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ABSTRACT

A Structural Approach to Estimating the Effect of Taxation on the Labor Market Dynamics of Older Workers*

We estimate a dynamic structural life-cycle model of employment, non-employment and retirement that includes endogenous accumulation of human capital and intertemporal non-separabilities in preferences. Additionally, the model accounts for the effect of the tax and transfer system on work incentives. The structural parameter estimates are used to evaluate the effects of a tax reform targeted at low income individuals on employment behavior and retirement decisions.

JEL Classification: C23, C25, J22, J64

Keywords: life-cycle labor supply, income taxation

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1 Introduction

The aim of this paper is to analyze how the labor market behavior of older individuals responds to the incentives provided by the tax and transfer system. Given our analysis, it is appropriate to work within a dynamic structural life-cycle model of labor supply. A dynamic model is required to take account of intertemporal non-separabilities in wages and preferences. Such effects imply that reforms of the tax system which affect the net incomes of young or middle aged individuals might induce incentives which change employment behavior towards the end of the working life. Similarly, a life-cycle model, featuring optimizing forward looking individuals, provides a desirable framework as it allows current labor supply to depend on the expected rewards to future employment. Thus, a life-cycle model captures the employment response of younger members of the labor force to a tax reform that affects the net incomes of older workers.

In common with the proceeding literature concerned with the specification and estimation of dynamic structural life-cycle models of labor supply, prominently Eckstein and Wolpin (1989), our model allows for on-the-job accumulation of human capital and for intertemporally non-separable preferences. Additionally, the implemented model captures the effects of income taxation, social security contributions and in-work and out-of-work transfers on labor supply incentives. The latter feature is necessary to represent correctly labor supply incentives. Despite this, very few papers in this literature have attempted to model the returns to working as net income rather than gross earnings. Indeed, while there exist several implementations of dynamic structural life-cycle models including a specification of the transfers paid to non-working individuals (see, *inter alia*, Adda, Costa Dias, Meghir, and Sianesi, 2007; Ferrall, 1997; Wolpin, 1992), the tax and transfer system applicable to the gross incomes of working individuals has been widely ignored. Exceptions include Yamada (2007), who models progressive income tax when analyzing the life-cycle employment behavior of Japanese women, Haan, Prowse, and Uhlendorff (2008) who use a full specification of all relevant elements of the German tax and transfer system when studying the effect of in-work benefits and Rust and Phelan (1997) who study the effect of the design of the social security system on the retirement decisions of American men.

In our framework, the transfer system determines the net incomes of non-working individuals through means-tested benefits while the net income of a working individual is defined as his or her gross earnings minus social security contributions and income tax plus any in-work transfers. The novelty of the current paper lies in the focus on the effect of the design of the system of taxation applied to earned income on the employment and retirement decision of older individuals. For this analysis we use a sample of German men and women aged between 40 and 65 years living in single adult households without dependent children. Each period non-retired individuals choose between full-time employment, non-employment and, if eligible, early retirement. In a similar vein to Low, Meghir, and Pistaferri (2006), dependent on age and health status, individuals can decide to retire before the compulsory retirement age of 65 years. In particular, individuals without health problems can enter retirement if they are aged 50 years or more while individuals with health problems can retire at any age.

The estimated structural parameters are used to derive the employment and retirement

effects of a reform to the system of income taxation. Specifically we look at the employment and retirement effects of a hypothetical policy change which reduces the taxable earnings of low income individuals. We compare the effect of this policy when individuals of all ages are affected with the effect when only those aged 60 years and above receive the reduction in taxable income. This analysis complements a large empirical literature which has evaluated the labor supply effects of policies that alter the net incomes of working individuals with low earning, prominently the Earned Income Tax Credit and the Working Tax Credit, (see the surveys by Blank, 2002; Blundell, 2000; Hotz and Scholz, 2003). In contrast to the reduced form and structural myopic methods of evaluation which have been used previously, we use a dynamic structural life-cycle model to determine the employment and retirement effects of a reform affecting the net incomes of working individuals. The main advantage of our approach is that the estimated structural parameters can be used to simulate the life-cycle effects of proposed or hypothetical reforms to tax and transfer schemes that affect the net incomes of working individuals while recognizing the forward looking and intertemporal nature of individuals' labor supply behavior.

The results show that a reduction in the taxable income of low earning individuals at all ages leads to a significant increase in employment, of around 1.5 percentage points on average, at most ages. The vast majority of the increase in employment is due to a reduction in non-employment, however for individuals aged over 60 years there is, averaged over the sample, a reduction in retirement, corresponding to a delay in the timing of movements into early retirement. The policy effects are, however, somewhat different when the tax reform is limited to only those aged 60 years and above. Indeed, since we model the labor supply in a dynamic setting with forward looking individuals, the employment behavior of younger individuals might be affected as they know that if their future earnings are sufficiently low they will receive the reduction in taxable income once they reach 60 years of age. The results show that the age dependent reform induces essentially no effects for individuals aged under 57 years. However, between age 57 and 60 years there is an increase in employment and a reduction in non-employment.

The remainder of this paper proceeds as follows. Section 2 presents a dynamic structural model of labor supply behavior over the life-cycle. This section closes with a presentation of the empirical specification of the flow utilities and the equation of motion for gross wages. Section 3 contains a full description of the institutional features of the German tax and transfer system that impact in the net incomes of employed and non-employed individuals. The strategy for estimation is outlined in Section 4 and the data source, the German Socio-Economic Panel (SOEP), and our sample selection criteria are discussed in Section 5. Estimation results and an analysis of goodness of fit are presented in Section 6. Section 7 shows the estimated employment and retirement effects of changes to the system of income taxation. Finally, Section 8 concludes.

2 Model and Empirical Specification

Overview

It is the purpose of this paper to study the effects of the tax and transfer system on the employment behavior of older individuals. To this end, we derive and estimate a dynamic structural life-cycle model of employment, non-employment and early retirement that accounts for the endogeneity of work experience, intertemporally non-separable preferences, and the effect of the tax and transfer system on work incentives. To reduce complexities, we restrict our sample to one particular population group. Specifically, we model only the life-cycle labor supply of men and women residing in single adult households without dependent children. Further, we focus on individuals aged 40 years and above. We assume that family composition is constant over the individual's future life and this is justified by the aforementioned age restriction. Additionally, it is assumed that men and women in this age category have finished their education and therefore all of the analysis is conditional on educational qualifications obtained prior to age 40 years.

Before proceeding, two further limitations of our analysis are discussed. Firstly, 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.[1] Secondly, unlike numerous studies focussing on the job search behavior, including Ferrall (1997) and Frijters and van der Klaauw (2006), we do not model job search; in our model, all non-retired individuals receive one job offer each period and all non-work among non-retired individuals, henceforth referred to as non-employment, corresponds to individuals who chose not to accept a job at the wage they were offered.

Job Offers and Net Income

Let $t = \tau_i$ denote the age at which individual i enters the labor market and let T denote the age of compulsory retirement. Similar to Low, Meghir, and Pistaferri (2006) we allow individuals aged T^R years or older and those with poor health to take early retirement while this alternative is not open to individuals without health problems aged under T^R years. Non-employed individuals remain in the labor force and may return to full-time employment in the future. In contrast, early retirement is a fully absorbing state and thus once an individual enters early retirement returning to employment in the future is precluded.[2]

In each period $t = \tau_i, ..., T$ every non-retired individual receives a single offer of a full-time job (f). The gross wage associated with the job offer received by individual i at time t is denoted $w_{i,t}$. Non-retired individuals without health problems aged younger than T^R must decide between accepting the full-time job, in which case they receive a net income in the current quarter of $m_{i,f,t}$, and rejecting the offer, in which case the individual is non-employed (n) and receives a net income of $m_{i,n,t}$. Individuals without health problems aged T^R or above and all

[1] French (2005) is one of the few examples of a discrete choice model of life-cycle labor supply that allows saving.

[2] This assumption is in line with the observed behavior of early-retired individuals in Germany. Hardly any of the early-retired transition into full-time employment.

individuals with health problems have a choice between full-time employment, non-employment, and retirement (r). In practice, retired individuals receive a pension which depends previous earnings and working history. We model pension payments in a reduced form manor as discussed in more detail below. A period is defined to be a quarter of a year. This provides a reasonable tradeoff between the reality of individuals being able to move between employment states on a monthly or even weekly basis and the need for computational tractability.

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 on labor supply incentives. This study uses the German tax and transfer system as a benchmark. Under the German system the net income of an employed individual is a function of the individual's gross earnings, gross non-labor income and the prevailing tax and transfer system. The tax and transfer system includes social security contributions, income taxation and, if net income is sufficiently low, a minimum income transfer to raise the individual's net income to the minimum income. The net income of a non-employed individual consists of any non-labor income, which may be taxed, and government provided transfers. Section 3 provides a more detailed description of the German legislation together with information concerning relevant recent changes to the system.[3]

Optimal Labor Supply over the Life-cycle

Having received a job offer with a wage of $w_{i,t}$ at time t individual i must decide whether to accept or reject the job offer. By drawing on dynamic programming techniques, we model optimal labor supply over the life-cycle in a forward looking setting where the individual considers the dependence of payoffs occurring in the future on his or her current labor supply decision. We differentiate two mechanisms linking today's employment decision with future payoffs. Firstly, intertemporally non-separable preferences due to habit formation and adjustment costs mean that an individual's current employment behavior affects his or her preference for employment relative to non-employment in future periods. Secondly, employment today adds to the individual's experience which leads to a higher expected pension and, assuming positive returns to experience, to higher expected future wage offers.

The individual's life-cycle utility can be expressed in terms of the employment 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 and the offered wage $w_{i,t}$ at time 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 early retirement is defined as the discounted value of the individual's

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

expected life-time utility if he or she enters retirement in the current quarter.

Formally, let $D_{i,t}$ be an indicator of individual i being eligible for early retirement at age t. $D_{i,t}$ takes the value one if the individual is aged T^R years or above and/or the individual has health problems and is zero otherwise. The employment state specific value functions for full-time employment and non-employment are defined recursively as follows

$$V_{i,t}^{j}(s_{i,t}) = \begin{cases} U_{i,j,t}(s_{i,t}) + \delta \mathbf{E}_t \left[\max\{V_{i,t+1}^{f}, V_{i,t+1}^{n}, V_{i,t+1}^{r}\} \middle| s_{i,t}, y_{i,j,t} = 1 \right] \text{ for } t = \tau_i, .., T-2, \\ U_{i,j,t}(s_{i,t}) + \delta \mathbf{E}_t \left[V_{t+1}^{r} \middle| s_{i,t}, y_{i,j,t} = 1 \right] \text{ for } t = T-1, \end{cases} \tag{1}$$

while the value function for early retirement is

$$V_{t}^{r}(s_{i,t}) = \begin{cases} U_{i,r,t} + \sum_{h=1}^{\overline{T}} \delta^h \mathbf{E}_t [U_{i,r,t+h} | s_{i,t}, y_{i,r,t} = 1] \text{ if } D_{i,t} = 1, \\ -\infty \text{ if } D_{i,t} = 0. \end{cases} \tag{2}$$

In the above $y_{i,j,t}$ for $j = f, n, r$ is an indicator variable taking the value one if the individual was in employment state j at time t and zero otherwise and $\overline{T} > T$ denotes the last period of the individual's life. In the empirical analysis the value of $\overline{T}$ is taken to be 78 years. $U_{i,j,t}$ denotes the individual's flow utility associated with employment state j at time t and is a function of the individual's current net income, socio-economic characteristics and his or her previous employment outcomes. 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.[4]

The individual 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 health problems implies acceptance of the job offer received at time $t < T^R$ if and only if $V_{i,t}^{f}(s_{i,t}) \geq V_{i,t}^{n}(s_{i,t})$. Conversely, if $V_{i,t}^{n}(s_{i,t}) \geq V_{i,t}^{f}(s_{i,t})$ then the individual will choose non-employment. A healthy individual aged $T_i^R \leq t < T$ or an individual with health problem aged $t < T$ will work full-time if and only if $V_{i,t}^{f}(s_{i,t}) \geq V_{i,t}^{n}(s_{i,t})$ and $V_{i,t}^{f}(s_{i,t}) \geq V_{i,t}^{r}(s_{i,t})$, will be non-employed if and only if $V_{i,t}^{n}(s_{i,t}) > V_{i,t}^{f}(s_{i,t})$ and $V_{i,t}^{n}(s_{i,t}) \geq V_{i,t}^{r}(s_{i,t})$, and otherwise the individual will move out of the labor market and into retirement. At age $t = T$ all remaining non-retired individuals enter compulsory retirement.

Empirical specification

This section contains descriptions of the chosen specification of the flow utilities, the distribution of offered wages and the treatment of the persistent unobservables, which takes into account the initial conditions problem.

[4]Previous studies, for example Karlstrom, Palme, and Svensson (2004), mention problems estimating the discount factor in similar life-cycle models.

Flow utilities

For the estimation, the flow utilities from full-time work and non-employment are specified as follows

$$U_{i,f,t}(x_{i,t}, m_{i,f,t}, \alpha_{ie}, \epsilon_{i,f,t}) = \beta_f + \beta_y \frac{m_{i,f,t}^{1-\rho} - 1}{1-\rho} + \beta_x x_{i,t} + \beta_\alpha \alpha_{ie} + \epsilon_{i,f,t}, \quad (3)$$

$$U_{i,n,t}(m_{i,n,t}, \epsilon_{i,n,t}) = \beta_y \frac{m_{i,n,t}^{1-\rho} - 1}{1-\rho} + \epsilon_{i,n,t}. \quad (4)$$

As common in this literature we assume that individuals are risk averse, and set $\rho = 1.5$. β_y determines the sign and magnitude of the preference for net income and therefore consumption. The intercept for full-time employment, denoted β_f, accounts for any disutility from work. The vector of observed individual characteristics $x_{i,t}$ includes an indicator of the individual's employment state in the last quarter, and individual's total labor market experience since leaving full-time education, measured in quarters, in addition to socio-economic variables. The lagged employment state and experience terms capture intertemporal non-separabilities in preferences due to the combined effects of habit formation and adjustment costs. The unobservables $\epsilon_{i,f,t}$ and $\epsilon_{i,n,t}$ 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 $\epsilon_{i,f,t}$ and $\epsilon_{i,n,t}$ but has no information about the future values of these error terms.

Persistence in unobservables is captured by α_{ie} which represents a time invariant individual specific random effect, assumed to be known to the individual but unobserved to the econometrician. α_{ie} is assumed to occur independently of observed socio-economic characteristics, however, by construction, at $t > \tau_i$ α_{ie} will be correlated with experience and the individual's previous employment state. Therefore, an initial conditions problem is encountered with estimating this model because individuals are first sampled after they have entered the labor market. We follow Wooldridge (2005) and model the distribution of the random effect conditional on the initial conditions. This is operationalized by allowing the mean of the random effect appearing in preferences to depend on the first observation of the individual's employment status and the proportion of the individual's working life spend in employment at the point when the individual enters the sample. The stochastic element of the random effect is drawn from a normal distribution with zero mean and variance $\sigma_{\alpha e}^2$.[5]

A reduced form specification of the value function for retirement $V_t^r(s_{i,t})$ is employed. Specifically we assume

$$V_t^r(s_{i,t}) = \gamma q_{i,t} \sum_{h=0}^{\overline{T}} \delta^h + \epsilon_{i,r,t}, \quad (5)$$

where $\epsilon_{i,r,t}$ is an error term with the same properties as $\epsilon_{i,j,t}$ for $j = f, n$. In the above $\gamma q_{i,t}$ can be interpreted as the deterministic component of the per-period utility of an individual who

[5] In order to obtain identification, the coefficients of the observed and unobserved individual characteristics $x_{i,t}$ and α_i have been normalized to zero in the flow utility from non-employment.

enters retirement at age t, relative to his or her utility from non-employment. The value function for retirement is formed by summing the discounted per period utilities over the individual's remaining life. In the above, $q_{i,t}$ contains age terms and also observed individual characteristics. The age terms in $q_{i,t}$ capture variation on the individual's payoff from retirement according to the age at which he or she retired. Such effects may arise either from the design of public early retirement schemes or from rules tying firm specific or private pension payments to the age of retirement.

Gross Wages

Gross wages are a central component of the model as the offered gross wage is a major determinant of an individual's net income from full-time work. In the empirical analysis individual i's log offered gross wage is assumed to evolve according to

$$\log(w_{i,t}) = \lambda_z z_{i,t} + \lambda_\alpha \alpha_{iw} + \upsilon_{i,t} \quad \text{for} \quad t = \tau_i, ..., T. \tag{6}$$

In the above $z_{i,t}$ are observed individual characteristics that affect wages including education, region of residence and years of experience in the labor market. The coefficient on experience captures 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^2_υ. 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_{iw} is a time invariant individual specific random effect assumed to be normally distributed with a mean that depends on the initial conditions, and a variance $\sigma^2_{\alpha w}$. After conditioning on the initial conditions, this random effect is assumed to be independent of the random effect α_{ie} occurring in preferences. However, since wages have an indirect effect on the preferences through net income, the persistent unobservables affecting the utility of full-time employment relative to non-employment are correlated with the persistent unobservables occurring in the wage equation.

Wages as observed by the econometrician are measured with error. Specifically

$$\log(w_{i,t})^* = \log(w_{i,t}) + \eta_{i,t} \quad \text{for} \quad t = \tau_i, ..., T, \tag{7}$$

where $\log(w_{i,t})^*$ represents the log gross wage observed by the econometrician and $\eta_{i,t}$ is a measurement error assumed to occur independently of the true wage and independently over time. Furthermore, $\eta_{i,t}$ is assumed to be normally distributed with zero mean and a variance σ^2_η.

3 The German Tax and Transfer System

In the following, we describe 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 - 2006, several reforms, discussed in detail below, affected the progressivity and generosity of this system. These reforms are important for this study as they provide an additional, exogenous, source of identification, in particular for the coefficient on net income.

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.[6] As shown in the first three columns of Table 1, 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).[7]

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 1). 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

Conditional on an individual's employment and earnings history, a non-working individual may receive unemployment insurance transfers. Additionally, depending on the level of any unemployment insurance transfers and income from other sources, the individual may receive a means-tested minimum income transfer, which includes a region specific housing benefit. The minimum income transfer does not depend on previous earnings and the transfer is permanent. We simplify the legislation and approximate out-of-work transfers by only the means-tested minimum income transfer. Given our sample selection criteria, unemployment insurance is relatively unimportant so there is little loss in including only the means-tested minimum income transfer. Specifically, in the empirical analysis we include only individuals with low educational qualifications. Such individuals tend to have low wages and therefore any unemployment insurance payments are wholly or mostly offset by the withdraw of the means-tested minimum income transfer. For two reasons, this approximation is most problematic for older individuals with long working histories. First, wages, and therefore any unemployment insurance transfers,

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

[7] 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 1: Key Parameters of the German Tax and Transfer System

	Social Security Contributions			Income Taxation		Minimum Income Transfers	
	Health Insurance in %	Retirement Pension in %	Unemployment Insurance in %	Tax Allowance per Year	Highest Marginal Tax Rate in %	Average per Month West	Average per Month East
1995	7	9.3	3.3	4050	53	564	553
1996	7.5	9.65	3.3	6021	53	571	560.50
1997	7.75	10.15	3.3	6021	53	580	569.50
1998	7.75	10.15	3.3	6156	53	586	575
1999	7.75	9.85	3.3	6507	53	594	584
2000	7.75	9.85	3.3	6876	51	606	596
2001	7.75	9.55	3.3	7200	48.5	617	606
2002	7.75	9.75	3.3	7200	48.5	629	617
2003	8	9.75	3.3	7200	48.5	634	622
2004	8	9.75	3.3	7632	45	643	631
2005	8.5	9.75	3.3	7632	42	653	637
2006	8.5	9.75	3.3	7632	42	658	642

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.

are increasing with experience. Second, the entitlement rules for the unemployment insurance are relatively generous for the older workers.[8] Minimum income payments made to non-working individuals are means-tested against capital income and income from renting. The last two columns of Table 1 show the average monthly minimum income transfer paid to non-working individuals for the years 1995 - 2006.

Working individuals with net incomes below the minimum income receive an in-work transfer to raise their income to the minimum income. However as, in our model, all work consists of full-time employment the majority of working individuals do not receive minimum income transfers. In Germany, minimum income transfers are not 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.

4 Estimation Strategy

The parameters describing gross wages and preferences are estimated jointly using the Method of Simulated Moments (MSM).[9] 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. The model contains 32 parameters and estimation is based on 48 moments including the mean values of the endogenous variables and correlations between these variable and the explanatory variables. The coefficient on net income is identified from correlations between functions of non-labor income and employment behavior. Changes in the tax and transfer system over time provide a further source of identification. Specifically, such changes provide exogenous variation in the relationship between net income and employment, see Table 1 for changes in the tax and transfer system over time. The state specific value functions, required to simulate data sets, are approximated using an adaptation of the method of Keane and Wolpin (1994).

Within the MSM framework it is straight forward to deal with missing wage observations.

[8] In an ongoing research project, Haan and Prowse (2009) distinguish between the different transfer schemes for the non-employed and model the endogeneity of entitlement to unemployment insurance payments in a life-cycle model. This more complex model is informative about the effects of changes in the entitlement period of the insurance based part of unemployment transfers. However such concerns are beyond the scope of this paper.

[9] In contrast Haan, Prowse, and Uhlendorff (2008) use a two-step procedure. This procedure reduced implicitly the number of state variables in the model thus allowing the tax and transfer system to be modeled for more complex household structures than considered in this paper. However, this method suffers from the general shortcomings of a two-step estimation procedure.

Given the above model and the data source described below, there are three reasons for missing wages. First, wages are observed only in one quarter of each year - the quarter in which the interview was conducted - while the individual's employment state is observed in every quarter. Second, only individuals in employment are asked to report their wage; the offered wage is not observed for non-working individuals. Third, some individuals in employment do not respond to all of the survey questions needed to construct the wage measure. The missing wage observations in the quarters without interviews and the unobserved wages for non-working individuals do not pose any particular difficulties when constructing the simulated data sets. In the estimation we match moments of the wages observed in the sample with moments computed from the simulated wages of individuals who, in the simulation, chose to work in the quarter in which they were interviewed. This procedure does not require wages for non-interview quarters and accounts for selection into employment based on both observed and unobserved individual characteristics. To account for survey non-response, the moments pertaining to simulated wages are computed by weighting the simulated wages according to observed socio-demographic variables. These adjusted simulated moments are then matched to the corresponding moments in the sample. This methodology accounts for survey non-response that varies according to observed socio-demographic variables but assumes that, conditional on observables, survey non-response is random.

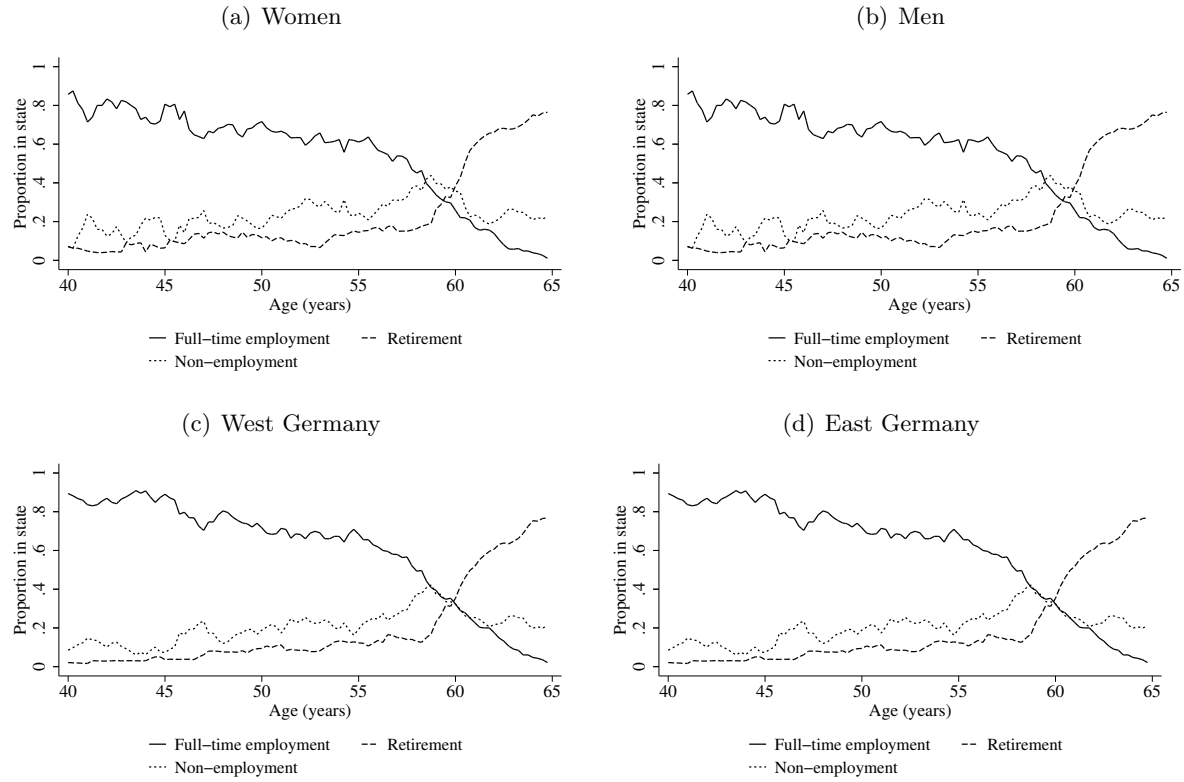
5 Data and Descriptive Evidence

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.[10] We construct an unbalanced panel of single adult households with consecutive observations in at least two years between 1996 - 2007 inclusive which yields retrospective information for the fiscal years 1995 - 2006. The sample is restricted to singles aged between 40 and 65 years inclusive. The maximum level of school qualifications of individuals in our sample is a medium degree (Realschule) and we drop individuals who have a higher vocational degree. Further, we exclude individuals whose primary earnings are from self-employment as their labor supply differs substantially from that of the rest of the population of interest. These exclusions yield a sample with 867 different single individuals, consisting of 489 women and 378 men. The median number of observations per individual is 24 quarters.

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. Individuals aged 50 years or above who report sufficient income from a pension are classified as retired

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

Figure 1: Observed life-cycle employment and retirement behavior by gender and region of residence



Source: Authors' calculations on the basis of the SOEP 1996-2007.

as are younger individuals with objective health problems who receive a large enough pension.[11]

Figure 1 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. Until the age of 55 years employment rates are fairly high while the employment rate declines 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 than in east 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.

In addition to the retrospective information on monthly employment states, 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

[11] The assumption that only individuals older than 50 years or with health problems can choose early retirement is supported by the data.

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.

Given that our sample is very homogenous, we condition preferences and wages on only a few demographic characteristics. Specifically in addition to gender, education, nationality and region of residence, which are time-invariant, we condition on 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.

6 Results

Table 2 shows the estimates of the parameters of the equation describing log wages. All parameters are in line with previous findings. Gross wages are increasing in experience: we find that an extra 10 years of experience increase the gross wage by 7%. We find quite large wage differentials by gender, education, nationality and region of residence while there is no significant effect of the health status. *Ceteris paribus* the gross wages of men are about 25% higher than for women. The average effect of medium education, defined as having a medium school degree or vocational qualification, is of a similar size. We find that for native Germans wages are roughly 30% higher and the wage differential between east and west Germany is on average about 50%. As expected, variables that describe the initial conditions of employment have a strong impact on wages. Moreover a large proportion on the unobserved component of log wages is due to persistent unobservables. In contrast, the effect of classical measurement error is relatively small and is not significant. The low measurement error we find is consistent with a well specified wage equation. Similarly, the estimated variance of the time dependent individual error term is small and insignificant.

Tables 3 and 4 show, respectively, the estimates of the parameters that determine the flow utility from full-time employment, relative to non-employment, and the value function associated with retirement. In terms of the flow utility from full-time employment, the coefficient of the indicator of being in employment in the previous quarter is highly significant. This state dependence effect may be due to adjustment costs or habit formation. Age is a significant determinant of preferences for full-time work only for individuals aged 59 years and above. As mentioned above the approximation of the out-of work transfers is most problematic for the older workers, since entitlement rules become more generous at the age of 60. Thus, the age related preference effect might capture to some extent institutional regulations that provide incentives to use non-employment as a stepping stone into retirement (Haan and Prowse, 2009). Interestingly we find that single men tend to have a lower preference for full-time work than single women, although in the data we find on average a slightly higher employment rate for men. This is related to the previously mentioned gender differential in offered gross wages. The higher

Table 2: Estimates of Parameters in the Wage Equation

	Coefficient	Standard Error
Intercept	0.946	0.266
West	0.522	0.159
Education	0.240	0.058
Experience/10	0.070	0.039
Male	0.251	0.054
German	0.304	0.063
Health problems	-0.028	0.045
Initial state	0.405	0.088
Initial proportion	-0.051	0.176
$\sigma_{\alpha w}$	0.282	0.031
σ_{η}	0.083	0.108
σ_{ν}	0.029	0.137

Note: West is an indicator of residing in west Germany, Education is a dummy for having a medium school degree or vocational qualification. Experience is measured in years to the nearest quarter, German is an indicator of being a German national. Health problems is an indicator or having some form a health problems that limit daily activities. Initial state and Initial proportion are controls for the initial conditions. Initial state is an indicator of being in full-time employment in the first quarter of observation. Initial proportion is the proportion of the individual's working life spent in employment as measured in the first quarter of observation.

work incentive for men are offset by their lower preference for employment. The negative effect of medium education can be explained in a similar way since offered wages for more educated workers are higher. The effect of experience on the preference for employment is related to the positive experience effect on wages and is found to be non significant. As expected individuals with health problems have a lower preference of full-time work relative to non-employment. Lastly, the coefficient on net income is significantly positive thus implying that net income is an important determinant of labor supply behavior. The variables describing the initial condition are not significant. Similarly, the standard deviation of individual unobserved effect $\sigma_{\alpha e}$ is only weakly significant. However, as discussed above, the individual specific unobservables in the wages process affect the labor supply decision indirectly through the net income. The same is true for the initial conditions variables.

The value function associated with retirement is increasing in experience and is higher for individuals aged over 59 than for younger individuals. These effects are consistent with the rules of both public and private pensions schemes. The size of pension depends crucially on the working history which is measured by experience. Moreover there are fairly large penalties in both public and private insurance plans if individuals claim their pension at earlier ages.

Figure 2 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.

Table 3: Estimates of Parameters Describing Preference for Employment

	Coefficient	Standard Error
Intercept	-6.688	0.752
Employed_{t-1}	5.162	0.830
Age_1	-0.111	0.109
Age_2	-0.686	0.254
Male	-0.884	0.396
Health problems	-1.293	0.295
Education	-0.495	0.258
Experience/10	-0.221	0.404
Initial state	0.602	0.848
Initial proportion	0.556	1.054
Coefficient on net income (β_y)	3.337	1.307
$\sigma_{\alpha e}$	1.041	0.589

Note: Age_1 and Age_2 are age terms. Age_1 is zero if the individuals is aged less than 54 years, increases in units of 0.25 per quarter between age 54 and age 59 and takes the value 1 if the individual is aged 59 years or older. Age_2 is zero if the individual is aged less than 59 years and increases in units of 0.25 per quarter for individuals aged over 59 years. See also the note for Table 2.

Table 4: Estimates of Parameters Describing Preference for Retirement

	Coefficient	Standard Error
Intercept	-11.076	1.522
Employed_{t-1}	-0.108	0.093
$\text{I}(59 \leq \text{Age} < 63)$	4.258	0.867
$\text{I}(63 \geq \text{Age})$	3.703	0.293
Male	-0.233	0.854
Health problems	0.033	0.929
Education	0.898	1.047
Experience/10	1.051	0.342

Note: I() denotes and indicator function. See also the note for Table 2.

Further evidence concerning the model's goodness of fit is presented in Table 5 which shows the empirical and simulated values of selected moments together the bootstrapped standard errors. There is a close correspondence between the observed and simulated moments.[12] However, there is some tendency for simulated log wages to be more persistent than observed wages. Formally, the χ^2 test statistic for the model fit rejects the null hypothesis of the validity of the 16 extra moment conditions. As shown in the last column of the table the bootstrapped standard errors of the observed moments are very small which is due to the large sample size. Hence, although the difference between the simulated and observed moments is fairly small in absolute terms, according to the bootstrapped standard errors this difference is significant.

[12]The same is true of the other moments used for estimation but not presented in this table.

Figure 2: 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.

7 Life-cycle Employment Effects of Tax Reforms

In the final section attention is turned to using the structural parameter estimates, reported above, to simulate the effects of a reform to the system of taxation of earned income on individuals' employment and retirement decision as they approach the age of compulsory retirement.

The German tax and transfer system can be characterized as a traditional welfare system with relatively generous out-of-work transfers and high marginal deduction rates when people start working. In the political discussion this has often been criticized and the low working incentives have been identified as a central reason for high unemployment, particularly among the low educated. Drawing on the international experience, mainly from EITC in the US and the WTC in the UK, there is an ongoing debate about changing the German welfare system by shifting more transfers to the working poor and thus increasing work incentives.

In the following we focus on one specific, hypothetical, change to the tax system designed to foster employment among low earning individuals. In contrast to recent reform proposals which concentrate on the design of out-of-work transfers, we propose a reform which reduces the marginal tax rate directly through a tax reduction for the working poor. Specifically, we consider the effect of a proportional reduction in taxable earnings for low income individuals. The calibration of this policy is based on year 2000 prices and is such that individuals with a gross hourly wage of less than 7.5 Euros per hour receive a 20% reduction on their taxable labor

Table 5: Values of selected observed and simulated moments and a χ^2 test statistic the validity of over-identifying restrictions

Moment	Observed	Simulated	Bootstrapped Standard Error
mean($y_{i,f,t}$)	0.468	0.506	0.012
mean($y_{i,r,t}$)	0.293	0.274	0.013
sd($lnw_{i,t}$)	0.373	0.411	0.013
mean($lnw_{i,t}$)	0.146	0.093	0.025
corr($lnw_{i,t}, lnw_{i,t-4}$)	0.851	0.951	0.036
corr($lnw_{i,t}, lnw_{i,t-8}$)	0.869	0.950	0.026
corr($y_{i,f,t}, y_{i,f,t-1}$)	0.946	0.951	0.035
corr($y_{i,f,t}, y_{i,f,t-2}$)	0.898	0.909	0.065
corr($y_{i,r,t}, y_{i,f,t-1}$)	-0.608	-0.635	0.017
sum($y_{i,f,t}(1 - y_{i,f,t-1})$)	268	239	15.301
sum($(1 - y_{i,f,t})y_{i,f,t-1}$)	142	136	13.825
corr($lnw_{i,t}$, West$_{i,t}$)	0.412	0.351	0.045
corr($lnw_{i,t}$, Education$_{i,t}$)	0.049	0.027	0.060
corr($lnw_{i,t}$, Experience$_{i,t}$)	0.047	0.116	0.044
corr($lnw_{i,t}$, Male$_{i,t}$)	0.186	0.144	0.054
corr($lnw_{i,t}$, German$_{i,t}$)	0.026	0.084	0.038
corr($lnw_{i,t}$, Health problems$_{i,t}$)	-0.004	-0.007	0.043
Pct$_{25}$($lnw_{i,t}$)	-0.087	-0.188	0.045
Pct$_{75}$($lnw_{i,t}$)	0.392	0.377	0.020
χ^2 statistic	81.315	d.f.=16	p=0.000

Note: sd denotes standard deviation and Pct$_j(a)$ denotes the j^{th} percentile of the variable a. The bootstrapped standard errors are based on 500 bootstrapped samples from the original data set.

earnings. Reductions of 15%, 10% and 5% are given to individuals whose gross hourly wage is, respectively, between 7.5 Euros and 10 Euros, between 10 Euros and 12.5 Euros and between 12.5 Euros and 15 Euros. Individuals with a gross hourly wage higher than 15 Euros are not affected by the policy change.

We consider two different implementations of this tax reforms. The first is targeted at the whole population and increases working incentives for low wage individuals of any age. In the second implementation eligibility for the tax relief is conditioned on age. Specifically, only workers older than 59 years are eligible for the tax reduction. The age specific reform has the advantage that it is targeted at a population with low employment rates and thus limits subsidies given to individuals who would choose employment without additional fiscal incentives. However, this change in income taxation for older workers induces dynamic effects over the life-cycle. Indeed, for younger individuals not directly targeted by the age-related tax reduction it might be optimal to adjust working behavior because of forward looking anticipation effects. A priori the work incentives induced by such a tax reform are ambiguous. On the one hand higher working experience increases the employment probability as well as gross wages at older ages and this makes a tax reduction more attractive. On the other hand, since the tax reduction is

conditional on hourly wages, it might be optimal for a younger worker to reduce employment, leading to lower future wages, in order to become eligible for the tax subsidy. These examples highlight the complexity of behavioral effects induced by fiscal policy over the life-cycle, and underline the importance of applying a dynamic life-cycle model which allows for adjustments in current labor supply in response to anticipated future incentives.

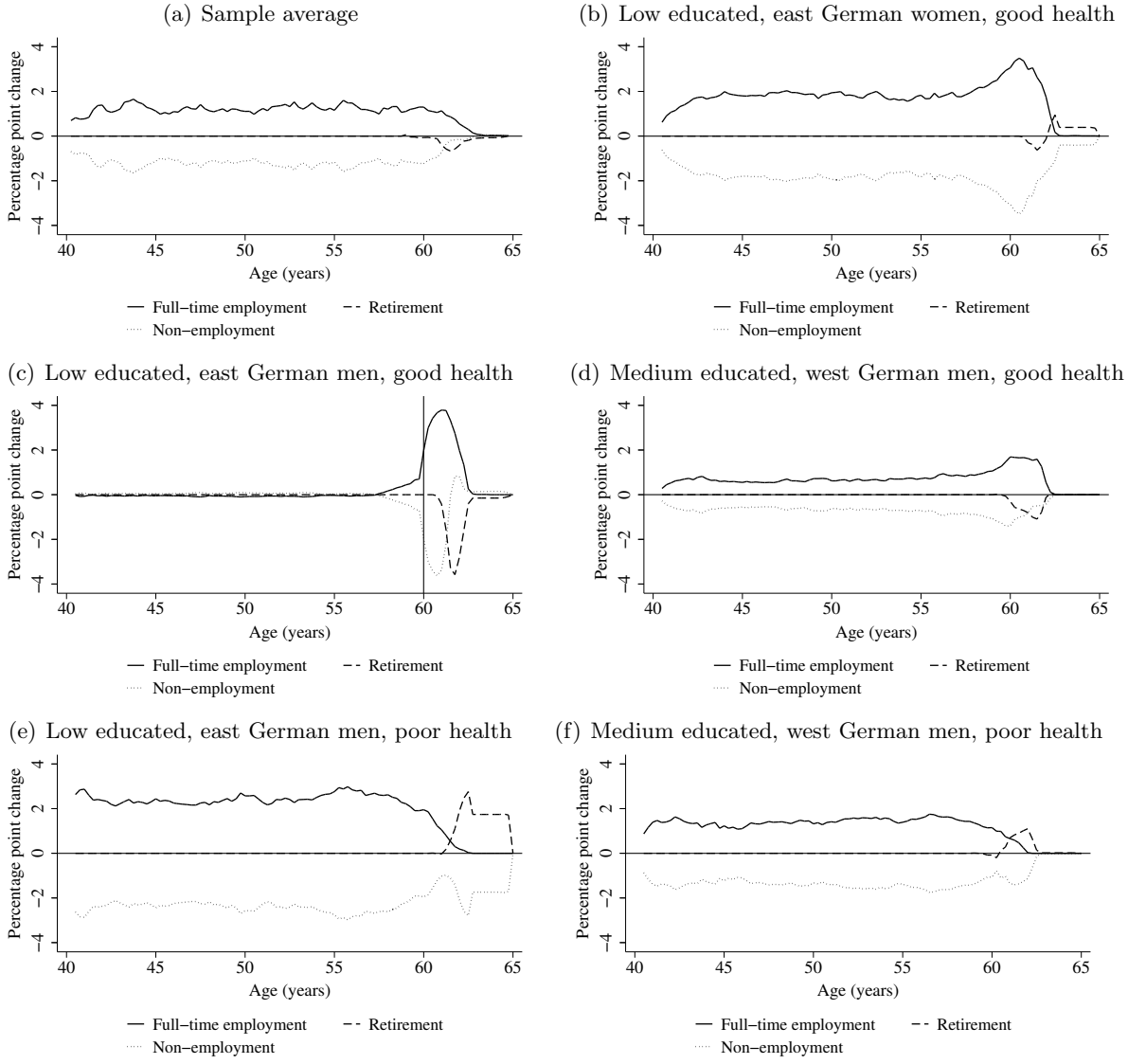
Figure 3 shows the effects on employment, non-employment and retirement when the tax reform is introduced for all individuals regardless of age.[13] Panel (a) shows that averaged across the whole population the policy leads to an increase in full-time work, of around 1.5 percentage point at most ages, and a similar sized reduction in non-employment. Effects on retirement decisions are negligible prior to age 60 while for individuals aged over 60 the policy leads individuals to delay their retirement. The tax reform induces counteracting incentives on the retirement behavior. Younger individuals might move earlier into retirement since the increased employment leads to higher pensions. On the other hand it might be optimal to postpone retirement in order to receive the subsidy for longer.

By definition, the tax reform leads to different behavioral responses for individuals with difference observed characteristics. Since eligibility for the tax reduction is conditional on low wages, individuals with low potential earnings have the highest incentive to take up or stay longer in employment. Moreover, the size of the employment effect depends on the observed employment shares of subgroups and is related to the estimated preference terms by observed and unobserved characteristics discussed above. In the remaining panels in Figure 3 we present the policy effects for selected subgroups of the population. Panels (b) shows effects for low educated, east German women in good health while panel (c) shows the effects for the corresponding group of men. The effects for men and women are of a similar magnitude and the only notable difference is that for women there is a small decrease in retirement followed by an increase in retirement, while retirement effects are always positive for men. Given the relatively minor difference between men and women, further comparisons focus only on men. Across the other subgroups we see larger effects on employment for the east German men with low education than for the west German men with medium education. This is in line with the work incentives provided by the tax reform. Being in poor health tends to reduce employment effects for low educated east Germans and to increase retirement effects for medium educated west Germans. Retirement effects are negative for medium educated west Germans, implying that the policy leads to delayed retirement among members of this group, but is positive for all other groups.

Figure 4 shows that the employment effects differ when the entitlement to the tax reduction is conditioned on age. Unsurprisingly, the employment effects are largest for individuals aged 60 and above, who are directly affected by the policy reform. On average we find an increase in employment of about 1 percentage point at around the age of 61 years. At the same time retirement is postponed. The age related tax reform does not induce incentives to move earlier into retirement as discussed above. By subgroups, we find the same differences as before. For east Germans with low education and with good health employment rates increase around the

[13] Clarity of presentation, bootstrapped confidence intervals are omitted from the following figures. The increase in full-time employment is in general significantly for all subgroups up to age 62 years.

Figure 3: Employment and retirement effects of a tax reform affecting all individuals: Sample average and by subgroup



Note: Simulations assume zero income from assets. When simulating the behavior for the subgroups we assume that at age 40 all individuals are in employment and have 20 years of experience.

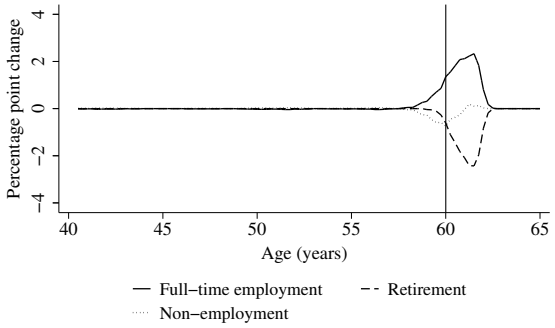
Figure 4: Employment and retirement effects of a tax reform affecting individuals aged years 60 and over: Sample average and by subgroup

(a) Sample average

(b) Low educated, east German women, good health

(c) Low educated, east German men, good health

(d) Medium educated, west German men, good health



(e) Low educated, east German men, poor health

(f) Medium educated, west German men, poor health

Note: See note for Figure 3.

age of 61 years by about 3 percentage points. The effects for the other subgroups are smaller, and dramatically so for individuals with poor health.

As discussed above, the age specific tax reform might induce behavioral effects for individuals younger than 60 years, who are not affected directly by the tax reform. These effects are due to anticipation effects which induce behavioral responses by younger individuals optimizing their life-cycle labor supply. The results show that before the age of 57 years behavioral responses are negligible. However at ages just before the policy change becomes effective, the employment rate increases, on average by about half a percentage point. The size of this effect depends on several features of the model, including the specification of intertemporal dependencies in preferences, modeled here with experience and the lagged dependent variable, and the mechanism for human capital accumulation, which here takes the form of years of previous employment. Additionally, the magnitude of any anticipation effects is driven by the discount factor. We have assumed individual to be forward looking with an annualized discount factor of 0.96. At the lower bound, with myopic individuals ($\delta = 0$) the employment effect for the younger individuals would be zero. The upper bound, with a discount factor of one, the behavioral responses of younger individuals would certainly by higher.

8 Conclusion

In this paper we have developed and estimated a dynamic structural life-cycle model of employment, non-employment and retirement that includes endogenous accumulation of human capital and intertemporal non-separabilities in preferences. Additionally, and in contrast to most of the previous literature, the model accounts for the effect of income taxation on work incentives. We argue that such a model is required to represent accurately individuals' labor supply incentives and to capture the various sources of dynamics in labor supply behavior.

Based on panel data from the SOEP we have estimated the parameters of a life-cycle model for single adult households without dependent children. The model fits the data well, including fitting accurately the distribution of wages, which are a key determinant of individuals' labor supply decisions. In line with the previous literature, the estimation results show significant dynamic effects which occur through both state dependent preferences and human capital accumulation. Furthermore, we find a significant effect of net income on the employment decision, which stresses the importance of a detailed modeling of the tax and transfer system.

The structural parameter estimates are used to evaluate the effects of a tax reform targeted at low income working individuals on employment behavior and retirement decisions. We find that a hypothetical change to the system of income tax which provides a proportionate reduction in taxable income for low earning individuals leads a 1.5 percentage point increase in the rate of full-time employment. Due to its focus on low earning individuals, the effect of this policy is larger for low educated than for medium educated individuals. Additionally, there is evidence of interactions between income taxation and retirement decisions. Averaged over the whole sample, there is a reduction in retirement implying that the cut in income tax for low earning individuals causes a delay in movements into early retirement. It is therefore the case that, on

average, the direct incentive created by the policy to move into employment outweighs the effect of greater pension entitlement due to more experience. We have also considered the labor market implications of conditioning the reduction in income tax on age, such that only individuals aged 60 years and above are eligible to receive the tax rebate. In this case, the policy leads to a large positive employment effect and a reduction in retirements among those aged 60 years and above. Also, due to the forward looking nature of individuals' labor supply decisions, individuals aged under 60 years, who are not affected directly by the policy, find it optimal to adjust their labor supply behavior. Specifically, for individuals aged 57-60 years we find an increase in full-time employment and a reduction in non-employment.

References

Adda, J., M. Costa Dias, C. Meghir, and B. Sianesi (2007): "Labour Market Programmes and Labour Market Outcomes: A Study of the Swedish Active Labour Market Interventions," *Mimeo*.

Blank, R. (2002): "Evaluating Welfare Reform in the United States," *Journal of Economic Literature*, 40(4), 1105–1166.

Blundell, R. (2000): "Work Incentives and "In-work" Benefit Reforms: A Review," *Oxford Review of Economic Policy*, 16(1), 27–44.

Eckstein, Z., and K. Wolpin (1989): "The Specification and Estimation of Dynamic Stochastic Discrete Choice Models: A Survey," *The Journal of Human Resources*, 24(4), 562–598.

Ferrall, C. (1997): "Unemployment Insurance Eligibility and the School-to-Work Transition in Canada and the United States," *Journal of Business & Economic Statistics*, 15(2), 115–29.

French, E. (2005): "The Effects of Health, Wealth, and Wages on Labour Supply and Retirement Behaviour," *Review of Economic Studies*, 72(2), 395–427.

Frijters, P., and B. van der Klaauw (2006): "Job search with nonparticipation," *Economic Journal*, 116, 45–83.

Haan, P., and V. Prowse (2009): "Unemployment Insurance versus Social Assistance - Effects on Working Behavior over the Life-cycle," *Mimeo*.

Haan, P., V. Prowse, and A. Uhlendorff (2008): "Employment Effects of Welfare Reforms: Evidence from a Dynamic Structural Life-Cycle Model," Discussion paper, Institute for the Study of Labor (IZA).

Haisken De-New, J., and J. Frick (2005): *Desktop Compendium to The German Socio-Economic Panel Study (SOEP)*. DIW.

Hotz, V. J., and J. K. Scholz (2003): "The Earned Income Tax Credit," in *Means-Tested Transfer Programs in the United States*, ed. by R. A. Moffitt, pp. 141–198. Chicago: University of Chicago Press.

Karlstrom, A., M. Palme, and I. Svensson (2004): "A Dynamic Programming Approach to Model the Retirement Behaviour of Blue-collar Workers in Sweden," *Journal of Applied Econometrics*, 19(6), 795–807.

Keane, M. P., and K. I. Wolpin (1994): "The Solution and Estimation of Discrete Choice Dynamic Programming Models by Simulation and Interpolation: Monte Carlo Evidence," *The Review of Economics and Statistics*, 76(4), 648–672.

Low, H., C. Meghir, and L. Pistaferri (2006): "Wage risk and employment risk over the life cycle," (W06/27).

Rust, J., and C. Phelan (1997): "How Social Security and Medicare Affect Retirement Behavior in a World of Incomplete Markets," *Econometrica*, 65(4), 781–832.

Wolpin, K. I. (1992): "The Determinants of Black-White Differences in Early Employment Careers: Search, Layoffs, Quits, and Endogenous Wage Growth," *The Journal of Political Economy*, 100(3), 535–560.

Wooldridge, J. M. (2005): "Simple Solutions to the Initial Conditions Problem in Dynamic, Nonlinear Panel Data Models with Unobserved Heterogeneity," *Journal of Applied Econometrics*, 20(1), 39–54.

Yamada, K. (2007): "Marital and Occupational Choices of Women: A Dynamic Model of Intra-household Allocations with Human Capital Accumulation," *Mimeo*.