Optimal Social Assistance and Unemployment Insurance in a Life-Cycle Model of Family Labor Supply and Savings*

Peter Haan† and Victoria Prowse‡

February 19, 2020

Abstract

We empirically analyze the optimal mix and optimal generosity of unemployment insurance and social assistance programs. To do so, we specify a structural life-cycle model of the labor supply, savings, and social assistance claiming decisions of singles and married couples. Partial insurance against wage and employment shocks is provided by social programs, savings, and the labor supplies of all adult household members. We show that the optimal policy mix is dominated by moderately generous social assistance, which guarantees a permanent universal minimum household income, with only a minor role for temporary earnings-related unemployment insurance. The optimal amount of social assistance is heavily influenced by income pooling in married households. This pooling provides partial insurance against negative economic shocks, reducing the optimal generosity of social assistance.

Key Words: Life-cycle labor supply; Family labor supply; Intra-household insurance; Unemployment insurance; Social assistance; Design of benefit programs; Household savings; Employment risk; Added worker effect.

JEL Classification Codes: J18; J68; H21; I38.

---

*This research was supported in part through computational resources provided by Information Technology at Purdue, West Lafayette, Indiana.

†FU Berlin and DIW Berlin, phaan@diw.de

‡Department of Economics, Purdue University, vprowse@purdue.edu

1 Introduction

In many countries, the 'social safety net' combines unemployment insurance with social assistance programs. Broadly speaking, unemployment insurance provides temporary earnings-related benefits to newly unemployed individuals, while social assistance programs guarantee households a permanent universal minimum income. Interestingly, the overall generosity of the social safety net and the relative importance of unemployment insurance and social assistance programs vary considerably across countries. In the United States, unemployment insurance provides earnings-related income replacement, but assistance benefits are markedly less generous, and consequently social support falls considerably when unemployment insurance benefits are exhausted. In the United Kingdom, however, essentially all social support is provided through social assistance: income replacement is universal, stable, and moderately generous. Many continental European countries, including France and Germany, combine the two systems: unemployment insurance provides temporary earnings-related benefits and social assistance programs guarantee all households a minimum income.[1]

These large differences across countries in the design of the social safety net suggest that there is little consensus regarding how to best combine unemployment insurance and social assistance. This motivates the first contribution of this paper, which is to provide empirical evidence concerning the optimal mix and optimal generosity of unemployment insurance and social assistance.[2] In doing so, we extend previous studies that analyze the optimal design of unemployment insurance or social assistance programs in isolation, e.g., Hopenhayn and Nicolini (1997), Saez (2002), Chetty (2006), and Shimer and Werning (2008). It is important to consider the optimal design of unemployment insurance and social assistance jointly, most obviously because social assistance provides an income floor that affects the moral hazard and insurance effects of unemployment insurance.

When studying the optimal design of unemployment insurance and social assistance, it is also important to account for interactions between the insurance provided by the social safety net and the intra-household insurance available from labor supply and savings: neglecting intra-household insurance will overstate the insurance value of the social safety net thereby biasing

[1]The OECD tax-benefit model calculates the net replacement rate (ratio of benefits to previous after tax earnings) for those in the initial phase of unemployment and those in long-term unemployment (see OECD, 2015). In 2014, single individuals without children who previously earned the average wage and who qualified for social assistance had an initial replacement rate of 59% in Germany, 45% in the US, and 38% in the UK. In contrast, the long-term replacement rates for the same groups were 38% in the UK, 35% in Germany, and only 6% in the US. Differences between countries and by the duration of unemployment are similar for other household types (e.g., married households and households with children).

[2]The unemployment insurance and social assistance programs that we study interact with each other and together form a policy instrument that combines insurance and assistance. The distinction that we draw in the presentation between unemployment insurance and social assistance is motivated by the institutional rules that govern how the social safety net is organized in practice.

upwards estimates of the optimal generosities of unemployment insurance and social assistance. Previous studies have typically considered the design of social insurance or social assistance programs in the presence of intra-household insurance from savings and a single source of labor supply or earnings. However, empirical findings from the literature suggest that married couples obtain insurance by adjusting one spouse's labor supply in response to employment and wage shocks affecting the other spouse, a pattern known as the added worker effect (see, e.g., Lundberg, l985, and Cullen and Gruber, 2000, for evidence from the US).[3] This paper makes a second contribution by exploring the optimal design of unemployment insurance and social assistance programs when households have additional intra-household insurance from spousal labor supply. Specifically, we recognize that married households make labor supply choices for both spouses–a so-called family labor supply decision (Blundell et al., 2016b)–and we derive the optimal mix and optimal generosity of unemployment insurance and social assistance in the presence of intra-household insurance from family labor supply.

We explore the optimal design of the social safety net in the presence of intra-household insurance from family labor supply by embedding a social insurance and assistance system in a dynamic structural model of life-cycle labor supply and savings decisions. The life-cycle model includes: i) a labor supply choice for both members of a married household, which recognizes intra-household insurance from spousal earnings as substitute for insurance from social insurance and assistance programs; ii) a social assistance claiming decision, which allows households to forgo their entitlement to social assistance; iii) a realistic schedule of progressive income taxation; iv) liquidity constraints that limit the ability of households to self-insure by dis-saving; v) heterogeneity in education, which generates a redistributive motive for social programs; and vi) search decisions and endogenous quits, both of which may be subject to moral hazard effects from social assistance and unemployment insurance. The model further includes wage risk and employment risk, which generate demand for insurance.

The parameters of the life-cycle model are estimated using indirect inference. Specifically, the estimation matches predictions from the life-cycle model to behavior in samples from the German Socio-Economic Panel (SOEP) and the German Survey of Income and Expenditure (EVS) and to existing evidence on the moral hazard effects of unemployment insurance from German social security records (as reported in Schmieder et al., 2012). The estimated life-

[3] Triebe (2015) replicates this finding using a similar sample to ours from the German Socio-Economic Panel (SOEP) and Halla et al. (2018) present similar findings for Austria using administrative data on plant closures. Fadlon and Nielsen (2015) explore the effects of fatal and non-fatal health shocks on spousal labor supply. Added worker effects may be driven by nonseparabilities between the spouses' leisure times (Goux et al., 2014) or by a preference for income replacement. Both leisure-driven and income-driven added worker effects imply that the family labor supply decision of married households is relevant to the optimal design of social insurance and assistance programs. Fadlon and Nielsen (2019) formalize this intuition and propose using the labor supply response of a spouse who is indirectly affect by a shock to evaluate the welfare gains from increasing the generosity of government benefits.

cycle model has good in-sample fit. Moreover, the estimated life-cycle model replicates existing reduced-form results on the employment effects of unemployment insurance, the consumption smoothing effect of unemployment insurance, and the added worker effect. For example, the estimated life-cycle model implies that a 10 percentage point increase in the unemployment insurance replacement rate increases the average time until re-employment by 0.57–0.94 weeks while a three month (i.e., quarter of a year) increase in the initial entitlement period for unemployment insurance increases the average time until re-employment by around 0.1 quarters. These predictions are in line with the findings of, e.g., Lalive et al. (2006). Consistent with the consumption smoothing effects of unemployment insurance found by Gruber (1997), Kroft and Notowidigdo (2016), and Ganong and Noel (2019), the estimated life-cycle model predicts that a 10 percentage point increase in the unemployment insurance replacement rate decreases the consumption fall associated with job loss by 2.3 percentage points. Similarly, aligning with the findings of Halla et al. (2018), the estimated life-cycle model predicts that the employment rate of married women increases by around one percentage point in the five years following their husband's job loss. We take the consistency of the estimated life-cycle model with previous findings as evidence that the model is well-suited for analyzing questions concerning the design of social assistance and unemployment insurance.

We use the estimated life-cycle model to study the optimal design of the social safety net. For this exercise, we define a baseline policy environment that closely resembles the year 2000 system in Germany: unemployment insurance replaces 60% of lost post-tax earnings for 12-30 months, depending on age; social assistance provides an income floor to wealth-poor households, starting at around 600 euros per month for a single household without children and increasing with household size; and income taxation is progressive and based on household income. Maintaining the baseline tax system, we find that a 5% cut in social assistance leads to a larger welfare loss than a revenue-equivalent cut in the unemployment insurance replacement rate (-0.53% versus -0.27% of baseline consumption). We trace the different welfare effects of the unemployment insurance and social assistance to differences in the insurance effects of the two programs: the cut in social assistance generates a larger increase in consumption uncertainty than the revenue-equivalent cut in unemployment insurance.

Building from this result, we consider the optimal mix of unemployment insurance and social assistance. In this analysis, we maintain the baseline tax system and restrict attention to policy reforms that are self-financing in the sense that they are revenue-equivalent to the baseline policy environment. We find that the optimal mix of unemployment insurance and social assistance is characterized by unemployment insurance with a replacement rate of 9% and a social assistance income floor equal to 133% of the baseline level. The optimal mix, therefore, focuses on permanent universal social assistance, with little role for temporary earnings-related unemployment insurance. In this assistance-orientated system, individuals who recently left employment receive a similar level of social support to those in long-term unemployment. Overall, the optimal policy mix resembles the UK system, in which essentially all social support is provided through social assistance.

We then introduce the average tax rate as an additional policy instrument and derive the optimal mix and optimal generosity of unemployment insurance and social assistance. We continue to focus on policy reforms that are revenue-equivalent to the baseline policy environment, however, the average tax rate can now be adjusted to finance changes in the generosity of the social safety net. With the average tax rate added to the set of policy instruments, we find that the optimal generosity of social assistance is 105% of the baseline level while unemployment insurance is no longer part of the optimal mix. Moving to the optimal mix and optimal generosity of unemployment insurance and social assistance increases welfare by 2.2% of baseline consumption compared to the baseline policy environment and by 0.9% of baseline consumption compared to when the optimal mix is derived holding the average tax rate fixed at the baseline rate.

Our findings about the optimal mix and optimal generosity of unemployment insurance and social assistance arise from a three-way trade-off between moral hazard, insurance, and redistribution. We quantify this trade-off by using a welfare decomposition that follows Koehne and Kuhn (2015) and Michelacci and Ruffo (2015) and find that our results are not driven by redistributive concerns. The absence of unemployment insurance from the optimal social safety net instead reflects that cuts in unemployment insurance generate modest welfare losses from reduced insurance that are more than offset by the welfare gains from lower moral hazard. Interactions between unemployment insurance and social assistance are important to this result: by guaranteeing a moderately generous minimum income to wealth-poor households, social assistance attenuates the consumption losses from cuts in unemployment insurance thereby providing substitute insurance to individuals with limited means to smooth their own consumption. We further explore the interaction between unemployment insurance and social assistance by showing that in the absence of meaningful social assistance the optimal replacement rate for unemployment insurance is 20%; this figure is comparable to the findings of Gruber (1997), who derives the optimal unemployment insurance replacement rate in the absence of social assistance.

We show that our results on the optimal mix and optimal generosity of unemployment insurance and social assistance are robust to varying several ancillary policy parameters, including the income exemption for social assistance, the duration of unemployment insurance, and the progressivity of taxation. We also demonstrate that our results are robust to modifying unemployment insurance by adding rules that typically appear in assistance benefits, including a wealth test and a spousal earnings test.

Finally, we explore how the presence of married households in the population affects the optimal mix and optimal generosity of unemployment insurance and social assistance. We find that the optimal generosity of social assistance for a society of single households is 166% of the baseline level. The presence of married households in the population therefore reduces the optimal generosity of social assistance from 166% to 105% of the baseline level. Unemployment insurance is not part of the optimal social safety net, irrespective of the marital composition of the population. The effect of married households on the design of the optimal policy is economically important: ignoring differences between single and married households when design the optimal policy leads welfare losses of almost 1% of baseline consumption. We show that income pooling in married households is the most important mechanism behind the effect of married households on the design of the optimal policy, explaining almost half of the effect. This finding highlights the importance of intra-household insurance for optimal policy design.

This paper builds on previous work that has linked optimal program design with empirical estimates of the effects of social insurance and assistance programs on consumption smoothing, search, and savings decisions. Gruber (1997) explores how the optimal unemployment insurance replacement rate depends on the effect of unemployment insurance on consumption smoothing and search. More recent studies have used similar approaches to derive the optimal design of other aspects of unemployment insurance (see, e.g., Schmieder et al., 2012, Kroft and Notowidigdo, 2016, Kolsrud et al., 2018, and Ganong and Noel, 2019). Chetty (2008) emphasizes the role of liquidity constraints in driving the optimal provision of unemployment insurance and Lentz (2009) shows that the optimal unemployment insurance replacement rate decreases with household wealth. This important role for intra-household insurance from savings suggests that intra-household insurance from family labor supply may also be policy relevant. In this vein, Fadlon and Nielsen (2019) propose a framework for using spousal labor supply to understand the welfare gains from more generous social insurance. Our results also add to research that emphasizes program interdependencies (see Keane and Moffitt, 1998, and Chan, 2013), and to a growing literature that makes comparisons between insurance-based and assistance-based social programs (see Low et al., 2010, Saporta-Eksten, 2014, and Low and Pistaferri, 2015).[4]

Our life-cycle model shares some features with other studies based on structural life-cycle models. Our approach of jointly modeling labor supply, savings, and wage determination, along with exogenous marriage and divorce, broadly follows van der Klaauw and Wolpin (2008) and

[4]Several papers provide theoretical insights into the optimal design of unemployment insurance: Flemming (1978) analyzes optimal unemployment insurance with perfect and imperfect capital markets; Shavell and Weiss (1979), Hopenhayn and Nicolini (1997), Shimer and Werning (2008), and Pavoni (2009) derive the optimal time path of unemployment insurance benefits; Pavoni et al. (2013) consider the optimal time path of insurance and assistance benefits when mandatory work and assisted search are policy instruments; Acemoglu and Shimer (1999) show that the optimal generosity of unemployment insurance depends on workers' willingness to accept employment risk; and Shimer and Werning (2007) propose an approach that is complementary to Baily (1978) and Chetty (2006) and relies on the reservation wage. Michelacci and Ruffo (2015) derive the optimal age-profile of unemployment insurance benefits. Paserman (2008) and Spinnewijn (2015) study the optimal design of unemployment insurance with, respectively, hyperbolic discounting and biased beliefs.

Adda et al. (2017). Our model follows the literature in how it captures interactions between the contemporaneous incentives presented by social insurance and assistance programs and the intertemporal incentives to accumulate human capital (see, e.g., Keane and Wolpin, 1997, Imai and Keane, 2004, Keane, 2016, Blundell et al., 2016a, and Adda et al., 2017). We also follow the literature in how we model incentives to accumulate entitlement to social insurance programs (see, e.g., French, 2005, Attanasio et al., 2008, De Nardi et al., 2010, Low et al., 2010, Heathcote et al., 2014, and Low and Pistaferri, 2015).[5]

This paper proceeds as follows. Section 2 introduces our life-cycle model. Section 3 describes the empirical specification. Section 4 describes the SOEP and EVS datasets and details our sample selection criteria. Section 5 outlines the estimation method. Section 6 presents our parameter estimates and explores the fit of the model. Section 7 reports our results on the optimal mix and optimal generosity of unemployment insurance and social assistance and discusses several robustness checks. Section 8 concludes.

2 Life-cycle Model

We propose a discrete-time dynamic model of the job search, labor supply, savings, and social assistance claiming decisions of single and married households over the life cycle. The decision problem starts when an individual enters the labor force after completing education. This occurs at age 18 years for individuals without a university degree (low education) or age 23 years for individuals with a university degree (high education). All individuals are single, childless, and have zero wealth when they enter the labor force. Once in the labor force, individuals may marry and divorce and women may have children (we do not distinguish between cohabitation and marriage). The decision problem ends when all members of the household have reached the compulsory retirement age of 65 years.

Decisions are made quarterly and each period proceeds as follows: i) a single individual may marry and a married individual may divorce, and a woman may give birth to a child; ii) an individual who was employed in the previous period may be subject to a job destruction, which precludes them from working in the current period; iii) wage and preference shocks are realized; iv) the household chooses a search intensity for each household member who was non-employed or in education in the previous period; v) an individual who was non-employed or in education in the previous period receives a job offer with a probability that is proportional to their search intensity (someone who was employed in the previous period and not subject

[5]Blau and Gilleskie (2006) and van der Klaauw and Wolpin (2008) analyze, respectively, health insurance and pension reforms with two-earner households. While these papers model couples, they focus on older populations, they do not include employment risk, and they do not compare insurance and assistance programs or explore the importance of the family unit for policy design.

to a job destruction receives a job offer without searching); vi) the household makes labor supply, savings, and social assistance claiming decisions; vii) the household may be taxed and/or may receive income from social insurance and assistance programs; viii) each household member enjoys utility that depends on household consumption, the labor supply outcomes of the household members, the household's social assistance claiming decision, and their own search intensity and preference shocks.

2.1 Choice Set

A household chooses a non-negative search intensity for each adult household member who was non-employed in the previous period. Consumption, equivalently savings, is a continuous choice variable but is constrained by a borrowing constraint and an intertemporal budget constraint. A household's social assistance claiming decision is binary: the household either claims all available social assistance or it does not claim social assistance. The labor supply states at the individual level are: non-employment (NE); full-time employment (FT, 40 hours of work per week); retirement (RT); and, for women only, part-time employment (PT, 20 hours of work per week). Labor supply choices are constrained by job destructions and job offers as described in Section 3.2. Retirement is permanent and is feasible from age 60 years for women and age 63 years for men and is compulsory at age 65 years for women and men. Once all household members have reached age 65 years there are no further opportunities for search or labor supply decisions. From this point onward, a household's consumption is equal to its income from pensions and social assistance plus the annuity value of the household's wealth.[6]

Marital status is determined by an exogenous process that allows education-based assortative mating. Reflecting the average male-female age difference for newly formed couples in our SOEP sample, in married households the husband is assumed to be 2.5 years older than the wife. We only model marriage and divorce prior to men reaching age 65 years (which corresponds to age 62.5 years for women). We do not attempt to model the response of marriage or divorce to changes in the design of social insurance and assistance programs. This aspect of our approach is consistent with existing empirical evidence showing that welfare programs and

[6]Our assumptions about individuals' employment and retirement options are based on legal rules and empirical regularities in Germany during the sample period. Our assumption about forced retirement at age 65 years reflects that the compulsory retirement age was 65 years and at this age all employment contracts ended by default. While not prohibited, working beyond age 65 years was rare in practice (the employment rate for individuals aged 65–70 years in the SOEP data from 1991–2004 is less than 0.3%). Our assumption that women have the option of retirement at a younger age than men reflects that women could enter retirement at age 60 years through the "pensions for women" retirement pathway while men did not have this option. At age 63 years all individuals could enter retirement using the pathway for long-term insured workers. Regarding the choice set for men, we note that if we extended the model to include part-time work for men then, given that only 5% of men work part-time, we would estimate a strong distaste for part-time work for men. Moreover, since the policy reforms that we consider do not particularly affect the relative attractiveness of part-time and full-time work, we would not expect the rate of part-time work by men to change depending on the policy environment.

in-work benefits have little or no effect on marital status (see, e.g., Eissa and Hoynes, 1998, Ellwood, 2000, and Bitler et al., 2004). For similar reasons, fertility is also assumed to be exogenous.[7]

2.2 Preferences

The per-period utility functions for women and men are given by:

$$U^F(m_{i,j,t}, d_{i,t}, d_{j,t}, s_{i,t}, \text{SAClaim}_{i,j,t}) \text{ and } U^M(m_{i,j,t}, d_{i,t}, d_{j,t}, s_{j,t}, \text{SAClaim}_{i,j,t}). \tag{1}$$

In the above, t denotes time, $i > 0$ denotes the identity of the woman in the household and $j > 0$ denotes the identity of the man in the household. To encompass both single-adult and married households, we use $j = 0$ to denote the absence of an adult male in female-headed single household. Likewise, we use $i = 0$ to denote the absence of an adult female in a male-headed single household. $m_{i,j,t}$ denotes the household's consumption. $d_{i,t}$ denotes woman i's labor supply state and $d_{j,t}$ denotes man j's labor supply state. If a women is present in the household, i.e, if the household is a female-headed single household or a married household, then $d_{i,t} \in \{FT, PT, NE, RT\}$ and otherwise $d_{i,t} = \emptyset$. If a man is present in the household then $d_{j,t} \in \{FT, NE, RT\}$ and otherwise $d_{j,t} = \emptyset$. $s_{i,t}$ denotes woman i's search intensity and $s_{j,t}$ denotes man j's search intensity. $\text{SAClaim}_{i,j,t} \in \{0, 1\}$ denotes the households social assistance claiming decision. While omitted from our notation, preferences are also affected by observed and unobserved individual characteristics as described in Section 3.[8]

At every point in time, a single woman chooses her search intensity, labor supply, savings, and social assistance claiming behavior to maximize the expected discounted value of her lifetime utility, which is given by:

$$\mathbb{E}\left[\sum_{\tau=t}^{T^F} \delta^{\tau-t} U^F(m_{i,j,\tau}, d_{i,\tau}, d_{j,\tau}, s_{i,\tau}, \text{SAClaim}_{i,j,\tau}) \middle| \Phi_{i,t}\right]. \tag{2}$$

In the above, δ is the discount factor, T^F denotes the last period of the woman's life, and $\Phi_{i,\tau}$ denotes the woman's information set at time τ. Likewise, at every point in time, a single man chooses his search intensity, labor supply, savings, and social assistance claiming behavior to

[7] We specify a flexible process for the arrival probability for a woman's first child (see Section 5). We then assume that a second child arrives three years after the first child and no further children are born. Children reside in their mother's household until they reach 18 years of age.

[8] Once all household members have reached age 65 years, a married individual also enjoys 'bequest utility' of $\iota_b b^F \bar{W}_{i,j}$ if female or $\iota_b b^M \bar{W}_{i,j}$ if male, where $\bar{W}_{i,j}$ denotes the value of the household's wealth in 100,000s of euros when youngest household member turns 65. Similarly, once reaching age 65 years, a single individual enjoys bequest utility of $b^F \bar{W}_{i,j}$ if female or $b^M \bar{W}_{i,j}$ if male.

maximize:

$$\mathbb{E}\left[\sum_{\tau=t}^{T^M}\delta^{\tau-t}U^M(m_{i,j,\tau},d_{i,\tau},d_{j,\tau},s_{j,\tau},\text{SAClaim}_{i,j,\tau})\middle|\Phi_{j,t}\right], \tag{3}$$

where T^M denotes the last period of the man's life and $\Phi_{j,\tau}$ denotes the man's information set at time τ. A married household chooses each spouse's search intensity and labor supply and the household's savings and social assistance claiming behavior to maximize the expected discounted value of a constant-weighted average of the spouses' discounted lifetime utilities:

$$\begin{aligned}\mathbb{E}\Bigg[&\alpha\sum_{\tau=t}^{T^F}\delta^{\tau-t}U^F(m_{i,j,\tau},d_{i,\tau},d_{j,\tau},s_{i,\tau},\text{SAClaim}_{i,j,\tau})+\\ &(1-\alpha)\sum_{\tau=t}^{T^M}\delta^{\tau-t}U^M(m_{i,j,\tau},d_{i,\tau},d_{j,\tau},s_{j,\tau},\text{SAClaim}_{i,j,\tau})\Bigg|\Phi_{i,t},\Phi_{j,t}\Bigg].\end{aligned} \tag{4}$$

We estimate the weight, $\alpha \in [0,1]$, attached to the woman's utility in the married household's objective function.

2.3 Borrowing and Intertemporal Budget Constraints

Consumption choices are subject to a borrowing constraint that requires that household wealth, $A_{i,j,t}$, is non-negative at all times. This constraint prevents a household from borrowing against its future income. Consumption choices are also subject to an intertemporal budget constraint. In the absence of a marriage or divorce in period t, the household's intertemporal budget constraint is given by:

$$A_{i,j,t} = A_{i,j,t-1} + y_{i,j,t} - m_{i,j,t} - \text{CC}_{i,j,t} + \text{PL}_{i,j,t}, \tag{5}$$

where $y_{i,j,t}$ denotes net household income, $\text{CC}_{i,j,t}$ denotes childcare costs, and $\text{PL}_{i,j,t}$ denotes parental leave benefits. Marriage augments household wealth by the wealth of the incoming spouse. In the event of divorce, the household's wealth is divided equally between the spouses.[9]

Based on the German tax and benefit system, the net household income for a married

[9]This assumption follows the legal default that applies to divorce proceedings, which stipulates equal division of wealth accumulated within the marriage.

household is given by:

$$y_{i,j,t} = W_{i,t}h_{i,t} + W_{j,t}h_{j,t} + rA_{i,j,t-1} + \text{Pension}_{i,t} + \text{Pension}_{j,t} + \text{CB}_{i,j,t} + \text{UI}_{i,t} + \text{UI}_{j,t} + \text{SA}_{i,j,t} - \text{Tax}_{i,j,t}. \tag{6}$$

In the above: W denotes the hourly wage; h denotes hours of work (and therefore $W \times h$ denotes earnings); r is the interest rate, assumed to be 3% annually ($rA_{i,j,t-1}$ thus denotes interest income); Pension denotes pension benefits; CB denotes child benefits; UI denotes unemployment insurance; SA denotes social assistance; and Tax denotes income tax (including social security contributions). The net income for a single household is obtained by taking (6) and suppressing the earnings, pension, and unemployment insurance of the person with the opposite gender to that of the single household head.[10]

The key programs for this paper are unemployment insurance, social assistance, and income tax. Sections 2.3.1–2.3.3 describe how we model these programs based on the year 2000 legislative rules in Germany.[11] Our models of childcare costs, parental leave benefits, child benefits, and pensions are also respectful of the Germany setting and are described in Appendix A. Web Appendix A documents the changes to unemployment insurance, social assistance, and income tax that occurred during the sample period 1991–2004 and shows that the year 2000 rules provide a good approximation to the year-specific rules.[12]

2.3.1 Unemployment Insurance

Unemployment insurance provides partial income replacement to eligible and entitled non-employed individuals. We use the following formula for individual $g \in \{i, j\}$'s unemployment insurance:

$$\text{UI}_{g,t} = \text{RR} \times \text{NW}_{g,t} \times \text{Elig}_{g,t} \times \mathbf{1}(\text{Ent}_{g,t} > 0), \tag{7}$$

where RR is the replacement rate, $\text{NW}_{g,t}$ is the individual's net earnings in previous employment (i.e., previous earnings after income tax), $\text{Elig}_{g,t}$ is an indicator of eligibility for unemployment insurance, and $\mathbf{1}(\text{Ent}_{g,t} > 0)$ is an indicator of the individual having remaining entitlement

[10] We do not model disability benefits (which are part of the pension system). In the model, non-employed individuals with work-limiting health conditions receive unemployment insurance and/or social assistance.

[11] The year 2000 rules for unemployment insurance and social assistance are described in Bundesministerium für Arbeit und Sozialordnung (2000). The rules for taxation and social security contributions are described in Bundesministerium für Finanzen (2001). We use the rules for west Germany.

[12] Labor market reforms starting in 2005, specifically the fourth stage of the so-called "Hartz reforms", considerably changed the design of unemployment insurance and social assistance. We therefore restrict the sample to the years 1991–2004. For further discussion of the Hartz reforms see, e.g., Launov and Waelde (2013) and Dustmann et al. (2014).

to unemployment insurance. The replacement rate is equal to 0.6 if no children reside in the individual's household or 0.67 if one or more children reside in the individual's household. Unemployment insurance is capped, however, this is largely irrelevant because the cap is high relative to earnings.[13]

An individual's unemployment insurance entitlement period, $\text{Ent}_{g,t}$, is initialized at the time of entry to non-employment, and is based on age: an individual who is under age 45 years at the start of his or her non-employment spell has an initial entitlement period of 12 months, while individuals entering non-employment at ages 45–46, 47–51, 52–56 and greater than or equal to 57 years have initial entitlement periods of 18, 21, 24, and 30 months, respectively.[14] The entitlement period evolves through the non-employment spell as follows:

$$\text{Ent}_{g,t} = \max\{\text{Ent}_{g,t-1} - 3, 0\}. \tag{8}$$

An individual's unemployment insurance eligibility, $\text{Elig}_{g,t}$, is determined at the time of entry to non-employment and is fixed over the non-employment spell. Specifically, an individual entering non-employment is eligible ($\text{Elig}_{g,t} = 1$) for unemployment insurance if he or she was employed in both of the previous two periods or entered employment in the previous period with remaining unemployment insurance entitlement, and otherwise the individual is ineligible ($\text{Elig}_{g,t} = 0$).[15,16]

Unemployment insurance is paid without regard to the spouse's earnings and benefits are not linked to the household's interest income; therefore, unemployment insurance may be received by non-employed individuals residing in households with substantial earned or unearned income. Furthermore, since there is no wealth test, non-employed individuals receive unemployment insurance benefits irrespective of their ability to smooth the marginal utility of consumption by dis-saving.

An eligible non-employed individual who exhausts their entitlement to unemployment insurance is transitioned on to unemployment assistance. Unemployment assistance replaces 53%

[13]Only previous earnings below 51,765 euros per year are considered when calculating unemployment insurance. In the SOEP sample, only 2.9% of newly non-employed individuals have previous earnings above this threshold.

[14]We round down the initial entitlement period to the nearest integer multiple of three months.

[15]According to the German legislation, individuals who quit their jobs and voluntarily transitioned into non-employment must wait three months before starting to receive unemployment insurance benefits. We neglect this rule because eligible individuals are seldom prevented from claiming unemployment insurance immediately upon entering non-employment. Specifically, our calculations based on administrative data collected by the German Federal Employment Agency for the year 2000 show that fewer than 5% of eligible new entrants to unemployment were sanctioned for quitting previous employment (Bundesagentur für Arbeit, 2013).

[16]We assume that women who enter non-employment with a child under the age of 24 months and women who give birth while receiving unemployment insurance forgo their eligibility to unemployment insurance during that spell of non-employment. Non-employed women who have a child aged under the age of 24 months may instead receive parental leave benefits (see Appendix A).

of the individual's previous net earnings if no children reside in the individual's household. A higher replacement rate of 57% applies if one or more children reside in the individual's household. In contrast to unemployment insurance, unemployment assistance is means-tested against the spouse's income and is subject to a wealth test.[17] The individual continues to receive unemployment assistance until the means test reduces their benefit to zero or their household fails the wealth test.

2.3.2 Social Assistance

Social assistance is a universal household benefit that tops up the net income of wealth-poor households to a level that we call the 'social assistance income floor' ($\text{SAFloor}_{i,j,t}$). The social assistance that is available to a wealth-poor household is thus given by:

$$\widetilde{\text{SA}}_{i,j,t} \quad = \quad \max\{\text{SAFloor}_{i,j,t} - \widetilde{y}_{i,j,t}, 0\}, \tag{9}$$

where $\widetilde{y}_{i,j,t}$ is net household income before social assistance is included.[18]

The social assistance income floor can be written as:

$$\text{SAFloor}_{i,j,t} \quad = \quad G \times E_{i,j,t}. \tag{10}$$

The equivalence scale, $E_{i,j,t}$, is equal to one for a single household without children and increases with the number of adults and children in the household. The generosity parameter, G, is equal to 605 euros per month.[19] Based on the generosity parameter and the equivalence scale, the social assistance income floor is equal to, e.g., 605 euros per month for a single household without children, 906 euros per month for a married household without children, 1,540 euros

[17]Specifically, unemployment assistance is withdrawn one-for-one against the sum of: i) the spouse's net taxable earnings (see the notes to Figure 1) above an allowance; ii) the spouse's unemployment insurance above the same allowance; and iii) and the spouse's pension income. The allowance is equal to the imputed value of the spouse's unemployment assistance. The wealth test restricts unemployment assistance to single individuals with wealth below 4,090 euros and married individuals whose household wealth is below 8,181 euros.

[18]Our empirical analysis includes one further detail that, for simplicity, is omitted from this discussion: only taxable earnings and taxable interest income are considered when calculating social assistance (for definitions, see the notes to Figure 1).

[19]We obtain a value of 605 euros per month for the generosity parameter by summing together 280 euros per month for non-housing assistance and 325 euros per month for housing (both figures are averages over the states in west Germany). We derive the equivalence scale $E_{i,j,t}$ by taking a weighted average of the equivalence scale that is used to calculate non-housing social assistance and the implicit equivalence scale used to guide the calculation of housing benefits (which we recover from the examples given in Bundesministerium für Arbeit und Sozialordnung, 2000), with a weight of 0.463 attached to the non-housing equivalence scale (corresponding to the share of total assistance for a single household without children that is due to non-housing assistance). For single households:

$$\begin{aligned} E_{i,j,t} = 1 \quad &+ \quad 0.25\ \text{C0–6}_{i,j,t} + 0.30\ \text{C7–13}_{i,j,t} + 0.42\text{C14–17}_{i,j,t} \\ &+ \quad 0.39\ \text{OneC}_{i,j,t} + 0.56\ \text{TwoC}_{i,j,t}, \end{aligned} \tag{11}$$

per month for a married household with two children aged between 7 and 13 years, and 1,198 euros per month for a single woman with a fifteen-year-old child. The legislation stipulates that social assistance is only available to households with little or no wealth. We operationalize this by assuming that only single households with wealth below 4,090 euros and married households with wealth below 8,181 euros are eligible for social assistance.[20]

Previous studies have documented substantial non-take-up of social assistance in Germany (see, e.g., Riphahn, 2001). This mirrors welfare benefit claiming behavior internationally. To ensure that the model captures the pattern of social assistance receipt, we allow households to decide whether or not to claim the social assistance for which they are eligible. The social assistance that a household actually receives is thus given by:

$$\mathrm{SA}_{i,j,t} = \widetilde{\mathrm{SA}}_{i,j,t} \times \mathrm{ClaimSA}_{i,j,t}, \tag{13}$$

where $\mathrm{ClaimSA}_{i,j,t}$ is an indicator for the household choosing to claim social assistance. Section 3.1 describes the costs of claiming social assistance.

2.3.3 Income Tax

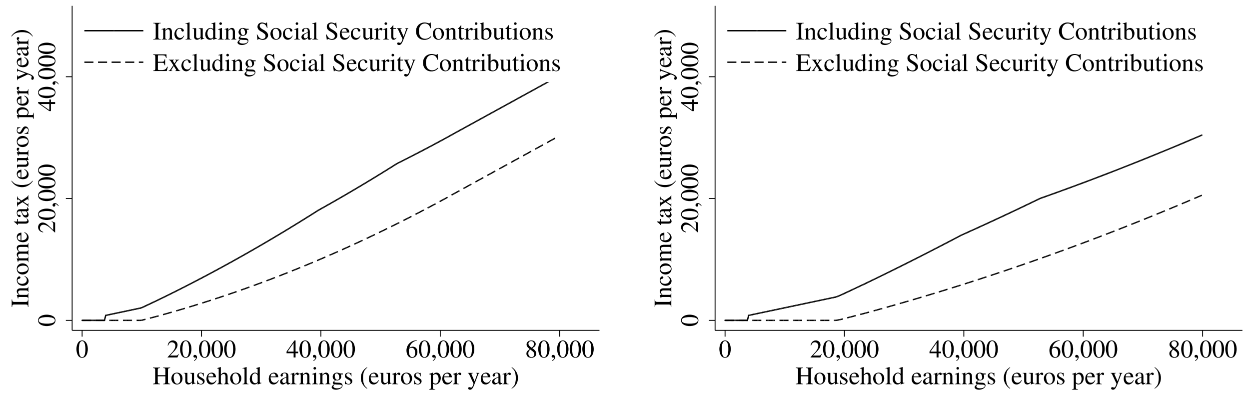
Figure 1 illustrates the progressive income tax schedules for a single individual without children and a married household with one earner. A single individual with full-time earnings of 30,608 euros per year (the mean in our sample) faces an average tax rate (including social security contributions) of 41.9%. Note, income tax (excluding social security contributions) is based on household income, i.e., taxation is joint: a single household with taxable income of x and a married household with taxable income of $2x$ face the same average tax rate on taxable income.

and for married households:

$$\begin{aligned} E_{i,j,t} = 1.59 \quad &+ \quad 0.23\ \mathrm{C0{-}6}_{i,j,t} + 0.30\ \mathrm{C7{-}13}_{i,j,t} + 0.42\mathrm{C14{-}17}_{i,j,t} \\ &+ \quad 0.16\ \mathrm{OneC}_{i,j,t} + 0.30\ \mathrm{TwoC}_{i,j,t}, \end{aligned} \tag{12}$$

where $\mathrm{C}x{-}y_{i,j,t}$ denotes the number of children aged between x and y years inclusive in the household, $\mathrm{OneC}_{i,j,t}$ is an indicator for there being exactly one child aged 17 years or younger in the household and $\mathrm{TwoC}_{i,j,t}$ is an indicator for there being exactly two children aged 17 years or younger in the household.

[20] A household cannot claim social assistance before claiming all entitlements to unemployment insurance and unemployment assistance. However, if the net income of a household that is receiving unemployment insurance or unemployment assistance is below the household-specific social assistance income floor, e.g., because there are children in the household, then the household may also receive social assistance to raise the household's net income up to the level of the social assistance income floor.



(a) Single individual without children

(b) Married household with one earner

Note: We use the west German rules for the year 2000. Income tax, excluding social security contributions, is based on taxable household income, which is equal to the taxable earnings of all household members plus the household's taxable interest income minus the household's tax-deductible social security contributions. Individual earnings in excess of 1,022 euros per year are taxable. Interest income in excess of 1,585 euros per year for a single household or 3,170 euros per year for a married household is taxable. Social security contributions up to 2,001 euros per year for a single household or 4,002 euros per year for a married household may be deducted (even if only one spouse is working). Single parents receive an additional tax free earnings allowance of 2,871 euros per year. The solidarity surcharge (Solidaritätszuschlag) is included in income tax and is equal to 5.5% of the household's tax liability, excluding social security contributions. Earnings are subject to social security contributions at rates of 7.75%, 9.65%, and 3.25% for health, retirement, and unemployment benefits. Individuals with earnings below 3,865 euros per year are exempt from social security contributions. Individual earnings above 52,765 euros per year are exempt from social security contributions for retirement and unemployment benefits and individual earnings above 75% of this amount (i.e., 39,574 euros per year) are exempt from social security contributions for health benefits. The illustrated tax schedules are for households with zero interest income.

Figure 1: Income tax schedule

3 Empirical Specification

In this section, we describe the empirical specifications of preferences, job offer and destruction probabilities, and wages (the specifications of the marriage, divorce, and fertility processes are provided in Section 5).

3.1 Preferences

We adopt the following specification a woman's preferences:

$$\begin{aligned} U^F(m_{i,j,t}, d_{i,t}, d_{j,t}, s_{i,t}, \text{SAClaim}_{i,j,t}) &= u^F(m_{i,j,t}, d_{i,t}, d_{j,t}) \\ &\quad -\varphi^F_{i,SA}\text{SAClaim}_{i,j,t} - \frac{s^2_{i,t}}{2} + \varepsilon_{i,t}(d_{i,t}), \end{aligned} \tag{14}$$

The sub-utility function, u^F, captures the systematic component of the woman's preference for consumption and the leisure times of the household members. Following Moffitt (1983), the woman faces a fixed cost, $\varphi^F_{i,SA}$, of claiming social assistance. Social assistance claiming costs are allowed to vary by marital status with $\varphi^F_{i,SA} = \varphi^F_{SA}$ if the woman is single and $\varphi^F_{i,SA} = \iota_{sa} \times \varphi^F_{SA}$ if the woman is married. Search costs are quadratic. $\varepsilon_{i,t}(d_{i,t})$ denotes unobserved preference shocks that are specific to the woman's labor supply state. The unobserved 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 ς_F.

Our specification of the sub-utility function is motivated by two established empirical regularities: i) there are important nonseparabilities between consumption and leisure (see, e.g., Browning and Meghir, 1991, and Attanasio and Weber, 1995); and ii) there are substantial intra-household cross-spouse correlations in employment and retirement decisions.[21] The former of these regularities largely accounts for the popularity of the single-agent preference specification used by, e.g., French and Jones (2011), which allows nonseparability between consumption and the individual's own leisure time; we extend the same preference specification to allow nonseparability between the spouses' leisure times.

In particular, we specify that:

$$u^F(m_{i,j,t}, d_{i,t}, d_{j,t}) = \frac{\left(\eta^F(d_{i,t}, d_{j,t}) m_{i,j,t}/E_{i,j,t}\right)^{1-\rho^F}}{1-\rho^F}, \tag{15}$$

where ρ^F is the coefficient of relative risk aversion for women and $E_{i,j,t}$ is the household equivalence scale that is implicit in the German social assistance system (see footnote 19). Consumption therefore is a household public good subject to congestion as household size increases. The woman's taste for consumption, $\eta^F(d_{i,t}, d_{j,t})$, depends on the household labor supply outcome and on demographic variables as follows:

$$\begin{aligned} \log \eta^F(d_{i,t}, d_{j,t}) \quad = \quad & \eta^F_{FT,S} X_{i,t} \times FT_{i,t} \times \text{Single}_{i,t} + \eta^F_{PT,S} X_{i,t} \times PT_{i,t} \times \text{Single}_{i,t} + \\ & \eta^F_{FT,C} X_{i,t} \times FT_{i,t} \times \text{Married}_{i,t} + \eta^F_{PT,C} X_{i,t} \times PT_{i,t} \times \text{Married}_{i,t} + \\ & \eta_C \mathbf{1}(d_{i,t} = NE \cup d_{i,t} = RT) \times \ell(d_{j,t}). \end{aligned} \tag{16}$$

In the above, $FT_{i,t}$ is an indicator for the woman working full-time, $PT_{i,t}$ is an indicator for the woman working part-time, $\text{Single}_{i,t}$ is an indicator for the woman being single, $\text{Married}_{i,t}$ is an indicator for the woman being married, and $X_{i,t}$ is a vector of demographics that may shift

[21] Gregg et al. (2010) find polarization of employment across households in several countries including Germany and the US. Relatedly, spouses are frequently observed to retire together (see Blau, 1998, and Coile, 2004). Important motivation for our specification comes from the results of Gustman and Steinmeier (2004), Casanova (2010), and Blundell et al. (2016b) who show that complementarity between spouses' leisure times plays a critical role in explaining couples' employment behavior.

consumption and leisure preferences. Specifically,

$$X_{i,t} = [1 - \text{AgeG50}_{i,t}, \text{AgeG50}_{i,t}, \text{Child 0-3}_{i,t}, \text{Child 3-6}_{i,t}],$$

where $\text{AgeG50}_{i,t}$ is an indicator for the woman being aged 50 years or older, Child $\text{0-3}_{i,t}$ is an indicator for the youngest child in the household being aged under 3 years, Child $\text{3-6}_{i,t}$ is an indicator for the youngest child in the household being aged between 3 and 6 years. $\eta^F_{FT,S}$ and $\eta^F_{PT,S}$ measure a single woman's taste for consumption when working full-time and part-time, respectively, relative to her taste for consumption when not working. $\eta^F_{FT,M}$ and $\eta^F_{PT,M}$ are the corresponding preference parameters for a married woman. Finally, the parameter η_C captures how a woman's preference for non-work depends on her spouse's leisure time, $\ell(d_{j,t})$.[22] We interpret η_C as the strength of between-spouse leisure complementarities. The utility function for men takes the same form as for women, except that child-related variables are omitted from men's preferences.

3.2 Job Offer and Job Destruction Probabilities

Recall, job offers arise endogenously, depending on an individual's search intensity. Specifically, a woman who was employed in the previous period and who is not subject to a job destruction receives a job offer without searching while a woman who was non-employed or in education in the previous period and who searches with intensity $s_{i,t} \in \left[0, \frac{1}{\chi_{i,t}}\right]$ receives a job offer with probability:

$$P^F_{i,t} = \chi_{i,t} s_{i,t}, \tag{17}$$

where $\chi_{i,t}$ denotes the woman's search productivity. Search productivity takes the following form:

$$\log(\chi_{i,t}) = \chi^F_1 + \chi^F_2 \text{AgeG50}_{i,t} + \chi^F_3 \text{HiEduc}_i + \chi^F_4 \text{Married}_{i,t}, \tag{18}$$

where HiEduc_i is an indicator for the woman having a university degree. The corresponding job-offer probability a man is obtained by replacing F with M and i with j in (17) and (18). Job destructions, meanwhile, are exogenous and occur with a probability that depends fully flexibly on the individual's gender, age category, education, and marital status. Job destructions are assumed to be independent across spouses, conditional on age and education.

[22] The spouse's leisure time is normalized to 1.0 for a non-working spouse, 0.5 for a part-time working spouse, and zero a for full-time working spouse. Spousal leisure time is zero for a single individual.

3.3 Wages

An individual's market wages depend on his or her experience, education, and unobserved productivity. Sample wage observations are mismeasured variants of market wages. Since wages are only observed for individuals in employment, the distribution of accepted wages will be different from the distribution of market wages. As explained in Section 5, we obtain estimates of the parameters of the market wage process by jointly modeling wages and labor supply and making use of exclusion variables, which affect labor supply but not market wages, to parse out the selection process.

In more detail, the sampled log real market wage of woman i at time t is given by:

$$\begin{aligned}\log \widetilde{W}_{i,t} &= \log W_{i,t} + \nu_{i,t}, && (19)\\ &= \beta_1^F + \beta_2^F \mathrm{Exp}_{i,t} + \beta_3^F \mathrm{HiEduc}_i + \beta_4^F \kappa_{i,t} + \nu_{i,t}, && (20)\end{aligned}$$

where $\mathrm{Exp}_{i,t}$ denotes the woman's experience (in years), $\kappa_{i,t}$ denotes the woman's unobserved productivity, and $\nu_{i,t}$ is measurement error. Experience is zero at the time of entry into the labor force from education, and increases by 0.25 for each period of full-time work and 0.125 for each period of part-time work. Unobserved productivity, $\kappa_{i,t}$, may be transitory, persistent or permanent. In particular, we assume that individuals are subject to productivity shocks leading $\kappa_{i,t} \in \{0, 1\}$ to evolve according to:

$$\kappa_{i,t} = \mathbf{1}(\theta_0^F (1 - \kappa_{i,t-1}) - \theta_1^F \kappa_{i,t-1} + \epsilon_{i,t} \geq 0), \tag{21}$$

where $\epsilon_{i,t}$ is assumed to be serially independent at the individual level with $\epsilon_{i,t} \sim N(0, 1)$. To aid interpretation, we note that a woman with low unobserved productivity experiences a good productivity shock with probability $\Phi(\theta_0^F)$ while a woman with high unobserved productivity experiences a bad productivity shock with probability $\Phi(\theta_1^F)$, where $\Phi()$ denotes the standard normal distribution function.[23] Measurement error, $\nu_{i,t}$, affects the sampled wage but not the market wage. Measurement errors are assumed to occur independently over time and over spouses with $\nu_{i,t} \sim N(0, \sigma_{\nu F}^2)$.

The wage process for men is obtained by replacing F with M and i with j in (19), (20), and (21). Note, 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

[23] An individual's initial unobserved productivity is drawn from the steady state distribution of unobserved productivity. In the steady state, a proportion Θ^F of women have high unobserved productivity ($\kappa = 1$), where

$$\Theta^F = \frac{\Phi(\theta_0^F)}{\Phi(\theta_0^F) + \Phi(\theta_1^F)}. \tag{22}$$

behaviors. A difference in the probability of a positive wage shock by gender, for example, may result from gender differences in risk taking, competitiveness or occupational choice, among other mechanisms. In addition, in the spirit of Attanasio et al. (2008) and Blundell et al. (2016b), we allow contemporaneous productivity shocks to be correlated between spouses in the same household. Specifically, we assume $\text{corr}(\epsilon_{i,t}, \epsilon_{j,t}) = \varrho$. Non-contemporaneous shocks to unobserved productivity are assumed to be independent across spouses.[24]

4 Data and Sample

Estimation is based on the German Socio-Economic Panel (SOEP) and the German Survey of Income and Expenditure (Einkommens- und Verbrauchsstichprobe, EVS).[25] Both data sources are designed to be representative of the German population. The SOEP provides panel data on a variety of household and individual characteristics including employment, marriage and cohabitation, age, experience, education, wages, children, and benefit receipt. The SOEP also includes information about wealth, however, the SOEP lacks detailed information on savings. We therefore follow Adda et al. (2017) and supplement the SOEP with information on savings from the EVS. The EVS is a repeated cross-sectional survey that includes information on household savings, wealth, employment, and demographic characteristics.[26] In the remainder of this section, we describe the SOEP and EVS samples. In Web Appendix C we establish comparability of the SOEP and EVS samples by showing that demographic characteristics, wealth, and employment behavior are similar in the two samples.

Based on the SOEP datasets, we construct a quarterly panel sample of west German households that covers the years 1991–2004.[27] Following the model, the SOEP sample comprises female-headed single households, male-headed single households, and married households. For married households, we randomly designate one spouse as the household head. The SOEP sample is restricted to household-quarter observations where the household head is aged 18–65 years. Additionally, we exclude household-quarter observations where the household head or head's spouse is: in education; a university graduate aged under 23 years; self-employed; or employed by the Civil Service. Finally, to avoid extreme outliers, we exclude the households with wealth in the top or bottom 1% of the surveyed values of wealth. The SOEP sample

[24]The household is assumed to have no information, beyond that given above, about the values of future market wage shocks. Blundell et al. (2016b) find little evidence of anticipation of wage shocks; for further discussion see Blundell and Preston (1998), Pistaferri (2001, 2003) and Guvenen (2007).

[25]Estimation also uses information on the employment effects of unemployment insurance from German social security records. Section 5 explains how we take the required information from the literature.

[26]See Wagner et al. (2007) for a description of the SOEP and Statistisches Bundesamt (2008) for further details about the EVS.

[27]As discussed in footnote 12, the sample ends before the fourth stage of the Hartz reforms.

	All	Single women	Single men	Married women	Married men
Share		0.16	0.12	0.36	0.36
Age (years)	44.30	43.07	40.49	43.84	46.57
High education	0.12	0.13	0.19	0.07	0.15
Experience	16.69	14.01	15.52	12.19	22.80
Child 0–3	0.08	0.03	-	0.10	0.10
Child 3–6	0.07	0.04	-	0.09	0.09
Part-time employed	0.13	0.14	-	0.30	-
Full-time employed	0.54	0.51	0.79	0.25	0.75
Retired	0.08	0.12	0.04	0.06	0.09
Non-employed	0.25	0.23	0.17	0.39	0.16
Non-employed households	0.11	0.23	0.17	0.08	0.08
Wage (Euros per hour)	14.72	13.19	15.66	11.60	17.13
Rate of Social Assistance receipt (Non-employed households)	0.12	0.22	0.05	0.08	0.08
Unique household observations	10,217	2,753	2,209	6,882	6,882
Individual-quarter observations	359,013	42,004	28,461	144,274	144,274
Observations of wage	43,052	4,736	3,842	14,031	20,443
Observations of wealth	7,866	947	639	3,140	3,140

Notes: Share is the (weighted) fraction of single women, single men, married women, or married men in the sample. High education is defined as a university degree. Child 0–3 is an indicator for the youngest child in the household being aged under 3 years. Child 3–6 is an indicator for the youngest child in the household being aged between 3 and 6 years. Labor force status (full-time employed, part-time employed, non-employed, retired) is defined by individual's situation in the first month of the quarter. A non-employed household is a household where all individuals are non-employed. The hourly wage is defined as gross earnings, including overtime pay, in the month prior to the survey divided by contractual working hours, including hours of paid overtime, during the same period. Wages are therefore observed only for individuals who were employed in the month prior to the survey. Wage is expressed in year 2000 prices using the Consumer Price Index. All statistics are weighted using the household weights supplied by the SOEP.

Table 1: Descriptive statistics for the SOEP sample

contains 10,217 unique households and 359,013 individual-quarter-year observations. Table 1 provides descriptive statistics on the variables that we use in the indirect inference estimation of the structural model.

From the EVS data, we construct a repeated cross-sectional sample of quarterly household saving rates for the years 1998 and 2003.[28] We form the EVS sample using the same selection criteria as we used to construct the SOEP sample, excluding households with extreme levels of wealth. In addition, we exclude households with quarterly savings or net income in the bottom or top 1% of the surveyed values of the respective variable. Table 2 summarizes the saving rates of single women, single men, and married households in the EVS sample.

[28]Although the 1993 EVS also falls within the time period covered by the SOEP sample, we do not use this dataset because the 1993 survey asked about savings during a one year period instead of the quarterly time frame used in the 1998 and 2003 surveys.

	Single women	Single men	Married households
All households	0.09	0.16	0.14
Age<50 years	0.10	0.16	0.15
Age≥50 years	0.08	0.13	0.11
High education	0.11	0.17	0.15
Low education	0.09	0.15	0.13
Number of households	8,748	4,033	26,512

Note: All statistics are for non-retired households. Statistics by age and education for married households are based on the characteristics of the husband. The saving rate is defined as quarterly household savings divided by net household income during a 'reference quarter'. Quarterly household savings is the difference between a household's spending on financial and tangible assets (including housing) and its revenue from the same assets classes during the reference quarter. Quarterly household savings includes loan repayments and revenue from new loans during the reference quarter. Net household income is reported in the EVS and accounts for all components of household income, including transfers, social security contributions, and income taxation.

Table 2: Saving rates in the EVS sample

5 Estimation Method

Estimation proceeds in two stages. In the first stage, we use the SOEP sample to estimate the strength of education-based assortative mating, rates of marriage, divorce, and births over the life cycle, and job destruction probabilities.[29]

In the second stage of the estimation, we use indirect inference to estimate the parameters in preferences, search productivity, and wages. Intuitively, we specify an auxiliary model that summarizes important aspects of observed (i.e., actual) behavior and behavior in a sample that we simulate using the decision rules and other equations of motion given by the life-cycle model. Parameter values then are chosen to maximize the similarity between the observed and simulated behaviors, as viewed from the perspective of the auxiliary model. Formally, let ω denote the collection of parameters to be estimated in the second stage. The indirect inference

[29] We estimate the strength education-based assortative mating by calculating the empirical probability that an individual's spouse has a university degree, conditional on the individual's own education. We use Lowess regressions to estimate marriage rates by age, gender and education, divorce rates by age and the spouses' education, and birth rates by age, education and marital status. We use the transitions out of employment where we observe the reason for the transition to calculate the share of transitions that are involuntary and then multiply this by the empirical probability of transition out of employment to derive job destruction probabilities. We define involuntary separations as separations due to layoff, plant closure, or the termination of a temporary contract.

estimator of ω is given by:

$$\widehat{\omega} = \underset{\omega}{\operatorname{argmin}} \left(\widehat{\psi} - \widehat{\psi}(\omega)\right)' \Sigma \left(\widehat{\psi} - \widehat{\psi}(\omega)\right), \tag{23}$$

where $\widehat{\psi}$ denotes the auxiliary model parameter estimates based on observed behavior, including estimates that we obtain from our SOEP and EVS samples and estimates from German social security records reported in the literature, $\widehat{\psi}(\omega)$ denotes the auxiliary model parameter estimates obtained using a sample simulated from the life-cycle model with parameter values ω, and Σ is a diagonal weighting matrix.[30] We obtain standard errors using the formula provided by Gourieroux et al. (1993). See Smith, Jr (1993), Gourieroux et al. (1993), and Gallant and Tauchen (1996) for a more general discussion of Indirect Inference.

We estimate the 55 parameters that appear in preferences, search productivity, and wages by matching 75 auxiliary model parameters. Each auxiliary model parameter summarizes a feature of labor supply, savings, social assistance receipt, or wages. Table 3 describes the auxiliary model parameters and lists the model parameters that are primarily identified by each group of auxiliary model parameters.

We discuss two important aspects of the auxiliary model. First, since wages are observed only for individuals in employment, it is important that the auxiliary model includes information that separates selection effects from wage determinants. Specifically, the auxiliary model should summarize how observed wages vary with at least one exclusion variable that affects employment but does not enter the wage process. In our setting, children, marital status, spousal education, and spousal experience satisfy the criteria for exclusion variables. We use all of these exclusion variables, along with education and experience, to predict the probability of employment for each observation, separating the estimation by gender. We then include in the auxiliary model the correlation between the predicted probability of employment and the residualized wage.[31]

Second, given the focus of this paper on the design of unemployment insurance, it is important that the auxiliary model is formulated to ensure a strong empirical foundation for the employment effect of unemployment insurance predicted by the estimated life-cycle model. In the life-cycle model, the employment effect of unemployment insurance depends on the effect

[30] When simulating samples from the life-cycle model, we plug in our estimates of the marriage, divorce, and birth rates, strength of assortative mating, and job destruction probabilities. The weighting matrix has diagonal elements that are inversely proportional to the variances of the auxiliary model parameters. Variances for the auxiliary model parameter that we obtain from our SOEP and EVS samples are estimated using bootstrapping with household-level clustering. Variances for the auxiliary model parameters that we take from the literature are calculated from the standard errors that accompany the published estimates. We upweight by a factor of ten three groups of auxiliary model parameters that are particularly important, namely, the employment effects of unemployment insurance, the social assistance receipt rates, and the sample analogues of the wage shock probabilities; this improves the numerical performance of the estimation routine.

[31] The wage exclusions are strongly statistically significant: the p-value for the correlation between predicted employment and the residualized wage in the SOEP sample is equal to 0.001 for women and 0.000 for men.

Description (Source)	Auxiliary model parameters	For	#	Primarily identifying
Voluntary quit rate (SOEP)	Coefficients from logit regressions of voluntary quits on demographics.	SF CF SM CM	16	$\eta^F_{FT,S}$ $\eta^F_{FT,C}$ $\eta^M_{FT,S}$ $\eta^M_{FT,C}$
Transition rate into employment (SOEP)	Coefficients from logit regressions of transitions into employment on demographics.	SF CF SM CM	16	χ^F χ^M
Part-time employment rate for the previously employed (SOEP)	Coefficient from logit regressions of part-time employment on demographics.	SF CF	10	$\eta^F_{PT,S}$ $\eta^F_{PT,C}$
Employment effect of unemployment insurance (German social security records)	Effect of a 6 month extension of unemployment insurance benefits on the time until reemployment (as reported by Schmieder et al., 2012).	F M	2	ς_F ς_M
Joint leisure time (SOEP)	Between-spouse leisure correlation. Log odds ratio of the proportion of childless married households with wife non-employed and husband employed.	C	2	α η_C
Saving rates (EVS)	Quarterly saving rate for households where the head (if single) or husband (if married) is: i) aged under 50; ii) age 50 or older; and iii) highly educated.	SF SM C	9	ρ^F ρ^M b^F b^M ι_b
Social assistance receipt rates (SOEP)	Log odds ratio of the social assistance receipt rate.	SF SM C	3	φ^F_{SA} φ^M_{SA} ι_{sa}
Wage regressions (SOEP)	Coefficients from OLS regressions of log wage on an intercept, high education, and experience.	F M	6	β^F_1 β^F_2 β^F_3 β^M_1 β^M_2 β^M_3
Summary of wage residuals (SOEP)	Correlation between predicted employment and the wage residual. Approximate sample analogues of wage shock probability, difference between probabilities of good and bad wage shocks, wage shock size, and variance of wage measurement error.	F M	10	θ^F_0 θ^M_0 θ^F_1 θ^M_1 β^F_4 β^M_4 $\sigma_{\nu F}$ $\sigma_{\nu M}$
	Between-spouse correlation of wage residuals.	C	1	ϱ

Note: Demographic variables are indicators for age<50 years, age≥50 years, high education, and (for women) indicators for the age category of the youngest child. High education is a university degree. S, C, F, and M denote, respectively, single, married, female, and male.

Table 3: Description of the auxiliary model

of unemployment insurance on utility and the productivity of job search. The effect of unemployment insurance on utility, in turn, depends on risk aversion, the employment-state-specific taste for consumption, and the scale of the preference shocks (note, the scale of the preference shocks controls the importance of consumption in utility compared to the preference shocks). We identify risk aversion from the saving rate. We identify the employment-state-specific taste from the labor supply choices of individuals who were employed in the previous period and are not subject to a job destruction. These individuals face an unconstrained labor supply problem and therefore their behavior maps directly to preferences.

We use two further empirical quantities to jointly identify the productivity of job search and the scale of the preference shocks. First, the auxiliary model includes the rate of transition from non-employment into employment, split by the variables that affect search productivity (age, education, gender, and marital status). Second, the auxiliary model includes estimates of the employment effects of unemployment insurance from German social security records. We take these estimates from Schmieder et al. (2012), who find that a 6-month extension in the initial entitlement period for unemployment insurance benefits increase the average duration until reemployment by 0.94 months for women and 0.64 months for men. The estimates of the employment effect of unemployment insurance directly inform on the importance of unemployment insurance in utility and, therefore, distinguish the determinants of search productivity from preference parameters.

6 Estimation Results

In this section, we present our estimates of the parameters of the life-cycle model, demonstrate the model's good in-sample fit, and show that implications of the model are consistent with previous studies.

6.1 Parameter Estimates

Figure 7 in Appendix B illustrates the estimated rates of marriages, divorces, and births over the life cycle. In line with the previous literature, we find that women tend to marry younger than men and the risk of divorce falls with age. The estimated birth probabilities are higher for married women than for single women and, conditional on marital status, decrease with education. Table 13 in Appendix B presents our estimates of the assortative mating process. We find strong education-based assortative mating. Table 4 presents our estimates of the job destruction probabilities. The probability of a job destruction falls with education, increases with age, and tends to be higher for women than for men. Marital status has no systematic effect on the probability of a job destruction.

	Single individuals		Married individuals	
	Women	Men	Women	Men
High education and age≥50 years	0.004	0.005	0.016	0.011
High education and age<50 years	0.007	0.003	0.010	0.002
Low education and age≥50 years	0.017	0.015	0.015	0.013
Low education and age<50 years	0.010	0.009	0.010	0.005

Table 4: Quarterly job destruction probabilities

	Women	Men
Intercept (β_1^F, β_1^M)	2.290 (0.044)	2.568 (0.030)
Experience/40 (β_2^F, β_2^M)	0.086 (0.056)	0.170 (0.035)
High education (β_3^F, β_3^M)	0.505 (0.037)	0.382 (0.038)
$\mathrm{P}(\kappa_t = 1 \mid \kappa_{t-1} = 0)$ ($\Phi(\theta_1^F), \Phi(\theta_1^M)$)	0.007 (0.001)	0.006 (0.001)
$\mathrm{P}(\kappa_t = 0 \mid \kappa_{t-1} = 1)$ ($\Phi(\theta_0^F), \Phi(\theta_0^M)$)	0.006 (0.001)	0.005 (0.001)
Loading on persistent unobservable (β_4^F, β_4^M)	0.668 (0.025)	0.621 (0.015)
Standard deviation of measurement error ($\sigma_{\nu F}, \sigma_{\nu M}$)	0.173 (0.015)	0.137 (0.014)
Between-spouse correlation of persistent wage shocks (ϱ)	0.865 (0.042)	

Note: Standard errors in parentheses. $\Phi()$ denotes the standard normal distribution function.

Table 5: Wage equation

Table 5 presents our estimates of the parameters in the wage equation. We find that the market wage increases with education and experience. The unobserved component of the market wage is persistent, with wage shocks being large, infrequent, and correlated between spouses. Based on our estimates, we calculate that the standard deviation of (annualized) wage shocks is equal to 0.1049 log points for women and 0.0933 log points for men; these figures are in line with the results for Germany reported by Krueger et al. (2010) and Fuchs-Schündeln et al. (2010).

	Women	Men
Intercept (χ_1^F, χ_1^M)	−2.493 (0.056)	−2.711 (0.086)
Age $\geq$ 50 (χ_2^F, χ_2^M)	−0.821 (0.131)	−1.176 (0.110)
High education (χ_3^F, χ_3^M)	0.261 (0.050)	0.213 (0.048)
Married (χ_4^F, χ_4^M)	−0.223 (0.062)	−0.022 (0.039)

Note: Standard errors in parentheses.

Table 7: Search productivity

Table 6 presents our estimates of the preference parameters. Panel I reports the estimates of the taste for consumption when employed. The negative estimates for individuals aged below 50 years and 50 years and older imply disutility from working, irrespective of hours, gender, age, or marital status. The disutility of full-time work varies from 14% of consumption for single men aged 50 years or older to 82% of consumption for married women aged under 50 years. The disutility of part-time work varies from 50% of consumption for married women aged 50

I: Taste for consumption when employed	Single women	Married women	Single men	Married men
Full-time employment ($\eta^F_{FT,S}, \eta^F_{FT,C}, \eta^M_{FT,S}, \eta^M_{FT,C}$):				
Age<50	−0.645 (0.043)	−1.262 (0.059)	−0.146 (0.055)	−0.286 (0.056)
Age≥50	−0.867 (0.116)	−1.718 (0.104)	−0.205 (0.099)	−0.837 (0.108)
Youngest child aged < 3	−0.395 (0.188)	−0.729 (0.076)	–	–
3 ≤ Youngest child aged < 6	−0.949 (0.070)	−0.678 (0.202)	–	–
Part-time employment ($\eta^F_{PT,S}, \eta^F_{PT,C}$):				
Age<50	−1.605 (0.068)	−1.012 (0.046)	–	–
Age≥50	−1.814 (0.121)	−0.693 (0.086)	–	–
Youngest child aged < 3	0.684 (0.328)	0.841 (0.064)	–	–
3 ≤ Youngest child aged <6	0.904 (0.161)	1.131 (0.786)	–	–

II: Further preference parameters for women and men	Women	Men
CRRA (ρ^F, ρ^M)	1.935 (0.040)	1.786 (0.118)
Scale of preference shocks (ς_F, ς_M)	3.365 (0.023)	5.086 (0.044)
Social assistance stigma ($\varphi^F_{SA}, \varphi^M_{SA}$)	−1.294 (0.169	−3.120 (0.588)
Bequest utility (b^F, b^M)	1.797 (0.249)	3.738 (0.566)

III: Further preference parameters for married households	
Between-spouse leisure complementarity (η_C)	0.113 (0.006)
Weight on female spouse (α)	0.492 (0.026)
Social assistance stigma relative to singles (ι_{sa})	0.447 (0.073)
Bequest utility relative to singles (ι_b)	2.750 (0.315)

Note: Standard errors in parentheses.

Table 6: Preference parameters

years or older to 84% of consumption for single women aged 50 years or older. For women, young children increase the disutility of full-time work but decreases the disutility of part-time work. Panel II shows that the CRRA is estimated to be 1.935 for women and 1.786 for men. These figures are in line with previous studies, which typically report estimates of the CRRA in the range of 1–3 (see, e.g., Attanasio and Weber, 1995). Panel II also shows that individuals experience significant disutility if they claim social assistance and receive significant bequest utility. Panel III reports further preference parameters that are specific to married households.

Notably, we find significant between-spouse leisure complementarity, with a non-working spouse estimated to increase the utility of consumption when not working by 11.3%. Women and men receive approximately equal weight in married households. Marriage decreases the cost of claiming social assistance and increases the bequest motive. Table 7 shows that search productivity decreases with age, increases with education, and is lower for married individuals than for singles.

6.2 In-Sample Goodness of Fit

Table 14 in Appendix C shows that the estimated life-cycle model obtains a close fit to the features of labor supply, social assistance receipt, savings, and wages that were targeted in the estimation. In terms of labor supply, the estimated life-cycle model fits the patterns of voluntary quits, transitions into employment, and part-time work by age, gender, education, and children that we observe in the SOEP sample. The estimated life-cycle model replicates closely the joint labor supply behavior of married couples, e.g., the correlation between spouses' leisure times is 0.29 in the SOEP sample while the estimated life-cycle model implies a figure of 0.25. The estimated life-cycle model obtains a good fit to the rates of social assistance receipt in the SOEP sample of 22%, 5%, and 8% for single women, single men, and married households, respectively; the corresponding figures based on the estimated life-cycle model are 22%, 7%, and 8%. As an aside, we note that the estimated life-cycle model suggests that 48% of households choose not to claim social assistance despite being eligible. Since the SOEP does not include information on benefit eligibility, we do not have a sample analogue for this prediction. However, a non-take-up rate of 48% is consistent with previous studies of benefit take-up in Germany including Kayser and Frick (2000) and Riphahn (2001) who report non-take-up rates of 52.3% and 63.1%, respectively. Furthermore, the estimated life-cycle model does a good job at fitting savings behavior and wages; for instance the saving rate for married households where the husband aged 50 year or older is 11% both in the EVS sample and according to the estimated life-cycle model, and the partial effect of high education on the log wage is 0.34 for women and 0.42 for men in the SOEP sample, compared to 0.31 and 0.35 according to the estimated life-cycle model.

We move beyond the quantities matched in the estimation to show that the estimated life-cycle model targets benefit receipt in a way that is consistent with behavior in the SOEP sample. Table 15 in Appendix C compares the characteristics of social assistance and unemployment insurance recipients in the SOEP sample with the characteristics of individuals who are predicted to receive social assistance or unemployment insurance based on the estimated life-cycle model. The estimated life-cycle model fits the observed concentration of social assistance on single women and the observed higher rates of unemployment insurance receipt among married individuals compared to singles. The estimated life-cycle model also fits the higher observed average age of unemployment insurance recipients compared to social assistance recipients.

6.3 Consistency with Previous Studies

In the spirit of, e.g., Todd and Wolpin (2006) and Low and Pistaferri (2015), we assess the validity of the estimated life-cycle model by comparing the model's implications with findings from related reduced-form studies. We perform model validation on three dimensions: the employment effects of unemployment insurance; the consumption smoothing effect of unemployment insurance; and the added worker effect.

6.3.1 The Effect of Unemployment Insurance on Employment

We show that the estimated life-cycle 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. Summarizing briefly, prior work suggests that a one-week increase in the unemployment insurance entitlement period increases the time until re-employment by 0.05–0.15 weeks.[32] Regarding the level of benefits, reduced-form evidence is less plentiful and more mixed. Prior research suggests that a 10 percentage point increase in the replacement rate increases the time until re-employment by 0.5–1.5 weeks, and reports elasticities ranging from 0.15 to above 2 (Card et al., 2015, survey recent findings).[33]

Based on the estimated life-cycle model, we derive marginal effects mirroring those reported in the reduced-form literature. Specifically, using the unemployment insurance system described

[32]Relevant prior evidence includes the estimates of Schmieder et al. (2012) for Germany that we used as targets for the estimation (see Section 5) and Lalive et al. (2006)'s results for Austria. Using a difference-in-differences approach, Lalive et al. (2006) find that a one-week increase in the initial entitlement period increases the average time until re-employment by 0.05 weeks at age 40–49 years and 0.1 weeks at age 50 years and above. Also see the surveys by Atkinson and Micklewright (1991) and Tatsiramos and van Ours (2014).

[33]Using a difference-in-differences approach and data from Austria, Lalive et al. (2006) report that a 6 percentage point increase in the replacement rate increases the average duration of non-employment 0.38 weeks. Using a regression kink design, Landais (2015) finds elasticities for the duration of benefit claims with respect to the replacement rate of between 0.2–0.7 for the US. Card et al. (2015) report elasticities for the time until re-employment with respect to the replacement rate for Austria ranging from 1.4 to above 2. There is little evidence on replacement rate effects for Germany. 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. Early studies estimated the employment effects of the level and duration of unemployment insurance benefits without appeal to exogenous policy changes, discontinuities, or other quasi-natural sources of variation. Using US data, Katz and Meyer (1990) find that a one-week extension of the initial entitlement period increased the time until re-employment by 0.16–0.20 weeks. Concerning the same quantity, Moffitt and Nicholson (1982) report a figure of 0.1 weeks for the US, and 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.

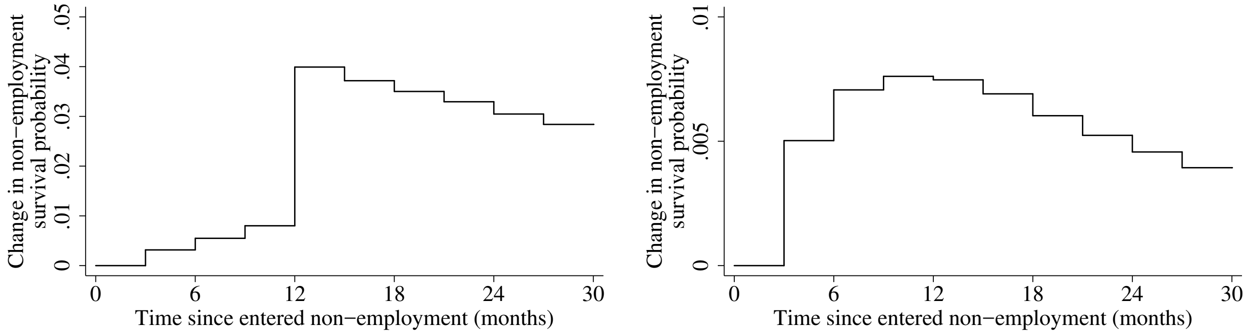
	Age at start of non-employment spell (years)		
	20	30	40
I: Effect of three month (quarter of a year) increase in the initial entitlement period on average quarters until re-employment:			
Women	0.076	0.102	0.100
Men	0.136	0.146	0.136
II: Effect of a 10 percentage point increase in the replacement rate on average weeks until re-employment:			
Women	0.939	0.773	0.792
Men	0.769	0.566	0.676

Note: Results are based on 92,232 simulated non-employment spells. Spells are right-censored at 30 months. Only eligible individuals are included. To ensure comparability with the literature, which generally reports effects for the gross replacement rate, our net replacement rate effects have been scaled by $(1 - \tau_0)^{-1}$, where τ_0 is the average tax rate of 0.418.

Table 8: Effect of unemployment insurance on the time until re-employment

in Section 2.3.1, we simulate inflow samples of unemployment insurance-eligible individuals entering non-employment at ages 20, 30, and 40 years. Subsequent employment outcomes are simulated under a baseline regime and under two counterfactuals. In the baseline regime, the unemployment insurance system is unchanged: the initial entitlement period is 12 months for individuals entering non-employment before age 45, and the replacement rate is 60% for individuals without children (or 67% for those with children). In the first counterfactual, there is an unanticipated increase of 3 months in the initial entitlement period. In the second counterfactual, there is an unanticipated increase in the replacement rate of 10 percentage points, occurring at the start of the non-employment spell. Panel I in Table 8 summarizes the implications of the estimated life-cycle model with respect to the initial entitlement period. The model predicts that a three month (i.e., quarter of a year) increase in the initial entitlement period increases the average time until re-employment by around 0.1 quarters for women and 0.15 quarters for men. Panel II in Table 8 shows that the model predicts that a 10 percentage point increase in the replacement rate increase the average time until re-employment by 0.57–0.94 weeks, with effects being slightly larger for women than for men. In summary, predictions from the estimated life-cycle model about how employment depends on the duration and generosity of unemployment insurance match the findings of previous reduced-form studies.

As a further plausibility check, we show that predictions from the estimated life-cycle model about the effect of unemployment insurance on the timing of exits from non-employment are in line with previously documented patterns. Consistent with the empirical results of Lalive et al. (2006), Figure 2(a) shows the model predicts that the effect of an increase in the initial



(a) Initial entitlement period extended from 12 to 15 months

(b) Replacement rate increased by 10 percentage points

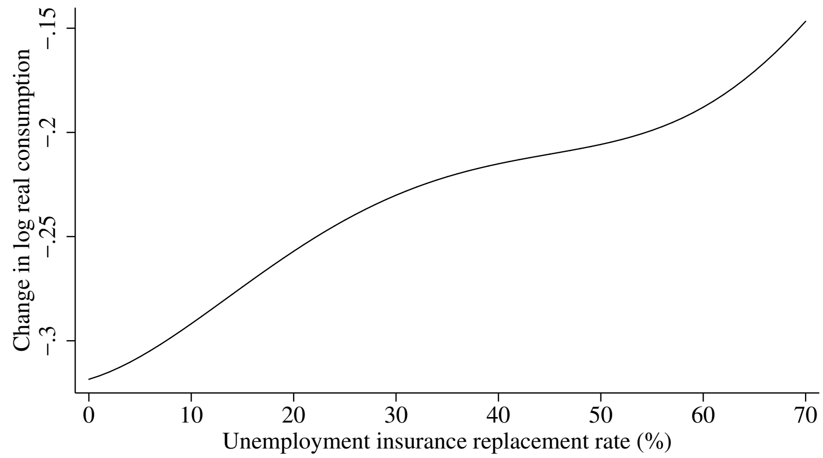
Note: Estimates from a pooled inflow sample of unemployment insurance-eligible individuals entering non-employment at ages 20, 30, and 40 years. Given the quarterly decision-making frequency in the model, exits from non-employment are possible only at three month intervals.

Figure 2: Effect of unemployment insurance on the non-employment survivor function

entitlement period is concentrated around the time of benefit exhaustion, i.e., at 12 months of non-employment. In contrast, and again consistent with Lalive et al. (2006), Figure 2(b) shows the model predicts that the employment effect of an increase in the replacement rate occurs mainly during the period of unemployment insurance covered non-employment, i.e., during the first 12 months of non-employment.

6.3.2 The Effect of Unemployment Insurance on Consumption Smoothing

Next, we compare the consumption smoothing effect of unemployment insurance predicted by the estimated life-cycle model to findings in the literature. Based on a pooled inflow sample of individuals entering non-employment due to exogenous job loss at age 20, 30, and 40 years, we use the estimated life-cycle model to simulate consumption trajectories under unemployment insurance replacement rates between 0% and 70%. Figure 3 summarizes the simulated consumption trajectories by showing the average change in log real consumption between the period before non-employment and the first period of non-employment according to the unemployment insurance replacement rate. Consumption declines by 15% when the unemployment insurance replacement rate is equal to 70% while without unemployment insurance consumption falls by 32%. Averaging over replacement rates between 0% and 70%, the estimated life-cycle model predicts that a 10 percentage point increase in the unemployment insurance replacement rate reduces the consumption fall associated with job loss by 2.3 percentage points. The consumption smoothing effect of unemployment insurance predicted by the estimated life-cycle model aligns with the results of Gruber (1997), Kroft and Notowidigdo (2016), and Ganong and Noel (2019) who report comparable consumption smoothing effects from US data of 2.6, 2.8, and 2.7 percentage points, respectively.



Note: As in Gruber (1997), the dependent variable is the average change in log real consumption between one period before entering non-employment and the first period of non-employment.

Figure 3: The effect of unemployment insurance on the consumption fall when entering non-employment

6.3.3 The Added Worker Effect

The added worker effect refers to a labor supply pattern in married households where the wife increases her labor supply when her husband looses his job. Halla et al. (2018) estimate the added worker effect using administrative data on plant closures in Austria. They find that, for women who were non-employed at the time of their husband's job loss, the employment rate during the five years following the husband's job loss increased by between 1.5 and 1.9 percentage points. We calculate an analogous added worker effect based on the estimated life-cycle model.[34] Figure 4 shows the estimated life-cycle model predicts that the employment rate of wives increases by around one percentage point during five years following their husband's job loss. The similarity between the added worker effect predicted by the estimated life-cycle model and the estimates of Halla et al. (2018) suggests that the life-cycle model provides a satisfactory micro-foundation for the added worker effect.

[34]Our life-cycle model provides a micro-foundation for the added worker effect. The added worker effect predicted by the model depends on leisure complementaries, which we estimate, the taxation of married individuals based on household income (i.e., joint taxation), which we base on the prevailing tax rules, the strength of risk aversion, which we estimate, and our assumption about income pooling in married households. In Section 7.4 we show that income pooling in married households is the most important mechanism behind the effect of married households on the optimal generosity of social assistance.

Note: We consider in turn the age points 20, 30, and 40 years and use the estimated life-cycle model to simulate optimal household behavior, first, when the husband is not subject to a job destruction at the age point of interest and, second, when the husband is subject to an unanticipated job destruction at the age point of interest. The figure shows the average effect of the husband's job destruction on the employment rate of wives who were non-employed at the time of their husband's job destruction. We consider optimal household behavior in each scenario and, therefore, the husband may return to employment. Results are for households that remained married between 3 months before and 5 years after the husband's job destruction.

Figure 4: Wives' employment response to husband's job loss

7 Counterfactual Policy Reforms

We use the estimated life-cycle model to explore the optimal design of the social safety net. Before proceeding to our policy results, we describe how we measure and decompose the welfare effects of policy reforms.

7.1 Welfare Metric and Welfare Decomposition

We summarize the welfare implications of policy changes by using an equivalent variation based welfare metric. Specifically, we designate the year 2000 policy environment described in Section 2.3 as the baseline. We then define the welfare value of an alternative environment as the proportional adjustment in consumption in the baseline environment that makes individuals ex ante indifferent between the two environments.[35]

Formally, let A denote the alternative environment and let B denote the baseline environment. The welfare value of environment A is denoted by γ_A and solves $V_B(\gamma_A) = V_A(0)$,

[35]We omit any social assistance claiming costs from this calculation.

where:

$$V_e(\gamma) = \mathbb{E}\left[\Upsilon \sum_{\tau=\underline{t}_i}^{T^F} \delta^{\tau-\underline{t}_i} U^F(m^e_{i,j,\tau}(1+\gamma), d^e_{i,\tau}, d^e_{j,\tau}, s^e_{i,\tau}) + \right.$$

$$\left. +(1-\Upsilon)\sum_{\tau=\underline{t}_j}^{T^M} \delta^{\tau-\underline{t}_j} U^M(m^e_{i,j,\tau}(1+\gamma), d^e_{i,\tau}, d^e_{j,\tau}, s^e_{j,\tau})\right] \text{ for } e \in \{A, B\}. \qquad (24)$$

In the above, $\underline{t}_i$ and $\underline{t}_j$ denote the time of woman i's and man j's entry into the labor force, e superscripts denote variable realizations in environment e, $\Upsilon = 0.5$ denotes the social planner's weight on women, and the expectation is with respect to education and with respect to all shocks, including wage shocks and job destructions. The consumption adjustment, γ, is implemented at ex post and, therefore, does not affect behavior.

We use a decomposition to understand the mechanisms behind the welfare effects of policy changes. Our approach follows Floden (2001), Benabou (2002), Koehne and Kuhn (2015), and Michelacci and Ruffo (2015). In particular, we decompose γ_A into five components:

$$\gamma_A = \underbrace{\gamma_{A,CL}}_{\substack{\text{consumption}\\ \text{level effect}}} + \underbrace{\gamma_{A,CI}}_{\substack{\text{consumption}\\ \text{inequality effect}}} + \underbrace{\gamma_{A,CU}}_{\substack{\text{consumption}\\ \text{uncertainty effect}}} + \underbrace{\gamma_{A,E}}_{\substack{\text{employment}\\ \text{effect}}} + \underbrace{\gamma_{A,S}}_{\substack{\text{search cost}\\ \text{effect}}} . \qquad (25)$$

The consumption level effect, $\gamma_{A,CL}$, is the welfare value of the change in the level of consumption in the economy. The consumption inequality effect, $\gamma_{A,CI}$, is the welfare value of the change in the inequality of lifetime consumption across individuals. This captures how the policy change redistributes consumption between individuals with different levels of lifetime consumption. The consumption uncertainty effect, $\gamma_{A,CU}$, is the welfare value of changes over time in variability of consumption at the individual level. This captures the consumption smoothing effect of the policy change. The employment effect, $\gamma_{A,E}$, is the welfare effect of changes that individuals make in their employment behavior in the response to the policy change. The search cost effect, $\gamma_{A,S}$, is the welfare effect of changes in job search costs. Appendix D formally defines each welfare component.[36]

Unless stated otherwise, the counterfactual policy analysis uses the rules for unemployment insurance and social assistance described in Section 2.3.[37] Throughout the counterfactual anal-

[36]This decomposition highlights that our problem combines an insurance problem with moral hazard, where agents are ex ante identical but face risk, and a redistribution problem with adverse selection, where agents have heterogeneous endowments but outcomes are certain conditional on behavior. Problems of this kind have been studied empirically, e.g., Blundell and Shephard (2011) and Chan (2013), but have seldom been studied theoretically. See Boadway and Sato (2014) for a theoretical treatment of optimal income taxation when earnings can differ because of ability and luck.

[37]For simplicity we assume a common replacement rate for unemployment insurance, irrespective of the presence of children in the household, and we omit unemployment assistance (which was abolished in 2005).

ysis, individuals are eligible for pensions, child benefits, and parental leave benefits as described in Section 2.3. To allow a transparent analysis of the interplay between the design of the social safety net and the nature of taxation, we replace the detailed model of the tax system that we have used so far with an accurate two-parameter approximating function.[38] Specifically, we approximate the tax paid by a single-adult household as follows:

$$\text{Tax} = \tau_0 \times \bar{y} \times \left(\frac{\text{Earnings+Interest Income}}{\bar{y}} \right)^{\tau_1}. \tag{26}$$

The parameter τ_0 controls the scale of the tax system. Specifically, τ_0 is equal to the average tax rate for individuals with earnings plus interest income equal to $\bar{y}$. We set $\bar{y}$ equal to the average annual earnings of the individuals in our sample (30,608 euros) and then interpret τ_0 as the average tax rate. The parameter τ_1 controls the progressivity of the tax system: tax is progressive if $\tau_1 > 1$; tax is flat rate if $\tau_1 = 1$; and tax is regressive if $\tau_1 < 1$. We continue to assume that married individuals are taxed based on household income, i.e., joint taxation.[39] We use non-linear least squares to estimate $\hat{\tau}_0 = 0.419$ and $\hat{\tau}_1 = 1.217$ based on the year 2000 tax rules. The R-squared for the approximation is equal to 0.9992. Figure A.3 in Web Appendix D shows the fitted two-parameter tax function provides a good approximation to the detailed tax rules.

7.2 Optimal Social Assistance and Unemployment Insurance

We gain some initial insights on the different functions of unemployment insurance and social assistance by contrasting a 5% cut in the social assistance income floor with a revenue-equivalent cut in the unemployment insurance replacement rate. Specifically, the cut in the unemployment insurance replacement rate is calibrated to generate the same increase in net government revenue as the 5% cut in the social assistance income floor (where net government revenue is equal to the present value of revenue from taxes minus the cost of unemployment insurance, social assistance, pension benefits, child benefits, and parental leave benefits). Households are taxed based on the year 2000 rules, therefore this exercise compares the effects of unemployment insurance and social assistance in the presence of the progressive schedule of income taxation households actually faced.

Column (1)–(3) of Table 9 summarize our results. Column (1) shows average household wealth and the employment rate in the baseline policy environment, where the social assistance income floor is equal to the year 2000 level and the unemployment insurance replacement rate

[38] The detailed tax model contains an infeasibly large number of parameter for an optimality exercise.

[39] Under joint taxation, the tax on a married household is equal to twice the tax for a single-adult household with earnings equal to the average earnings of the husband and wife plus half of the married household's interest income.

	(1)	(2)	(3)	(4)	(5)
I: Policy environment (denotes a parameter that has been optimized to maximize welfare)*					
Unemployment insurance replacement rate (%)	60	60	54	9*	0*
Social assistance income floor (% of baseline)	100	95	100	133*	105*
Average tax rate (τ_0)	0.42	0.42	0.42	0.42	0.39*
Change in net government revenue (% of baseline)	–	1.23	1.23	0.00	0.00
II: Behaviors					
Wealth (euros per household)	94,853	95,944	94,628	87,109	100,864
Employment rate	0.647	0.649	0.649	0.649	0.671
III: Welfare effects					
Welfare gain (% of baseline consumption)	–	-0.53	-0.27	1.32	2.20
Welfare decomposition:					
Consumption level effect	–	0.11	-0.11	-1.06	3.63
Consumption inequality effect	–	-0.04	0.01	0.23	-0.20
Consumption uncertainty effect	–	-0.33	0.01	1.57	-0.24
Employment effect	–	-0.16	-0.25	-0.56	-1.44
Search cost effect	–	-0.11	0.07	1.14	0.44

Note: Column (1) summarizes the baseline policy environment. Column (2) summarizes outcomes when the social assistance income floor is cut by 5% from the baseline level. Column (3) summarizes outcomes when the unemployment insurance replacement rate is cut to generate the same change in net revenue government as the 5% cut in social assistance. Column (4) shows outcomes when the unemployment insurance replacement rate and social assistance income floor are jointly chosen to maximize welfare subject to generating the same net government revenue as in the baseline policy environment. Column (5) shows outcomes when the unemployment insurance replacement rate, social assistance income floor, and the average tax rate (τ_0) are jointly chosen to maximize welfare again subject to generating the same net government revenue as in the baseline policy environment. In (1)–(5) households face the year 2000 rules for pension benefits, child benefits, and parental leave benefits. In (1)–(4) households face the year 2000 tax system while in (5) they face a tax system with the year 2000 progressivity and the average tax rate resulting from the welfare optimization problem. Net government revenue is equal to the present value of revenue from taxes minus the cost of unemployment insurance, social assistance, pension benefits, child benefits, and parental leave benefits. Wealth is average household wealth for single households where the household head aged 18–65 years and married households where the wife is aged 18–65 years. The employment rate is for all individuals aged 18–65 years. The welfare gain and the components of the welfare decomposition are calculated using the method described in Section 7.1.

Table 9: Optimal mix & optimal generosity of unemployment insurance and social assistance

is equal to 60%. Columns (2) and (3) show the effects of revenue-equivalent cuts in social assistance and unemployment insurance, respectively. Panel I shows a 5% cut in the social assistance income floor increases average net government revenue by 1.2%; a 6 percentage point cut in the unemployment insurance replacement rate–from 60% to 54%–generates the same increase in net government revenue. Panel II shows that the revenue-equivalent cuts in social assistance and unemployment insurance both increase the employment rate by around 0.25

percentage points. The 5% cut in the generosity of social assistance increases average household wealth by 1.2% compared to the baseline while the revenue-equivalent cut in unemployment insurance has no appreciable effect on average household wealth. The cut in social assistance, therefore, elicits more substitution from public to intra-household insurance than the cut in unemployment insurance.

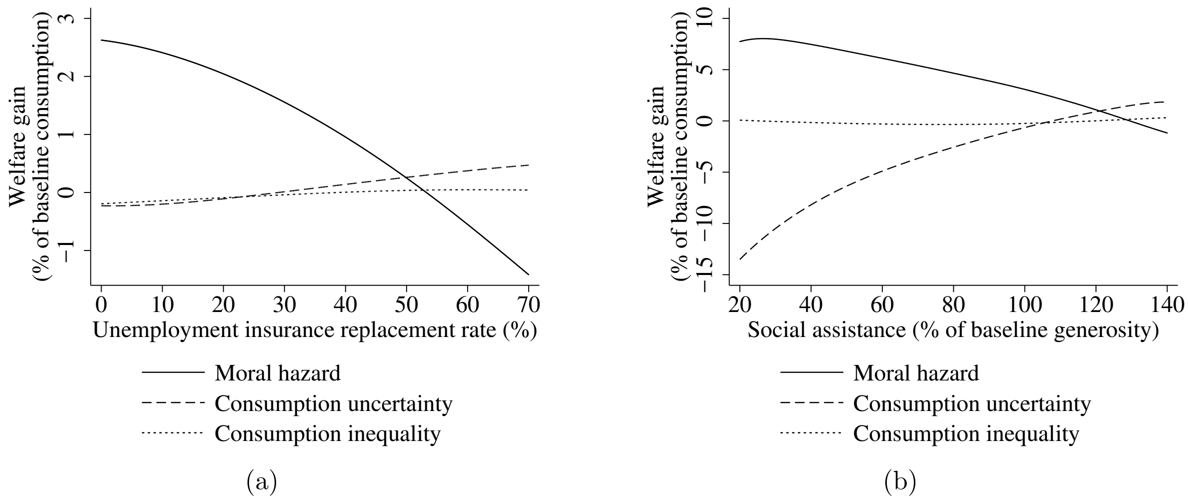
Columns (2) and (3) in Panel III of Table 9 show the welfare effects of revenue-equivalent cuts in social assistance and unemployment insurance, respectively. We find that the cut in social assistance leads to a larger welfare loss than the revenue-equivalent cut in unemployment insurance (-0.53% versus -0.27% of baseline consumption). The welfare decomposition shows that the difference between the welfare effects of the cuts in social assistance and unemployment insurance is primarily explained by the different insurance effects of the two programs. Specifically, the cut in social assistance decreases the consumption uncertainty component of the welfare gain by 0.33% of baseline consumption while the revenue-equivalent cut in unemployment insurance has a negligible effect on consumption uncertainty. The different insurance effects of social assistance and unemployment insurance reflect the leading difference between the two programs: social assistance targets the poorest households by providing a means-tested minimum income to wealth-poor households while unemployment insurance is paid to individuals who have recently left employment, irrespective of wealth or other household income. The other welfare components are less important. In particular, the consumption inequality effects are small, suggesting that the cuts in social assistance and unemployment insurance have modest redistributive effects.

We now turn to the optimal mix of unemployment insurance and social assistance. Specifically, we consider all combinations of the unemployment insurance replacement rate and the social assistance income floor that are revenue equivalent to the baseline policy environment and identify the combination that maximizes welfare. Individuals continue to face the progressive year 2000 tax system. Column (4) of Table 9 shows that the optimal mix is characterized by an unemployment insurance replacement rate of 9% and a social assistance income floor that is equal to 133% of the baseline level. That is, the optimal mix of unemployment insurance and social assistance focuses on permanent universal social assistance, with a minor role for temporary earnings-related unemployment insurance. The optimal mix of unemployment insurance and social assistance is fundamentally different from the current German system, in which both time-limited earnings-related unemployment insurance and long-term universal social assistance are important. Instead, our optimal policy rule shares many features with assistance-orientated social support systems, such as the benefit system in the United Kingdom.

Our finding that social assistance dominates the optimal mix is consistent with our earlier results showing that a cut in social assistance leads to a larger welfare loss than a revenue-equivalent cut in unemployment insurance. Column (4) of Table 9 shows moving from the baseline policy environment to the optimal mix of unemployment insurance and social assistance increases welfare by 1.32% of baseline consumption. The welfare gains comprise negative consumption level and employment effects and positive consumption uncertainty, consumption inequality, and search costs effects. The negative consumption level effect is driven by the decrease in interest income due to lower wealth accumulation and the negative employment effect reflects the increase in the employment rate. The welfare gains from the reduction in consumption uncertainty are due to the consumption smoothing effect of social assistance while the gains from lower search costs reflect a combination of an increase in the employment rate and a decrease in search intensity among the non-employed. The welfare gains from a reduction in the inequality of consumption show that social assistance is more effective at redistributing lifetime income than unemployment insurance.

Next, we explore whether our conclusions about the optimal mix of unemployment insurance and social assistance continue of hold when we introduce the average tax rate as an additional policy instrument. Note, while the unemployment insurance replacement rate and social assistance income floor together determine the *mix* of unemployment insurance and social assistance, the average tax rate sets the overall *generosity* of the social safety net. Column (5) of Table 9 shows the combination of the unemployment insurance replacement rate, social assistance income floor, and average tax rate that maximizes welfare subject to generating the same net government revenue as in the baseline. Compared to column (4), where the average tax rate was fixed at the baseline rate, the optimal generosity of social assistance falls from 133% to 105% of the baseline generosity while the optimal unemployment insurance replacement rate falls from 9% to 0%. Commensurate with the lower overall generosity of the social safety net, the average tax rate falls from 42% to 39%: at the baseline average tax rate the efficiency benefit from cutting taxes exceeds the utility loss from less generous unemployment insurance and social assistance. In summary, adding the average tax rate as a policy instrument reduces the optimal generosity of the social safety net but social assistance continues to dominate unemployment insurance in the optimal mix.

The move to the optimal mix and optimal generosity of unemployment insurance and social assistance increases welfare by 2.2% of baseline consumption compared to the baseline policy environment and by 0.9% of baseline consumption compared to when the optimal mix is derived holding the average tax rate fixed at the baseline rate. Therefore, lowering the average tax rate in conjunction with cutting the generosity of unemployment insurance and social assistance generates appreciable additional welfare gains. The welfare decomposition shows that the composition of the welfare gains changes when the average tax rate is added as a policy instrument. Specifically, the consumption level effect becomes the dominating welfare component, increasing welfare by 3.6%, while the lower generosity of social assistance has negative implications for the inequality and uncertainty of consumption. The higher average level of consumption is



Note: Consumption uncertainty and consumption inequality are taken directly from the welfare decomposition in Section 7.1. Moral hazard is defined as the sum of the consumption level, employment, and search cost effects in the welfare decomposition. In (a) social assistance is set to the optimal generosity of 105% of the baseline level and in (b) the unemployment insurance replacement rate is set to the optimal value of 0%. In all cases, tax progressivity is as in the baseline and the average tax rate is adjusted to generate the same net government revenue as in the baseline.

Figure 5: Moral hazard, consumption uncertainty, and consumption inequality effects of unemployment insurance and social assistance

the result of increases in employment and wealth. The increase in employment also drives the larger employment effect in the welfare decomposition.

Our results on the optimal mix and optimal generosity of unemployment insurance and social assistance arises from a three-way trade-off between moral hazard, consumption uncertainty (insurance), and consumption inequality (redistribution). We explore how this trade-off drives our finding of a zero optimal replacement rate for unemployment insurance. Figure 5(a) shows the welfare effects of moral hazard (defined as the sum of the consumption level, employment, and search cost effects), consumption uncertainty, and consumption inequality against the unemployment insurance replacement rate. At each value of the unemployment insurance replacement rate, social assistance is set to the optimal generosity of 105% of the baseline level and the average tax rate is adjusted to generate the same net government revenue as in the baseline policy environment. As the unemployment insurance replacement is cut, there are modest welfare losses from increases in consumption uncertainty and consumption inequality. However, the zero optimal unemployment insurance replacement rate arises because these losses are more than offset by the increase in welfare due to the reduction in moral hazard.

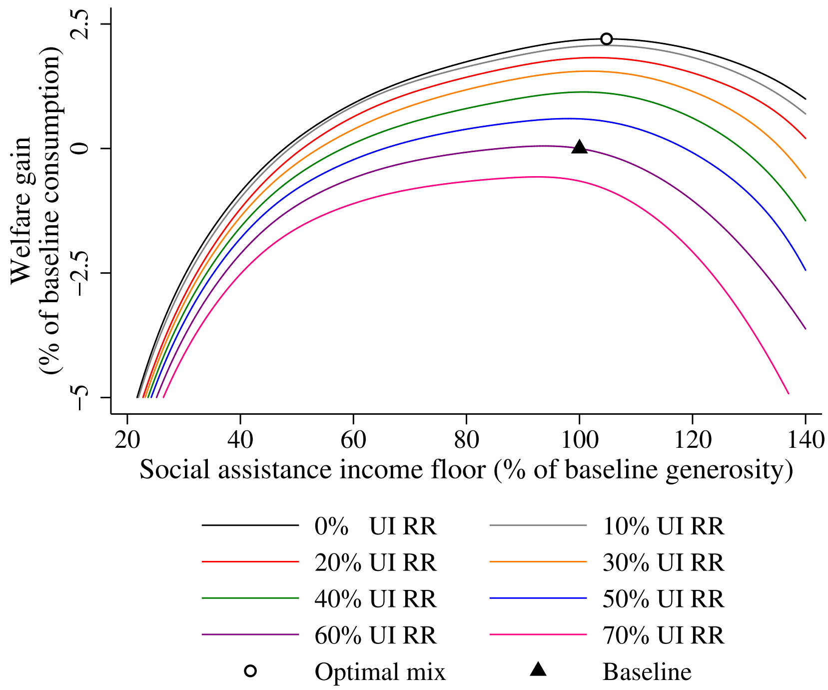
The modest increase in consumption uncertainty as unemployment insurance is cut reflects two factors. First, individuals optimally respond to cuts in unemployment insurance by increasing their labor supply, which reduces the expected duration of the lower consumption that accompanies job loss.[40] Second, interactions between unemployment insurance and social assistance limit the consumption losses from cuts in unemployment insurance for individuals with limited means to smooth their own consumption. Specifically, social assistance with a generosity of 105% of the baseline level guarantees a moderately generous minimum income to wealth-poor households and, therefore, provides individuals in low-income wealth-poor households with an alternative source of insurance in the face of cuts in unemployment insurance. We explore the interaction between unemployment insurance and social assistance further by calculating the consumption smoothing effect and optimal generosity of unemployment insurance in the presence of less generous social assistance. We find that unemployment insurance is a valuable consumption smoothing device when social assistance fixed at 5% or 10% of the baseline generosity. Consequently, the optimal unemployment insurance replacement rate is 20% when the social assistance income floor is equal to 5% of the baseline generosity or 10% when the social assistance income floor is equal to 10% of the baseline generosity.[41] These optimal replacement rates are comparable to the findings of Gruber (1997) who derives the optimal unemployment insurance replacement rate in the absence of social assistance.

We also explore the trade-off behind our finding that the optimal generosity of social assistance is 105% of the baseline level. Figure 5(b) shows the welfare effects of moral hazard, consumption uncertainty, and consumption inequality against the generosity of social assistance. At each value of social assistance, the unemployment insurance replacement rate is set to the optimal value of 0% and the average tax rate is adjusted to generate the same net government revenue as in the baseline policy environment. The welfare effects of social assistance operate almost entirely through moral hazard and consumption uncertainty, with little effect coming through changes in the inequality of consumption. Starting at the baseline generosity of social assistance, increasing the generosity of social assistance increases welfare by reducing consumption uncertainty and this effect is slightly larger than the reduction in welfare from the increase in moral hazard. However, starting at social assistance generosities of 105% of the baseline level, the moral hazard costs from increases in generosity of social assistance start to outweigh the welfare gains from the reduction in consumption uncertainty. Figure 5(b) also shows that at social assistance generosities below 100% of the baseline level consumption uncertainty increases rapidly as the generosity as social assistance decreases. This highlights an important role for social assistance in protecting households against spells of low consumption.

We compare the 2.2% welfare gain from the optimal mix and optimal generosity of unemployment insurance and social assistance with the gains from other revenue-equivalent combinations of social assistance, unemployment insurance, and the average tax rate. This comparison es-

[40]This effect reconciles the consumption fall associated with job loss reported in Section 6.3.2 with the modest changes in the welfare effect of consumption uncertainty shown in Figure 5(a).

[41]See Figure A.4 in Web Appendix D for further details.



Note: UI RR denotes the unemployment insurance replacement rate. In the baseline, the social assistance income floor is equal to 100% of the year 2000 level, the unemployment insurance replacement rate is 60%, and the average tax rate is 41.9%. In each alternative environment, the average tax rate is set to make the policy environment revenue equivalent to the baseline.

Figure 6: Welfare effects of unemployment insurance and social assistance

tablishes that welfare is sufficiently sensitive to the parameters of the policy environment to make the precise design of the social safety net economically important. In more detail, Figure 6 shows, conditional on the optimal social assistance income floor of 105%, welfare increases as the unemployment insurance replacement rate is decreased, however, the welfare gain from cutting unemployment is decreasing in the replacement rate, e.g., cutting the unemployment insurance replacement rate from 70% to 60% increases welfare by about 0.7% of baseline consumption while a cut from 10% to 0% increases welfare by 0.13% of baseline consumption. We also find, conditional on the optimal unemployment insurance replacement rate of 0%, there are modest welfare losses from local changes in the generosity of social assistance away from the optimal generosity of 105%, e.g., a 10 percentage point increase or decrease in the generosity of social assistance from its optimal generosity decreases welfare by around 0.1% of baseline consumption. However, larger changes in social assistance away from its optimal level have important welfare implications, e.g., continuing to hold the unemployment insurance replacement rate at 0%, cuts in the generosity of social assistance to 75%, 50%, and 25% of its baseline generosity give welfare losses of 0.6%, 2%, and 6.1% of baseline consumption compared to the optimal generosity of social assistance.

7.3 Robustness

In Section 7.2 we restricted the optimal policy analysis to three parameters: the unemployment insurance replacement rate; the social assistance income floor; and the average tax rate. Table 10 shows that our results on the optimal mix and optimal generosity of unemployment insurance and social assistance are robust to changes in other policy parameters. First, we explore the consequences of more generous means-testing for social assistance. Neither the introduction of an income exemption for the means test of 2,000 euros per year (column 1) nor a reduction in the taper rate from 100% to 50% (column 2) substantially changes our results. Next, we explore whether a role for unemployment insurance emerges as the entitlement is shortened; this is possible because shortening the entitlement period reduces the distortionary effects of unemployment insurance on search effort while still protecting individuals against the immediate effects of job loss. Columns (3) and (4) in Table 10 show that the optimal unemployment insurance replacement rate remains at zero when the duration of benefits is capped at 12 or 6 months.

In a further round of robustness checks we modify unemployment insurance by adding rules that typically appear in assistance benefits and then recalculate the optimal mix and optimal generosity of unemployment insurance and social assistance. The modifications we consider restrict unemployment insurance to relatively less advantaged individuals thereby moving the insurance-incentive-redistribution trade-off in favor of more generous unemployment insurance. The results of this exercise are summarized in columns (5)–(7) of Table 10. The optimal unemployment insurance replacement rate remains at zero when we make unemployment insurance subject to the social assistance wealth test. A small amount of unemployment insurance is optimal when we also add a spousal earnings test that reduces a married individual's unemployment insurance one-for-one against their spouse's post-tax earnings; however, the welfare gain from the spousal earnings test is negligible. When we additionally lower the cap on earnings that are eligible for unemployment insurance from 51,567 euros per year to 30,000 euros per year the optimal unemployment insurance replacement rate falls back to zero. The final two columns of Table 10 show that social assistance continues to dominate the optimal policy mix when: i) the tax base is changed from the household to the individual; and ii) the progressivity of the tax schedule is adjusted along with the unemployment insurance replacement rate, the social assistance income floor, and the average tax rate to maximize welfare.

We also explore the robustness of our results on the optimal mix and optimal generosity of unemployment insurance and social assistance to several assumptions in the estimated life-cycle model. Table 11 shows how the optimal policy changes when we move away from the estimated life-cycle model by suppressing saving, increasing risk aversion, suppressing wage shocks, or introducing a correlation between spouses' employment shocks. For each alternative

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Unemployment insurance replacement rate (%)	0	0	0	0	0	10	0	0	0
Social assistance income floor (% of baseline)	102	106	105	105	105	105	105	115	80
Average tax rate (τ_0)	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.38	0.39
Tax progressivity (τ_1)									1.65
Welfare gain (% of baseline consumption)	2.62	2.96	2.20	2.20	2.20	2.20	2.20	3.17	3.12
Change in policy environment:									
SA income exemption (euros per year)	2,000								
SA taper rate		50%							
Maximum UI duration (months)			12	6	6	6	6		
UI wealth test (euros)					Yes	Yes	Yes		
UI spousal earnings test						Yes	Yes		
UI eligible earnings cap (euros per year)							30,000		
Individual taxation								Yes	
Optimize tax progressivity ($\tau_1 = 1.22$ in baseline)									Yes

Note: For each alternative policy environment, the unemployment insurance replacement rate, social assistance income floor, and average tax rate (τ_0) are jointly chosen to maximize welfare subject to generating the same net government revenue as in the baseline policy environment. In column (10), tax progressivity (τ_1) is also optimized. The baseline policy parameters are as follows: social assistance (SA) income exemption of zero; SA taper rate of 100% (i.e., social assistance is withdrawn one-of-one against the household's income from other sources); maximum unemployment insurance (UI) duration of 12–30 months (depending on age); no UI wealth test; no UI spousal earnings test; and an UI eligible earning cap of 51,765 euros per year. Under the UI wealth test only single individuals with wealth below 4,090 euros and individual in married households with wealth below 8,181 euros are eligible for unemployment insurance. Under the UI spousal earnings test a married individual's income from unemployment insurance is reduced one-for-one against their spouse's earnings. Column (5) in Table 9 shows the optimal unemployment insurance replacement rate, social assistance income floor, and average tax rate when all other policy parameters take their baseline values.

Table 10: Robustness to ancillary parameters of the policy environment

model specification, we continue to find that there is no role for unemployment insurance in the optimally designed social safety net and that the optimal generosity of social assistance is similar to the generosity suggested by the estimated life-cycle model (the average tax rate varies across specifications because this parameter is chosen to ensure revenue equivalence to the baseline policy environment in the estimated life-cycle model).[42] Web Appendix E shows that the optimal policy continues to be dominated by social assistance when we include equilibrium effects.

[42]Figure A.5 in Web Appendix D shows the moral hazard, consumption uncertainty, and consumption inequality effects of unemployment insurance when households cannot save. The welfare effects of unemployment insurance with and without saving are qualitatively similar, although suppressing saving decreases the moral hazard effects and increases the consumption uncertainty effects.

	(1)	(2)	(3)	(4)
Unemployment insurance replacement rate (%)	0	0	0	0
Social assistance income floor (% of baseline)	116	92	99	108
Average tax rate (τ_0)	0.44	0.39	0.38	0.40
Change in model specification compared to the estimated model:				
Suppress saving	Yes			
Increase in risk aversion by 10%		Yes		
Suppress wage shocks			Yes	
Introduce correlation of 0.7 between spouses' employment shocks				Yes

Note: For each model specification, the unemployment insurance replacement rate, social assistance income floor, and average tax rate (τ_0) are jointly chosen to maximize welfare subject to generating the same net government revenue as in the estimated life-cycle model with the baseline policy environment. Column (5) in Table 9 shows the optimal unemployment insurance replacement rate, social assistance income floor, and average tax rate based on the estimated life-cycle model.

Table 11: Robustness to the model specification

7.4 Optimal Policy and the Family

Finally we explore how the presence of married households in the population affects the design of the optimal social safety net. For this purpose, we consider the optimal mix and optimal generosity of unemployment insurance and social assistance under two models: a family model and a single model. The family model is the estimated life-cycle model that we used for the policy analysis in Section 7.2. Note, the family model includes the empirical mix of single and married households. The single model is obtained by setting the marriage probabilities in the family model to zero, thereby generating a model of the life-cycle behavior of single households. Panel I of Table 12 shows that the marital composition of the population strongly affects the optimal generosity of social assistance. In a society of only single households the optimal generosity of social assistance is 166% of the baseline generosity. The presence of married households in the population therefore reduces the optimal generosity of social assistance from 166% to 105% of the baseline generosity. In contrast, unemployment insurance is optimally absent from the optimal policy, irrespective of the marital composition of the population.[43] Welfare calculations show that the difference between the optimal policies derived from the single and family models is economically important: imposing the optimal policy from the single model on a population with the empirical mix of single and married households leads to a welfare loss of 0.96% of baseline consumption compared to the optimal policy from the family model, which increases welfare by 2.2% of baseline consumption (see column 5 in Table 9).

There are four mechanisms through which marital status can affect the optimal design of

[43]Reflecting this result, Figure A.6 in Web Appendix D shows that consumption uncertainty changes with the unemployment insurance replacement rate similarly in the single and family models.

	Optimal policy parameters		Fraction of family SA effect explained by change
	UI	SA	
I: Comparison of the family model and the single model			
Family model	0	105	
Single model	0	166	
Family effect (effect of married households on optimal policy)	0	-61	
II: Decomposition of the family effect			
Successive change to the family model:			
Married individuals taxed on individual income	0	115	0.17
Remove husband provided childcare	0	115	0.00
Married individuals have singles' parameters	10	136	0.35
Remove income pooling in married households	0	166	0.48

Note: The family model is the estimated life-cycle model that we used for the policy analysis in Section 7.2. The single model is obtained by setting the marriage probabilities in the family model to zero. For each model, the unemployment insurance replacement rate, social assistance income floor, and average tax rate (τ_0) are jointly chosen to maximize welfare subject to generating the same net government revenue as in the estimated life-cycle model with the baseline policy environment. The column headed UI show the optimal unemployment insurance replacement rate. The column headed SA denotes the optimal generosity of social assistance as a percentage of the baseline generosity.

Table 12: Effect of married households on the optimal mix and optimal generosity of unemployment insurance and social assistance

the safety net. First, the taxation of married individuals based on household income, i.e., joint taxation, gives a tax benefit to married individuals with a non-working spouse compared to if they were single. Second, husband-provided childcare allows a working married woman to receive free childcare from her husband if he is not working while a working single woman must purchase childcare. Third, marital status may affect the parameters of preferences and technology. Fourth, income pooling in married households provides intra-household insurance. The intra-household insurance from income pooling arises from two effects: the endogenous labor supply response to a spousal income shock, which may partly compensate the reduction in household income, i.e., the added worker effect, and the income effect from spousal earnings that applies irrespective of the added worker effect.[44]

Panel II of Table 12 shows that income pooling is the most important mechanism, explaining almost 50% of the effect of married households on the optimal generosity of social assistance.

[44]Spousal income in married households has important implications for social assistance. We use a regression-based decomposition based on data simulated from the estimated life-cycle model to understand how spousal income affects social assistance receipt. Focusing on non-working married individuals, we find that having a working spouse reduces the rate of social assistance receipt for married individuals from 7.0% to 0.1%. If the same individuals were single then 20.4% would receive social assistance.

This large effect of income pooling is consistent with the importance of intra-household insurance through family labor supply documented in Blundell et al. (2016b). The taxation of married individuals based on household income, i.e., joint taxation, explains 17% of the effect of married households on the optimal generosity of social assistance. Intuitively, switching from joint to individual taxation removes a tax benefit from working married individuals with a non-working spouse, leading to a reduction in disposable income and demand for more generous social assistance. Reflecting the high employment rate of married men, husband-provided childcare is unimportant to the optimal generosity of social assistance. Parameter differences between single and married individuals explain 35% of the effect of married households on the optimal generosity of social assistance.

8 Conclusion

There are large international differences in how social insurance and social assistance programs are combined to support households facing job loss and other adverse circumstances. The US, Germany, and France, for example, combine temporary earnings-related benefits with permanent or long-term social assistance that is not based on previous earnings. In contrast, social support in the UK is provided primarily through universal social assistance. In this paper, we have explored how best to combine unemployment insurance and social assistance, given intra-household insurance from savings and family labor supply.

Our main finding is that assistance-orientated social support systems dominate insurance-based programs of support. In the most preferred social insurance and assistance system, permanent universal social assistance guarantees a moderately generous income to wealth-poor households, and there is little or no role for temporary earnings-related unemployment insurance. The optimal system resembles the UK's assistance-orientated framework for social support, and differs fundamentally from the existing programs of social support in the US, Germany, and France. The limited rule for unemployment insurance in the optimal social safety net arises because social assistance provides an income guarantee to wealth-poor households that limits the insurance value of unemployment insurance. We also show that marital status matters for the design of the optimal social safety net. Mainly due to income pooling in married households, the presence of married households in the population decreases the optimal generosity of social assistance.

Our analysis provides some more general insights that are relevant to future research. Our finding of complementarity between the leisure times of the husband and wife suggests that understanding the policy relevance of intra-household insurance requires recognition of the preference-based drivers of couples' behavior. Meanwhile, our results showing that social assistance reduces the insurance value of unemployment insurance highlight the importance of accounting for program interdependencies when evaluating and designing programs that support low-income populations.

References

Acemoglu, D. and **Shimer, R.** (1999). Efficient Unemployment Insurance. *Journal of Political Economy*, 107(5): 893–928

Adda, J., **Dustmann, C.**, and **Stevens, K.** (2017). The Career Costs of Children. *Journal of Political Economy*, 125(2): 293–337

Atkinson, A.B. and **Micklewright, J.** (1991). Unemployment Compensation and Labor Market Transitions: A Critical Review. *Journal of Economic Literature*, 29(4): 1679–1727

Attanasio, O., **Low, H.**, and **Sanchez-Marcos, V.** (2008). Explaining Changes in Female Labor Supply in a Life-cycle Model. *American Economic Review*, 98(4): 1517–1552

Attanasio, O.P. and **Weber, G.** (1995). Is Consumption Growth Consistent with Intertemporal Optimization? Evidence from the Consumer Expenditure Survey. *Journal of Political Economy*, 103(6): 1121–1157

Baily, M.N. (1978). Some Aspects of Optimal Unemployment Insurance. *Journal of Public Economics*, 10(3): 379–402

Benabou, R. (2002). Tax and Education Policy in a Heterogeneous-Agent Economy: What Levels of Redistribution Maximize Growth and Efficiency? *Econometrica*, 70(2): 481–517

Bitler, M.P., **Gelbach, J.B.**, **Hoynes, H.W.**, and **Zavodny, M.** (2004). The Impact of Welfare Reform on Marriage and Divorce. *Demography*, 41(2): 213–236

Blau, D.M. (1998). Labor Force Dynamics of Older Married Couples. *Journal of Labor Economics*, 16(3): 595–629

Blau, D.M. and **Gilleskie, D.B.** (2006). Health Insurance and Retirement of Married Couples. *Journal of Applied Econometrics*, 21(7): 935–953

Blundell, R. and **Preston, I.** (1998). Consumption Inequality and Income Uncertainty. *Quarterly Journal of Economics*, 113(2): 603–640

Blundell, R., **Costa Dias, M.**, **Meghir, C.**, and **Shaw, J.** (2016a). Female Labor Supply, Human Capital, and Welfare Reform. *Econometrica*, 84(5): 1705–1753

Blundell, R., **Pistaferri, L.**, and **Saporta-Eksten, I.** (2016b). Consumption Inequality and Family Labor Supply. *American Economic Review*, 106(2): 387–435

Blundell, R. and **Shephard, A.** (2011). Employment, Hours of Work and the Optimal Taxation of Low-Income Families. *The Review of Economic Studies*, 79(2): 481–510

Boadway, R. and **Sato, M.** (2014). Optimal Income Taxation and Risk: The Extensive-Margin Case. *Annals of Economics and Statistics/Annales d'Économie et de Statistique*, (113/114): 159–183

Browning, M. and **Meghir, C.** (1991). The Effects of Male and Female Labor Supply on Commodity Demands. *Econometrica*, 59(4): 925–951

Bundesagentur für Arbeit (2013). *Arbeitsmarkt 2012 - 60. Jahrgang, Sondernummer 2*

Bundesministerium für Arbeit und Sozialordnung (2000). *Übersicht über das Sozialrecht.* Bonn

Bundesministerium für Finanzen (2001). *Amtliches Einkommensteuer-Handbuch 2001.* Bonn

Card, D., **Lee, D.S.**, **Pei, Z.**, and **Weber, A.** (2015). Inference on Causal Effects in a Generalized Regression Kink Design. *Econometrica*, 83(6): 2453–2483

Casanova, M. (2010). Happy Together: A Structural Model of Couples' Joint Retirement Choices. *Mimeo*

Chan, M.K. (2013). A Dynamic Model of Welfare Reform. *Econometrica*, 81(3): 941–1001

Chetty, R. (2006). A General Formula for the Optimal Level of Social Insurance. *Journal of Public Economics*, 90(10): 1879–1901

Chetty, R. (2008). Moral Hazard vs. Liquidity and Optimal Unemployment Insurance. *Journal of Political Economy*, 116(2): 173–234

Coile, C. (2004). Retirement Incentives and Couples' Retirement Decisions. *Topics in Economic Analysis & Policy*, 4(1)

Cullen, J. and **Gruber, J.** (2000). Does Unemployment Insurance Crowd Out Spousal Labor Supply? *Journal of Labor Economics*, 18(3): 546–572

De Nardi, M., **French, E.**, and **Jones, J.** (2010). Why do the Elderly Save? The Role of Medical Expenses. *Journal of Political Economy*, 118(1): 39–75

Dustmann, C., **Fitzenberger, B.**, **Schoenberg, U.**, and **Spitz-Oener, A.** (2014). From Sick Man of Europe to Economic Superstar: Germany's Resurgent Economy. *Journal of Economic Perspectives*, 28(1): 167–188

Eissa, N. and **Hoynes, H.W.** (1998). The Earned Income Tax Credit and the Labor Supply of Married Couples. *NBER Working Paper 6856*

Ellwood, D.T. (2000). The Impact of the Earned Income Tax Credit and Social Policy Reforms on Work, Marriage, and Living Arrangements. *National Tax Journal*, 53(4): 1063–1105

Fadlon, I. and **Nielsen, T.H.** (2015). Family Labor Supply Responses to Severe Health Shocks. Technical report, National Bureau of Economic Research

Fadlon, I. and **Nielsen, T.H.** (2019). Household Labor Supply and the Gains from Social Insurance. *Journal of Public Economics*, 171: 18–28

Flemming, J.S. (1978). Aspects of Optimal Unemployment Insurance: Search, Leisure, Savings and Capital Market Imperfections. *Journal of Public Economics*, 10(3): 403–425

Floden, M. (2001). The Effectiveness of Government Debt and Transfers as Insurance. *Journal of Monetary Economics*, 48(1): 81–108

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

French, E. and **Jones, J.B.** (2011). The Effects of Health Insurance and Self-Insurance on Retirement Behavior. *Econometrica*, 79(3): 693–732

Fuchs-Schündeln, N., **Krueger, D.**, and **Sommer, M.** (2010). Inequality Trends for Germany in the Last Two Decades: A Tale of Two Countries. *Review of Economic Dynamics*, 13(1): 103–132

Gallant, A.R. and **Tauchen, G.** (1996). Which Moments to Match? *Econometric Theory*, 12(4): 657–681

Ganong, P. and **Noel, P.** (2019). Consumer Spending During Unemployment: Positive and Normative Implications. *American Economic Review*, forthcoming

Gourieroux, C., **Monfort, A.**, and **Renault, E.** (1993). Indirect Inference. *Journal of Applied Econometrics*, 8(S1): S85–S118

Goux, D., **Maurin, E.**, and **Petrongolo, B.** (2014). Worktime Regulations and Spousal Labor Supply. *American Economic Review*, 104(1): 252–276

Gregg, P., **Scutella, R.**, and **Wadsworth, J.** (2010). Reconciling Workless Measures at the Individual and Household level. Theory and Evidence from the United States, Britain, Germany, Spain and Australia. *Journal of Population Economics*, 23(1): 139–167

Gruber, J. (1997). The Consumption Smoothing Benefits of Unemployment Insurance. *American Economic Review*, 87(1): 192–205

Gustman, A.L. and **Steinmeier, T.L.** (2004). Social Security, Pensions and Retirement Behaviour Within the Family. *Journal of Applied Econometrics*, 19(6): 723–737

Guvenen, F. (2007). Learning Your Earning: Are Labor Income Shocks Really Very Persistent? *American Economic Review*, 97(3): 687–712

Halla, M., **Schmieder, J.**, and **Weber, A.** (2018). Job Displacement, Family Dynamics, and Spousal Labor Supply. *CEPR Discussion Papers, No. 13247*

Ham, J.C. and **Rea, S.A.** (1987). Unemployment Insurance and Male Unemployment Duration in Canada. *Journal of Labor Economics*, 5(3): 325–353

Heathcote, J., **Storesletten, K.**, and **Violante, G.** (2014). Consumption and Labor Supply with Partial Insurance: An Analytical Framework. *American Economic Review*, 104(7): 2075–2126

Hopenhayn, H. and **Nicolini, P.** (1997). Optimal Unemployment Insurance. *Journal of Political Economy*, 105(2): 412–438

Hunt, J. (1995). The Effect of Unemployment Compensation on Unemployment Duration in Germany. *Journal of Labor Economics*, 13(1): 88–120

Imai, S. and **Keane, M.P.** (2004). Intertemporal Labor Supply and Human Capital Accumulation. *International Economic Review*, 45(2): 601–641

Katz, L.F. and **Meyer, B.D.** (1990). The Impact of the Potential Duration of Unemployment Benefits on the Duration of Unemployment. *Journal of Public Economics*, 41(1): 45–72

Kayser, H.A. and **Frick, J.R.** (2000). Take It or Leave It:(Non-) Take-up Behavior of Social Assistance in Germany. Technical report, DIW Berlin, German Institute for Economic Research

Keane, M.P. (2016). Life-cycle Labour Supply with Human Capital: Econometric and Behavioural Implications. *The Economic Journal*, 126(592): 546–577

Keane, M.P. and **Moffitt, R.** (1998). A Structural Model of Multiple Welfare Program Participation and Labor Supply. *International Economic Review*, 39(3): 553–589

Keane, M.P. and **Wolpin, K.I.** (1997). The Career Decisions of Young Men. *Journal of Political*

Economy, 105(3): 473–522

Koehne, S. and **Kuhn, M.** (2015). Should Unemployment Insurance be Asset Tested? *Review of Economic Dynamics*, 18(3): 575–592

Kolsrud, J., **Landais, C.**, **Nilsson, P.**, and **Spinnewijn, J.** (2018). The Optimal Timing of Unemployment Benefits: Theory and Evidence from Sweden. *American Economic Review*, 108(4-5): 985–1033

Kroft, K. and **Notowidigdo, M.** (2016). Should Unemployment Insurance Vary with the Unemployment Rate? Theory and Evidence. *Review of Economic Studies*, 83: 1092–1124

Krueger, D., **Perri, F.**, **Pistaferri, L.**, and **Violante, G.L.** (2010). Cross-Sectional Facts for Macroeconomists. *Review of Economic Dynamics*, 13(1): 1–14

Lalive, R., **van Ours, J.**, and **Zweimüller, J.** (2006). How Changes in Financial Incentives Affect the Duration of Unemployment. *Review of Economic Studies*, 73(4): 1009–1038

Landais, C. (2015). Assessing the Welfare Effects of Unemployment Insurance using the Regression Kink Design. *American Economic Journal: Economic Policy*, 7(4): 243–78

Launov, A. and **Waelde, K.** (2013). Estimating Incentive and Welfare Effects of Nonstationary Unemployment Benefits. *International Economic Review*, 54(4): 1159–1198

Lentz, R. (2009). Optimal Unemployment Insurance in an Estimated Job Search Model with Savings. *Review of Economic Dynamics*, 12(1): 37–57

Low, H., **Meghir, C.**, and **Pistaferri, L.** (2010). Wage Risk and Employment Risk over the Life Cycle. *American Economic Review*, 100(4): 1432–1467

Low, H. and **Pistaferri, L.** (2015). Disability Insurance and the Dynamics of the Incentive Insurance Trade-Off. *American Economic Review*, 105(10): 2986–3029

Lundberg, S. (l985). The Added Worker Effect. *Journal of Labor Economics*, 3(1): 11–37

Michelacci, C. and **Ruffo, H.** (2015). Optimal Life Cycle Unemployment Insurance. *American Economic Review*, 105(2): 816–59

Moffitt, R. and **Nicholson, W.** (1982). The Effect of Unemployment Insurance on Unemployment: The case of Federal Supplemental Benefits. *Review of Economics and Statistics*, 64(1): 1–11

Moffitt, R. (1983). An Economic Model of Welfare Stigma. *American Economic Review*, 73(5): 1023–1035

OECD (2015). Taxes and Benefits (Edition 2015). *Available from OECD webpage: http://www.oecd.org/els/benefits-and-wages-statistics.htm*

Paserman, D. (2008). Job Search and Hyperbolic Discounting: Structural Estimation and Policy Evaluation. *Economic Journal*, 118(531): 1418–1452

Pavoni, N. (2009). Optimal Unemplyment Insurance with Human Capital Depreciation and Duration Dependence. *Internation Economic Review*, 50(2): 323–362

Pavoni, N., **Setty, O.**, and **Violante, G.L.** (2013). Search and Work in Optimal Welfare Programs. *NBER Working Paper 18666*

Pistaferri, L. (2001). Superior Information, Income Shocks, and the Permanent Income Hypothesis. *Review of Economics and Statistics*, 83(3): 465–476

Pistaferri, L. (2003). Anticipated and Unanticipated Wage Changes, Wage Risk, and Intertemporal Labor Supply. *Journal of Labor Economics*, 21(3): 729–754

Riphahn, R.T. (2001). Rational Poverty or Poor Rationality? The Take-up of Social Assistance Benefits. *Review of Income and Wealth*, 47(3): 379–398

Saez, E. (2002). Optimal Income Transfer Programs: Intensive versus Extensive Labor Supply Responses. *Quaterly Journal of Economics*, 117: 1039–1073

Saporta-Eksten, I. (2014). Job Loss, Consumption and Unemployment Insurance. *Mimeo*

Schmieder, J., **von Wachter, T.**, and **Bender, S.** (2012). The Effects of Extended Unemployment Insurance over the Business Cycle: Evidence from Regression Discontinuity Estimates Over 20 Years. *Quarterly Journal of Economics*, 127(2): 701–752

Shavell, S. and **Weiss, L.** (1979). The Optimal Payment of Unemployment Insurance Benefits over Time. *Journal of Political Economy*, 97(6): 1347–1362

Shimer, R. and **Werning, I.** (2007). Reservation Wages and Unemployment Insurance. *Quarterly Journal of Economics*, 122(3): 1145–1185

Shimer, R. and **Werning, I.** (2008). Liquidity and Insurance for the Unemployed. *American Economic Review*, 98(5): 1922–1942

Smith, Jr, A.A. (1993). Estimating Nonlinear Time-Series Models Using Simulated Vector Autoregressions. *Journal of Applied Econometrics*, 8(S1): S63–S84

Spinnewijn, J. (2015). Unemployed but Optimistic: Optimal Insurance Design with Biased Beliefs. *Journal of the European Economic Association*, 13(1): 130–167

Statistisches Bundesamt (2008). *Einkommens- und Verbrauchsstichprobe Aufgabe, Methode und Durchführung, 15(7)*

Tatsiramos, K. and **van Ours, J.C.** (2014). Labor Market Effects of Unemployment Insurance Design. *Journal of Economic Surveys*, 28(2): 284–311

Todd, P. and **Wolpin, K.** (2006). Using Experimental Data to Validate a Dynamic Behavioral Model of Child Schooling: Assessing the Impact of a School Subsidy Program in Mexico. *American Economic Review*, 96(5): 1384–1417

Triebe, D. (2015). The Added Worker Effect Differentiated by Gender and Partnership Status – Evidence from Involuntary Job Loss. *SOEPpapers on Multidisciplinary Panel Data Research*, 740

van der Klaauw, W. and **Wolpin, K.I.** (2008). Social Security and the Retirement and Savings Behavior of Low-Income Households. *Journal of Econometrics*, 145(1-2): 21–42

Wagner, G., **Frick, J.**, and **Schupp, J.** (2007). The German Socio-Economic Panel Study (SOEP) - Scope, Evolution and Enhancements. *Schmollers Jahrbuch*, 127(1): 139–169

Wrohlich, K. (2011). Labor Supply and Child Care Choices in a Rationed Child Care Market. *DIW Discussion Paper 1169*

Appendix

A Additional Programs

Child-care Costs

We assume that a married household with one or more pre-school aged children must pay for full-time childcare if both spouses work full-time. A married household incurs part-time childcare costs if the wife works part-time and the husband works full-time. A single woman with one or more pre-school aged children must pay childcare costs reflecting her hours of work. Based on Wrohlich (2011), we estimate monthly childcare 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.

Child Benefits and Parental Leave Benefits

A household receives child benefits of 138 euros per month for each dependent child. A household also receives parental leave benefits of 306 euros per month if the youngest child in the household is aged under 24 months and the mother is not employed. Parental leave benefits are restricted to households whose net annual income, excluding social assistance, is below a threshold that depends on marital status and the number of children in the household. Additionally, if the youngest child is older than 6 months then the monthly parental leave benefit is withdrawn at a rate of 3.3% against the household's net annual income, excluding social assistance, above an allowance.[45]

Pensions

A retired individual's annual pension is proportional to his or her lifetime earnings:

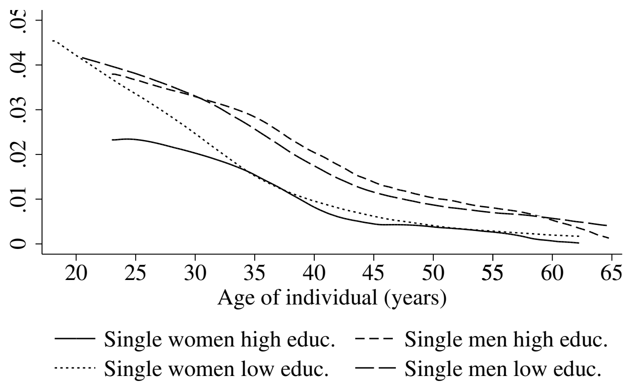
$$\text{Pension}_{g,t} = \Xi \times \text{Exp}_{g,t} \times W_g(\text{HiEduc}_g, 0.5 \times \text{Exp}_{g,t}, \overline{\kappa}) \quad \text{for} \quad g \in \{i, j\}. \tag{27}$$

In the above, $W_g()$ denotes the gender-specific market wage function (20) evaluated at the individual's education, average experience over the life-cycle, and the population average of the

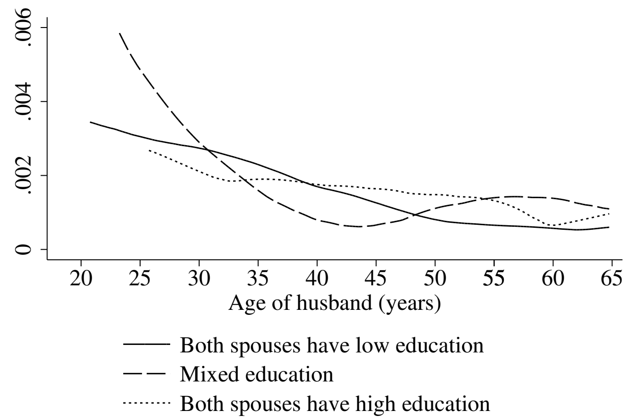
[45] The net annual income thresholds for the first means test are as follows: 51,129 euros for a married household with one child; 53,277 euros for a married household with two children; 38,347 euros for a single household with one child; and 40,494 euros for a single household with two children. The annual allowances for the second means test are equal to: 15,032 euros for a married household with one child; 17,179 euros for a married household with two children; 12,118 euros for a single household with one child; and 14,265 for the single household with two children.

wage unobservable, $\overline{\kappa}$ (see footnote 23). Reflecting the pension system that was effective during the sample period, we set Ξ to 20.

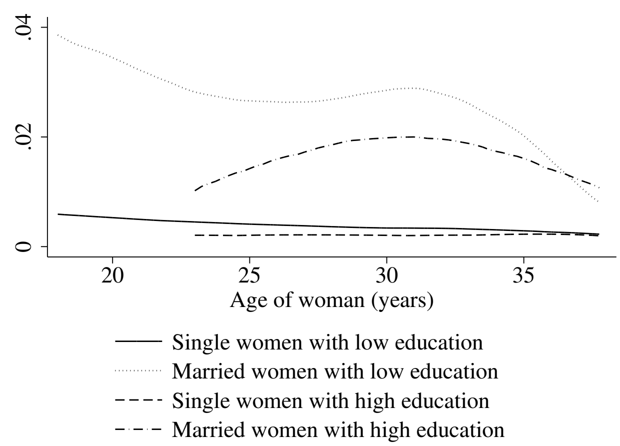
B Marriage, Divorce, Fertility, & Assortative Mating



(a) Marriage



(b) Divorce



(c) Birth

Figure 7: Quarterly marriage, divorce, and birth probabilities

Women		Men	
Low education	High education	Low education	High education
0.118	0.627	0.069	0.412

Table 13: Probability that an individual's spouse has high education

C Internal Goodness of Fit

I: Voluntary quit rate

	Single women		Married women		Single men		Married men	
	Obs.	Fitted	Obs.	Fitted	Obs.	Fitted	Obs.	Fitted
Age<50 years	0.01	0.01	0.02	0.02	0.01	0.01	0.00	0.00
Age≥50 years	0.03	0.02	0.03	0.02	0.02	0.02	0.02	0.02
High education	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01
Youngest child aged < 3	0.05	0.04	0.06	0.05				
3 ≤ Youngest child aged <6	0.02	0.02	0.02	0.02				

II: Transition rate into employment

	Single women		Married women		Single men		Married men	
	Obs.	Fitted	Obs.	Fitted	Obs.	Fitted	Obs.	Fitted
Age<50 years	0.08	0.09	0.04	0.05	0.11	0.10	0.11	0.10
Age≥50 years	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01
High education	0.08	0.11	0.04	0.06	0.10	0.12	0.06	0.06
Youngest child aged < 3	0.06	0.05	0.04	0.03				
3 ≤ Youngest child aged <6	0.07	0.06	0.04	0.05				

III: Part-time employment rate for previously employed women

	Single women		Married women	
	Obs.	Fitted	Obs.	Fitted
Age<50 years	0.21	0.20	0.52	0.53
Age≥50 years	0.21	0.17	0.57	0.59
High education	0.19	0.22	0.43	0.53
Youngest child aged < 3	0.52	0.43	0.76	0.79
3 ≤ Youngest child aged <6	0.67	0.66	0.79	0.81

IV: Employment effect of unemployment insurance

	Women		Men	
	Obs.	Fitted	Obs.	Fitted
	0.94	0.73	0.64	0.76

V: Joint leisure time and between-spouse wage correlation in married households

	Obs.	Fitted
Between-spouse leisure corr.	0.29	0.25
Wife non-emp. and husband emp.	0.21	0.21
Wage correlation	0.16	0.13

VI: Saving rates and social assistance receipt rates

	Single women		Single men		Married households	
	Obs.	Fitted	Obs.	Fitted	Obs.	Fitted
Saving rate: Age<50 years	0.10	0.09	0.16	0.15	0.15	0.15
Saving rate: Age≥50 years	0.08	0.06	0.13	0.13	0.11	0.11
Saving rate: High education	0.11	0.10	0.17	0.16	0.15	0.17
Social assistance receipt rate	0.22	0.22	0.05	0.07	0.08	0.08

VII: Wage regressions (Reg) and summary of wage residuals (Res)

	Women		Men	
	Obs.	Fitted	Obs.	Fitted
Reg: Intercept	2.38	2.39	2.67	2.67
Reg: Experience/40	0.37	0.30	0.21	0.21
Reg: High education	0.34	0.31	0.42	0.39
Res: Corr(predicted emp,residual)	0.13	0.01	0.05	0.00
Res: P(shock)	0.03	0.03	0.02	0.02
Res: P(good shock)-P(bad shock)	0.05	0.03	0.02	0.01
Res: Shock size	0.64	0.63	0.57	0.61
Res: Var(wage measurement error)	0.03	0.03	0.02	0.02

Note: See Table 3 for a description of the auxiliary model.

Table 14: Internal goodness of fit

	Unemployment insurance		Social assistance	
	Observed	Fitted	Observed	Fitted
Single woman	0.21	0.14	0.43	0.51
Single man	0.15	0.13	0.07	0.08
Married woman	0.23	0.40	0.25	0.20
Married man	0.41	0.34	0.25	0.20
Age (years)	47.12	50.95	41.21	40.64
High education	0.08	0.11	0.08	0.08
Youngest child aged < 3	0.03	0.03	0.24	0.11
3 ≤ Youngest child aged <6	0.06	0.03	0.15	0.06

Table 15: Characteristics of unemployment insurance and social assistance recipients

D Welfare Decomposition: Further Details

In this appendix, we provide formal definitions of the welfare components that appear in (25) in Section 7.1.

Consumption Level Effect

The consumption level effect $\gamma_{A,CL}$, solves:

$$V_B(\gamma_{A,CL}) = V_B((m_A - m_B)/m_B), \tag{28}$$

where $V_B()$ was defined in (24) and m_e denotes average household consumption in environment e. It is immediate that $\gamma_{A,CL} = (m_A - m_B)/m_B$, i.e., the consumption level effect is equal to the fractional change in aggregate consumption.

Consumption Inequality Effect

The consumption inequality effect, $\gamma_{A,CI}$, solves:

$$\begin{aligned} V_B(\gamma_{A,CL} + \gamma_{A,CI}) \;=\; \mathbb{E}\Bigg[& \Upsilon \sum_{\tau=t_i}^{T^F} \delta^{\tau-t_i} U^F(m^B_{i,j,\tau}(m_{A,i}/m_{B,i}), d^B_{i,\tau}, d^B_{j,\tau}, s^B_{i,\tau}) \;+ \\ & +(1-\Upsilon) \sum_{\tau=t_j}^{T^M} \delta^{\tau-t_j} U^M(m^B_{i,j,\tau}(m_{A,j}/m_{B,j}), d^B_{i,\tau}, d^B_{j,\tau}, s^B_{j,\tau}) \Bigg], \end{aligned} \tag{29}$$

where $m_{e,i}$ and $m_{e,j}$ denote woman i's and man j's average consumption per period in environment e.

Consumption Uncertainty Effect

The consumption uncertainty effect, $\gamma_{A,CU}$, solves:

$$\begin{aligned} V_B(\gamma_{A,CL}+\gamma_{A,CI}+\gamma_{A,CU}) \;&=\; \mathbb{E}\Bigg[\Upsilon \sum_{\tau=t_i}^{T^F} \delta^{\tau-t_i} U^F(m^A_{i,j,\tau}, d^B_{i,\tau}, d^B_{j,\tau}, s^B_{i,\tau}) + \\ &\quad +(1-\Upsilon)\sum_{\tau=t_j}^{T^M} \delta^{\tau-t_j} U^M(m^A_{i,j,\tau}, d^B_{i,\tau}, d^B_{j,\tau}, s^B_{j,\tau})\Bigg]. \end{aligned} \tag{30}$$

Note, the right hand side of (30) is evaluated using consumption in the alternative environment and employment and search effort in the baseline environment.

Employment Effect

The employment effect, $\gamma_{A,E}$, solves:

$$\begin{aligned} V_B(\gamma_{A,CL}+\gamma_{A,CI}+\gamma_{A,CU}+\gamma_{A,E}) = \mathbb{E}\Bigg[\Upsilon \sum_{\tau=t_i}^{T^F} \delta^{\tau-t_i} U^F(m^A_{i,j,\tau}, d^A_{i,\tau}, d^A_{j,\tau}, s^B_{i,\tau}) + \\ +(1-\Upsilon)\sum_{\tau=t_j}^{T^M} \delta^{\tau-t_j} U^M(m^A_{i,j,\tau}, d^A_{i,\tau}, d^A_{j,\tau}, s^B_{j,\tau})\Bigg]. \end{aligned} \tag{31}$$

Note, the right hand side of (31) is evaluated using consumption and employment in the alternative environment and search effort in the baseline environment.

Search Cost Effect

The search cost effect, $\gamma_{A,S}$, is the welfare effect of the final step to the alternative environment, where search effort is updated. $\gamma_{A,E}$ is therefore equal to the difference between the total welfare effect of the policy change and the sum of the four welfare components defined above.

Optimal Social Assistance and Unemployment Insurance in a Life-Cycle Model of Family Labor Supply and Savings

Web Appendix

(intended for online publication only)

Peter Haan and Victoria Prowse

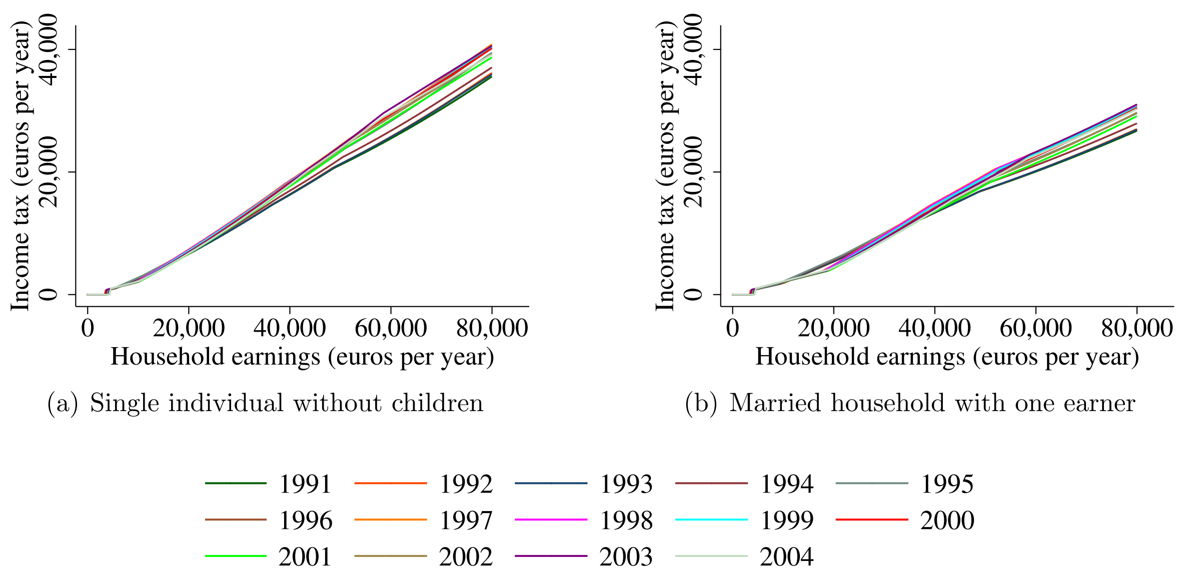
October 25th, 2019

In this web appendix we provide further details that were omitted from the main text to conserve space. Web Appendix A describes how taxes and benefits changed during the sample period 1991–2004 and shows that the behavioral effects of these changes are modest. Web Appendix B describes how we solve the model to derive optimal behavior over the life cycle. Web Appendix C demonstrates the comparability of our SOEP and EVS samples. Web Appendix D includes graphs that provided further details about results in the main text. Web Appendix E shows that our findings on the optimal mix and optimal generosity of unemployment insurance and social assistance are robust to including equilibrium effects.

Web Appendix A Taxes and Benefits 1991–2004

Web Appendix A.I Income Tax

Figure A.1 shows the income tax schedules for single households without children and married households over the sample period 1991–2004. Income tax varied little across years for individuals earning below average level of individual earnings of 30,608 euros per year. At high levels of earnings there were larger changes in taxation. Five factors account for the illustrated changes. First, an income tax reform in 1996 reduced the average income tax rates faced by very low earning households. Second, an income tax reform in 2000 reduced average income tax rates for high earning households. Third, the solidarity surcharge fluctuated between 0% and 7.5% of income tax (excluding social security contributions). Fourth, the contribution rates for health and retirement benefits increased and the threshold above which earnings are exempt from social security contributions also increased (these increases partly offset the effects of the year 2000 tax reform). Fifth, there were incremental changes in the parameters of the tax system that did not match exactly the rate of inflation.



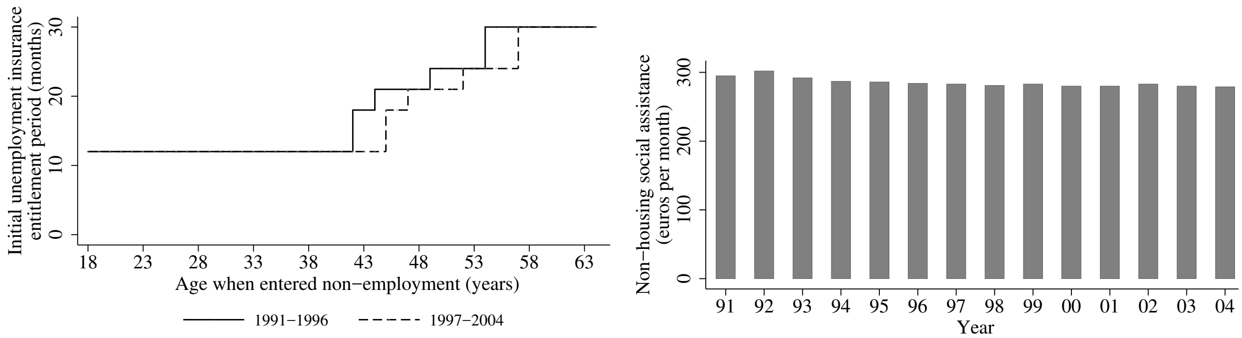
Note: Income tax and household earnings are in year 2000 prices. Income tax includes social security contributions.

Figure A.1: Income tax schedules 1991–2004

Web Appendix A.II Unemployment Insurance & Social Assistance

The year 2000 unemployment insurance and unemployment assistance replacement rates applied from 1994 onwards and the year 2000 unemployment insurance entitlement period applied from 1997 onwards. During the period 1991–1993 slightly higher replacement rates applied: 63%

for unemployment insurance and 56% for unemployment assistance if there were no children in the individual's household or 68% for unemployment insurance and 58% for unemployment assistance if one or more children resided in the individual's household. Prior to 1997 the initial unemployment insurance entitlement period was slightly longer for individuals entering employment at ages 42–46, 49–52, and 54–57 years (see Figure A.2(a)).



(a) (b)

Note: Initial entitlement periods are rounded down to the nearest integer multiple of three months. Social assistance benefits are expressed in year 2000 prices.

Figure A.2: Initial unemployment insurance entitlement period and non-housing social assistance 1991–2004

Regarding social assistance, recall from Section 2.3.2 that the social assistance income floor is equal to the product of a generosity parameter and a household equivalence scale. The generosity parameter, in turn, comprises a component for non-housing assistance and a component for housing (see footnote 19). The policy on support for housing costs did not change during the sample period and, therefore, we assume that this component of the social assistance income floor increased with inflation. Figure A.2(b) illustrates the evolution of the non-housing component of the social assistance income floor during the sample period. The changes in non-housing benefits were modest, reflecting that throughout the sample period non-housing benefits were calculated to ensure that all households could obtain a basic standard of living. Furthermore, the equivalence scale did not change during the sample period. In summary, during the sample period, there were no major changes to social assistance and only modest changes to unemployment insurance.

Web Appendix A.III Behavioral Effects of Tax & Benefit Changes

We explore the behavioral effects of the changes in taxes and benefits that occurred during the sample period by simulating behavior from the life-cycle model under each of the fourteen year-specific tax and benefit systems. Throughout this exercise, we use the parameter estimates reported in Section 6.1. Table A.1 shows that the predicted voluntary quit rate, transition rate into employment, saving rate, and social assistance receipt rate vary little with the year-specific rules. This supports using the year 2000 rules for the entire sample period.

	Year													
	91	92	93	94	95	96	97	98	99	00	01	02	03	04
Voluntary quit rate at age<50 years														
Single women	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Single men	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.01
Married women	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01
Married men	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Transition rate into employment at age<50 years														
Single women	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
Single men	0.10	0.10	0.11	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Married women	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Married Men	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.11	0.11	0.11	0.11
Saving rate at age<50 years														
Single women	0.09	0.09	0.11	0.11	0.11	0.10	0.10	0.10	0.10	0.09	0.10	0.10	0.10	0.10
Single men	0.14	0.13	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.15	0.15	0.15	0.15	0.16
Married households	0.13	0.14	0.16	0.16	0.16	0.16	0.15	0.16	0.16	0.15	0.15	0.15	0.15	0.15
Social assistance receipt rate														
Single women	0.24	0.23	0.22	0.23	0.23	0.24	0.24	0.24	0.24	0.22	0.20	0.22	0.21	0.21
Single men	0.08	0.08	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.08
Married households	0.11	0.10	0.08	0.08	0.09	0.08	0.08	0.09	0.08	0.08	0.07	0.07	0.07	0.06

Note: Each column summarizes behavior simulated from the life-cycle model with the year-specific tax and benefit rules and the parameter estimates reported in Section 6.1.

Table A.1: Robustness of behavior to changes in the tax and benefit rules

Web Appendix B Optimal Life-cycle Behavior

We solve the model by characterizing optimal life-cycle behavior using the value functions for single and married women and men. Recall a household's choice problem ends when the youngest household member reaches the compulsory retirement age of 65 years. From this time onward, the household members cannot search or work, and the household consumes pension and social assistance benefits plus the actuarially fair annuity value of household wealth at the compulsory retirement age. In each period prior to the compulsory retirement age a household's optimization problem proceeds in two stages. First, the search intensity of each household member is optimized. Second, job offers arrive and the household optimizes household consumption, household social assistance claiming behavior, and labor supply behavior of each household member. This within-period problem is solved backwards: we determine optimal consumption, social assistance claiming, and labor supply behavior for each possible set of feasible labor supply choices, and then solve for the optimal search intensity, taking into account the effect of search on the probability of employment constraints.

Before proceeding, we define the state variables for women and men. A woman's state space, $\Phi_{i,t}$, contains the following individual characteristics: age; education; experience; persistent wage type; unemployment insurance eligibility; unemployment insurance entitlement period; unemployment assistance eligibility; hours of work in previous employment; labor supply state in the previous period; job destruction status; household wealth; current period preference shocks; and the age of the first-born child. A man's state space, $\Phi_{j,t}$, contains the same variables that appear in a woman's state space except for hours of work in previous employment and the age of the first-born child.

Web Appendix B.I Single Households

We first consider the problem facing a single woman. A single woman's choice problem ends when she reaches the compulsory retirement age of 65 years. We denote this time by $\widetilde{T}$. The terminal value function for single woman i is given by:

$$V_{\widetilde{T}}^{Fs}(\Phi_{i,\widetilde{T}}) = \mathbb{E}\left[\sum_{\tau=\widetilde{T}}^{T^F} \delta^{\tau-t} U^F(m_{i,\emptyset,\widetilde{T}}, d_{i,\widetilde{T}}, d_{\emptyset,\widetilde{T}}, s_{i,\widetilde{T}}, \text{SAClaim}^*_{i,\emptyset,\widetilde{T}}) \middle| \Phi_{i,\widetilde{T}}\right]. \tag{A1}$$

In (A1), $m_{i,\emptyset,\widetilde{T}}$ denotes the woman's consumption in retirement, $d_{i,\widetilde{T}}$ takes the value RT, indicating that the woman is retired, $d_{\emptyset,\widetilde{T}}$ denotes the absence of a husband, $s_{i,\widetilde{T}}$ is equal to zero, reflecting that retired individuals cannot not search, $\text{SAClaim}^*_{i,\emptyset,\widetilde{T}}$ denotes the social assistance claiming choice that maximizes the woman's remaining lifetime utility, $\Phi_{i,\widetilde{T}}$ denotes the values of the woman's state variables at the compulsory retirement age, and T^F denotes the last period of the woman's life. Based on the German Human Mortality Database we estimate that T^F is equal to 79.5 (and for men we estimate that T^M is equal to 73.25).

Prior to the compulsory retirement age, the labor supply-specific value functions for single woman i at time t are given by:

$$V_t^{Fs}(d|s, \Phi_{i,t}) = \max_{m,\text{SAClaim}} \Big\{ U^F(m, d, d_{\emptyset,t}, s, \text{SAClaim}) +$$
$$\delta \mathbb{E}\left[(1-\phi_{i,t+1}^{Fs}) V_{t+1}^{Fs}(\Phi_{i,t+1}) + \phi_{i,t+1}^{Fs} V_{t+1}^{Fc}(\Phi_{i,t+1}, \Phi_{j,t+1}) \middle| \Phi_{i,t}, d\right] \Big\} \quad \text{for} \quad d \in \mathcal{D}^F. \tag{A2}$$

In the above, $\phi^{Fs}_{i,t+1}$ is the woman's probability of marrying at time $t+1$, and $V^{Fc}_{t+1}(\Phi_{i,t+1}, \Phi_{j,t+1})$ is woman's value function in the next period if she marries (the value functions for married individuals are defined below in Web Appendix B.II). Note, for each labor supply-specific value function, consumption, m, and social assistance claiming, SAClaim, are optimized conditional on the woman's labor supply state. The optimization of consumption is subject to the intertemporal budget constraint and the non-negativity constraint on household wealth. The expectation in (A2) is evaluated assuming that individuals' 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 him or herself; individuals expect that the husband will enter the marriage with 7% more experience and 5% more wealth than the wife. We also assume individuals expect any future spouse to enter the marriage with the same wage unobservable as themself.

We now characterize a single woman's optimal labor supply behavior given the set of feasible choices, as determined by the outcome of search activities, job destructions, and the age-based restrictions on retirement eligibility. Let D^F_k for $k = 1, ..., K^F$ denote all possible sets of feasible labor supply choices. Given the set of feasible choices D^F_k, the single woman chooses the labor supply alternative with the highest choice-specific value function:

$$d^*_{i,t}(D^F_k) = \underset{d \in D^F_k}{\operatorname{argmax}} \big\{ V^{Fs}_t(d|s, \Phi_{i,t}) \big\}. \tag{A3}$$

The single woman's optimal search intensity, $s^*_{i,t}$, is given by:

$$s^*_{i,t} = \underset{s \in [0,1/\chi_{i,t}]}{\operatorname{argmax}} \left\{ \sum_{k=1}^{K^F} P(D^F_k|s, \Phi_{i,t}) V^{Fs}_t \left(d^*_{i,t} \left(D^F_k \right) \middle| \, s, \Phi_{i,t} \right) \right\}, \tag{A4}$$

where $P(D^F_k|s, \Phi_{i,t})$ is the probability of the set D^F_k of feasible labor supply choices given search intensity s. Note, as search intensity, s, varies $P(D^F_k|s, \Phi_{i,t})$ changes according to the effect of search on the probability of receiving a job offer as described by (17). Evaluating the term in braces in (A4) at the optimal search intensity, $s^*_{i,t}$, obtains the single woman's value function, $V^{Fs}_t(\Phi_{i,t})$.

A single man's value function, $V^{Ms}_t(\Phi_{j,t})$, is obtained in the same way as shown here for a single woman. We assume than a single man expects his any future wife to enter the marriage without preexisting children.

Web Appendix B.II Married Households

We now turn to the problem facing a married household. A married household's choice problem ends when the wife reaches the compulsory retirement age, i.e., at time $\widetilde{T}$. The terminal value function for woman i in married household (i,j) is given by:

$$V_{\widetilde{T}}^{Fc}(\Phi_{i,\widetilde{T}},\Phi_{j,\widetilde{T}}) \;=\; \mathbb{E}\left[\sum_{\tau=\widetilde{T}}^{T^F}\delta^{\tau-\widetilde{T}}U^F(m_{i,j,\widetilde{T}},d_{i,\widetilde{T}},d_{j,\widetilde{T}},s_{i,\widetilde{T}},\text{SAClaim}^*_{i,j,\widetilde{T}})\middle|\,\Phi_{i,\widetilde{T}},\Phi_{j,\widetilde{T}}\right], \quad \text{(A5)}$$

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

$$V_{\widetilde{T}}^{Mc}(\Phi_{i,\widetilde{T}},\Phi_{j,\widetilde{T}}) \;=\; \mathbb{E}\left[\sum_{\tau=\widetilde{T}}^{T^M}\delta^{\tau-\widetilde{T}}U^M(m_{i,j,\widetilde{T}},d_{i,\widetilde{T}},d_{j,\widetilde{T}},s_{j,\widetilde{T}},\text{SAClaim}^*_{i,j,\widetilde{T}})\middle|\,\Phi_{i,\widetilde{T}},\Phi_{j,\widetilde{T}}\right]. \quad \text{(A6)}$$

In the two above equations, $m_{i,j,\widetilde{T}}$ denotes the household's consumption in retirement, $d_{i,\widetilde{T}}$ and $d_{j,\widetilde{T}}$ take the value RT, indicating that both spouses are retired, $s_{i,\widetilde{T}}$ and $s_{j,\widetilde{T}}$ are equal to zero, reflecting that retired individuals do not search, and $\text{SAClaim}^*_{i,j,\widetilde{T}}$ denotes the social assistance claiming choice that maximizes the household's remaining lifetime utility. The married household's objective function is an α-weighted average of the spouses' payoffs and, therefore, the terminal value function for the married household is given by:

$$V^{FM}(\Phi_{i,\widetilde{T}},\Phi_{j,\widetilde{T}}) \;=\; \alpha V_{\widetilde{T}}^{Fc}(\Phi_{i,\widetilde{T}},\Phi_{j,\widetilde{T}})+(1-\alpha)V_{\widetilde{T}}^{Mc}(\Phi_{i,\widetilde{T}},\Phi_{j,\widetilde{T}}). \quad \text{(A7)}$$

The labor supply-specific value functions for the married household prior to the wife reaching the compulsory retirement age are given by:

$$\begin{aligned}
V_t^{FM}(d^F,d^M|s^F,s^M,\Phi_{i,t},\Phi_{j,t}) \;=\; & \max_{m,\text{SAClaim}}\Big\{\alpha U^F(m,d^F,d^M,s^F,\text{SAClaim}) \\
& +(1-\alpha)U^M(m,d^F,d^M,s^M,\text{SAClaim}) \\
& +\delta\mathbb{E}\Big[(1-\phi^c_{i,j,t+1})\left(\alpha V_{t+1}^{Fs}(\Phi_{i,t+1})+(1-\alpha)V_{t+1}^{Ms}(\Phi_{j,t+1})\right) \\
& +\phi^c_{i,j,t+1}V_{t+1}^{FM}(\Phi_{i,t+1},\Phi_{j,t+1})\Big|\Phi_{i,t},\Phi_{j,t},d^F,d^M\Big]\Big\} \\
& \text{for } d^F\in\mathcal{D}^F \text{ and } d^M\in\mathcal{D}^M. \qquad \text{(A8)}
\end{aligned}$$

In the above, $\phi^c_{i,j,t+1}$ is the probability that the spouses remain married between periods t and $t+1$. Similar to single households, consumption, m, and social assistance claiming, SAClaim, are optimized conditional on household labor supply. $V_{t+1}^{Fs}(\Phi_{i,t+1})$ and $V_{t+1}^{Ms}(\Phi_{j,t+1})$ are the wife's and husband's value functions in the next period if they divorce (the value function for single individuals were defined above in Web Appendix B.I). van der Klaauw and Wolpin (2008) and Fernández and Wong (2014) use similar preference specifications for couples in studies of, respectively, the effect of Social Security on household retirement behavior and the effect of divorce risk on female labor force participation.

Let D_k^c for $k = 1, ..., K^c$ denote all possible sets of feasible labor supply choices for a married household. Given the set of feasible labor supply choices D_k^c, the household chooses the labor supply alternative with the highest choice-specific value function:

$$(d_{i,t}^*(D_k^c), d_{j,t}^*(D_k^c)) = \underset{(d^F, d^M) \in D_k^c}{\operatorname{argmax}} V_t^{FM} \left(d^F, d^M | s^F, s^M, \Phi_{i,t}, \Phi_{j,t} \right). \tag{A9}$$

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

$$(s_{i,t}^*, s_{j,t}^*) = \underset{\substack{s^F \in [0, 1/\chi_{i,t}] \\ s^M \in [0, 1/\chi_{j,t}]}}{\operatorname{argmax}} \left\{ \sum_{k=1}^{K^c} P(D_k^c | s^F, s^M) V_t^{FM}(d_{i,t}^*(D_k^c), d_{j,t}^*(D_k^c) \mid s^F, s^M, \Phi_{i,t}, \Phi_{j,t}) \right\}, \tag{A10}$$

where $P(D_k^c | s^F, s^M)$ is the probability of choice set D_k^c, given search intensities s^F for the wife and s^M for the husband. Last, we split the married household's value function into the value functions for the wife and husband that appear in the single household's optimization problem. For a married woman:

$$V_t^{Fc}(\Phi_{i,t}, \Phi_{j,t}) = \sum_{k=1}^{K^c} P(D_k^c | s_{i,t}^*, s_{j,t}^*) V_t^{Fc} \left(d_{i,t}^*(D_k^c), d_{j,t}^*(D_k^c) \middle| s_{i,t}^*, s_{j,t}^*, \Phi_{i,t}, \Phi_{j,t} \right), \tag{A11}$$

where

$$\begin{aligned} V_t^{Fc} \left(d_{i,t}^*(D_k^c), d_{j,t}^*(D_k^c) \middle| s_{i,t}^*, s_{j,t}^*, \Phi_{i,t}, \Phi_{j,t} \right) &= U^F(m^*, d_{i,t}^*(D_k^c), d_{j,t}^*(D_k^c), s_{i,t}^*, \text{SAClaim}^*) \\ &+ \delta \mathbb{E}\left[(1 - \phi_{t+1}^c) V_{t+1}^{Fs}(\Phi_{i,t+1}) + \phi_{t+1}^c V_{t+1}^{Fc}(\Phi_{i,t+1}, \Phi_{j,t+1}) \middle| \Phi_{i,t}, \Phi_{j,t}, d_{i,t}^*(D_k^c), d_{j,t}^*(D_k^c) \right] \end{aligned} \tag{A12}$$

and m^* and SAClaim* denote optimal household consumption and optimal social assistance claiming from (A8). The value function for a married man is derived in the same way as shown here for a married woman.

Web Appendix C Sample Comparability

We examine the comparability of the SOEP and EVS samples described in Section 4 by comparing the average values of demographic characteristics, employment and retirement outcomes, and wealth across the two samples. Table A.2 shows that the EVS and SOEP samples are highly comparable. In particular, the rates of employment, non-employment, and retirement are similar across the two samples, both overall and when we split by gender and marital status. The same is true for age, eduction, the age category of the youngest child, and wealth.

Variable	All individuals		Single women		Single men		Married women		Married men	
	SOEP	EVS	SOEP	EVS	SOEP	EVS	SOEP	EVS	SOEP	EVS
Share			0.17	0.17	0.12	0.10	0.35	0.37	0.35	0.37
Age (years)	44.70	44.09	43.38	43.64	41.18	40.64	44.28	43.30	47.03	46.01
High education	0.14	0.15	0.13	0.18	0.22	0.22	0.08	0.11	0.16	0.17
Child 0–3	0.07	0.09	0.04	0.02	-	-	0.09	0.11	0.09	0.11
Child 3–6	0.06	0.08	0.04	0.03	-	-	0.08	0.10	0.08	0.10
Wealth (Euros)	119,986	126,147	52,775	59,579	56,445	70,826	147,955	149,845	147,955	149,845
Part-time employed	0.15	0.15	0.18	0.21	-	-	0.33	0.33	-	-
Full-time employed	0.53	0.54	0.51	0.50	0.78	0.79	0.26	0.24	0.74	0.78
Retired	0.08	0.06	0.12	0.10	0.04	0.03	0.07	0.04	0.09	0.07
Non Employed	0.24	0.25	0.19	0.19	0.18	0.18	0.35	0.40	0.17	0.15

Note: For all variables except wealth, we use the full EVS sample, which covers the years 1998 and 2003, and a SOEP sub-sample that includes only observations from the years 1998 and 2003. For wealth, we use the EVS sub-sample that includes only observations from the year 2003 and a SOEP sub-sample that includes only observations from the year 2002 (since wealth was only observed in the SOEP in 2002). Wealth comprises financial, housing, and durable assets, is measured at the household level, and is expressed in year 2000 prices using the Consumer Price Index. See the notes to Table 1 for further variable definitions. All statistics are weighted using the household weights supplied by the SOEP or EVS.

Table A.2: Comparison of the SOEP and EVS samples

Web Appendix D Further Graphs

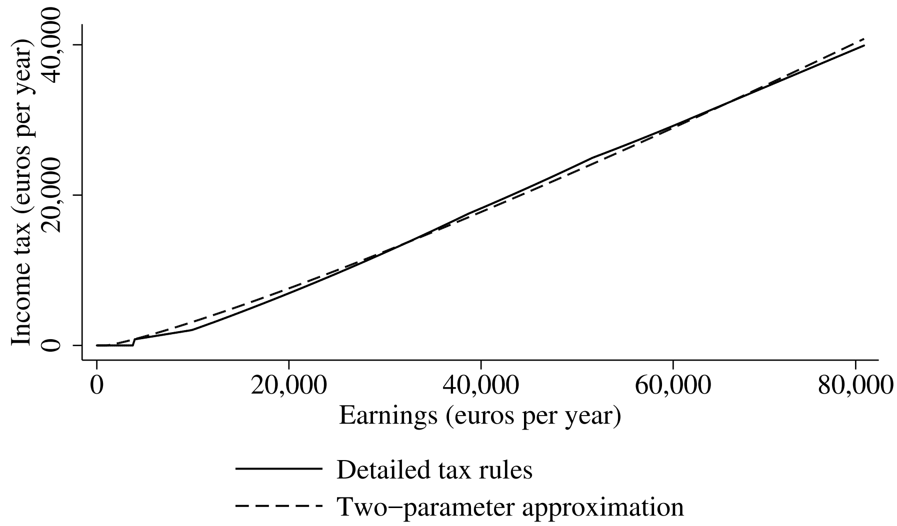
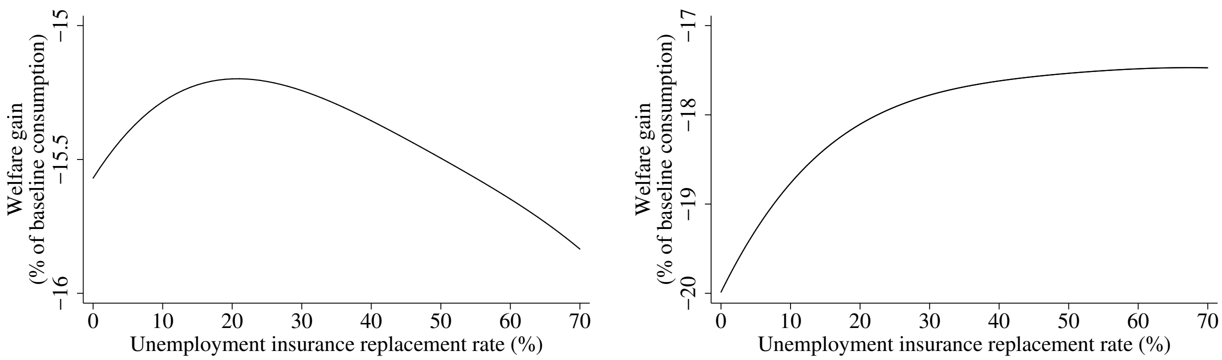
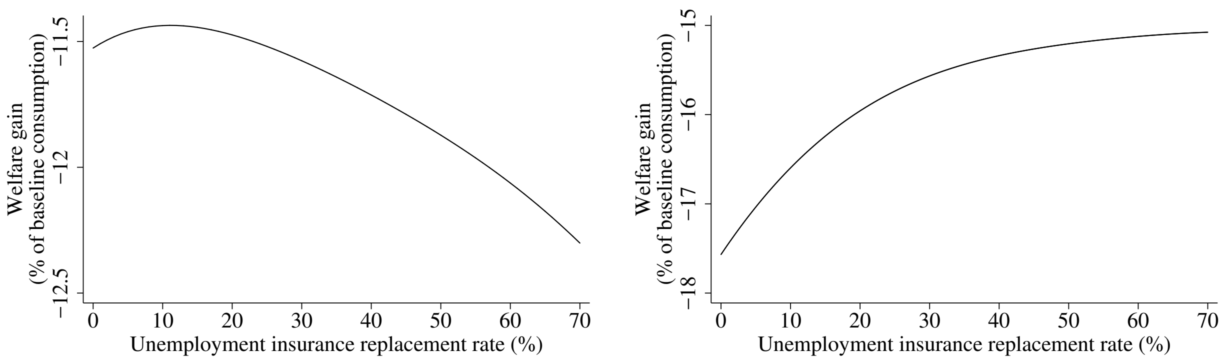


Figure A.3: Tax function approximation



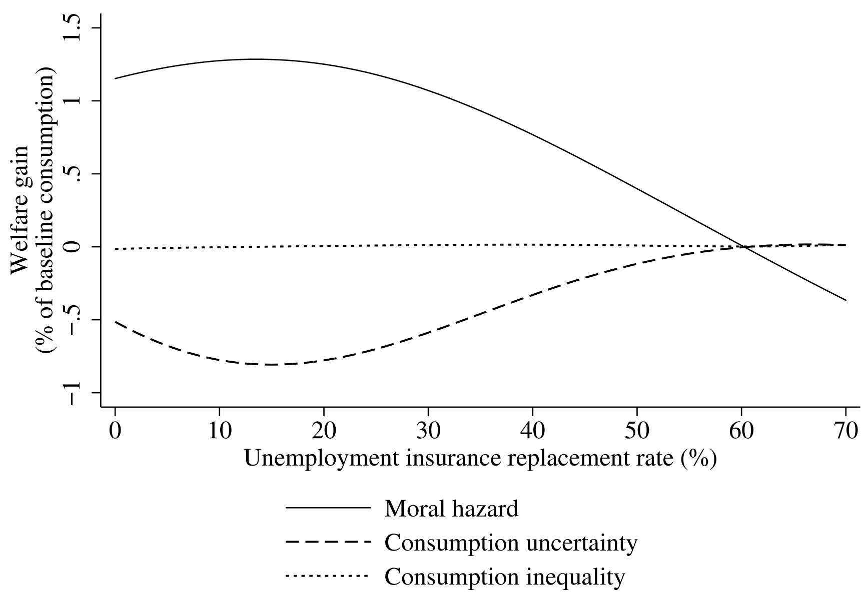
(a) Social assistance generosity 5% of baseline level



(b) Social assistance generosity 10% of baseline level

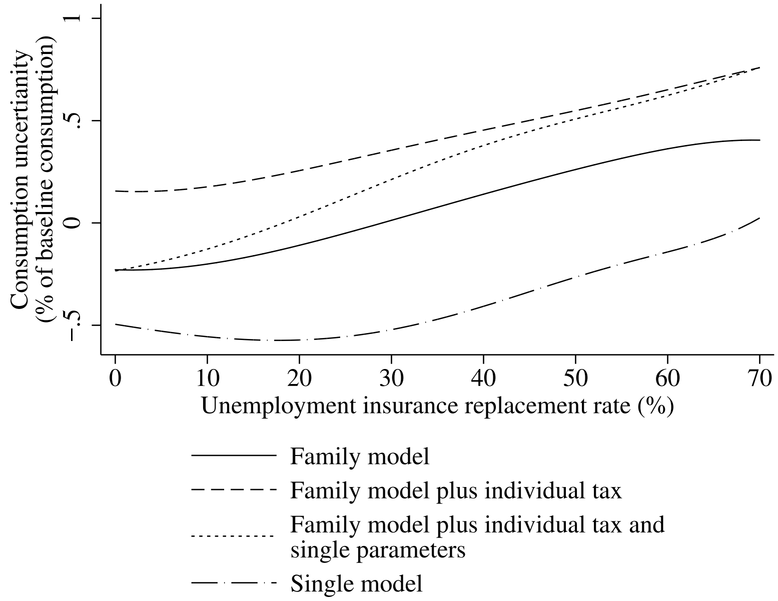
Notes: Figures show the total welfare gain (left) and the welfare gain from the consumption uncertainty effect (right).

Figure A.4: Welfare effects of unemployment insurance when the generosity of social assistance is 5% and 10% of the baseline level



Note: Consumption uncertainty and consumption inequality are taken directly from the welfare decomposition in Section 7.1. Moral hazard is defined as the sum of the consumption level, employment, and search cost effects in the welfare decomposition. Social assistance is set to the baseline generosity (100% of the year 2000 level). Tax progressivity is as in the baseline and the average tax rate is adjusted to generate the same net government revenue as in the baseline. For comparability, welfare gains are normalized to zero at an unemployment insurance replacement rate of 60%.

Figure A.5: Moral hazard, consumption uncertainty, and consumption inequality effects of unemployment insurance when households cannot save



Note: Consumption uncertainty is defined in the welfare decomposition in Section 7.1. At each value of the unemployment insurance replacement rate, social assistance is set to the optimal generosity shown in Panel II of Table 12 and the average tax rate is adjusted to generate the same net government revenue as in the estimated life-cycle model with the baseline policy environment. Removing husband-provided childcare from the family model has a negligible effect on consumption uncertainty and therefore is omitted from the presentation.

Figure A.6: Decomposing the consumption uncertainty effect of unemployment insurance

Web Appendix E Equilibrium Effects

In this appendix, we propose an extension to our baseline model that captures the equilibrium effects of changes in unemployment insurance and social assistance. We use the extended model to explore how our main conclusions may be affected by equilibrium effects. In summary, we continue to find that the optimal social safety net is dominated by social assistance.

Lalive et al. (2015) explain that the total effect, or macro effect, of a change in the design of unemployment insurance is the sum of a micro effect and an externality effect. The micro effect is the change in labor market outcomes due to changes in job search behavior at the individual level. This is already included in our baseline model. The externality effect arises from changes in the equilibrium conditions in the labor market that affect an individual's job finding probability given their search behavior. More generous unemployment insurance creates externalities through two channels. First, as unemployment insurance becomes more generous there is less competition for jobs and, therefore, a worker's probability of receiving a job offer at any given level of search effort increases. Second, more generous unemployment insurance strengthens the bargaining position of workers, driving up wages and leading firms to scale back job creation; this decreases a worker's probability of receiving a job offer at any given level of search effort. Lalive et al. (2015) study the equilibrium effects of the Regional Extension Benefit Program in Austria, which gave eligible unemployed workers an extra three years of benefits. They find that unemployment durations for ineligible workers decreased by 6–8 weeks with no change in reemployment wages. The externality effect of the unemployment benefit extension on ineligible workers made the macro effect of the benefit extension on unemployment durations around 21% smaller than the micro effect. Lalive et al. (2015)'s findings are consistent with the small related literature on this topic. Using data from an online job posting board in the US, Marinescu (2017) finds no effect of the potential duration of unemployment insurance benefits on posted wages, which is further evidence of against an equilibrium effect on wages. Levine (1993) and Marinescu (2017) report differences between the micro and macro effects of unemployment insurance that are similar to the findings of Lalive et al. (2015).

We explore how our results may be affected by equilibrium effects by recalculating the optimal mix and optimal generosity of unemployment insurance and social assistance while allowing search productivity to vary the generosity of unemployment insurance and social assistance. Specifically, we augment equation (18) in Section 3.2 to allow search productivity to depend on the generosity of unemployment insurance and social assistance. The augmented search productivity for women, $\chi_{i,t}$, is given by:

$$\log(\chi_{i,t}) = \chi_1^F + \chi_2^F \text{AgeG50}_{i,t} + \chi_3^F \text{HiEduc}_i + \chi_4^F \text{Married}_{i,t} + \mu \log(\text{G}^e/\text{G}^0), \quad \text{(A13)}$$

where G^e is benefit generosity in the policy environment under study, G^0 is benefit generosity in the baseline policy environment, and μ is the elasticity of search productivity with respect to benefit generosity. Benefit generosity is defined as the sum of the social assistance income floor and the unemployment insurance benefit for an individual with average earnings. The corresponding augmented search productivity for men is obtained by replacing F with M and i with j in (A13). We match findings of Lalive et al. (2015) by calibrating an elasticity of search productivity with respect to benefit generosity such that the equilibrium effect explains 21% of the employment effect of moving from the baseline policy environment to the optimal mix and optimal generosity of unemployment insurance and social assistance. In more detail, Panel II of Table A.3 shows that employment increases by 3.68% when we move from the baseline environment shown in column (1) to the optimal mix and optimal generosity of unemployment insurance and social assistance in column (2) (columns (1) and (2) in Table A.3 repeat the baseline and optimal mix and optimal generosity results from Table 9 in Section 7.2). We find that an elasticity of search productivity with respect of benefit generosity of 0.075 attenuates the employment effect of this policy change from 3.68% to 2.92%, i.e, a 21% decrease as found by Lalive et al. (2015). Column (3) shows outcomes under the optimal policy in column (2) but with the calibrated equilibrium effect on search productivity. The equilibrium effect reduces net government revenue by an average of 2,455 euros per person or 1.41% of baseline net government revenue. The equilibrium effect decreases the welfare gain of moving to the optimal mix and optimal generosity of unemployment insurance and social assistance from 2.20% to 1.01% of baseline consumption, reflecting that the lower benefit generosity under the optimal policy creates a negative externality on search productivity. However, because the equilibrium effect reduces net government revenue, the welfare gains in column (3) do not fully capture the welfare impact of the equilibrium effect.

Column (4) Table A.3 shows the optimal mix and optimal generosity of unemployment insurance and social assistance when the optimal policy calculation incorporates the micro and equilibrium effects of policy changes. We identify the optimal policy by jointly choosing the unemployment insurance replacement rate, social assistance income floor, and the average tax rate to maximize welfare while accounting for the calibrated equilibrium effect of benefit generosity on search productivity and subject to generating the same net government revenue as in the baseline policy environment. We continue to find that the optimal mix is dominated by social assistance. However, the introduction of equilibrium effects leads to two changes in the optimal policy. First, the optimal generosity of social assistance increases slightly from 105% to 110% of the baseline generosity. Second, the optimal unemployment insurance replacement rate increases from 0% to 20%. The higher optimal generosities of social assistance and unemployment insurance reflect that the equilibrium effect leads to additional welfare gains from generous benefits via higher returns to search effort.

	(1)	(2)	(3)	(4)
I: Policy environment (denotes a parameter that has been optimized to maximize welfare)*				
Unemployment insurance replacement rate (%)	60	0*	0	20*
Social assistance income floor (% of baseline)	100	105*	105	110*
Average tax rate (τ_0)	0.42	0.39*	0.39	0.40*
Equilibrium effect on search productivity	No	No	Yes	Yes
Change in net government revenue (% of baseline)	-	0.00	-1.41	0.00
II: Behaviors				
Wealth (euros per household)	94,853	100,864	100,490	95,740
Employment rate	0.647	0.671	0.666	0.658
% Change in employment from baseline		3.68	2.92	1.78
III: Welfare effects				
Welfare gain (% of baseline consumption)	–	2.20	1.01	0.85
Welfare decomposition:				
Consumption level effect	–	3.63	3.09	1.27
Consumption inequality effect	–	-0.20	-0.25	-0.04
Consumption uncertainty effect	–	-0.24	-0.39	0.28
Employment effect	–	-1.43	-1.54	-1.09
Search cost effect	–	0.44	0.10	0.42

Note: Columns (1)–(2) repeat columns (1) and (5) in Table 9. Column (1) summarizes the baseline environment. Column (2) shows outcomes when unemployment insurance replacement rate, social assistance income floor, and the average tax rate (τ_0) are jointly chosen to maximize welfare subject to generating the same net government revenue as in the baseline (without equilibrium effects). Column (3) shows outcomes under the optimal policy identified in column (2) but with an equilibrium effect that leads the productivity of job search to increase with the generosity of unemployment insurance and social assistance (generosity is defined as the sum of the social assistance income floor and the unemployment insurance benefit for a individual with the average level of earnings). We calibrate the size of the equilibrium effect to match the findings of Lalive et al. (2015) and this gives an elasticity of search productivity with respect to benefit generosity of 0.075. Column (4) shows outcomes when the unemployment insurance replacement rate, social assistance income floor, and the average tax rate (τ_0) are jointly chosen to maximize welfare while accounting for the calibrated equilibrium effect of benefit generosity on search productivity and subject to generating the same net government revenue as in the baseline. In (1) households face the year 2000 tax system while in (2)–(4) they face a tax system with the year 2000 progressivity and the average tax rate resulting from the respective welfare maximization problem. See the notes to Table 9 for variable definitions.

Table A.3: Robustness of the optimal mix and optimal generosity of unemployment insurance and social assistance to equilibrium effects

References (Web Appendix)

Fernández, R. and **Wong, J.C.** (2014). Divorce Risk, Wages and Working Wives: A Quantitative Life-Cycle Analysis of Female Labour Force Participation. *Economic Journal*, 124(576): 319–358

Lalive, R., **Landais, C.**, and **Zweimüller, J.** (2015). Market Externalities of Large Unemployment Insurance Extension Programs. *American Economic Review*, 105(12): 3564–3596

Levine, P.B. (1993). Spillover Effects between the Insured and Uninsured Unemployed. *Industrial and Labor Relations Review*, 47(1): 73–86

Marinescu, I. (2017). The General Equilibrium Impacts of Unemployment Insurance: Evidence from a Large Online Job Board. *Journal of Public Economics*, 150: 14–29

van der Klaauw, W. and **Wolpin, K.I.** (2008). Social Security and the Retirement and Savings Behavior of Low-Income Households. *Journal of Econometrics*, 145(1-2): 21–42