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

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Abstract

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 effects of income tax, social security contributions and the transfer system on work incentives. The structural parameter estimates are used to evaluate the employment effects of a tax reform focused on low income individuals. This tax reform is found to cause a significant increase in employment and we find evidence for anticipation effects if the reform is only targeted at older workers.

Keywords: Life-cycle labor supply; income taxation; in-work credit; tax reform.

JEL Classification: C23; C25; J22; J64.

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1 Introduction

In most developed countries, the employment rates of older workers are relatively low, and long-term unemployment is heavily concentrated among older workers. For example, in Germany almost two-thirds of all unemployed people aged 55 - 64 years have been unemployed for more than a year, compared to roughly 40 percent in the total population. This is particularly problematic for the low educated and individuals living in east Germany as they generally have the lowest employment rates. Responding to this phenomena, in several countries labor market policy targeted at older people has recently shifted from early retirement schemes to "active" labor market programs aimed at increasing the employment rates of older unemployed people.

The aim of this paper is to evaluate how changes in the tax and transfer system could be effective in fostering employment among older members of the workforce in Germany. 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 work incentives implicit in the system have been identified as a central reason for high unemployment, particularly among the low educated. Drawing on the international experience, mainly from the Earned Income Tax Credit (EITC) in the US and the Working Tax Credit (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 their work incentives.

In this analysis we evaluate the introduction of an in-work credit for the working poor designed similarly to the EITC. We consider two different implementations of this tax reform. The first is targeted at the whole population and increases working incentives for employed individuals of any age. In the second implementation eligibility for the tax credit is conditioned on age. Specifically, only workers aged 60 years and above are eligible for the transfer. The age specific reform has the advantage that it is targeted at a population with low employment rates and thus the design limits subsidies given to individuals who are likely to choose employment without additional fiscal incentives.

However, this change in the tax and transfer system for older workers induces dynamic effects over the life-cycle. In order to account for theses potential dynamic effect, 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 only 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 et al., 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 et al. (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 et al. (2009), 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.

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 earnings, prominently the EITC and the WTC, (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. In contrast to a growing literature on retirement behavior based on dynamic structural life-cycle models, e.g. Rust and Phelan (1997) or French (2005), we do not focus on the behavioral effects of specific reforms to the pension system. Instead we show how changes in the tax and transfer system might induce positive employment effects while holding the pension system fixed. In this sense our study is similar to Adda et al. (2007) and Adda et al. (2009) who evaluate the employment effect of different labor market policies over the life-cycle. However, while these papers focus on the beginning of the working career, we analyze the employment effects towards the end of the working life.

Our results show that the introduction of an in-work credit targeted at low earning individuals of any age leads to a significant increase in employment and a postponement in retirement. In addition, anticipation effects occur 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 then they will be eligible for the tax credit once they reach 60 years of age. Our 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 postponement of retirement.

The remainder of this paper proceeds as follows. Section 2 presents our 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 equations of motion for gross wages and health status. Section 3 contains a full description of the institutional features of the German tax and transfer system that impact on 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

2.1 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.

Each period an individual reoptimizes his or her labor supply and retirement behavior. 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. Following e.g., Rust and Phelan (1997), we account for gender and age specific life-expectancy which is calculated on the basis of the Human Mortality Database.[1]

Before proceeding, two further limitations of our analysis are discussed. Firstly, as is common in this literature, e.g., Rust and Phelan (1997), we make the restrictive assumption that

[1]Human Mortality Database is provided by the University of California, Berkeley (USA), and Max Planck Institute for Demographic Research (Germany). The database is available at www.mortality.org.

individuals do not save and are credit constrained.[2] Therefore, the estimated employment effects of a tax subsidy should be interpreted as upper bounds. In a more general model, in addition to the tax and transfer system, precautionary savings would 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. However, since in this study we focus on a sample of low educated men and women, ignoring precautionary savings as potential insurance should only be of minor importance.[3] 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. That implies that job transitions are driven mainly by persistence or state dependence effects in employment and by experience or human capital accumulation which might affects wages.

2.2 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 et al. (2009), 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.[4]

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 individuals with health problems have a choice between full-time employment, non-employment, and retirement (r). In practice, the net income of pensioners, $m_{i,r,t}$, is mainly determined by pension payments which depend on previous earnings and the working history over the whole life-cycle. Since we focus on the employment effects of a tax reform which does not affect the pension system, we do not model pension payments explicitly but instead implement a reduced form specification for payoffs associated with retirement which absorbs the effect of pension income. Section 2.5 below provides further details.

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

[3]On average, the low educated men and women in our sample save roughly 5% of average gross earnings.

[4]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.

2.3 Financial Rewards by Employment Status

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 working incentives and assume that individuals make their employment 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 Section 3 below provides a more detailed description together with information concerning recent relevant changes to the system.[5] Our estimation includes a tax simulation model that maps all relevant features of the tax and transfer system and generates for each individual the employment state specific net income conditional on the individual's demographic characteristics, the offered wage and non-labor income.

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.[6]

Net Income in Non-employment

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 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. Therefore, in our implementation, the net income for a non-employed individual depends on the non-labor income and the transfer system in the given year

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

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 withdrawal of the means-tested minimum income transfer. For

[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.

[6] 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.

two reasons, this approximation is most problematic for older individuals with long working histories. First, wages, and therefore any unemployment insurance transfers, are increasing with experience. Second, the entitlement rules for the unemployment insurance are relatively generous for the older workers.[7]

2.4 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 assume that the individual has full information about the tax and transfer system in the current period and makes his or her labor supply decision assuming that the current tax and transfer system will prevail in all future periods.[8]

We differentiate two mechanisms linking today's employment decision with future payoffs. First, 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. Second, employment today adds to the individual's experience which, assuming positive returns to experience, leads 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 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

[7] 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 richer 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.

[8] This assumption rules out anticipation of tax reforms. In general tax reforms are not announced long before their implementation and often the timing or design is subject to alteration, as was the case with Tax Reform 2000 in Germany.

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

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

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 maximum length of the individual's life. $U_{i,j,t}$ 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. $\kappa_{i,h,t}$ denotes the probability that individual i will survive at least h periods conditional on having survived until age t. 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.[9]

In each quarter the individual maximizes his or her discounted expected life-cycle utility subject a budget constraint. Since, in our framework, individuals neither save nor borrow, the budget constraint dictates that 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 age $t < T^R$ 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.

2.5 Empirical Specification

This section describes the chosen specifications of the flow utilities, the distribution of offered wages and the stochastic health process. Finally, we detail how the initial conditions are modeled.

[9]Previous studies, e.g., Karlstrom et al. (2004), discuss 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 $\rho = 1.5$.[10] 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 socio-economic variables including gender and health status. The lagged employment state captures 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. Prior to entering the labor market each individual draws a value of α_{ie} from a standard normal distribution. Draws are assumed to be independent of observed socio-economic characteristics and independent over individuals. By construction, the persistent unobservable α_{ie} will be correlated with the lagged dependent variable, experience and the individual's initial employment status. Our estimation methodology, described below, fully accounts for these effects.[11]

A reduced form specification of the value function for retirement $V_t^r(s_{i,t})$ is adopted. The reduced form captures the effects of both pension income and preference on the value function for retirement. Specifically we assume

$$V_t^r(s_{i,t}) = \gamma q_{i,t} + \epsilon_{i,r,t}, \quad (5)$$

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, $q_{i,t}$ contains age terms and the individual's expected duration of retirement at time t. The age terms capture effect arising from either the design of public early retirement schemes or rules tying firm specific or private pension payments to the age of retirement. The expected duration of retirement is defined as the individual's age and gender adjusted life expectancy, computed from the survival rates published in the Human Mortality Database, minus the individual's age.

[10] In Appendix II we provide a robustness check of this assumption by re-estimating the model with $\rho = 2.5$, which corresponds to higher risk aversion.

[11] 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.

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_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_{iw} is a time invariant individual specific random effect assumed to be unconditional normally distributed with zero mean and unit variance. Again, by construction, α_{iw} will be correlated with previous employment choices and therefore experience, and our estimation methodology accounts for this endogeneity.

Health Process

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, Health Problems$_{i,t}$, which takes value one if the individual has health problems at time t and zero otherwise. We assume that health status evolves stochastically over the life-cycle according to the following equation

$$\text{Health Problems}_{i,t} = \begin{cases} 1 \text{ if } \pi_1 \text{Health Problems}_{i,t-1} + \pi_2 g_{i,t} + \phi_{i,t} \geq 0 \\ \\ 0 \text{ otherwise,} \end{cases} \tag{7}$$

where $g_{i,t}$ consists of individual characteristics that impact on health, including education and age. The health status in the previous quarter, Health Problems$_{i,t-1}$, 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 (7) 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 employment 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 employment state, we generalize this to account for the endogeneity of both the initial employment 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 is 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 $\alpha_{i,w}$ and $\alpha_{i,e}$, 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 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 source of identification for the coefficient on net income, β_y, which is not affecting the coefficients of the wage equation.

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.[12] 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).[13]

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

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

[13] 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 Euros. The rates of the SSC describe only the employee's share. The employer contributes the same amount. The minimum income includes housing benefits.

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 property. 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

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 transfers 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, preferences 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. Similar to e.g., French (2005), we estimate the health process separately from preference and wages in a first step (see Appendix I).

The dynamic structural life-cycle model itself contains 42 parameters and estimation is based on 214 moments including year and age specific mean values of the endogenous variables, and partial correlations between these variable and the explanatory variables obtained from multivariate regressions. Similarly, partial correlations between employment transitions and explanatory variables are included. Intertemporal correlations of the endogenous variables and the number of transitions provide information about persistence in wages and in employment behavior and about the distribution of unobserved heterogeneity. The coefficient on net income is identified from correlations between functions of non-labor income, i.e., income from assets, 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. 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 information about income from all sources at the individual and household levels.[14] 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 874 different single individuals, consisting of 491 women and 383 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 as are younger individuals with objective health problems who receive a large enough pension.[15]

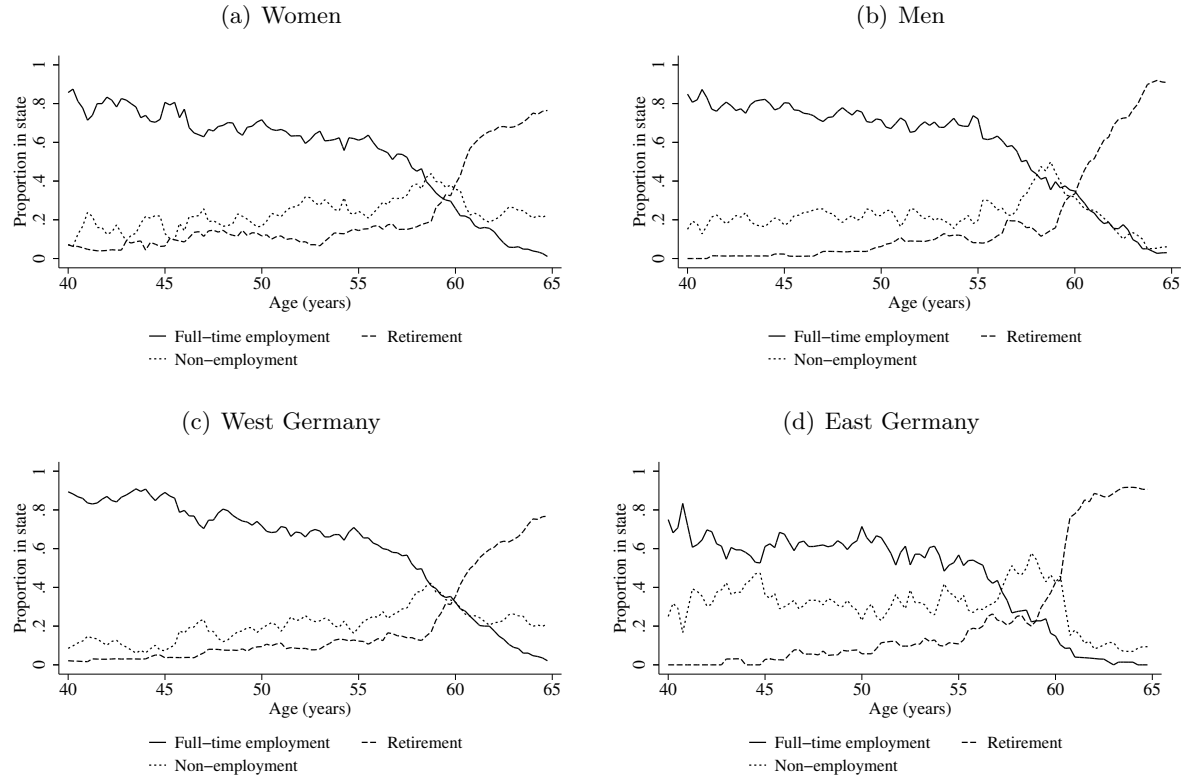
Figure 1 shows the shares of employment, non-employment and retirement by age separately for men and women and by region. In general, the behavior of the various subgroups is similar. Until the age of 55 years employment rates are fairly high while the employment rate declines to zero over the last 10 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 prior to age 60 year, east Germans have a higher propensity to retire than west Germans. 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 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

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

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

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.

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, experience and the stochastic health status. 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 during the sample period.

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 30%.[16] We find quite large wage differentials by gender, nationality and in particular by region of residence, while education has only a minor effect. The health effect is negative but not statistically significant and wages are lower for individuals older than 59 years. Quantitatively, the gross wages of men are about 25% higher than for women. *Ceteris paribus*, wages for native Germans wages are roughly 20% higher

[16]Our specification implies that wages are convex in experience. In an additional estimation, not reported, we also included squared experience, but this variable was insignificant.

than for non-natives and the wage differential between east and west Germany is about 60%. The average effect of medium education, defined as having a medium school degree or vocational qualification, is about 13%. Moreover a large proportion on the unobserved component of log wages is due to persistent unobservables: the estimated variance of the time dependent individual error term is slightly smaller than the variance of the persistent unobserved component of wages.

Table 2: Estimates of Parameters in the Wage Equation

	Coefficient	Standard Error
Intercept	0.684	0.145
West	0.630	0.050
Education	0.139	0.040
Experience (years) /10	0.306	0.048
Male	0.254	0.038
German	0.188	0.053
Health Problems	-0.063	0.043
Age_1	0.002	0.014
Age_2	-0.085	0.029
λ_α	0.173	0.046
σ_ν	0.146	0.018

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 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.

The top and bottom panels of Table 3 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 on the indicator of being in employment in the previous quarter is positive and highly significant. This state dependence effect may be due to adjustment costs or habit formation. The significant and negative intercept shows that on average individuals experience a disutility from work. The relatively large standard deviation of individual unobserved effect $\sigma_{\alpha e}$ however implies that, *ceteris paribus*, a fraction of the population derives utility from work. Age is a significant determinant of preferences for full-time work for individuals aged 55 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 end of the working life. 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, see Haan and Prowse (2009). We find that single men tend to have a higher preference for full-time work than single women. Education has no significant effect on preferences which is not surprising given that we exclude the higher educated from this analysis. As expected, individuals with health

problems have a significantly lower preference of full-time work relative to non-employment. Lastly, but importantly, the coefficient on net income is significantly positive thus implying that net income is an important determinant of labor supply behavior.

The value function associated with retirement is significantly decreasing with the gender and age specific life-expectancy. This implies for individuals with a high life expectancy early retirement is not attractive, perhaps because they would suffer a pension penalty due to the long expected duration of their retirement. Conditional on the life-expectancy, the value function associated with retirement for individuals aged 55-60 years is not significantly different from that of younger individuals while individuals aged over 60 years have a significantly lower value function from retirement than younger individuals. The latter effect could arise as older individuals are relatively likely to have poor health and therefore have a low value of leisure when retired.

Table 3: Estimates of Parameters Describing Preference for Employment and Retirement

Employment		
	Coefficient	Standard Error
Intercept	-2.861	0.448
Age_1	-0.808	0.128
Age_2	-0.840	0.171
Employed_{t-1}	4.436	0.325
Health Problems	-1.053	0.435
Education	0.006	0.416
West	-0.174	0.423
Male	0.836	0.371
Coefficient on net income (β_y)	1.273	0.266
β_α	3.750	0.515
Retirement		
	Coefficient	Standard Error
Intercept	-7.895	6.037
$\text{I}(59 < \text{Age} \leq 62)$	0.687	2.341
$\text{I}(\text{Age} > 62)$	-3.819	0.844
Life Expectancy	-7.767	2.442

Note: See note for Table 2.

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.

Goodness of Fit

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.[17]

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

Table 4: Estimates of Parameters describing Initial Conditions

Employment		
	Coefficient	Standard Error
Intercept	0.615	1.056
Individual employment effect	1.337	0.278
Individual wage effect	0.168	0.320
$\text{Age}_3/10$	-0.462	0.558
Age_4	-0.422	0.162
Experience/10	-0.437	0.290
Education	0.461	0.590
West	1.467	0.653
Male	0.448	0.868
Health Problems	-1.842	0.481
Asset 1	1.417	0.741
Asset 2	0.961	0.598
Children Previously	-0.080	1.073
Previous Previously	-0.036	0.589
Retirement		
	Coefficient	Standard Error
Intercept	-2.899	0.127
$\text{I}(55 < \text{Age} \leq 57)$	0.566	0.359
$\text{I}(\text{Age} > 57)$	1.400	0.243

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 2.

7 Life-cycle Employment Effects of Tax Reforms

In this final section attention is turned to using the structural parameter estimates, reported above, to simulate the employment and retirement effects of a reform to the system of taxation of earned income. The current German tax and transfer system is a traditional welfare system with relatively high out-of-work transfers. Transfers to the non-working are rapidly withdrawn with earnings once an individual enters the labor market, creating high marginal tax rates and low incentives to supply labor. The current system has often been identified as an important factor underlying the relatively low employment rate in Germany. There is an ongoing debate about changing the German welfare system by shifting more transfers to the working poor and thus increasing work incentives, as has been achieved in the UK via the WFTC and the US with the EITC.

In the following we focus on one particular, hypothetical, change to the tax system designed to foster employment among low earning individuals. Specifically, we consider an in-work tax credit, similarly designed as the EITC, which reduces the marginal tax rate directly through the

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.

introduction earnings related transfers for the working poor. The calibration of this policy is based on year 2000 prices and is such that individuals with monthly gross earnings below 1267 Euros, which corresponds to a gross hourly wage of less than 7.5 Euros for a full-time worker, receive a monthly tax credit of 200 Euros. In contrast to the EITC, there is no phase-in but a monotonic phase-out of the tax credit.[18] The taper rate is roughly 47% which implies that individuals with monthly gross earnings above 1689 Euros are not eligible for any tax credit.

We consider two different implementations of this tax reform. The first is targeted at the whole population and increases working incentives for individuals with low earnings of any age. In the second implementation eligibility is conditioned on age. Specifically, only workers aged 60 years and older are eligible for the in-work credit. 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 credit 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, as higher working experience increases the employment probability at older ages, the in-work credit makes

[18]Since we only focus on full-time working individuals there is an explicit hours rule for the tax credit.

employment prior to age 60 years more attractive. On the other hand, since the tax credit is conditional on gross earnings, 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 in-work credit is introduced for all individuals regardless of age. We present the results for different subgroups, by gender, education level and region of residence. More precisely based on the estimated parameters we simulate the group specific behavioral effect over the life-cycle. Since we condition on other household characteristics, these effects are similar to group specific marginal effects. By construction, this tax reform leads to different behavioral responses for individuals with different observed characteristics. Since eligibility for the tax credit is conditional on low earnings, individuals with low potential earnings have the highest incentive to take-up or remain in employment. Moreover, the size of the employment effect depends on the observed employment shares of the subgroups and is related to the estimated preference terms by observed and unobserved characteristics discussed above.

Overall, we find a fairly similar life-cycle pattern of the behavioral responses for all subgroups, however the magnitudes of the effects differ. The largest employment effects are around the age of 40 years and thereafter the behavioral adjustment is lower. This age pattern is partly related to the returns to experience; we find a relatively high experience effect on wages and this implies that the more experienced workers loose their eligibility for the in-work credit. Moreover, the in-work credit leads to a postponement of retirement for all groups. However, the largest fraction of the previously retired chooses to be non-employed rather than to work. Recall that retirement is an absorbing state and therefore, once retired, individuals never will benefit from the tax credit. Thus, the tax credit creates a strong incentive to postpone retirement. For the elderly and those with an interrupted working history, however, employment is not attractive. Indeed, high state dependence effects, which includes adjustment costs, make a transition into employment difficult. Second, as discussed above, we find strong negative age effects in the utility from employment which can be partly related to the institutional setting of out-of-work transfers. Still, since individuals are forward looking they know that in future periods they might make a transition into employment thus benefitting from the in-work credit.

Panels (a) to (d) show the employment effects for women and panels (e) to (h) show the effects for men. As discussed above we estimate an overall gender differential in wages of about 25% and hence given the lower wages, *ceteris paribus*, more full-time working women are eligible for the in-work credit than men. On the other hand the estimates suggest that women tend to have a lower taste for work than men which reduces the behavioral responses to financial incentives. Still, for all subgroups we find the largest employment effects for women.

There is no clear picture by education. The education effect on wages is relatively small and hence the incentives effects of in-work credits are only slightly higher for the low educated. On the other hand there is an indirect effect on the employment behavior which is related to the initial conditions and the health status. For example, we find that, *ceteris paribus*, better education reduces the health risk by about 3% (Table 5 in the Appendix). Bad health however,

has a strong effect both on the initial employment state and on the life-cycle employment. In this respect the better educated respond stronger to financial incentives. The latter effect seems to dominate for all groups, but the difference is negligible.

Not surprisingly, we find the largest difference between individuals living in east and west Germany and this is mainly related to the enormous regional wage gap. In other words, east German men and women are far more likely to benefit from the in-work credit than those full-time employed in the west, and therefore we find higher behavioral effects in the eastern part.

Figure 4 shows that the employment effects differ when the entitlement to the tax credit is conditioned on age. We present the effects by the above defined subgroups. Unsurprisingly, the employment effects are largest for individuals aged 60 years and above, who are directly affected by the policy reform. Again, we find heterogeneity by gender, education, and region. The effects are highest for east Germans, tend to be higher for women and by education there is no sizable difference. For east German women and men we find an increase in employment of about 2 percentage points around the age of 63 years. At the same time retirement is postponed which leads to the above described increase in non-employment amongst the elderly.

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 of 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. Even stronger is the postponement effect for retirement which occurs as individuals avoid moving into retirement in order to become eligible to the in-work credit after the age of 60 years. The size of this anticipation 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 individuals to be forward looking with an annualized discount factor of 0.96. At the lower bound, with myopic individuals ($\delta = 0$), the anticipation effects for the younger individuals would be zero. The upper bound, with a discount factor of one, the behavioral responses of younger individuals would certainly be 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 labor supply 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

Figure 3: Employment and retirement effects of a tax reform affecting all individuals

(a) Low educated, east German women

(b) Medium educated, east German women

(c) Low educated, west German women

(d) Medium educated, west German women

(e) Low educated, east German men

(f) Medium educated, east German men

(g) Low educated, west German men

(h) Medium educated, west German men

Note: Simulations assume zero income from assets and that individuals have not previously been married or previously had children.

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

(a) Low educated, east German women

(b) Medium educated, east German women

(c) Low educated, west German women

(d) Medium educated, west German women

(e) Low educated, east German men

(f) Medium educated, east German men

(g) Low educated, west German men

(h) Medium educated, west German men

Note: See note for Figure 3.

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 the introduction of an in-work credit similar to the EITC leads to positive employment effects and to a postponement in retirement. Due to its focus on low earning individuals, the effect of this policy is largest for individuals with lower earnings potentials, in particular for men and women in east Germany. We have also considered the labor market implications of an age specific tax reform, such that only individuals aged 60 years and above are eligible to receive the credit. 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 strong postponement effect for retirement.

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 (7) 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
Intercept	3.914	0.148
Health Problems$_{t-1}$	0.150	0.037
(Age (years)-40)/10	-0.033	0.049
Education	0.091	0.046
West	0.102	0.048
Male	-0.062	0.026
Experience/10	-2.317	0.086

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 2.

Appendix II: Robustness Checks

Laibson et al. (2007) discuss in detail the difficulties associated with identifying the coefficient of relative risk aversion, ρ. In the above analysis $\rho = 1.5$ was imposed. To check the robustness of our results with respect to the calibration of this parameter, we re-estimate the dynamic life-cycle model assuming higher risk aversion ($\rho = 2.5$). Figures 5 and 6 show the policy effects for the subgroups we have discussed previously in Section 7. The similarities between the estimated policy effects obtained using different values of ρ show that our conclusions do not strongly depend on the assumed degree of risk aversion.

Figure 5: Robustness Checks: Employment and retirement effects of a tax reform affecting all individuals ($\rho = 2.5$)

(a) Low educated, east German women

(b) Medium educated, east German women

(c) Low educated, west German women

(d) Medium educated, west German women

(e) Low educated, east German men

(f) Medium educated, east German men

(g) Low educated, west German men

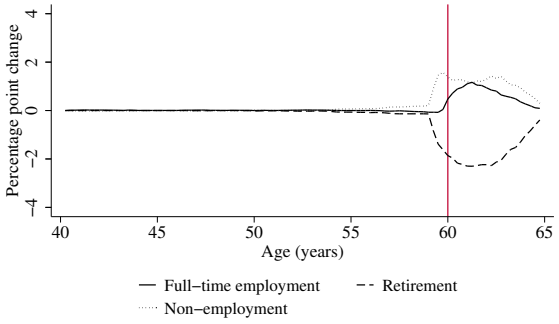
(h) Medium educated, west German men

Note: See note for Figure 3.

Figure 6: Robustness Checks: Employment and retirement effects of a tax reform affecting individuals aged 60 years and over ($\rho = 2.5$)

(a) Low educated, east German women

(b) Medium educated, east German women



(c) Low educated, west German women

(d) Medium educated, west German women

(e) Low educated, east German men

(f) Medium educated, east German men

(g) Low educated, west German men

(h) Medium educated, west German men

Note: See note for Figure 3.

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