strongly determined by gender, education and region which are omitted in that version. Similarly, the magnitude of the variance and the sign of the correlation between the unobservables might be related to the missing variables. The current estimation indicate that unobserved effects in both processes are positively correlated. This implies that individuals with a low type of unobserved effects face a higher risk of separation but are at the same time more likely to get a job offer. In other words they have a faster turn-over on the labor market.

As expected we find that individuals have a significantly positive preference for consumption. Together with the assumed parameter of risk aversion this implies that individuals enjoy consumption, yet at a decreasing rate. The preference for consumption is central for explaining how individuals respond to changes in financial incentives and will be the key determinant when analyzing the behavioral effects of changes in the design of unemployment insurance. We

Table 3: Employment and retirement

Preferences		
	Coefficient	Standard Error
Search cost	0.298	0.098
Transition cost to employment	0.808	0.107
Transition cost to non-employment	0.194	0.182
θ	0.937	0.112
σ_η	0.282	0.074
Consumption	1.539	0.098
Access to Retirement		
	Coefficient	Standard Error
Intercept	-2.763	0.037
Age2	0.514	0.049
Age3	-0.815	0.246
Health	1.347	0.089

Note: Age_1 and Age_2 are age terms. West is an indicator of residing in west Germany, Education is a dummy for having a medium school degree or vocational qualification. German is an indicator of being a German national. Health Problems is an indicator of having health problems that limit daily activities.

estimate the mean θ and the variance σ_η of the degree of complementarity between consumption and leisure η (Equation 8) and assume that the distribution is truncated form above one and below zero. The conditional mean of the truncated distribution is about 0.9. This implies that on average the net reservation wage for full time work is 10% higher than income out-of work. However, the estimation of the variance shows that there exists significant unobserved heterogeneity in the population.

Search costs and costs of transitions between the states are positive and of sizable magnitude. The chosen specification allows us to interpret these costs in monetary terms. The findings imply that on average, the search costs of unemployed amount to 200 Euro per months. These cost include both direct search cost as well as stigma effects of being on the job search which are expressed in monetary terms. Transitions from unemployment into employment are estimated to be quite costly, i.e., 800 Euros, whereas transitions from employment to unemployment are markedly lower (200 Euros) and these are not statistically significant. The costs are mainly related to the loss of habit formation as well as to fixed cost of starting a new job for an unemployed.

As expected, we find that the probability to having access to early retirement increases with age and is positively related to being in bad health conditions.

To complete the description of the estimation results, Table 4 presents the coefficients appearing in the initial conditions. These parameters are descriptive of individuals' behavior prior to their entering the sample, but do not have a structural interpretation.

Table 4: Estimates of Parameters describing Initial Conditions

Employment		
	Coefficient	Standard Error
Intercept	2.40	0.49
Individual employment effect	2.70	0.70
Individual wage effect	0.81	0.27
Individual job offer effect	0.41	0.16
Individual job separation rate	-0.95	0.23
$\text{Age}_3/10$	-0.53	0.29
Age_4	-0.55	0.09
Experience/10	-1.36	0.17
Education	-1.14	0.34
West	4.59	0.43
Male	-1.13	0.37
Health Problems	-4.05	0.61
Asset 1	2.10	0.42
Asset 2	2.19	0.47
Children Previously	-0.49	0.40
Previous Previously	-0.94	0.30
Retirement		
	Coefficient	Standard Error
Intercept	-3.40	0.11
$\text{I}(55 < \text{Age} \leq 57)$	1.27	0.29
$\text{I}(\text{Age} > 57)$	2.16	0.24

Note: Age_3 and Age_4 are age terms. Age_3 is zero for individuals aged less than 40 years, increases at a rate of 0.25 per quarter up to age 55 years, and takes the value 15 if the individual is aged 55 years or older. Age_4 is zero for individuals aged less than 55 years and increases at a rate of 0.25 per quarter thereafter. Asset 1 is an indicator of income from assets being positive but less than 400 Euros per year, and Asset 2 is an indicator of income from assets being greater than 400 Euros per year. Children Previously and Married Previously are indicators of having had dependent children or having been married prior to entering the sample. For further details, see the note for Table 1.

Goodness of Fit

Figure 3 presents a graphical analysis of the model's goodness of fit. Employment, non-employment and retirement are predicted satisfactorily. The distribution of the simulated log wages for individuals in employment in the quarter in which they were interviewed and adjusted for survey non-response, matches accurately the distribution of sampled wages.[22]

6 The design of unemployment insurance

There exists an important theoretical literature on the design of unemployment insurance and the effects on unemployment duration, job search and employment behavior (for an overview see

[22]We provide detailed information about the 214 simulated moments as supplementary material on the home page of the Journal.

Figure 3: Goodness of Fit

Note: Simulation results based on 50 simulated data sets each of the same size as the sample. Log wages are in year 2000 prices.

the Handbook chapter by Krueger and Meyer, 2002). Central for our analysis is the contribution of Mortensen (1977) in which he shows that changes in the generosity of unemployment insurance have an ambiguous effect on employment over the life-cycle.

We use the estimated model to analyze how changes in the design of unemployment insurance, namely the replacement ratio and the entitlement period, affect the employment behavior over the life cycle. The advantage of an analysis based on a dynamic structural life-cycle model is that the estimation is directly embedded in a theoretical model and therefore a clear and more general interpretation of the empirical findings is possible. In particular we can directly test for the importance of the entitlement effect Mortensen (1977) and can evaluate how this effect varies by age, employment status and entitled months of eligibility.

In the following we simulate changes in the employment behavior over the life-cycle which are induced by i) a reduction in the replacement ration from 60% of the previous net-income to 50% and ii) by a reduction in the entitlement period for the eligible to 6 months independent of age. We use the German tax and transfer system of the year 2001 as the status quo scenario. We simulate the employment effects over the life-cycle, measured in changes in percentage points of the employment rate, for three different populations. For an individual with average characteristics of the whole population at the age of 40, for an individual with characteristics of those

who are employed at the age of 40, and finally for one with characteristics unemployed at the age of 40. More precisely we take the group specific observed and unobserved characteristics together with the estimated structural parameters and simulate the employment outcomes for the different policy regimes. The difference between the population can not be interpreted as marginal effects of one characteristic, instead the differences can be attributed to all differences, including the initial employment state, difference in wages, arrival and separation rates and unobserved types. Further simulations by different subgroups will be conducted in order to better understand the driving forces of the results.

6.1 Employment effects of a reduction in the replacement ratio

A reduction in the replacement ratio leads to very different effects in the employment behavior over the life-cycle. For an individual with average characteristics we find hardly any or even slightly negative employment effects of a reduction in the generosity until the age of 55. Thereafter, the change in employment rates increases to close to one percentage point at the age of 60 and finally when the majority of individuals are in retirement, the effect vanishes again. The positive employment effect of the individuals older 55 is in line with previous findings such as Lalive et al. (2006) who use regional and time specific variation in the design of unemployment insurance to identify the causal effect of the replacement ratio and the entitlement period on the duration of unemployment in a reduced form model. As discussed above, for this age group unemployment insurance is generous due to longer entitlement periods and higher payments related to experience effects in the wages. Hence, we find that the employment effect related to changes in working incentives in the current period clearly outweighs the entitlement effect. This is in line with the theoretical predictions of Mortensen (1977) who shows that the entitlement effect becomes less important for older individuals for whom the expected future utility flows become less important.

In contrast for younger individuals we find that the entitlement effect outweighs or even dominates the effect related to the working incentives for the current period. This difference over the life-cycle become even clearer when focussing only on individuals unemployed at the age of 40. This group has either short or no entitlement for unemployment insurance and therefore they are mainly affected by the entitlement effect in future periods. Hence, we provide empirical evidence that the entitlement effect is dominating for this group. This is in line with Wolpin (1992) who finds for the U.S. that black individuals which tend to face higher unemployment risk significantly increase their employment when increasing the generosity of unemployment insurance. Similarly in a recent study based on time use data, Krueger and Mueller (2008) find evidence that unemployment duration decreases for non-eligible unemployed when generosity of the unemployment increases.

When focussing on individuals employed at the age of 40 the entitlement effect is not present in the beginning. However, since we simulate the behavior over the life-cycle at older ages, the entitlement effect becomes more important.

Figure 4: Employment effect of change in replacement ratio

Note: The employment status refers to the initial state at the age of 40. Results have been derived for an individual with the group specific average characteristics. Simulation results based on 50 simulated data sets each of the same size as the sample. Employment effects are induced by a reduction in the replacement ratio from 60% to 50%.

6.2 Employment effects of a reduction in the entitlement period

In this section we perform a similar simulation as above however focussing at a reduction in the entitlement period to 6 months. We need to preform more detailed simulations in order to better discuss the employment effects. However, most important even this figure underlines the dominance of the entitlement effect at younger ages and in particular for those unemployed at the age of 40.

7 Conclusion

In this study we have developed a dynamic structural life-cycle model of labor supply behavior which accounts for endogenous accumulation of human capital and for the effect of the tax and transfer system on work incentives. In addition to income tax, social security contributions and social assistance, the model incorporates unemployment insurance benefits which are endogenous with respect to life-cycle employment. The empirical analysis is based on a long panel of single households taken from the German Socio Economic Panel (SOEP). We use simulated method of moments to estimate the dynamic structural life-cycle model. In the econometric specification control for unobserved heterogeneity, the non-randomness of the initial state and for measurement error in wages.

Figure 5: Employment effect of change in entitlement period

Note: The employment status refers to the initial state at the age of 40. Results have been derived for an individual with the group specific average characteristics. Simulation results based on 50 simulated data sets each of the same size as the sample. Employment effects are induced by a reduction of the entitlement period to 6 months.

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Appendix I: Estimation of the Health Equation

The sampled individuals were asked to record their health status only in the quarter when the annual survey took place. A standard probit model cannot therefore be used to estimate the parameters in Equation (3.1) as health status in the previous quarter, Health Problems$_{i,t-1}$, is

unobserved. Instead we use the Method of Simulated Moments (MSM) to estimate the unknown parameters. Table 5 reports the MSM parameter estimates. The coefficient on health status in the previous quarter is highly significant indicating strong persistence in health status on a quarter by quarter basis. Additionally we see that health tends to decline with age but improves with experience and education.

Table 5: Estimates of Parameters in the Health Process

	Coefficient	Standard Error
Health Problems$_{t-1}$	4.122	0.129
(Age (years)-40)/10	0.210	0.041
Education/10	-0.206	0.048
West	-0.008	0.052
Male	0.119	0.045
Experience/10	-0.100	0.027
Intercept	-2.091	0.034

Note: Most of the moments are OLS regression coefficients from a regression of observed health status on the previous observation of health status, Health Problems$_{i,t-4}$, and explanatory variables. Additionally we included the proportions of individuals whose health remains good, remains poor and changes from good to poor between adjacent surveys. Also see note for Table 1.

Appendix II: The German Tax and Transfer System

This Appendix describes the key elements of the German tax and transfer system and how we implement the legislation in the setting of a dynamic life-cycle model of labor supply. Although the general structure of income tax, social security contributions and transfers was unchanged over the years 1995 - 2007, several reforms, discussed in detail below, affected the progressivity and generosity of this system. As discussed in Section 3 these reforms provide an additional, exogenous, source for identification of the structural model.

Social Security Contributions (SSC)

In each month, an individual's income from employment is subject to social security deductions for health, unemployment and pension benefits.[23] As shown in the first three columns of Table 6, except for unemployment insurance, the rates for SSC increased slightly over time. Social security contributions are capped, and the upper level of monthly earnings subject to SSC is higher in west Germany than in the East (5200 Euros compared to 4500 Euros in 2005).[24]

[23] In addition to the employee's SSC, the employer contributes about the same amount in SSC.

[24] Low earning individuals pay SSC at a subsidized rate. However, since we only consider the full-time employed, the lower bound is of no relevance for our application.

Table 6: Key Parameters of the German Tax and Transfer System

	Social Security Contributions			Income Taxation		ALG I			ALG II	
	Health Insurance in %	Pension Insurance in %	Unemployment Insurance in %	Tax Allowance per Year	Top Marginal Tax Rate in %	Max. Period in Months	% of prev. income full ALG I	% of prev. income reduced ALG I	Average West per Months	Average East per Months
1995	7	9.3	3.3	4050	53	32	60	53	564	553
1996	7.5	9.65	3.3	6021	53	32	60	53	571	560.5
1997	7.75	10.15	3.3	6021	53	32	60	53	580	569.5
1998	7.75	10.15	3.3	6156	53	32	60	53	586	575
1999	7.75	9.85	3.3	6507	53	32	60	53	594	584
2000	7.75	9.85	3.3	6876	51	32	60	53	606	596
2001	7.75	9.55	3.3	7200	48.5	32	60	53	617	606
2002	7.75	9.75	3.3	7200	48.5	32	60	53	629	617
2003	8	9.75	3.3	7200	48.5	32	60	53	634	622
2004	8	9.75	3.3	7632	45	32	60	53	643	631
2005	8.5	9.75	3.3	7632	42	32	60	-	653	637
2006	8.5	9.75	3.3	7632	42	18	60	-	658	642
2007	8.5	9.75	2.1	7632	42*	18	60	-	662	645

*: From 2007, taxable income above 250 000 Euro per year is taxed at a rate of 45%.

*Note:*All payments are given in Euro. The rates of the SSC describe only the employee's share. The employer contributes the same amount. The minimum income includes housing benefits.

Income Taxation

In contrast to SSC, income tax is computed on an annual basis and at the household level. Since we focus only on single households, issues pertaining to the joint taxation of couples do not affect our model. An individual's annual taxable income is defined as the sum of gross income from employment above an exemption threshold, gross income from assets above a disregard and income from renting. Moreover SSC up to a maximum amount are deducted. An individual's annual income tax liability is obtained by applying the income tax function to taxable income. The income tax function is a smooth function of taxable income above a further exemption threshold. The exemption threshold increased between 1995 and 2006 while, over the same period, the top marginal tax rate decreased from 53% to 42% (see Table 6). In additional to income tax, individuals pay an extra tax (Solidaritaetszuschlag) to finance the cost of German reunification. This extra tax was decreased in 1998 from 7.5% to 5.5% of income tax payments.

Transfer System

Transfers to the unemployed consist of a unemployment insurance component, termed ALG I, which is, depending on the level, paid in addition to or instead of social assistance (ALG II). Individuals entering unemployment who have worked at least one year in the last three years are eligible to receive ALG I. Eligible unemployed individuals receive ALG I payments of 60% of previous net earnings for an entitlement period.[25] The period of entitlement to ALG I benefits at the 60% rate varies between 6 and 18-32 months, depending on age and employment history. Schmitz and Steiner (2007) provide a detailed description of the determinants of the entitlement period for eligible unemployed individuals.

As mentioned above, over the period of interest the age and working requirements, as well as the entitlement period changed. Most notably, in 2006 the maximum period of entitlement to ALG I benefits at the 60% rate was reduced from 32 to 18 months. Before the year 2005, the amount of ALG I was reduced to 53% of previous net earnings when the entitlement period expired. This reduced ALG I was then a permanent transfer. From 2005 on, the long-term unemployed who have exhausted their entitlement to ALG I at the higher rate receive only the ALG II social assistance payments. For the long-term unemployed with relatively high previous earnings, this reform had a large effect on their out-of work transfers and thus on working incentives.

The amount of ALG II (social assistance) does not depend on previous earnings. Entitlement rules are independent of the previous working history and the transfer is permanent. The transfer consists of a person-related part that varies by region (Bundesland) and of housing benefits that may vary by individual. However, housing benefits only guarantee a reasonable apartment given the number of household numbers. In the last two columns of Table 6 we provide information about the average monthly benefit payments by year and east and west Germany. Note ALG II is means-tested against income from all sources. Thus, if the ALG I payments for an eligible unemployed individual are lower than the ALG II payments, then he receives in addition to

[25] The 60% rate is applicable to single individuals without dependent children. Higher rates apply to individuals with dependent children, see Schmitz and Steiner (2007).

ALG I the difference between the two transfers. The same applies to a worker if the earnings from work are lower that the ALG II payments. However, since in this model we focus only on full-time working men the means-testing against earnings from work is of no relevance.[26]

Transfers are not taxed as income in Germany. Instead, ALG I is added to taxable income to determine the individual's average tax rate, which is then applied to taxable income to determine the individual's tax liability. ALG II payments have no tax implications.

Pension system

In theory, overall pensions consist of various sources including state pensions, private pension or firm-specific pension plans. Moreover if individuals are not entitled for any pension or if the overall sum of pensions are sufficiently low, the retired receive means-tested minimum income. Given the limited data at hand we cannot model all sources of pensions. Instead we mainly focus on state pensions which in Germany provide the largest share of overall pensions.

In brief, pension payments depend on the total number of years in employment over the working life and on the related gross earnings. For unemployment spells, the amount unemployment insurance defines the share of the final pension payments. Non-eligible unemployed cannot accumulate any claims for their pensions. A fraction of the pension together with all non-labor income is subject to income taxation.

Implementation

As described above, income tax is based on annual income. However we model labor supply decisions at quarterly intervals. In our implementation of the German tax and transfer system we calculate net income in the current quarter based on an annualized version of the individual's income in the current quarter. The procedure assumes implicitly that individuals base their labor supply decision in the current quarter on their net income relating to their current gross income and ignore any adjustments in taxes and transfer pertaining to income received previously in the fiscal year. Additionally we assume full take-up of benefits.

[26]For both ALG I and ALG II, there exists a different withdrawal design of additional earnings for the unemployed. Again, since in our model workers can only work full time the withdrawal design does not apply.