Optimal Unemployment Insurance and Social Assistance in a Life-cycle model of Family Labor Supply and Savings

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Abstract

We study the interplay between family labor supply, savings decisions and the effective design of public insurance programs. For this purpose, specify and estimate a life-cycle model of the labor supply, retirement and savings decisions of single adults and married couples. Unemployment Insurance and Social Assistance benefits provide partial insurance against employment and productivity shocks. Meanwhile, households may smooth the impact of shocks through adjustments of saving and labor supply; in the case of couple households, each spouse’s labor supply may provide insurance. We estimate the model parameters using Indirect Inference applied to a panel sample of German households. The model-implied dependence of labor supply on Unemployment Insurance is consistent with existing evidence. We show optimal generosities of Unemployment Insurance and Social Assistance benefits below current levels, and we explore the optimal mix of Unemployment Insurance and Social Assistance benefits. Finally, we show that intra-household insurance from family labor supply reduces optimal benefit generosities.

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1 Introduction

In this paper, we consider the optimal design of public insurance programs in the presence of intra-household insurance from family labor supply and savings. By including family labor supply, we recognize that the behavioral impact and optimal design of public insurance programs may be impacted by a household’s ability to adjust either one spouse’s or both spouses’ labor supply in response to wage and employment shocks. Our analysis sheds new light on the optimal trade-off between insurance, redistribution and incentives. In particular, based on our estimation results from a dynamic structural life-cycle model, we locate the optimal generosities of Unemployment Insurance and Social Assistance in the presence of intra-household insurance from family labor supply and savings, and we show that family labor supply has quantitatively important implications for the optimal design of public insurance programs.

A growing literature explores empirically the insurance-incentive trade-off inherent in the design of public insurance programs. For example, Low and Pistaferri (2010) on Disability Insurance, and Chetty (2008), Lentz (2009), and Low et al. (2010) on Unemployment Insurance. These studies focus on single individuals or households facing a single labor supply decision. We extend this work and consider the implications of intra-household insurance from family labor supply for optimal policy design of public insurance programs.

Our extension to the family context is partly motivated by previous research documenting the insurance role of family labor supply. Focusing on labor supply, Lundberg (1985) and Hyslop (2001) document empirically an “added worker effect” whereby a woman increases her labor supply in response to a decline in her spouse’s earnings. Similarly, Cullen and Gruber (2000) demonstrate that generous Unemployment Insurance for a newly-unemployed individual reduces his or her spouse’s labor supply. Meanwhile, Blundell et al. (2012) link labor supply and consumption at the household level and show that permanent shocks to men’s and women’s wages are largely insured by adjustments of family labor supply. However, these papers do not speak directly to the implications of household labor supply for the optimal design of public insurance programs. In contrast, we posit a model of the life-cycle household behavior that includes an explicit and detailed specification of the public insurance system, including Unemployment Insurance and Social Assistance benefits. This framework allows us to address questions surrounding the interplay between publicly-provided insurance from social programs and intra-household

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1Low (2005) and Heathcote et al. (2009) discuss the insurance role of individual labor supply.
2Restricting to older household, van der Klaauw and Wolpin (2005) consider the optimality of the pension system with one-earner and two-earner households.
3Using a similar methodology, this finding has been replicated based on the data used in our analysis, the German Socio-Economic Panel, see, e.g., Triebe (2014).
insurance from family labor supply.

Building on these related works, we are the first to look at the optimal generosity of Unemployment Insurance and Social Assistance benefits in the presence of family labor supply and savings. With family labor supply, the insurance-incentive trade-off is more nuanced than for households that face a single labor supply decision. On the one hand, each spouse can provide insurance against shocks hitting his or her partner. On the other hand, with two potential sources of labor supply, there is greater scope for adverse incentive effects. A further novelty of our analysis is to consider the optimal policy mix of Unemployment Insurance and Social Assistance benefits. Last, we explore how conclusions about optimal policy depend on intra-household insurance from the ability to adjust jointly the husband’s and wife’s labor supply in a couple household.

We accomplish our analysis by specifying and estimating a life-cycle model of the labor supply, retirement and savings decisions of individuals in single-adult and couple households. In our model, the combination of job destructions and labor market frictions creates individual employment risk, and individual productivity risk enters via persistent unanticipated movements in market wages. Households may draw on intra-household and public insurance devices when hit by shocks. We model public insurance in the forms of Unemployment Insurance, Social Assistance and pension benefits, which are financed by social security contributions and income taxation. We also model the intra-household insurance available from household labor supply. In couple households, the labor supply decisions of the spouses are made jointly, and therefore the spousal labor supply is a modeled source of intra-household insurance. Intra-household insurance is also provided by household savings, however, households face borrowing constraints, i.e., they are liquidity constrained, and so cannot borrow against future income when hit by shocks.

We adopt use a dynamic structural life-cycle model in which the constraints and incentives presented by public and intra-household insurance devices appear alongside inter-temporal incentives to accumulate human capital and to accumulate entitlements to public insurance programs. The forward-looking households in our model thus choose self-insurance and to draw on public insurance programs while simultaneously considering the implications of current behavior for expected future labor market outcomes, future self-insurance options and future entitlements to transfers from public insurance programs. We have elected to study the interplay between public and intra-household insurance in this general life-cycle framework in part because previous work on life-cycle labor supply has shown that expected future returns to endogenously-accumulated human capital and expected future social transfers have important behavioral implications (see, e.g., Keane and Wolpin, 1997 and Blundell et al., 2011, for discussion of endogenous accumulation of human capital, and see, e.g., French, 2005, Low, 2005, Attanasio et al., 2008, Heathcote et al., 2009, and Low et al., 2010, for evidence on responses of benefit entitlement).
The estimation sample is constructed from a long panel of single-adult and couple households taken from the German Socio-Economic Panel. The estimation sample contains semi-annual panel observations of employment and retirement outcomes, household composition and household-level and individual-level demographic characteristics. The sample further contains rich cross-sectional information on household wealth. We supplement this household data with information on gender-specific life expectancy obtain from the Human Mortality database for German. Similar to, e.g., Altonji et al. (Forthcoming), we use Indirect Inference to estimate the parameters of the structural life-cycle model.

The estimated model has good in-sample fit. Based on the estimated model, we are able to replicate the observed life-cycle profiles of labor supply, wealth and wages. We also fit the joint distribution of spouses’ labor supply outcomes. Further, following, e.g., Todd and Wolpin (2006) and Low and Pistaferri (2010), we conduct an external model validation exercise. Specifically, based on the estimated model, we replicate results from the reduced-form literature on the employment effects of changes in the level and duration of Unemployment Insurance (see, e.g., Katz and Meyer, 1990, Lalive et al., 2006 and Schmieder et al., 2012). For example, in line with this literature, the estimated model implies that a 1 month increase of the maximum entitlement period for Unemployment Insurance increases the duration in unemployment by about 0.1-0.2 months. We take the consistency of the model with reduced form findings as evidence that the model is well-suited to analyzing questions surrounding the optimal design of Unemployment Insurance and Social Assistance benefits.

Based on the estimated model, we find that cuts in Unemployment Insurance or Social Assistance generosity solicit large increases in household saving and modest increases in employment. Optimal generosities of Unemployment Insurance and Social Assistance benefits are found to be below their current levels. We show important substitutability between Unemployment Insurance and Social Assistance, meaning that the optimal Unemployment Insurance generosity is decreasing in the generosity of Social Assistance. We show welfare gains from the joint determination of Unemployment Insurance and Social Assistance generosities, beyond the gains obtained by considering each program in isolation. Last, we explore the implications of intra-household insurance from family labor supply for the optimal design of public insurance programs. We show that intra-household insurance from family labor supply reduces the optimal generosities of Unemployment Insurance and Social Assistance.

This paper proceeds as follows. Section 2 describes our model of households’ labor supply, retirement and savings decisions over the life-cycle. Section 3 details the relevant features of the SOEP survey and describes our estimation sample. Section 4 outlines the adopted Indirect Inference estimation procedure, and describes the specification of the auxiliary model. Section 5 presents the structural parameter estimates and explores the model’s in-sample and out-of-sample goodness of fit. Section 6 discusses the trade-
offs involved in designing Unemployment Insurance and Social Assistance benefits, and reports the results of our counterfactual policy analysis.

2 Model

2.1 Overview

We propose a discrete-time dynamic model of the labor supply, retirement and consumption outcomes of individuals in single and couple households over the life-cycle. Decisions are made semi-annually, i.e., one period lasts for 6 months. Figure 1 illustrates the timing of events. Individuals enter the labor force from full-time education. For those in the labor force, each period proceeds as follows: (i) household type (single-adult or couple) is updated; (ii) the household observes fertility outcomes; (iii) the household observes each member’s market wage, job destruction status and current-period preference shocks; (iv) the household chooses each member’s search intensity; and (v) job offers are realized and the household makes savings, labor supply and retirement decisions.

![Figure 1: Timing of events over an individual’s life-cycle.](image)

The labor supply states at the individual level are: full-time employment (FT); non-employment (NE); and, for women only, part-time employment (PT). An individual

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4We do not distinguish cohabitation from marriage. Henceforth, we refer to the adult members of couple households as “spouses”.

5The timing of the transition from education into the labor force is assumed to be exogenous.

6Reflecting the average male-female age difference for newly-formed couple households in the estimation sample, the husband is assumed to be 2.5 years older than the wife.
permanently exits the labor force when he or she enters retirement (RT). Combining
across spouses, for a couple household there are a total of 12 labor supply and retirement
states. Retirement mandatory at age 65, and is feasible from age 60 for women and from
age 63 for men. Once the youngest adult member reaches the compulsory retirement
age there are no further opportunities for job search or labor supply decisions. From
this point onward, the household supplements any pension and transfer income with the
annuity value of the household’s wealth when the youngest household member is age 65
years.

We describe below: the specification of preferences (Section 2.3); labor market fric-
tions (Section 2.4); the wage process (Section 2.5); the intertemporal budget constraint
(Section 2.6); and optimal life-cycle behavior (Section 2.7). As described in Section 2.6.1,
the intertemporal budget is the channel through which public insurance programs, in-
cluding Unemployment Insurance and Social Assistance, enter the model. Appendix A
describes the exogenous processes that determine job destructions, household type and
fertility outcomes.

2.2 Notational Definitions

Women are indexed by $i$, and men are indexed by $j$. Age is indexed by $t$. One unit of $t$
represents 6 months of calendar time, i.e., one model period. $\bar{T}$ denotes to the compulsory
retirement age, which is 65 years for both men and women. Age at labor force entry is
denoted by $T(i)$ for women and $T(j)$ for men. In couple households, the husband is $\Delta \equiv 5$
periods, i.e., 2.5 years, older than the wife. Household-level quantities, such as wealth and
consumption, are indexed by $(i, j, t)$, with $i(j) = \emptyset$ for a male(female) headed single-adult
household and, for couple households, $t$ refers to the age of the wife. The set of potentially
feasible labor supply and retirement states is denoted by $D^F = \{FT, PT, NE, RT\}$ for
women and $D^M = \{FT, NE, RT\}$ for men.

2.3 Preferences

The per-period utility function of woman $i$ at age $t$ is given by:

$$U^F(m_{i,j,t}, d_{i,t}, d_{j,t+\Delta}, s_{i,t}, \varepsilon_{i,t}) = u^F(m_{i,j,t}, d_{i,t}, d_{j,t+\Delta}) - \frac{s_{i,t}^2}{2} + \varepsilon_{i,t}(d_{i,t}), \quad (1)$$

7 This age difference is approximately the average male-female age difference for newly-formed couple
households in the SOEP estimation sample.

8 As discussed in Section 2.4, the set of choices that is actually, rather than potentially, feasible depends
on: the individual’s age, which determines retirement eligibility; the individual’s previous retirement
choices (retirement is an absorbing state); and job availability, which in turn depends on the individual’s
previous employment status, job destructions and the success of any search activities.
where \( m_{i,j,t} \) denotes household consumption, \( d_{i,t} \in D^F \) and \( d_{j,t} \in D^M \) denote the woman’s and (if present) the man’s age \( t \) labor supply and retirement outcomes, and \( s_{i,t} \) denotes that woman’s age \( t \) search intensity. The woman experiences time-varying labor market and retirement state-specific preference shocks, \( \varepsilon_{i,t}(d_{i,t}) \), that are observed by the household at the start of each period. The woman’s preference shocks are assumed to be independent over time, and contemporaneous preference shocks are assumed to be mutually independent and normally distributed with mean zero and standard deviation \( \sigma_{\varepsilon,F,S} \) for single women and \( \sigma_{\varepsilon,F,C} \) for married women.

The sub-utility function takes the form:

\[
u^F(m_{i,j,t}, d_{i,t}, d_{j,t} + \Delta) = \left( \frac{\eta^F(d_{i,t}, d_{j,t} + \Delta) m_{i,j,t}}{e_{i,j,t}} \right)^{1-\rho^F}, \tag{2}\]

where \( \rho^F \) is the woman’s coefficient of relative risk aversion, and \( e_{i,j,t} \) is a household equivalence scale.\(^9\) The woman’s taste for consumption, \( \eta^F(d_{i,t}, d_{j,t} + \Delta) \), depends on the household labor supply and retirement outcome and on demographic variables. We specify:

\[
\log \eta^F(d_{i,t}, d_{j,t} + \Delta) = \sum_{k \in D^F} \eta_{1,k}^F 1(d_{i,t} = k) + \sum_{k \in D^F} \eta_{2,k}^F 1(d_{i,t} = k) X_{i,t}^F + \eta_3^F \pi(d_{i,t}, d_{j,t} + \Delta). \tag{3}\]

In the above, \( X_{i,t}^F \) contains an indicator of the woman being aged 50 or older and indicators of the age category of the household’s youngest child (with reference category being a child aged 6 or above or no children). The parameters \( \eta_{1,k}^F \) for \( k \in D^F \) reflect the preference for consumption in state \( k \) of a single woman aged under 50 without young children. The term \( \pi(d_{i,t}, d_{j,t} + \Delta) \) contains interactions of the spouse’s leisure times (see below), and the parameter \( \eta_3^F \) reflects the strength of leisure complementarities for women. The preference specification for men is obtained by replacing \( d_{i,t} \) with \( d_{j,t} + \Delta \) in the first two terms on the right hand side of (3), and replacing \( F \) with \( M \) throughout (3). Child-related variables are omitted from men’s preferences.\(^{10}\) We capture iterations between the spouse’s leisure times as follows:

\[
\pi(d_{i,t}, d_{j,t} + \Delta) = 1(d_{i,t} = NE) \times \left( \eta_4 1(d_{j,t} + \Delta = NE) + \eta_5 h(d_{j,t} + \Delta) \right). \tag{4}\]

In the above, the gender-invariant parameter \( \eta_4 \) captures the preference for joint non-employment, and \( \eta_5 \) reflects variation in the utility of leisure time according to the spouse’s hours of work, \( h(d_{j,t}) \).

\(^9\)We use the OECD-modified equivalence scale (Hagenaars et al., 1996). Accordingly, the first adult receives a weight of 1, each subsequent adult and each child aged 14 and over receives a weight of 0.5, and each child aged under 14 receives a weight of 0.3.

\(^{10}\)Except for leisure complementarities, non-employment and retirement are assumed to be identical in terms of their complementarity with consumption, and retirement and non-employment combined form the reference category. Formally, for women we impose \( \eta_{1,NE}^F = \eta_{1,RT}^F = 0 \) and \( \eta_{2,NE}^F = \eta_{2,RT}^F = 0 \), and likewise for men. For identification purposes, we impose \( \eta_3^M = 1 \).
As described in Section 2.7.2, a couple household’s objective function is based on constant-weighted average of spouses’ utilities. In the empirical analysis, we estimate the weight, \( \alpha \in [0, 1] \), attached to the woman’s utility in the couple household’s objective function. To capture correlated tastes within the household, beyond the effect of age which enters the state-specific taste for consumption, we allow cross-spouse correlations between the husband’s and wife’s contemporaneous preference shocks. Specifically, we assume \( \text{corr}(\varepsilon_{i,t}(d), \varepsilon_{j,t+\Delta}(d)) = \varphi \) for \( d \in D^M \) and \( \text{corr}(\varepsilon_{i,t}(PT), \varepsilon_{j,t+\Delta}(FT)) = 0.5\varphi \). Otherwise, the spouses’ preference shocks are assumed to be independent.

### 2.4 Labor Market Frictions

Labor supply is subject to frictions: an employed individual is at risk of exogenous job destruction, and job offers arrive with a probability that reflects the individual’s search intensity.

In more detail, each period an employed individual experiences a job destruction with a probability that varies by gender, age, education and marital status. An individual who experiences a job destruction cannot work in the current period; the individual must enter non-employment or, if eligible, may retire. Job destructions thus constitute a substantial risk for employed individuals. We estimate the job destruction probabilities prior to estimation of the parameters of the life-cycle model. Appendix A provides further details.

For a non-employed individual, a transition into employment is possible only if a job offer is received. The job offer probability is proportional to the individual’s search intensity, and depends on individual characteristics through a factor of proportionality \( \chi_{i,t} \). Formally, the job offer probability for woman \( i \) who searches with intensity \( s_{i,t} \in [0, 1/\chi_{i,t}^F] \) is given by:

\[
\Pr(\text{Job offer}^F) = \chi_{i,t}^F s_{i,t}^F,
\]

where

\[
\log(\chi_{i,t}^F) = \chi_1^F + \chi_2^F \mathbf{1}(\text{age}_{i,t} \geq 50) + \chi_3^F \mathbf{1}(\text{Education}_i \geq 12 \text{ years}) + \chi_4^F \text{Married}_{i,t}
\]

The job offer probability for men is obtained by replacing \( F \) by \( M \) and \( i \) by \( j \) in (5) and (6).

### 2.5 Wage Process

We posit an individual-level process for the market wage, i.e., the wage that is observed prior to search, labor supply, retirement and savings choices and that determines earnings.
if the individual is employed. Following, e.g., Low et al. (2010), sample wage observations are assumed to additionally contain measurement error. Note, we model the wage process jointly with labor supply and retirement behavior; in doing so, we account explicitly for the effect of wage-based selection into employment on the distribution of accepted wages.

2.5.1 Market Wages

The age $t$ log real market wage of women $i$ is given by:

$$\log W_{i,t} = \beta_1 F + \beta_2 F_1 (\text{Education}_i \geq 12 \text{ years}) + \beta_3 F \text{Exp}_{i,t} + \beta_4 F \kappa_{i,t}. \tag{7}$$

In the above, Exp denotes years of experience; this variable is zero at the time of labor force entry and is incremented by 0.5 for each period of full-time work and increases by 0.25 for each period of part-time work. $\kappa_{i,t} \in \{0, 1\}$ represents the unobserved component of the individual’s market wage. This wage component may be transitory, persistent or permanent. Specifically, subsequent to labor force entry, wage unobservables for women and men evolve according to:

$$\kappa_{i,t} = 1(\theta_{F_0} (1 - \kappa_{i,t-1}) + \theta_{F_1} \kappa_{i,t-1} + \epsilon_{i,t} \geq 0), \tag{8}$$

$$\kappa_{j,t} = 1(\theta_{M_0} (1 - \kappa_{j,t-1}) + \theta_{M_1} \kappa_{j,t-1} + \epsilon_{j,t} \geq 0), \tag{9}$$

where the $\epsilon$s are assumed to be serially independent at the individual level with $\epsilon_{i,t} \sim N(0, 1)$ and $\epsilon_{j,t} \sim N(0, 1)$. In the spirit of, e.g., Attanasio et al. (2008) and Blundell et al. (2012), contemporaneous wage shocks may be correlated between spouses. Specifically, we assume $\text{cov}(\epsilon_{i,t}, \epsilon_{j,t+\Delta}) = \varrho$. Non-contemporaneous wage shocks are assumed to be independent across spouses. An individual’s wage unobservable at the time of entry into the labor force from full-time education is a draw from steady state distribution.  

The market wage process for men is obtained by replacing $F$ by $M$ and $i$ by $j$ in (7), (8) and (9). Thus, all parameters of the wage process may vary by gender. This aspect of the specification captures gender differences in labor market conditions and labor market-related behaviors. For example, a difference in the probability of a positive wage shock by gender may result from gender differences risk taking, competitiveness or occupational

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12 Solving for the steady state, a proportion $\Theta^F$ of women and a proportion $\Theta^M$ of men have the high wage unobservable ($\kappa = 1$), where:

$$\Theta^F = \frac{\Phi(\theta_{F_0})}{1 + \Phi(\theta_{F_0}^F) - \Phi(\theta_{F_1}^F)}, \tag{10}$$

$$\Theta^M = \frac{\Phi(\theta_{M_0})}{1 + \Phi(\theta_{M_0}^M) - \Phi(\theta_{M_1}^M)}, \tag{11}$$

and $\Phi()$ denotes the standard normal cumulative distribution function.
choice, among other mechanisms. The household is assumed to have no information, beyond that given above, about the values of future market wage shocks.\textsuperscript{13}

2.5.2 Measurement Error

Sample wage observations, $\tilde{W}_{i,t}$ for women and $\tilde{W}_{j,t}$ for men, are assumed to contain measurement error of the following form:

$$\log \tilde{W}_{i,t} = \log W_{i,t} + \nu_{i,t} \quad \text{and} \quad \log \tilde{W}_{j,t} = \log W_{j,t} + \nu_{j,t},$$

(12)

where $\nu_{i,t} \sim N(0, \sigma^2_{\nu,F})$ for women and $\nu_{j,t} \sim N(0, \sigma^2_{\nu,M})$ for men. Measurement errors are assumed to occur independently over individuals and independently over time.

2.6 Intertemporal Budget Constraint

With no marriage or divorce at time $t$, the intertemporal budget constraint for household $(i, j)$ is given by:

$$A_{i,j,t} = A_{i,j,t-1}(1 + r) + y_{i,j,t} - m_{i,j,t},$$

(13)

In the above, $A_{i,j,t}$ denotes the combined net value of the household’s financial, housing and durable assets, $r$ is the real interest rate, and $y_{i,j,t}$ is the net-of-tax real value of the household’s income from employment and social transfers. Marriage augments the assets of an individual’s household by the assets of the new spouse. In the event of divorce, household assets are assumed to be divided equally between the spouses.

Households are assumed to be unable to borrow against future earnings or future entitlements to social transfers. Reflecting this, household assets must be non-negative:

$$A_{i,j,t} \geq 0.$$  

(14)

Given this borrowing constraint, there is an insurance motive for Unemployment Insurance and Social Assistance to smooth the marginal utility of consumption over the life-cycle in the presence of employment and productivity shocks.\textsuperscript{14}

2.6.1 Household Net Income

The empirical analysis focuses on Germany, and our model of the net-of-tax real value of household income is based the German tax and transfer system. The net-of-tax real


\textsuperscript{14}Given heterogeneity in education, Unemployment Insurance and Social Assistance may also be socially desirable on redistributive grounds. See Section 6 for further discussion.
value of household income for couple household \((i,j)\) is given by:

\[
y_{i,j,t} = (W_{i,t}h_{i,t} + UI_{i,t} + Pension_{i,t} - SSC_{i,t}) +
(W_{j,t+\Delta}h_{j,t+\Delta} + UI_{j,t+\Delta} + Pension_{j,t+\Delta} - SSC_{j,t+\Delta}) +
SA_{i,j,t} - Tax_{i,j,t} + CB_{i,j,t} - CC_{i,j,t}.
\]  

(15)

In the above, \(UI\) denotes Unemployment Insurance benefits, \(SSC\) denotes Social Security Contributions, and \(Pension\) denotes public pension benefits; all three schemes are administered at the individual level. \(SA\) and \(Tax\) denote Social Assistance benefits and income tax respectively; both programs are administered at the household level. \(CB\) denotes child benefits, paid through the transfer system, and \(CC\) denotes child-care costs associated with employment. \(h\) denotes hours of work. The net income for a single-adult household is obtained by taking (15) and suppressing the earnings, Unemployment Insurance, Pension, and Social Security contributions of the person with the opposite gender to that of the household head. Children are assumed to reside in the mother’s household. Child benefits and child-care costs therefore do not enter a single man’s budget constraint.

Our analysis of interactions between public and intra-households insurance centers on Unemployment Insurance and Social Assistance. The model of these two programs is described below in Sections 2.6.2 and 2.6.3. The treatment of the remaining components of the budget constraint is described in Appendix B.

### 2.6.2 Unemployment Insurance

Unemployment Insurance benefits provide eligible and entitled non-employed individuals with benefits that replace a fraction of previous net earnings. We use the following formula to model weekly Unemployment Insurance benefits:

\[
UI_t = Elig_t \times 1/UIEnt_t > 0 \times RR \times NW_t \times HourPrev_t.
\]  

(16)

The replacement rate, \(RR\), is 0.6 for an individual without dependent children or 0.67 if the individual has one or more dependent children. The net wage, \(NW\), is a function of the individual’s market wage and the tax schedule. Hours of work in previous employment, \(HourPrev\), are 40 if the individual entered non-employment from full-time work and 20 if the individual entered non-employment from part-time work.\(^{15}\)

An individual’s Unemployment Insurance entitlement period (\(UIEnt\)) is initially determined at the time of entry to non-employment and evolves through the non-employment spell as benefits are paid and entitlement reduced. Reflecting the German system, the entitlement period is an increasing function of age. In particular, an individual who is aged under 45 at the start of his or her non-employment spell has an initial entitlement

\(^{15}\)Additionally, Unemployment Insurance benefits are capped at 1,750 Euros per month.
period of 12 months. Individuals entering non-employment at ages 45-46, 47-56 and $\geq 57$ have initial entitlement periods of 18, 24 and 30 months respectively.\textsuperscript{16} The entitlement period evolves though the non-employment spell as follows:

$$\text{UIEnt}_t = \max(\text{UIEnt}_{t-1} - 6, 0) \quad (17)$$

An individual’s Unemployment Insurance eligibility, $\text{Elig} \in \{0, 1\}$ is determined at the start of the non-employment spell and is based on the individual’s recent working history.\textsuperscript{17} We implement the following criteria for eligibility:

$$\text{Elig}_t = \begin{cases} 
1 & \text{if employed in both of the previous two periods} \\
1 & \text{if entered employment in the previous period} \\
& \text{with non-zero remaining UI entitlement (UIEnt}_{t-1} > 0) \\
0 & \text{otherwise.}
\end{cases}$$

Unemployment Insurance benefits are not means tested, i.e., benefits are neither contingent on the earnings of other household members nor linked to the household’s interest income from wealth. Further, there is no wealth test; individuals receive Unemployment Insurance benefits irrespective of their own ability of smooth the marginal utility of consumption by drawing on savings.

2.6.3 Social Assistance

Social Assistance is a household-level transfer that provides an income floor to wealth-poor households. Broadly following the German legislation, we use the following formula for household Social Assistance benefits:

$$\text{SA}_{i,j,t} = \begin{cases} 
1(A_{i,j,t} < 10,000 \text{ Euros}) \times \\
\max(0, \text{SAFloor} - \text{UI}_{i,t} - \text{UI}_{j,t+\Delta} - W_{i,t}h_{i,t} - W_{j,t+\Delta}h_{j,t+\Delta} - \\
\text{Pension}_{i,t} - \text{Pension}_{j,t+\Delta} - \text{CB}_{i,j,t}).
\end{cases} \quad (18)$$

\textsuperscript{16}Given the semi-annual decision making frequency, the initial Unemployment Insurance entitlement period corresponds to 2, 3, 4 or 5 periods in the model.

\textsuperscript{17}In principle, according to the German legislation, those who voluntarily choose to move into non-employment must wait three months before they may start to receive Unemployment Insurance. We neglect this rule because, in reality, very few individuals are prevented from claiming Unemployment Insurance immediately upon becoming non-employed. Specifically, according to the administrative data of the “Bundesagentur für Arbeit” (German Federal Employment Agency), during the period 1996 - 2005 about 5% of those making a transition from employment into non-employment were sanctioned (see Bundesagentur für Arbeit, 2013).
The Social Assistance income floor, SAFloor, is around 600 Euros per month (including housing benefit) for a single-adult household without children, and increases with the number of adults and children in the household – e.g., the Social Assistance income floor for a couple household with two pre-school age children is 1,425 Euros per month. Social Assistance benefits are withdrawn at a rate of 100% against the earnings, Unemployment Insurance benefits and pension income of all household members, and are means-tested against child benefits. Social Assistance benefits are therefore focused on those households with little or no income from other sources. Further, Social Assistance benefits are paid only to households that satisfy a wealth test. Specifically, households with assets of 10,000 Euros or above do not qualify for Social Assistance.

2.7 Optimal Life-cycle Behavior

We characterize optimal life-cycle behavior using the value functions for single and married men and women. Given the forward looking nature of the dynamic problem, the optimization problems facing single individuals and couple households are interdependent: a single individual’s decisions are partly driven by the expected consequences if he or she marries in the future, and a couple household’s decisions are influenced by the expected consequences for each spouse in the event of divorce.

2.7.1 Single-adult Households

First, consider a single woman (a single man’s problem takes same form). The woman’s choice problem ends when she reaches the compulsory retirement age, \( \tilde{T} \). From the compulsory retirement age onward the woman cannot search or work, and consumes pension and transfer income plus the actuarially fair annuity value of household wealth at the compulsory retirement age.\(^\text{18}\) The woman’s terminal value function is given by:

\[
\nabla F^s(\Psi_{i,\tilde{T}}) = P^F(\tilde{T}) \times u^F(m_{i,\emptyset,\tilde{T}}, RT, \emptyset),
\]

where \( P^F(\tilde{T}) \) denotes the woman’s discounted expected duration of retirement at the compulsory retirement age, and \( \Psi_{i,t} \) denotes the woman’s state variables at age \( t \).\(^\text{19}\)

\(^{18}\)Annuity values are computed assuming a real interest rate of 3%. The annuity calculations for single households are based on the individual’s gender-specific life expectancy at the compulsory retirement age, while annuity calculations for couple households are based on the wife’s life expectancy at the compulsory retirement age.

\(^{19}\)The woman’s state space, \( \Psi_{i,t} \), contains the following characteristics of the woman: age; education category; persistent wage type; Unemployment Insurance eligibility; Unemployment Insurance entitlement period; previous hours; job destruction status; employment and retirement status in the previous period; household wealth; current period preference shocks; and the age of the first born child.
In each period prior to the compulsory retirement age, a single woman’s optimization problem proceeds in two stages. First, search intensity is optimized. As a result of search efforts, job offers may arrive, and the set of feasible labor supply retirement choices is observed by the household. Second, the household optimizes consumption, labor supply and retirement behavior. This within-period problem is solved backwards: we determine optimal behavior for each possible set of feasible labor supply and retirement choices, and then solve for the optimal search intensity, taking into account the effect of search on the probability of employment constraints.

Prior to the compulsory retirement age, the labor supply and retirement-specific value functions for woman $i$ are given by:

$$V_{t}^{F,s}(d|s, \Psi_{i,t}) = U^{F}(m^{*}(d), d, \emptyset, s, \varepsilon_{i,t}) + \delta \mathbb{E}\left[\phi_{t+1}^{F,s}V_{t+1}^{F,s}(\Psi_{i,t+1}) + (1 - \phi_{t+1}^{F,s})V_{t+1}^{F,c}(\Psi_{i,t+1}, \Phi_{j,t+\Delta+1})\right|\Psi_{i,t}, d],$$

for $d \in D_{F}$.

In the above, $\delta = \sqrt{0.98}$ is the semi-annual subjective time discount factor, $s$ denotes the woman’s search intensity, and $\Phi_{j,t}$ denotes man $j$’s state variables at age $t$.\footnote{The man’s state space, $\Phi_{j,t}$, contains all variables that appear in the woman’s state space (see footnote 19), except for previous hours and the age of the first born child.} The single woman’s value function reflects the likelihood marriage in the next period: her value function in the next period is the sum of the probability of remaining single, $\phi_{t+1}^{F,s}$, times the single woman’s value function at age $t + 1$, $V_{t+1}^{F,s}(\Psi_{i,t+1})$, and the probability of marriage in the next period times the married woman’s value function at age $t + 1$, $V_{t+1}^{F,c}(\Psi_{i,t+1}, \Phi_{j,t+\Delta+1})$. The value functions for single and married women are defined below. Last, $m^{*}(d)$ is consumption choice that maximizes the labor supply and retirement-specific value function.\footnote{Assumptions on expectations about the observable characteristics of future spouses reflect the modal in-sample pattern of marriage matching: an individual expects that his or her future spouse will enter the marriage with the same education, employment status, and Unemployment Insurance entitlement and eligibility as his or her self; individuals expect that the husband will enter the marriage with 7% more experience and 5% more wealth than the wife; and a man expects his future wife to enter with marriage without preexisting children. Regarding the wage unobservable, an individual expects any future spouse to enter the marriage with the same wage unobservable as his or herself.}

We now characterize optimal labor supply and retirement behavior given the set of feasible choices, as determined by the outcome of search activities, job destructions and the age-based restrictions retirement eligibility. Let $D_{k}^{F}$ for $k = 1, ..., K^{F}$, denote all possible sets of feasible employment and retirement choices. Given the set of feasible choices $D_{k}^{F}$, the woman chooses the labor supply and retirement alternative with highest
The woman’s optimal search intensity, \( s^*_i,t \), is given by:

\[
\argmax_{s \in [0, 1/\chi_{i,t}]} \left\{ \sum_{k=1}^{K_F} P(D_F^k | s, \Psi_{i,t}) V_{F,s}^F(d^*_i,t(D_F^k) \mid s, \Psi_{i,t}) \right\},
\]

where \( P(D_F^k | s, \Psi_{i,t}) \) is the probability of set \( D_F^k \) of feasible labor supply and retirement choices given search intensity \( s \). Evaluating the term in braces in (22) at the optimal search intensity, \( s^*_i,t \), obtains the single woman’s value function, \( V_{F,s}^F(\Psi_{i,t}) \).

2.7.2 Couple Households

A couple household’s choice problem ends when the wife reaches the compulsory retirement, \( \tilde{T} \), and therefore when the husband is age \( \tilde{T} + \Delta \). Once the wife reaches the compulsory retirement wage, neither spouse can search or work, and the household consumes pension and transfer income plus the actuarially fair annuity value of household wealth at the time when the wife reached the compulsory retirement age. The terminal value for woman \( i \) in couple household \((i,j)\) is given by:

\[
V_{F,c}^F(\Psi_i, \tilde{T}, \Phi_j, \tilde{T} + \Delta) = P_F^F(\tilde{T}) \times u_F^F(m_{i,j}, \tilde{T}, RT, RT),
\]

and the terminal value for man \( j \) in couple household \((i,j)\) is given by:

\[
V_{M,c}^M(\Psi_i, \tilde{T}, \Phi_j, \tilde{T} + \Delta) = P_M^M(\tilde{T} + \Delta) \times u_M^M(m_{i,j}, \tilde{T}, RT, RT).
\]

In the above \( P_F^F(\tilde{T}) \) and \( P_M^M(\tilde{T} + \Delta) \) denote, respectively, the wife’s and husband’s expected durations of retirement measured when the wife reaches the compulsory retirement age. As mentioned above, the couple household’s objective function is formed from an \( \alpha \)-weighted average of the spouses’ utilities. Therefore, the terminal value function for the couple household takes the form:

\[
\alpha V_{F,c}^F(\Psi_i, \tilde{T}, \Phi_j, \tilde{T} + \Delta) + (1 - \alpha) V_{M,c}^M(\Psi_i, \tilde{T}, \Phi_j, \tilde{T} + \Delta).
\]

In each period prior to the wife reaching the compulsory retirement age, the couple’s optimization problem proceeds in two stages, as for singe-adult households: first, search intensities are optimized and job offers arrive; second, the household optimizes consumption, labor supply and retirement behavior. We have the following labor supply and
retirement-specific value functions for the couple household prior to the wife reaching the compulsory retirement age:

\[
V^F_t(d^F, d^M | s^F, s^M, \Psi_{i,t}, \Phi_{j,t+\Delta}) = \alpha U^F(m^*(d^F, d^M), d^F, d^M, s^F, \varepsilon_{i,t}) + (1 - \alpha) U^M(m^*(d^F, d^M), d^F, d^M, s^M, \varepsilon_{j,t+\Delta}) + \\
\delta E \left[ (1 - \phi_{c+1}^F) \left( \alpha V^F_{t+1}(\Psi_{i,t+1}) + (1 - \alpha)V^M_{t+\Delta+1}(\Phi_{j,t+\Delta+1}) \right) + \phi_{c+1}^M V^M_{t+\Delta+1}(\Psi_{i,t}, \Phi_{j,t+\Delta}, d^F, d^M) \right] \\
\text{for } d^F \in D^F \text{ and } d^M \in D^M. \quad (26)
\]

In the above, \(\phi_{c+1}^F\) is the probability that the spouses remain married, and \(m^*(d^F, d^M)\) denotes the consumption choice that maximizes the labor supply and retirement-specific value function. The couple household’s value function reflects the possibility of divorce: the couple households value function in the next period is weighted by the probability that the marriage survives and the complementary probability is attached to an \(\alpha\)-weighted average of value functions of single women and men (see Section 2.7.1). van der Klaauw and Wolpin (2008) use a similar specification in the context of model of household reinterment and savings decisions.

Let \(D^F_k\) for \(k = 1, \ldots, K^F_M\), denote all possible sets of feasible employment and retirement choices for a couple household. Given the set of feasible labor supply and retirement choices \(D^F_k\), the household chooses the labor supply and retirement alternative with highest choice-specific value function:

\[
(d^*_t(D^F_k), d^*_j_{t+\Delta}(D^F_k)) = \arg\max_{(d^F, d^M) \in D_F} V^F_t(d^F, d^M | s^F, s^M, \Psi_{i,t}, \Phi_{j,t+\Delta}). \quad (27)
\]

The wife’s and husband’s optimal search intensities are given by:

\[
(s^*_{i,t}, s^*_{j,t+\Delta}) = \arg\max_{s^F \in [0, 1/\chi_{i,t}], s^M \in [0, 1/\chi_{j,t+\Delta}]} \left\{ \sum_{k=1}^{K^F_M} P(D^F_k | s^F, s^M) \left[ V^F_t(d^*_t(D^F_k), d^*_j(D^F_k) | s^F, s^M, \Psi_{i,t}, \Phi_{j,t+\Delta}) \right] \right\}, \quad (28)
\]

where \(P(D^F_k | s^F, s^M)\) is the probability of set \(D^F_k\) of feasible labor supply and retirement choices given search intensities \(s^F\) for the wife and \(s^M\) for the husband.

Last, we split the couple household’s value function into value functions for the husband and wife – as described in (20), the future value functions for married men and women appear in the value functions for single-adult households. For a married woman:

\[
V^{F,c}_t(\Psi_{i,t}, \Phi_{j,t+\Delta}) = \sum_{k=1}^{K^F_M} P(D^F_k | s^*_{i,t}, s^*_{j,t}) V^{F,c}_t(d^*_t(D^F_k), d^*_j(D^F_k) | s^*_{i,t}, s^*_{j,t}, \Psi_{i,t}, \Phi_{j,t+\Delta}), \quad (29)
\]
where

\[
V_t^{F,c} \left( d_{i,t}^*(D_{k}^{FM}), d_{j,t}^*(D_{k}^{FM}) \right) | s_{i,t}, s_{j,t}, \Psi_{i,t}, \Phi_{j,t+\Delta} = (30)
\]

\[
U_F(m^*(d_{i,t}^*(D_{k}^{FM})), d_{j,t}^*(D_{k}^{FM})), d_{j,t}^*(D_{k}^{FM}), s_{i,t}, \varepsilon_{i,t}) + \delta E \left[ (1 - \phi_{t+1}^c) V_{t+1}^{F,c}(\Psi_{i,t+1}) + \phi_{t+1}^c V_{t+1}^{F,c}(\Psi_{i,t+1}, \Phi_{j,t+\Delta+1}) \right] .
\]

The value function for a married man may be derived in the same way.

### 3 Data and Sample

Estimation of the model uses a semi-annual panel sample of west German single-adult and couple households constructed from the German Socio-Economic Panel (SOEP) survey data sets (see Wagner et al., 2007, for a description of the SOEP). The sample covers the period 1991–2005.\(^22\) Attention is restricted to single-adult households in which the adult household member is aged 16–65 years and couple households in which both spouses are aged 16 or older and at least one spouse is age 65 or younger. We exclude individuals before their initial transition into the labor force from full-time education. We also exclude households in which any adult household member reports being self-employed or employed by the Civil Service.

The estimation sample contains 210,110 individual-half-year observations (corresponding to 135,779 household-half-year observations). Couples account for around 69% of the household observations. We note four features of the sample construction. First, although the SOEP surveys are conducted annually, there is sufficient information to construct semi-annual measures of employment and retirement outcomes and household demographics. In more detail, an individual is asked to report his or her labor supply and retirement status in each month of the previous calendar year. From this information, it is possible to distinguish between non-employment, part-time employment, full-time employment and retirement. Consistent with the theoretical framework, the category of non-employment contains all non-retired, non-working individuals. Semi-annual outcomes are defined by the individual’s status in the first month of the period. We construct the sample to ensure that retirement is an absorbing state. Specifically, an individual is classified as retired from the date on which he or she reports first entering retirement.\(^23\)

Second, labor market experience is derived from a combination of retrospective information about pre-sample behavior, and in-sample labor supply outcomes. At the point of sample entry, individuals are asked to report their employment status in each half year between entering the labor market and the survey date. Using this information, we form

\(^{22}\)We use the Retail Price Index to express all nominal variables in year 2000 prices.

\(^{23}\)From retrospective information on household type, we construct a semi-annual household type variable (single or married), again based on the individual’s status in January and July.
an accurate measure of years of labor market experience at the time of survey entry. We obtain our experience variable by augmenting initial experience in line with in-sample labor supply outcomes.

Third, the gross hourly wage is defined as gross earnings, including overtime pay, in the month prior to the survey date divided by reported contractual working hours, including hours of paid overtime, during the same period. Wages are thus sampled only for those individuals who are employed in the month prior to the survey date.24

Fourth, we construct a measure of household assets (comprising financial, housing and durable assets) using information collected via a detailed household questionnaire administered as part of the 2002 SOEP survey. Although the wealth data is cross-sectional, it describes a broad class of asset holdings for single and couple households at different points in the life-cycle. This information is used as an input to the estimation, providing valuable information on risk preferences (see Appendix C).

Table 1 reports descriptive statistics for the estimation sample. We highlight two regularities that appear in the following discussion. First, the employment rate of married men is 4 percentage points higher than the employment rate of single men, while for women the pattern is reversed. Second, wealth is higher for single men than for single women, although the difference is only around 5,000 Euros, relative to an average wealth level of around 50,000 Euros for single men.

We supplement the SOEP sample with information on life expectancy taken from the German Human Mortality Database (HMD) for Germany.25 Specifically, using the gender-specific life expectancies for 1970 birth cohort and an annualized discount factor of 0.98, we calculate the discounted expected retirement durations that appear in (19), (23) and (24).26

4 Indirect Inference Estimation Routine

Estimates of structural model parameters are obtained using indirect inference (see Smith, 1993, Gourieroux et al., 1993, and Gallant and Tauchen, 1996). This simulation-based estimation method uses an auxiliary model to summarize both the estimation sample and a sample simulated using the decision rules and other equations of motion given by the structural model. Values of the structural parameters are chosen to minimize the dis-

24When constructing the sample we make use of the longitudinal dimension of the data to match the correct wage information to the corresponding period defined by the retrospective employment information.

25The HMD is provided by the University of California, Berkeley and Max Planck Institute for Demographic Research. The database is available at www.mortality.org.

26Our calculation give $P^F(\bar{T}) = 18.02$, $P^M(\bar{T}) = 15.99$ and $P^M(\bar{T} + \Delta) = 15.08$. 
<table>
<thead>
<tr>
<th>Variable</th>
<th>Single men</th>
<th>Single women</th>
<th>Married men</th>
<th>Married women</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Obs.</td>
<td>Mean</td>
<td>Obs.</td>
<td>Mean</td>
</tr>
<tr>
<td>Age (years)</td>
<td>13959</td>
<td>39.32</td>
<td>20541</td>
<td>42.40</td>
</tr>
<tr>
<td>Education (years)</td>
<td>13959</td>
<td>12.29</td>
<td>20541</td>
<td>11.76</td>
</tr>
<tr>
<td>High education</td>
<td>13959</td>
<td>0.42</td>
<td>20541</td>
<td>0.36</td>
</tr>
<tr>
<td>Experience (years)</td>
<td>13959</td>
<td>14.97</td>
<td>20541</td>
<td>14.27</td>
</tr>
<tr>
<td>Full-time employed (FT)</td>
<td>13959</td>
<td>0.73</td>
<td>20541</td>
<td>0.47</td>
</tr>
<tr>
<td>Part-time employed (PT)</td>
<td>-</td>
<td>-</td>
<td>20541</td>
<td>0.14</td>
</tr>
<tr>
<td>Retired (RT)</td>
<td>13959</td>
<td>0.05</td>
<td>20541</td>
<td>0.10</td>
</tr>
<tr>
<td>Non-employed (NE)</td>
<td>13959</td>
<td>0.28</td>
<td>20541</td>
<td>0.30</td>
</tr>
<tr>
<td>Assets (Euros, household)</td>
<td>533</td>
<td>49.174</td>
<td>805</td>
<td>44.766</td>
</tr>
<tr>
<td>Wage (gross, hourly)</td>
<td>3358</td>
<td>15.56</td>
<td>4535</td>
<td>12.71</td>
</tr>
<tr>
<td>Age 1st Child (years)</td>
<td>-</td>
<td>-</td>
<td>5394</td>
<td>11.37</td>
</tr>
</tbody>
</table>

Notes: High education is defined as 12 or more years of education. Children always reside in the mother’s household. Assets are right censored at 250,000 Euros for single-adult households and 500,000 Euros for couple households. Descriptive statistics are for individuals aged 16-65 years.

Table 1: Descriptive statistics for the SOEP estimation sample 1991–2005.

similarity between the estimation sample and the simulated sample, as viewed from the perspective of the auxiliary model.

The adopted auxiliary model contains 108 parameters, and is designed to provide identifying information on the 47 parameters of the structural model. In more detail, the auxiliary model is composed of 108 one-parameter sub-models. The sub-model parameters pertain to one or more of the three modeled outcome variables: wages; labor supply; and household assets. In Tables 10 and 11 in Appendix C we describe the auxiliary sub-model parameters and link these parameters to the identification of the parameters of the structural model.

Following, e.g., Low and Pistaferri (2010) and Adda et al. (2011), we use an Indirect Inference estimation routine based on matching the estimated auxiliary parameters. Our Indirect Inference estimator of the structural parameters is defined by:

\[
\hat{\phi} = \arg \min_{\phi} (\hat{\psi} - \hat{\psi}(\phi))^\prime \Sigma(\hat{\psi} - \hat{\psi}(\phi)),
\]

where \(\hat{\psi}\) denotes the vector of auxiliary model parameter estimates obtained from the estimation sample, and \(\hat{\psi}(\phi)\) denotes the auxiliary model parameters estimated using

27In related life-cycle models, Altonji et al. (Forthcoming) conduct indirect inference based on the quasi likelihood of the auxiliary model, and Gourieroux et al. (1993) and van der Klaauw and Wolpin (2008) base estimation on the score function of the auxiliary model. De Nardi et al. (2010) and Eckstein and Lifshitz (2011) use the closely-related Method of Simulated Moments.
a sample simulated from the structural model with structural parameter values $\phi$. The diagonal weighting matrix, $\Sigma$, has diagonal elements equal to the inverse of the variance of each of the auxiliary model parameters, estimated using bootstrapping with clustering at the household level. We obtain standard errors using the formula provided by Gourieroux et al. (1993).

5 Parameter Estimates, In-sample Fit, Consistency with Previous Studies and Implied Life-cycle Behavior

5.1 Structural Parameter Estimates

Estimates of the structural parameters are reported in Tables 2, 3, 4 and 5. Table 2 shows that wages are increasing in education and experience, with both dependencies being larger for men than for women. The unobserved component of the market wage is persistent, with wage shocks being large but infrequent. Negative wage shocks are somewhat more likely for women than for men. The wage unobservable is positively correlated between spouses.

Table 3 shows that the probability of a job offer, conditional on search intensity, is decreasing in age, increasing in education, and is lower for married individuals than for singles. Table 4 reports negative intercepts in the equations describing women’s and men’s preferences for full-time and part-time work. Recall, non-employment and retirement combined form the reference category. Therefore, in addition to any leisure complementarities, men and women have positive utility of leisure time. Women whose youngest child is aged under 6 years have an additional distaste for full-time work, and an additional positive preference for part-time work. The distaste for work increases with age for both men and women.

From Table 5, the CRRA is estimated to be 1.609 for women and 1.562 for men. These figures are in line with previous studies, which typically report estimates of the CRRA in the range of 1–3. In couple households, women receive a weight of 0.724. Leisure complementarities are present, with an individual’s preference for non-employment being increased by the presence of a non-employed spouse. However, an individual’s preference for non-employment is increasing in the spouse’s hours of work, implying that non-employment is least attractive when the spouse is working part-time.
<table>
<thead>
<tr>
<th></th>
<th>Women</th>
<th>Men</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept ((\beta^F_1, \beta^M_1))</td>
<td>2.484</td>
<td>2.829</td>
</tr>
<tr>
<td></td>
<td>(0.097)</td>
<td>(0.016)</td>
</tr>
<tr>
<td>Exp/40 ((\beta^F_2, \beta^M_2))</td>
<td>0.038</td>
<td>0.181</td>
</tr>
<tr>
<td></td>
<td>(0.016)</td>
<td>(0.020)</td>
</tr>
<tr>
<td>Education ≥ 12 years ((\beta^F_3, \beta^M_3))</td>
<td>0.217</td>
<td>0.337</td>
</tr>
<tr>
<td></td>
<td>(0.017)</td>
<td>(0.018)</td>
</tr>
<tr>
<td>(P(\kappa_{i,t} = 1</td>
<td>\kappa_{i,t-1} = 1) \ (\Phi(\theta^F_1), \Phi(\theta^M_1)))</td>
<td>0.963</td>
</tr>
<tr>
<td></td>
<td>(0.003)</td>
<td>(0.003)</td>
</tr>
<tr>
<td>(P(\kappa_{i,t} = 0</td>
<td>\kappa_{i,t-1} = 1) \ (\Phi(\theta^F_0), \Phi(\theta^M_0)))</td>
<td>0.056</td>
</tr>
<tr>
<td></td>
<td>(0.004)</td>
<td>(0.002)</td>
</tr>
<tr>
<td>Loading on persistent unobservable ((\beta^F_4, \beta^M_4))</td>
<td>0.728</td>
<td>0.765</td>
</tr>
<tr>
<td></td>
<td>(0.018)</td>
<td>(0.017)</td>
</tr>
<tr>
<td>Between-spouse correlation of persistent wage shocks (\varrho)</td>
<td>0.697</td>
<td>(0.081)</td>
</tr>
<tr>
<td>Standard deviation of measurement error ((\sigma_{\nu,F}, \sigma_{\nu,M}))</td>
<td>0.061</td>
<td>0.027</td>
</tr>
<tr>
<td></td>
<td>(0.018)</td>
<td>(0.005)</td>
</tr>
</tbody>
</table>

Notes: Standard errors in parentheses. \(\Phi()\) is the standard normal distribution function.

Table 2: Wage equation parameters.
<table>
<thead>
<tr>
<th></th>
<th>Women</th>
<th>Men</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Taste for consumption:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Full-time employment:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>$-0.324$</td>
<td>$-0.419$ ( (0.030) )</td>
</tr>
<tr>
<td>( (\theta_1^F, \theta_1^M, \theta_2^F, \theta_2^M) ) Youngest child aged &lt; 3</td>
<td>$-0.647$</td>
<td>$-$ ( (0.022) )</td>
</tr>
<tr>
<td>( 3 \leq \text{Youngest child aged &lt; 6} )</td>
<td>$-0.520$</td>
<td>$-$ ( (0.110) )</td>
</tr>
<tr>
<td>Age $\geq 50$</td>
<td>$-0.517$</td>
<td>$-0.478$ ( (0.066) )</td>
</tr>
<tr>
<td>Age $\geq 50 \times \text{Married}$</td>
<td>$-0.460$</td>
<td>$-0.774$ ( (0.079) )</td>
</tr>
<tr>
<td><strong>Part-time employment:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>$-0.506$</td>
<td>$-$ ( (0.046) )</td>
</tr>
<tr>
<td>( (\theta_1^{P,T}, \theta_2^{P,T}) ) Youngest child aged &lt; 3</td>
<td>$0.282$ ( (0.042) )</td>
<td>$-$</td>
</tr>
<tr>
<td>( 3 \leq \text{Youngest child aged &lt; 6} )</td>
<td>$0.503$ ( (0.123) )</td>
<td>$-$</td>
</tr>
<tr>
<td>Age $\geq 50$</td>
<td>$-0.360$ ( (0.068) )</td>
<td>$-$</td>
</tr>
<tr>
<td>Age $\geq 50 \times \text{Married}$</td>
<td>$0.178$ ( (0.089) )</td>
<td>$-$</td>
</tr>
</tbody>
</table>

Notes: Standard errors in parentheses.

Table 4: Preference parameters I.
Weight on female spouse ($\alpha$) & 0.724 (0.014) \\
Complementarity parameter: ($\eta_3^F$) & 1.786 (0.150) \\
Complementarity parameter: ($\eta_4$) & 0.535 (0.047) \\
Complementarity parameter: ($\eta_5$) & 0.841 (0.082) \\
Between-spouse correlation of preference shocks ($\varphi$) & 0.234 (0.027) \\

<table>
<thead>
<tr>
<th></th>
<th>Women</th>
<th>Men</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>CRRA ($\rho^F, \rho^M$)</td>
<td>1.609</td>
<td>1.562</td>
<td>(0.020)</td>
<td>(0.068)</td>
</tr>
<tr>
<td>Scale of preference shocks for single individuals ($\sigma_{F,S}, \sigma_{M,S}$)</td>
<td>0.676</td>
<td>0.651</td>
<td>(0.021)</td>
<td>(0.031)</td>
</tr>
<tr>
<td>Scale of preference shocks for married individuals ($\sigma_{F,C}, \sigma_{M,C}$)</td>
<td>1.068</td>
<td>0.812</td>
<td>(0.038)</td>
<td>(0.028)</td>
</tr>
</tbody>
</table>

Notes: Standard errors in parentheses.

Table 5: Preference Parameters II.
5.2 In-sample Goodness of Fit

We assess the in-sample fit of the model by examining the model’s ability to fit the 108 auxiliary model parameters, which summarize the patterns of labor supply, wages and wealth seen in the estimation sample. Tables 12-15 in Appendix D shows that the differences between the auxiliary model parameters obtained using the estimation sample and obtained using a sample simulated based on the estimated model are insubstantial. For example: in the estimation sample 76% of single men aged under 50 are employed while in corresponding employment rate in the simulated sample is 78%; average wealth for couple households where the husband is aged 50 or older is 197,000 Euros in the estimation sample and 183,000 Euros in the simulated sample; and the correlations between log wages in consecutive years for women and men are 0.11 and 0.12, respectively, in the estimation sample, compared to 0.12 and 0.13 in the simulated sample.

5.3 Consistency with Previous Studies

Following, e.g., Todd and Wolpin (2006) and Low and Pistaferri (2010), we assess the plausibility of the estimated model by comparing the model’s implications with the findings of related reduced-form studies. Specifically, we show that the estimated model implies that employment depends on key parameters of the Unemployment Insurance system in a way that is consistent with findings from reduced-form studies that exploit plausibly-exogenous variation in benefit rules. These reduced-form quantities are not targeted in our estimation routine, and therefore this exercise provides external support for the estimated model.

In particular, the estimated model reproduces the previously-documented response of employment to exogenous changes in potential benefit duration, or entitlement period, and the replacement rate. Summarizing briefly the key related findings, prior work suggests that a one week increase in the potential benefit duration increases the time until re-employment by 0.05-0.2 weeks. Regarding the level of benefits, prior research suggests that a 10 percentage point increase in the replacement rate increases the time until re-

28For example, looking at Germany and using a sample period similar to our study, Schmieder et al. (2012, Table II) exploit an age-based discontinuity and find that a one week extension of the potential benefit duration increases the time until re-employment by 0.1-0.13 weeks for individuals in their 40s. Using a difference-in-differences approach to estimate the same quantity for Austria, Lalive et al. (2006, Table 5) find a value of 0.05 weeks at ages 40-49 and 0.1 weeks age at 50 and above. Also see the survey by Tatsiramos and van Ours (2012).
employment by 0.5-1.5 weeks.29,30

Based on the estimated model, we derive marginal effects that mirror those reported in the reduced-form literature. Using the year 2000 Unemployment Insurance rules, we simulate inflow samples of individuals who enter non-employment at ages 20, 30 and 40 years. Subsequent employment outcomes are constructed under two regimes: a baseline regime in which the year 2000 Unemployment Insurance rules continue to apply; and an alternative regime in which an unanticipated increase in either the potential benefit duration or the replacement rate occurs at the start of the non-employment spell. Table 6 summarizes the implications of the estimated model with respect to the potential benefit duration. The model predicts that at one week extension of the potential benefit duration increases the duration until re-employment by 0.05-0.15 weeks. Consistent with the findings of Schmieder et al. (2012), the model’s predictions concerning the employment effects of an increase in the potential benefit duration vary little by gender or age. Table 7 shows that a 10 percentage point increase in the replacement rate is predicted to increase the duration until re-employment by 0.3 - 0.6 weeks.

<table>
<thead>
<tr>
<th>Age at start of non-employment spell (years)</th>
<th>20</th>
<th>30</th>
<th>40</th>
</tr>
</thead>
<tbody>
<tr>
<td>Women</td>
<td>0.052</td>
<td>0.075</td>
<td>0.091</td>
</tr>
<tr>
<td>Men</td>
<td>0.098</td>
<td>0.110</td>
<td>0.134</td>
</tr>
</tbody>
</table>

Notes: Spells are right censored at 30 months.

Table 6: Effect of 1 week increase in UI entitlement period on average weeks until reemployment.

29For example, using administrative data from Austria, Lalive et al. (2006, Table 5) report that a 10 percentage point increase in the level of benefits increases the average duration of non-employment 0.63 weeks. For Germany, there is hardly any evidence on this margin, reflecting that there is little variation in the replacement rate over time or by demographics. One exception is Hunt (1995) who finds that a cut of the replacement rate in the 1980s for individuals without children increased the exit rate from unemployment into retirement.

30Early studies estimated the employment effects of the level and duration of Unemployment Insurance benefits without appeal to exogenous policy changes, age discontinuities or other quasi-natural sources of variation. Using US data, Katz and Meyer (1990) find that a one week extension of the potential benefit duration increases the time until re-employment by 0.16-0.20 weeks. Moffitt and Nicholson (1982) report a figure of 0.1 weeks for the same quantity. Ham and Rea (1987) find effects in the range of 0.26-0.33 weeks for Canada. Katz and Meyer (1990) report that a 10 percentage point increase in the replacement rate increases the duration until re-employment by 1.2-1.5 weeks.
<table>
<thead>
<tr>
<th>Age at start of non-employment spell (years)</th>
<th>20</th>
<th>30</th>
<th>40</th>
</tr>
</thead>
<tbody>
<tr>
<td>Women</td>
<td>0.303</td>
<td>0.500</td>
<td>0.438</td>
</tr>
<tr>
<td>Men</td>
<td>0.405</td>
<td>0.407</td>
<td>0.662</td>
</tr>
</tbody>
</table>

Notes: Spells are right censored at 30 months.

Table 7: Effect of 10 percentage point increase in replacement rate on average weeks until reemployment.

As a further plausibility check, we show that the model-implied effect of Unemployment Insurance on the timing of exits from non-employment is in line with previously-documented patterns.\(^{31}\) Consistent with the empirical results of Lalive et al. (2006), Figure 2 shows that the effect of an increase in the potential benefit duration is concentrated around the time of benefit exhaustion. In contrast, and again consistent with Lalive et al. (2006), we find that an increase in the replacement rate for a fixed entitlement period of 12 month, increases the survivor function for non-employment during the whole entitlement period, i.e., during the first 12 months of the non-employment spell.

![Change in survival probability (non-employment)](image)

(a) Potential benefit duration extension from 12 to 18 months.
(b) 10 percentage point increase in the replacement rate.

Notes: Survivor functions are estimated using a pooled inflow sample of individuals entering non-employment at age 20, 30 or 40 years.

Figure 2: Effect of Unemployment Insurance generosity on the non-employment survivor function: own, cross-spouse and total effects.

\(^{31}\)Note, given the semi-annual decision making frequency in the model, exits from unemployment are possible only at 6-monthly intervals.
6 Optimal Unemployment Insurance and Social Assistance Benefits

6.1 Overview

The optimal design of Unemployment Insurance and Social Assistance benefits derives from a trade-off between insurance, redistributive and incentive effects. It is helpful to first consider a society of always-single men or women with a particular level education. The life-cycle outcomes differ only due to different sequences of shocks (wage shocks, job destructions, job offers, preference shocks and fertility outcomes). There is no redistributive motive for social transfers, and the optimal generosities of Social Assistance and Unemployment Insurance are determined by a trade-off between providing insurance against adverse shocks and limiting distortions in labor supply and search incentives. With complete and competitive capital markets, individuals can fully self-insure, and optimal program generosities are zero.\(^{32}\) With incomplete or non-competitive capital markets, optimal generosities of Social Assistance and Unemployment may be non-zero.\(^{33}\) Due to differences in the ways that Social Assistance and Unemployment Insurance and targeted, it maybe optimal to provide insurance through a combination of these programs. In particular, Unemployment Insurance provides temporary assistance that is linked to previous earnings; Unemployment insurance therefore is relatively effective at mitigating the short-term effects of job loss. Social Assistance, meanwhile, provides long-term assistance but is not earnings-related, meaning that insurance is greater for low-wage individuals.

In a world where individuals differ in terms of education, which impacts wages and the extent of labor market frictions, there is redistributive motive for social programs, along side the insurance motive. Both Unemployment Insurance and Social Assistance are redistributive, however, by targeting directly low-income, wealth-poor individuals, Social Assistance redistributes strongly toward the low educated individuals. Due to its link with earnings, Unemployment Insurance is less strongly redistributive.

An important contribution of this paper is to shed light on the optimal design of Unemployment Insurance and Social Assistance benefits while recognizing the family context. As for single individuals, Unemployment Insurance provides cohabiting individuals with short-term income replacement following job loss. However, because Unemployment Insurance benefits are paid without regard to spousal earnings, the benefits are not focused on individuals in households where the effects of job loss are most severe. Unemployment Insurance, therefore, is a less well targeting insurance device for couples than it is

---

\(^{32}\) Assuming implicitly that the individual behavior when faced with zero transfers optimizes the Social Welfare Function. This is true of our welfare measure (see Section 6.2).

\(^{33}\) We model borrowing restrictions that constrain assets to be non-negative (See Section 2.6.)
for singles. Further, the presence of a spouse makes Unemployment Insurance a weaker redistributive device because benefits are paid without regard to the spouse’s education. Social Assistance benefits, meanwhile, continue to provide long-term insurance and to redistribute toward to cohabiting individuals who would otherwise be poor after accounting for both spouse’s earnings. Social Assistance will, therefore, tend to be an attractive transfer mechanism when many individuals live in couple households. A distinguishing feature of the couple household is the presence of intra-household insurance from labor supply: a couple household may adjust one spouse’s or both spouses’ labor supply in response to a wage or employment shock. This additional intra-household insurance is likely to work to reduce the socially optimal generosity of insurance-motivated social transfers.

The above life-cycle model was specified to allow us to explore the welfare effects of Unemployment Insurance and Social Assistance when individuals may be single or married. Of particular relevance: borrowing constraints limit self-insurance and therefore social transfers may serve an insurance function; and the modeled heterogeneity in education may generate a redistributive motive. Drawing on the estimated model, we compare a range of Unemployment Insurance and Social Assistance systems in terms of social welfare, labor supply outcomes, saving behavior. A comparison of welfare effects across different systems informs on the optimal generosity of Unemployment Insurance and Social Assistance benefits. In these calculations, we focus one dimension of each system: for Unemployment Insurance, we locate the optimal replacement rate; and for Social Assistance we identify the optimal income floor. In a further round of analysis, we extend the optimality exercise and consider the optimal mix of Unemployment Insurance and Social Assistance generosity. For each policy environment, we impose revenue equivalence to the baseline, year 2000 system, by imposing an appropriately calibrated flat-rate earnings tax or subsidy.

6.2 Welfare Metric

We compare the welfare implications policy reforms using a weighted average of a money-metric measure of the life-time gains to women and men. Formally, the welfare value of a move from the baseline environment, $B$, i.e., the year 2000 Unemployment Insurance and Social Assistance regime, to an alternative policy environment, $A$, is defined as:

$$W^A(\Upsilon) = \Upsilon \phi^F_A P^F(t) + (1 - \Upsilon) \phi^M_A P^M(t), \quad (32)$$

where $\phi^F_A$ and $\phi^M_A$ are defined below and denote the ex ante per-period money-metric values to women and men of a move to environment $A$, $\Upsilon$ is the weight on women’s welfare gains, and $P^F(t)$ and $P^M(t)$ denote the discounted expected duration until death for women and men, measured at time of labor force entry. In our presentation, we focus on the results for $\Upsilon = 0.5$, i.e., equal weight on women’s and men’s life-time welfare gains.
However, we also illustrate optimal policies for $\Upsilon = 1$ (full weight on women’s gains) and $\Upsilon = 0$ (full weight on men’s gains).

The key inputs to the welfare metric are the per-period money metric values of the policy change, $\phi^F_A$ for women and $\phi^M_A$ for men. We obtain these quantities by computing the per-period adjustment in consumption in the baseline environment that is required to equalize an individual’s expected discounted life-time utility across the baseline and alternative environments. Formally, we define $W^F_G(\phi)$ to be the ex ante discounted expected life-time utility for a woman in environment $G$, given per-period consumption increment, $\phi$:

$$\omega^F_G(\phi) = \mathbb{E} \left[ \sum_{\tau=t(i)}^{LE^F} \delta^{(\tau-t(i))} U^F( m_{i,j,\tau}^G + \phi, d_{i,\tau}^G, d_{j,\tau+\Delta}, s_{i,\tau}, \varepsilon_{i,t}^G) \bigg| \text{Env. } G \right]. \quad (33)$$

The corresponding quantity for men, $\omega^M_G(\phi)$, is defined in same way. Then $\phi^F_A$ and $\phi^M_A$ solve:

$$\omega^F_B(\phi^F_A) = \omega^F_A(0) \quad \text{and} \quad \omega^M_B(\phi^M_A) = \omega^M_A(0), \quad (34)$$

respectively.

The per-period consumption increments, $\phi^F_A$ and $\phi^M_A$, defined above closely resemble equivalent variation-based measure of the welfare used in Low et al. (2010). Our aggregate welfare measure defined in (32) is formed by weighting these individual per-period welfare measures by women’s and men’s discounted life expectancies and by the distributional weight, $\Upsilon$. Finally, note that our welfare value is obtained by weighting individuals according to their utilities, with no further adjustment for earnings, income, or other dimensions of heterogeneity.

### 6.3 Optimal Social Assistance Generosity

Recall, Social Assistance benefits provide wealth-poor households with a household composition specific income floor against which income from other sources is means-tested. When assessing the behavioral effects and optimality of the Social Assistance system, we consider proportional adjustments of the baseline income floor. In doing so, we vary the overall generosity of the Social Assistance system while maintaining the link between the income floor and household composition.

Figure 3 compares welfare, wealth and employment across a range of revenue-equivalent Social Assistance systems. The welfare-maximising Social Assistance income floor is 50% of the baseline generosity, meaning that, e.g., a couple household with 2 pre-school age children receives a maximum of 712 Euros per month in Social Assistance benefits, instead.

---

34Here, ex ante is defined as before individual’s age education and initial unobserved wage type are realized.
of the baseline level of 1425 Euros per month. The welfare gains from a move to the optimal generosity of Social Assistance benefits are substantial, amounting to an average of around 47,000 Euros over an individual’s life-time.\textsuperscript{35} One important aspect of the welfare effects of Social Assistance is the large positive welfare effects of a small reduction on the generosity of Social Assistance, starting at the baseline level: a revenue neutral cut of 10% in the generosity of Social Assistance benefits increases average life-time welfare by around 35,000 Euros per person.

\begin{figure}[h]
\begin{center}
\begin{subfigure}{0.45\textwidth}
\centering
\includegraphics[width=\textwidth]{welfare.png}
\caption{Welfare.}
\end{subfigure}
\begin{subfigure}{0.45\textwidth}
\centering
\includegraphics[width=\textwidth]{wealth.png}
\caption{Wealth.}
\end{subfigure}
\begin{subfigure}{0.45\textwidth}
\centering
\includegraphics[width=\textwidth]{femaleemployment.png}
\caption{Female employment.}
\end{subfigure}
\begin{subfigure}{0.45\textwidth}
\centering
\includegraphics[width=\textwidth]{maleemployment.png}
\caption{Male employment.}
\end{subfigure}
\end{center}
\end{figure}

Notes: An appropriately-calibrated flat-rate earnings tax ensures that all policies are revenue-equivalent to the baseline, year 2000, system.

Figure 3: Welfare, wealth, employment outcomes by Social Assistance income floor.

\textsuperscript{35}Income floors above 100% of the baseline generosity (in conjunction with an Unemployment Insurance replacement rate of 60%) are prohibitively expensive, i.e., there is no flat-rate earnings tax that imposes revenue equivalence to the baseline environment.
tance income floor is decreased below its currently level, reflecting substitution between
intra-household insurance from wealth accumulation and public insurance from Social
Assistance benefits. Figures 3(c) and 3(d) show a cut in Social Assistance generosity to
80% of the baseline level increase the employment rate across the board, however, the
employment response is larger for women than for men. Further cuts in the generosity of
Social Assistance increase the aggregate employment rate.\textsuperscript{36}

6.4 Optimal Unemployment Insurance Replacement Rate

Figure 4(a) shows welfare over a range of Unemployment Insurance replacement rates.\textsuperscript{37}
Among revenue-equivalent Unemployment Insurance replacement rates, a replacement
rate of 0% maximizes welfare, i.e., welfare maximization entails the complete elimination
of Unemployment Insurance benefits. The life-time welfare gains associated with a revenue
neutral cut in the replacement rate from the current level of 60% to the welfare-maximizing
level of 0% average around 39,000 Euros per person.

Two factors are of particular importance in driving the optimal Unemployment In-
surance replacement rate to zero. First, in this exercise, Unemployment Insurance is
optimized holding fixed the generosity of Social Assistance benefits and the baseline level.
Social Assistance benefits directly increase the incomes of low income, wealth-poor house-
holds; given generous Social Assistance benefits, the redistributive and insurance motives
for Unemployment Insurance are limited.\textsuperscript{38} Second, Unemployment Insurance is avail-
able to individuals who voluntarily quit their jobs as well as those who are laid off. The
availability of Unemployment Insurance to the voluntary quitters, while in line the with
administration of Unemployment Insurance in Germany, creates an incentive for individ-
uals to select out of employment to receive Unemployment Insurance. This selection is
a form of moral hazard that exists along side the disincentive effect of Unemployment
Insurance on search intensity.

Figure 4(b) shows that wealth accumulation is decreasing in the generosity of Un-
employment Insurance, although wealth accumulation is less sensitive to Unemployment
Insurance than to Social Assistance. Figures 4(c) and 4(d) show the employment rates
for single and married men and women according to the Unemployment Insurance re-
placement rate. As for Social Assistance, female employment is relatively sensitive to the
Unemployment Insurance replacement rate.

\textsuperscript{36}Cuts in the generosity of Social Assistance lead to earlier retirement, however, the effects are small.
\textsuperscript{37}Throughout the optimality analysis, individuals with and without dependent children receive Unem-
ployment Insurance benefits at the same rate.
\textsuperscript{38}One consequence of the limited redistributive role of Unemployment Insurance is that of our con-
clusions regarding the optimal replacement rate are plausibly robust to increasing the welfare weight
attached to low income, wealth poor individuals.
Notes: An appropriately-calibrated flat-rate earnings tax ensures that all are policies revenue-equivalent to the baseline, year 2000, system.

Figure 4: Welfare, wealth, employment and retirement by Unemployment Insurance replacement rate (revenue-equivalent policies).

6.5 The Optimal Mix of Social Assistance and Unemployment Insurance Generosities

Next, we consider the optimal mix of Unemployment Insurance and Social Assistance benefits. As explained in Sections 2.6.1 and 6.1, these programs are targeted differently. The potential exists, therefore, to obtain welfare gains by exploiting program interdependencies. Figure 5 shows average life-time welfare gains from various combinations of the Social Assistance income floor and the Unemployment Insurance replacement rate.

Average life-time welfare gains are maximized by combining Social Assistance income floor of 70% of the baseline level with a zero replacement rate for Unemployment Insur-
ance. The average life-time welfare gain from a move to this combination is around 59,000 Euros per person - an increase of around 12,000 Euros per person on that gain obtained from optimizing Social Assistance in isolation, and an increase of 20,000 Euros per person on the gain from optimizing Unemployment Insurance in isolation. Thus, while the joint optimization of Social Assistance and Unemployment Insurance generosities yields appreciable gains over those obtained when one or the other program is considered alone, around two-thirds of the obtainable welfare gains may be realized by reforming a single program. Men and women agree on the optimal policy, despite differences in preferences. Finally, we note that at low levels of Social Assistance the optimal Unemployment Insurance replacement rate is above zero, reflecting substitutability between Social Assistance and Unemployment Insurance.

![Optimal Policy Graph](image)

Notes: An appropriately-calibrated flat-rate earnings tax ensures that all policies are revenue-equivalent to the baseline, year 2000, system.

Figure 5: Life-time welfare gains from combined adjustments in Unemployment Insurance and Social Assistance generosities.

### 6.6 Optimal Policy and Family Labor Supply

Last, we explore how optimal program generosities depend on a couple household’s ability to cross-insure by adjusting either or both spouses’ labor supply in response to wage and employment shocks. To this end, we consider an alternative process for labor supply in couple households. Under this alternative process, the joint optimization of family labor supply is absent. Instead, we solve for optimal labor supply and consumption of an arbitrarily chosen member of the couple household, given an exogenous process for...
the spouse’s labor supply. The exogenous process for the spouse’s labor supply is chosen to match the distribution of optimal labor supply outcomes from the above family labor supply model. We allow the exogenous process for spousal labor supply to depend on household characteristics, and state variables that pertain specifically to the exogenous spouse, including the spouse’s own employment and wage shocks. We obtain the welfare value of a policy environment without the joint optimization of family labor supply using metric defined by (32) and applied to the life-time utilities of individuals whose choices are optimal, rather than exogenous. We continue to consider policy environments that are revenue-equivalent to the baseline system.

Table 8 shows that the optimal generosities of Unemployment Insurance and Social Assistance benefits depend on the family labor supply process. We find that the joint optimization of labor supply in couple households works to reduce the optimal generosities of both benefits, reflecting a net substitutability between public and intra-household insurance from family labor supply.

<table>
<thead>
<tr>
<th></th>
<th>Replacement rate</th>
<th>Income floor (% of baseline)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Optimal Unemployment Insurance replacement rate:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Family labor supply</td>
<td>0%</td>
<td>100 (Fixed)</td>
</tr>
<tr>
<td>Exogenous spousal labor supply</td>
<td>15%</td>
<td>100 (Fixed)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Replacement rate</th>
<th>Income floor (% of baseline)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Optimal Social Assistance income floor:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Family labor supply</td>
<td>60 (Fixed)</td>
<td>50%</td>
</tr>
<tr>
<td>Exogenous spousal labor supply</td>
<td>60 (Fixed)</td>
<td>60%</td>
</tr>
</tbody>
</table>

Table 8: Optimal Unemployment Insurance and Social Assistance with family labor supply and with exogenous spousal labor supply.
Appendix

A Employment Risk, Marriage, Divorce and Fertility

As part of the annual SOEP surveys, any individual who left a job during the last year is asked the reason for his or her most recent job separation. Based on this variable, we identify involuntary separations, defined as separations that are attributed to layoff, plant closure or the termination of a temporary contract. We estimate the probability of an involuntary separation conditional on a transition out of employment. We also estimate the semi-annual probability of a transition out of employment. Both probabilities are allowed to vary freely according to the individual’s gender, marital status, age category and education category. Table 9 reports the estimated job destruction probabilities, obtained by taking the product of the probability of an involuntary separation, conditional on a transition out of employment, and the semi-annual probability of a transition out of employment.

<table>
<thead>
<tr>
<th></th>
<th>Single adult households</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Women</td>
<td>Men</td>
<td></td>
</tr>
<tr>
<td>High education and age ≥ 50 years</td>
<td>0.041</td>
<td>0.032</td>
<td></td>
</tr>
<tr>
<td>High education and age &lt; 50 years</td>
<td>0.017</td>
<td>0.018</td>
<td></td>
</tr>
<tr>
<td>Low education and age ≥ 50 years</td>
<td>0.024</td>
<td>0.042</td>
<td></td>
</tr>
<tr>
<td>Low education and age &lt; 50 years</td>
<td>0.024</td>
<td>0.020</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Couple households</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Women</td>
<td>Men</td>
<td></td>
</tr>
<tr>
<td>High education and age ≥ 50 years</td>
<td>0.029</td>
<td>0.014</td>
<td></td>
</tr>
<tr>
<td>High education and age &lt; 50 years</td>
<td>0.019</td>
<td>0.006</td>
<td></td>
</tr>
<tr>
<td>Low education and age ≥ 50 years</td>
<td>0.039</td>
<td>0.029</td>
<td></td>
</tr>
<tr>
<td>Low education and age &lt; 50 years</td>
<td>0.020</td>
<td>0.020</td>
<td></td>
</tr>
</tbody>
</table>

Notes: High education refers to 12 or more years of education. Estimation uses the SOEP sample for 1991-2005 (see Table 1). 1170 (1679) observations on men (women) are used to estimated the involuntary separation probabilities conditional on a transition out of employment. 204251 (165642) observations on men (women) are used to estimate the semi-annual probabilities of a transition out of employment.

Table 9: Semi-annual job destruction probabilities.

Marriages and divorces are assumed to follow exogenous processes. Marriage proba-
abilities are estimated using a Lowess regressions of marriage on age, using a sample of individuals who were in single-adult households in the previous period. Similarly, divorce probabilities are estimated using Lowess regressions of divorce on the age of the female spouse age, using a sample of women who were in couple households in the previous period. Figure 6 illustrates the estimated semi-annual marriage and divorce probabilities.

Notes: Estimation uses the SOEP sample for 1991-2005 (see Table 1).

Figure 6: Estimated semi-annual marriage and divorce probabilities.

The first child arrives exogenously with a probability that depends on the woman’s age, education and marital status. The probability of birth of the first child is assumed to be zero for women aged below 18 years or 38 years or older. For women aged 18-37.5 years, the probability of birth of the first child is estimated using Lowess regressions of a firth birth indicator on age. Separate Lowess regressions are estimated for high and low educated women in single-adult and couple households. Figure 7 illustrates the estimated semi-annual probabilities of the birth of the first child.

A second child is assumed to arrive three years after the first child, and no further children are born. Children reside in the mother’s household until they reach age 18 years, at which point they leave the household. The age of the first born child summarizes fully the number and age of a woman’s children, and therefore the age of the first born child is the only child-related variable included in the state space.
Figure 7: Estimated semi-annual birth probabilities.

B Social Security Contributions, Income tax, Pensions, Child benefits, and Child-care Costs

We describe our modeling of Social Security Contributions, income tax, pensions, child benefits and child-care costs. The specification continues to be based on the German system. Unemployment Insurance and Social Assistance benefits are described above in Sections 2.6.2 and 2.6.3.

Individuals must pay Social Security Contributions (SSC) for health, unemployment and pension benefits. SSC amount to about 20% of gross earned income below a cap of around 4,300 Euros per month. Employers are required to match employees’ contributions. In contrast to SSC, income tax is computed at the household level: for a single-adult household income tax is based on the individual’s taxable income, while for a couple household income tax is based on the average of the spouses’ taxable incomes. An individual’s taxable income comprises gross income from employment above an exemption threshold and gross interest income above a disregard, less SSC. The income tax function is a smooth progressive function of average household taxable income above an exemption threshold. Conditional on average household taxable income, a couple household’s income tax liability is twice that of a single-adult household. Households pay a further tax (Solidaritaetszuschlag) of 5.5% of the household income tax liability.

39When calibrating revenue equivalent policy reforms (Section 6) we account for individual and employer SSC.
Under the German pension system, individuals accumulate pension entitlement for each year of work, with the entitlement being roughly proportional to annual earnings (for further details see Börsch-Supan and Wilke, 2004, and Haan and Prowse, Forthcoming). Mirroring this, in our model a retired individual receives an annual pension that is proportional to his or her approximate life-time earnings:

\[
Pension_{g,t} = \Xi \times \text{Exp}_{g,t} \times W_g(\text{Education}_g, 0.5 \times \text{Exp}_{g,t}, \bar{\pi}) \quad \text{for} \quad g = i, j. \quad (35)
\]

In the above, \(\text{Exp}\) continues to denote years of experience, and the function \(W_g()\) denotes the gender-specific market wage function (7) evaluated at the individual’s education, average experience over the life-cycle, and the population average of the wage unobservable, \(\bar{\pi}\).\(^{40}\) Reflecting the pension system that was effective during the sample period, we set the proportionality factor \(\Xi\) to 20.

The model includes child benefits worth 150 Euros per month for each dependent child. Social Assistance benefits are means-tested against child benefits, however child benefits do not affect Unemployment Insurance benefits. We also model child-care costs. We assume that a couple household with one or more per-school age children must pay for full-time child-care if both spouses work full-time. Part-time child-care costs are incurred if the wife works part-time and the husband work full-time. Similarly, a single woman with one or more per-school age children must pay child-care costs reflecting her hours of work. Based on Wrohlich (2011), we estimate expected monthly child-care costs for a child younger than 3 years of 183 Euros for part-time care and 397 Euros for full-time care. The corresponding figures for a child aged between 3 and 6 years are 90 Euros and 167 Euros. These figures reflect the relatively limited access to subsidized child-care for infants, and assume a price of 5 Euros per hour for unsubsidized child-care.

C Auxiliary Model Parameters

Tables 10 and 11 describe the auxiliary sub-model parameters, and link these parameters to the identification of the parameters of the structural model.

\(^{40}\) The population average of the wage unobservable, \(\bar{\pi}\), is computed using the steady state distribution. See footnote 12.
<table>
<thead>
<tr>
<th>Auxiliary model parameters</th>
<th>Number</th>
<th>Structural parameters primarily identified, and notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1: Mean log wage for: all women; women with high education; women with high experience; women whose youngest child is aged under 3 years; women whose youngest child is aged 3–6 years; women whose spouse has high education.</td>
<td>6</td>
<td>Intercept and coefficients on education and experience in wage process for women ( (\beta^F_1, \beta^F_2, \beta^F_3) ). Note: the inclusion of information on wages specifically for women with children and with a high educated spouse ensures the separation of selection effects from determinants of the market wage.</td>
</tr>
<tr>
<td>Group 2: Parameters in Group 1. estimated for men.</td>
<td>6</td>
<td>( \beta^M_1, \beta^M_2, \beta^M_3 ).</td>
</tr>
<tr>
<td>Group 3: Variance of log wage estimated for: women; and men.</td>
<td>2</td>
<td>Standard deviation of wage measurement error for women and men ( (\sigma_{\nu,F}, \sigma_{\nu,M}) ).</td>
</tr>
<tr>
<td>Group 4: Covariance of spouses’ of log wages.</td>
<td>1</td>
<td>Between-spouse correlation of persistent wage shocks ( (\rho) ).</td>
</tr>
<tr>
<td>Group 5: Mean squared annual change in log wage for: women; and men.</td>
<td>2</td>
<td>Loadings on persistent unobservable in wage processes for women and men ( (\beta^F_4, \beta^M_4) ).</td>
</tr>
<tr>
<td>Group 6: Log odd ratio of the probability that a woman who was employed at ( t - 2 ) with a log wage less than 2.5 experiences a wage increase between periods ( t - 2 ) and ( t ); log odd ratio of the probability that a woman who was employed at ( t - 2 ) with a log wage greater than 2.5 experiences a wage decrease between periods ( t - 2 ) and ( t ).</td>
<td>2</td>
<td>Parameters determining the probabilities of persistent shocks to women’s wages ( (\theta^F_0, \theta^F_1) )</td>
</tr>
<tr>
<td>Group 7: Parameters in Group 6. estimated on men.</td>
<td>2</td>
<td>( \theta^M_0, \theta^M_1 )</td>
</tr>
<tr>
<td>Group 8: Log odd ratios of the probabilities of a voluntary quit at time ( t ) and of full-time employment at time ( t ), given employed at time ( t - 1 ) for: single women aged under 50; and single women aged 50–65. Proceeding log odds ratios for cohabiting women. Log odds ratios of probabilities of full-time and part-time employment for: single women whose youngest child is aged under 3 years; single women whose youngest child is aged 3 or over and under 6 years; cohabiting women whose youngest child is aged under 3 years; cohabiting women whose youngest child is aged 3 or over and under 6 years;</td>
<td>5</td>
<td>Preference of women for consumption when working full-time or part-time ( (\eta^{F,FT}_1, \eta^{F,FT}_2, \eta^{F,PT}_1, \eta^{F,PT}_2) ). Note: Employment-state specific consumption preference of married individuals is identified from information on singles.</td>
</tr>
</tbody>
</table>

Notes: We take the following steps to ensure that the wage selection rules for the simulated sample are the same as for the estimation sample: the simulated wage observations include measurement error; we include simulated wage observations only for employed individuals and only for the first half of each year (in the estimation sample, the wage is only observed at the time of annual interview which typically falls between January and June); and we exclude wage observations with the non-response probability observed in the estimation sample. See also Table 11.

Table 10: Auxiliary model parameters I.
### Auxiliary model parameters

<table>
<thead>
<tr>
<th>Group</th>
<th>Description</th>
<th>Number</th>
<th>Structural parameters primarily identified, and notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>Log odd ratio of the probability of a voluntary quit at time $t$ given employment at time $t-1$ for: single men aged under 50; single men aged 50-65.</td>
<td>5</td>
<td>Preference of men for consumption when working full-time. $(\eta_{1,F,T}, \eta_{2,F,T})$.</td>
</tr>
<tr>
<td>10</td>
<td>Log odd ratios of the probabilities of full-time employment and part-time employment for: single women with high education; single women aged under 50; and single women aged 50-65. Same log odds ratios for married women.</td>
<td>7</td>
<td>Parameters describing the search technology for women $(\chi^F_1, \chi^F_2, \chi^F_3, \chi^F_4)$. Note: Given the employment-state specific preference for consumption, employment levels are informative above search costs, which impact the transition rate into employment.</td>
</tr>
<tr>
<td>11</td>
<td>Log odd ratio of the probability of full-time: single men with high education; single men aged under 50; and single men aged 50-65. Same log odds ratios for married men.</td>
<td>4</td>
<td>Parameters describing the search technology for men $(\chi^M_1, \chi^M_2, \chi^M_3, \chi^M_4)$.</td>
</tr>
<tr>
<td>12</td>
<td>Log odd ratios of the probability of husband non-employment and: wife working full-time; wife working part-time; and being non-employed. Log odd ratios of the probability of husband being non-employed and: wife working part-time; and wife being non-employed.</td>
<td>5</td>
<td>Complementarity parameters $(\eta^F_3, \eta_4, \eta_5)$, correlation of preference shocks, $\varphi$, and weight on female utility in couples’ objective function $(\alpha)$.</td>
</tr>
<tr>
<td>13</td>
<td>Mean household wealth for: single women aged less than 50; single women aged 50 and above; single women with high education; single men aged less than 50; single men aged 50 or above; single men with high education; couple households where husband is aged under 50; couple households where husband is aged 50 or above; couple households where husband has high education.</td>
<td>9</td>
<td>Coefficients of relative risk aversion for women and men $(\rho^F, \rho^M)$.</td>
</tr>
<tr>
<td>14</td>
<td>Log odd ratio of the probability of voluntary quit at time $t$ given full-time employment at time $t-1$ for single and married men and women with high experience and for single and married men with high education. Log odd ratio of the probability of part-time employment at time $t$ given full-time employment at time $t-1$ for single and married men and women with high education. Log odd ratio of the probability of full-time employment and (women only) part-time employment for single and married men and women with high experience.</td>
<td>11</td>
<td>Standard deviation of preference shocks $(\sigma_{F,S}, \sigma_{F,C}, \sigma_{M,S}, \sigma_{M,C})$. Note: Conditional on income, preferences do not depend on experience or education. Variation in behavior along these dimensions therefore provides identifying information about the scale of the unobservable that impact labor supply and retirement outcomes.</td>
</tr>
</tbody>
</table>

Notes: High experience refers to above average experience. See also Table 10.

Table 11: Auxiliary model parameters II.
## D Internal Goodness of Fit

<table>
<thead>
<tr>
<th>Mean of:</th>
<th>Single women</th>
<th></th>
<th>Married women</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Observed</td>
<td>Simulated</td>
<td>Observed</td>
<td>Simulated</td>
</tr>
<tr>
<td>Full-time work</td>
<td>Age&lt;50</td>
<td>0.54</td>
<td>0.60</td>
<td>0.29</td>
</tr>
<tr>
<td>Part-time work</td>
<td>Age&lt;50</td>
<td>0.16</td>
<td>0.19</td>
<td>0.30</td>
</tr>
<tr>
<td>Full-time work</td>
<td>Age≥50</td>
<td>0.44</td>
<td>0.47</td>
<td>0.22</td>
</tr>
<tr>
<td>Part-time work</td>
<td>Age≥50</td>
<td>0.12</td>
<td>0.12</td>
<td>0.26</td>
</tr>
<tr>
<td>Full-time work</td>
<td>High Educ. &amp; High Exp.</td>
<td>0.70</td>
<td>0.69</td>
<td>0.43</td>
</tr>
<tr>
<td>Part-time work</td>
<td>High Educ. &amp; High Exp.</td>
<td>0.12</td>
<td>0.16</td>
<td>0.33</td>
</tr>
<tr>
<td>Full-time work</td>
<td>Low Educ. &amp; High Exp.</td>
<td>0.49</td>
<td>0.52</td>
<td>0.35</td>
</tr>
<tr>
<td>Part-time work</td>
<td>Low Educ. &amp; High Exp.</td>
<td>0.15</td>
<td>0.13</td>
<td>0.33</td>
</tr>
<tr>
<td>Full-time work</td>
<td>High Educ. &amp; Low Exp.</td>
<td>0.57</td>
<td>0.63</td>
<td>0.28</td>
</tr>
<tr>
<td>Part-time work</td>
<td>High Educ. &amp; Low Exp.</td>
<td>0.18</td>
<td>0.22</td>
<td>0.31</td>
</tr>
<tr>
<td>Voluntary quit</td>
<td>Age&lt;50 &amp; Emp. at t−1</td>
<td>0.02</td>
<td>0.02</td>
<td>0.03</td>
</tr>
<tr>
<td>Voluntary quit</td>
<td>Age≥50 &amp; Emp. at t−1</td>
<td>0.04</td>
<td>0.04</td>
<td>0.03</td>
</tr>
<tr>
<td>Voluntary quit</td>
<td>High Educ. &amp; High Exp. &amp; Emp. at t−1</td>
<td>0.02</td>
<td>0.02</td>
<td>0.03</td>
</tr>
<tr>
<td>Voluntary quit</td>
<td>Low Educ. &amp; High Exp. &amp; Emp. at t−1</td>
<td>0.02</td>
<td>0.02</td>
<td>0.02</td>
</tr>
<tr>
<td>Voluntary quit</td>
<td>High Educ. &amp; Low Exp. &amp; Emp. at t−1</td>
<td>0.03</td>
<td>0.04</td>
<td>0.02</td>
</tr>
<tr>
<td>Voluntary quit</td>
<td>Emp. at t−2 &amp; Emp. at t−1</td>
<td>0.03</td>
<td>0.02</td>
<td>0.04</td>
</tr>
<tr>
<td>Full-time work</td>
<td>Age&lt;50 &amp; Emp. at t−1</td>
<td>0.75</td>
<td>0.73</td>
<td>0.48</td>
</tr>
<tr>
<td>Full-time work</td>
<td>Age≥50 &amp; Emp. at t−1</td>
<td>0.76</td>
<td>0.75</td>
<td>0.44</td>
</tr>
<tr>
<td>Full-time work</td>
<td>High Educ. &amp; High Exp. &amp; Emp. at t−1</td>
<td>0.77</td>
<td>0.74</td>
<td>0.47</td>
</tr>
<tr>
<td>Full-time work</td>
<td>Low Educ. &amp; High Exp. &amp; Emp. at t−1</td>
<td>0.83</td>
<td>0.78</td>
<td>0.55</td>
</tr>
<tr>
<td>Full-time work</td>
<td>High Educ. &amp; Low Exp. &amp; Emp. at t−1</td>
<td>0.74</td>
<td>0.75</td>
<td>0.50</td>
</tr>
<tr>
<td>Full-time work</td>
<td>Emp. at t−2 &amp; Emp. at t−1</td>
<td>0.74</td>
<td>0.72</td>
<td>0.44</td>
</tr>
<tr>
<td>Full-time work</td>
<td>Age&lt;50 &amp; Youngest child aged&lt;3</td>
<td>0.16</td>
<td>0.09</td>
<td>0.10</td>
</tr>
<tr>
<td>Part-time work</td>
<td>Age&lt;50 &amp; Youngest child aged&lt;3</td>
<td>0.34</td>
<td>0.37</td>
<td>0.32</td>
</tr>
<tr>
<td>Full-time work</td>
<td>Age&lt;50 &amp; 3≤Youngest child aged&lt;6</td>
<td>0.29</td>
<td>0.15</td>
<td>0.15</td>
</tr>
<tr>
<td>Part-time work</td>
<td>Age&lt;50 &amp; 3≤Youngest child aged&lt;6</td>
<td>0.42</td>
<td>0.52</td>
<td>0.41</td>
</tr>
</tbody>
</table>

Notes: Emp. refers to full-time and part-time employment combined. High Exp. is above average experience. High Educ. is 12 or more years of education. The Indirect Inference estimation procedure seeks to match the log odds ratios of the labor supply outcomes.

Table 12: Internal goodness of fit I: Labor supply of single and married women.
## Table 13: Internal goodness of fit II: Labor supply of single and married men.

<table>
<thead>
<tr>
<th>Mean of:</th>
<th>Single men</th>
<th>Married men</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Observed</td>
<td>Simulated</td>
</tr>
<tr>
<td>Full-time work</td>
<td>Age&lt;50</td>
<td>0.76 0.78</td>
</tr>
<tr>
<td>Full-time work</td>
<td>Age≥50</td>
<td>0.61 0.58</td>
</tr>
<tr>
<td>Full-time work</td>
<td>High Educ. &amp; High Exp.</td>
<td>0.78 0.71</td>
</tr>
<tr>
<td>Full-time work</td>
<td>Low Educ. &amp; High Exp.</td>
<td>0.66 0.67</td>
</tr>
<tr>
<td>Full-time work</td>
<td>High Educ. &amp; Low Exp.</td>
<td>0.81 0.86</td>
</tr>
<tr>
<td>Voluntary quit</td>
<td>Age&lt;50 &amp; Emp. at t−1</td>
<td>0.02 0.02</td>
</tr>
<tr>
<td>Voluntary quit</td>
<td>Age≥50 &amp; Emp. at t−1</td>
<td>0.03 0.03</td>
</tr>
<tr>
<td>Voluntary quit</td>
<td>Low Educ. &amp; High Exp. &amp; Emp. at t−1</td>
<td>0.02 0.02</td>
</tr>
<tr>
<td>Voluntary quit</td>
<td>Low Educ. &amp; Low Exp. &amp; Emp. at t−1</td>
<td>0.02 0.02</td>
</tr>
<tr>
<td>Voluntary quit</td>
<td>Emp. at t−2 &amp; Emp. at t−1</td>
<td>0.02 0.02</td>
</tr>
</tbody>
</table>

Notes: See notes to Table 12.

## Table 14: Internal goodness of fit III: Joint labor supply in couple households, and wealth by household type.

<table>
<thead>
<tr>
<th>Mean of:</th>
<th>Observed</th>
<th>Simulated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wife non-employed &amp; Husband non-employed</td>
<td>0.04</td>
<td>0.04</td>
</tr>
<tr>
<td>Wife part-time work &amp; Husband non-employed</td>
<td>0.02</td>
<td>0.02</td>
</tr>
<tr>
<td>Wife full-time work &amp; Husband non-employed</td>
<td>0.04</td>
<td>0.03</td>
</tr>
<tr>
<td>Wife non-employed &amp; Husband full-time work</td>
<td>0.33</td>
<td>0.31</td>
</tr>
<tr>
<td>Wife part-time work &amp; Husband full-time work</td>
<td>0.29</td>
<td>0.28</td>
</tr>
<tr>
<td>Wealth</td>
<td>Single man age&lt;50</td>
<td>0.26</td>
</tr>
<tr>
<td>Wealth</td>
<td>Single man age≥50</td>
<td>0.75</td>
</tr>
<tr>
<td>Wealth</td>
<td>Single men with High Educ.</td>
<td>0.48</td>
</tr>
<tr>
<td>Wealth</td>
<td>Single woman age&lt;50</td>
<td>0.35</td>
</tr>
<tr>
<td>Wealth</td>
<td>Single women age≥50</td>
<td>0.86</td>
</tr>
<tr>
<td>Wealth</td>
<td>Single women with High Educ.</td>
<td>0.51</td>
</tr>
<tr>
<td>Wealth</td>
<td>Couple household with husband age&lt;50</td>
<td>1.11</td>
</tr>
<tr>
<td>Wealth</td>
<td>Couple household with husband age≥50</td>
<td>1.97</td>
</tr>
<tr>
<td>Wealth</td>
<td>Couple household with husband High Educ.</td>
<td>1.68</td>
</tr>
</tbody>
</table>

Notes: Joint labor supply outcomes are summarized for couple households in which at least one spouse is aged under 50. Wealth is measured in 1000s of Euros. Also see notes to Table 12.
<table>
<thead>
<tr>
<th>Quantity</th>
<th>Observed</th>
<th>Simulated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean wage</td>
<td>Woman</td>
<td>2.42</td>
</tr>
<tr>
<td>Mean wage</td>
<td>Woman &amp; High educ.</td>
<td>2.51</td>
</tr>
<tr>
<td>Mean wage</td>
<td>Woman &amp; High exp.</td>
<td>2.51</td>
</tr>
<tr>
<td>Mean wage</td>
<td>Woman &amp; Spouse High educ.</td>
<td>2.46</td>
</tr>
<tr>
<td>Mean wage</td>
<td>Woman &amp; Youngest child aged&lt;3</td>
<td>2.39</td>
</tr>
<tr>
<td>Mean wage</td>
<td>Woman &amp; 3≤Youngest child aged&lt;6</td>
<td>2.36</td>
</tr>
<tr>
<td>Mean wage</td>
<td>Man</td>
<td>2.75</td>
</tr>
<tr>
<td>Mean wage</td>
<td>Man &amp; High educ.</td>
<td>2.85</td>
</tr>
<tr>
<td>Mean wage</td>
<td>Man &amp; High exp.</td>
<td>2.77</td>
</tr>
<tr>
<td>Mean wage</td>
<td>Man &amp; Spouse high educ.</td>
<td>2.85</td>
</tr>
<tr>
<td>Mean wage</td>
<td>Man &amp; Youngest child aged&lt;3</td>
<td>2.75</td>
</tr>
<tr>
<td>Mean wage</td>
<td>Man &amp; 3 ≤Youngest child aged&lt;6</td>
<td>2.79</td>
</tr>
<tr>
<td>Variance wage</td>
<td>Woman</td>
<td>0.15</td>
</tr>
<tr>
<td>Variance wage</td>
<td>Man</td>
<td>0.15</td>
</tr>
<tr>
<td>Covariance of husband’s and wife’s wages</td>
<td>0.04</td>
<td>0.04</td>
</tr>
</tbody>
</table>

| Mean absolute wage change between $t - 2$ and $t$| Woman | 0.05 | 0.05 |
| Mean absolute wage change between $t - 2$ and $t$| Woman and previous wage<2.5 | 0.41 | 0.42 |
| Mean absolute wage change between $t - 2$ and $t$| Woman and previous wage≥2.5 | 0.49 | 0.45 |

| Mean absolute wage change between $t - 2$ and $t$| Man | 0.04 | 0.04 |
| Mean absolute wage change between $t - 2$ and $t$| Man and previous wage<2.5 | 0.33 | 0.39 |
| Mean absolute wage change between $t - 2$ and $t$| Man and previous wage≥2.5 | 0.51 | 0.50 |

| Intertemporal wage correlation| Woman | 0.11 | 0.12 |
| Intertemporal wage correlation| Man | 0.12 | 0.13 |

Notes: Wages are in logs. All quantities are computed from observations on employed individuals. Simulated wage observations include measurement error. In the estimation sample, the wage exclusions (child variables and spouse’s education) are jointly significant (p. value<0.01 for women and for men). Also see notes to Table 12.

Table 15: Internal goodness of fit IV: Wages.
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