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DISCUSSION PAPER SERIES

IZA DP No. 16124

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ABSTRACT

Long-Run Consequences of Informal Elderly Care and Implications of Public Long-Term Care Insurance*

We estimate a dynamic structural model of labor supply, retirement, and informal care supply, incorporating labor market frictions and the German tax and benefit system. We find that in the absence of Germany's public long-term insurance scheme, informal elderly care has adverse and persistent effects on labor market outcomes and, thus, negatively affects lifetime earnings and future pension benefits. These consequences of caregiving are heterogeneous and depend on age, previous earnings, and institutional regulations. Policy simulations suggest that public long-term care insurance policies are fiscally costly and induce negative labor market effects. But we also show that they can offset the personal costs of caregiving to a large extent and increase welfare for those providing care, especially for low-income individuals.

JEL Classification: I18, I38, J14, J22, J26

Keywords: long-term care, informal care, long-term care insurance, labor supply, retirement, pension benefits, dynamic structural model

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1. Introduction

Long-term care (LTC)[1] is among the fastest growing branches of health care markets. In 2015, public LTC spending accounted for 1.7% of GDP across OECD[2] countries (OECD, 2017). Due to population aging, this spending on LTC as share of GDP is projected to double by 2060 (De la Maisonneuve & Martins, 2013). Today, throughout the industrialized world, most LTC is provided informally by the family. For example, about 70% of all LTC recipients in the U.S. and Germany rely on some kind of informal care (Skira, 2015; Pfaff, 2013). Yet, acting as an informal caregiver often competes with participating in the labor force and, hence, might result in sizable opportunity costs for the involved caregiver (e.g. Ettner, 1996; Bolin et al., 2008; Crespo & Mira, 2014). To mitigate these negative effects of informal caregiving, many of the existing social security systems aim to insure against the financial risk of LTC. This often includes transfers to compensate the informal caregiver (Brugiavini et al., 2017). In light of increasing demand for LTC and its rising costs, key questions for investigation concern the effects of informal care provision on caregivers' labor supply, the resulting consequences on welfare and lifetime income, as well as how these outcomes are affected by public long-term care insurance (LTCI) or similar institutions. Another important question is how LTC policies affect total fiscal costs, also accounting for indirect costs like reduced tax revenues or social security contributions.

In this paper, we address these questions by estimating a dynamic structural model that is used to simulate individual and fiscal consequences of informal care provision under varying institutional regulations. After evaluating the effects of care provision on labor supply, lifetime income and welfare under a status quo baseline scenario, we use counterfactual policy simulations to analyze two distinct features of the German public LTCI: (i) cash transfers intended to reimburse informal caregivers and (ii) pension entitlements for informal caregiving that allow caregivers to increase expected pensions. Both measures are designed to decrease the opportunity costs of care provided by the family. Yet, any monetary transfer also has income effects and, thus, could have unintended negative consequences on labor supply. The policies analyzed in this paper reveal an important tradeoff between (i) the need to further stimulate informal care provision as a less ex-

[1]Long-term care usually includes services that provide help to impaired individuals who cannot care for themselves for longer periods. It incorporates non-medical help to perform activities of daily living like eating, dressing, and using the bathroom.

[2]The Organization for Economic Co-operation and Development.

pensive alternative to nursing care and (ii) retaining labor supply against the trend of demographic aging.

Long-term care provision can have long-run consequences on labor market outcomes, earnings, and retirement benefits. Yet, while many papers address the effects of informal care provision on caregivers' labor supply (see Bauer & Sousa-Poza, 2015; Lilly et al., 2007, for reviews), the majority of these papers only considers short-run effects. Only a handful of studies also consider long-run effects of informal caregiving (Michaud et al., 2010; Skira, 2015; Schmitz & Westphal, 2017; Fevang et al., 2012; Frimmel et al., 2020). For instance, Skira (2015) and Schmitz & Westphal (2017) show that reducing working hours or dropping out of the labor force might lead to a lower chance of future employment if, due to labor market frictions, caregivers are unable to take up employment again after their caregiving activity has ended. Skira (2015) also finds that work interruptions might affect human capital accumulation resulting in missed promotion steps or a worse bargaining position that could adversely affect future wage offers. In contrast, Fevang et al. (2012), who analyze Norwegian register data, detect no long-lasting effects of caregiving. Arguably, this might be due to the generous option of paid leave that is available to informal caregivers in Norway and allows caregivers to temporarily leave employment in order to provide care without the risk of being unemployed after the care period has ended.[3] In line with this argument, Skira (2015) shows in counterfactual simulations that (paid) leave reforms can reduce the long-run consequences of informal caregiving.

In this paper, we provide additional estimates of the long-run consequences of informal care provision. Building on the work by Skira (2015), we estimate a dynamic model in which agents can make discrete decisions about their labor supply, their retirement state, and whether they want to provide informal LTC to a relative. Each choice yields a payoff in the current period but also affects future payoffs due to the transition of state variables. Therefore, the agent makes decisions based on current and future discounted utility. The model is estimated using the 2002 through 2019 waves of the German Socio-Economic Panel (SOEP). The SOEP comprises nearly 11,000 households and about 30,000 persons each year (Goebel et al., 2019).

Using information on parents and spouses of potential caregivers we estimate a two-step latent care demand variable. We make use of external information to validate our estimates for care de-

[3] In Norway, paid leave is equivalent to 100% of the previous wage (Colombo et al., 2011).

mand in the population of interest. Firstly, the model predictions show that informal caregiving reduces labor market participation in the short run. Due to labor market frictions, these reductions are persistent, have long-run negative impacts on labor supply, and hasten retirement. These factors in turn reduce lifetime labor income and, *ceteris paribus* , retirement benefits. We show that if women enter prime caregiving ages with a higher labor market attachment, average career costs of caregiving tend to rise. Second, while institutional regulations in Germany have negative impacts on labor supply, they significantly reduce the short- and long-run personal monetary impacts of caregiving. Due to these institutional regulations and higher probabilities for inheritances, caregiving can even be beneficial from a personal lifetime income perspective. Third, caregiving has heterogeneous welfare gains for those deciding to provide care. Those are higher for women in upper income groups. Institutional regulations for LTC in Germany are welfare improving for caregivers. Fourth, we demonstrate that while informal caregiving might be less costly for the LTC insurance than formal care, there are indirect costs that make up about 20% of total fiscal costs of informal caregiving.

The results contribute to the literature in four ways. First, the estimated model includes retirement choices and annuities from the public pension system.[4] While, e.g., Skira (2015) focuses primarily on dynamics in wages and the job offer probability, in this paper, we additionally consider the pension system, which imposes further dynamics that likely affect decisions about LTC and labor supply – especially close to retirement ages. The results in this paper indicate that, absent institutional regulations, informal caregiving induces lower total retirement income because individuals retire earlier to provide informal care or collect fewer pension entitlements due to interruptions in their working lives. This result is in line with Meng (2012) and Van Houtven et al. (2013), who also show that informal care can affect the timing of retirement.

As a second contribution, we include benefits from the German public LTCI into the model.[5] In general, if public LTCI is available, the negative consequences of caregiving should be less severe. We use the German institutional setting, which offers several interesting features that are important for other countries as well. German LTCI provides benefits solely based on recipients' needs of

[4] By allowing for retirement choices, the paper also relates to the literature analyzing the effects of social security on retirement decisions (e.g. Rust & Phelan, 1997; Gustman & Steinmeier, 2005; French & Jones, 2011; Haan & Prowse, 2014).

[5] In this paper, we always refer to the *public* Long-term care insurance system as LTCI.

care. The benefit scheme for home care consists of two parts: informal care, in general provided by nonprofessional family members, and formal care, provided by professional health care services. Informal care benefits are given as cash transfers and are intended to reimburse informal caregivers. Most (European) countries rely on a similar mix of informal and formal care, with many providing cash support to family caregivers (Colombo et al., 2011; Brugiavini et al., 2017; Heger & Korfhage, 2018). A unique feature of the German LTC system relates to the pension system: If caregivers provide intensive care – i.e. more than 14 hours of care per week – the public pension system accounts for this care activity by providing pension entitlements. With these public institutions in place, the consequences of caregiving on labor supply, lifetime income, and welfare are more ambiguous because they set additional incentives to potential family caregivers.

Compared to the literature on the general relationship between caregiving and work, fewer studies refer explicitly to policy reforms or use structural models to identify behavioral effects. Løken et al. (2016) find for Norway that daughters specifically reacted to an increase in formal care supply with reduced absence from work. For Japan, Sugawara & Nakamura (2014) show that the negative relationship between caregiving and female labor supply diminished following the introduction of the LTCI system in 2000. Similarly, Fu et al. (2017) find that the introduction of LTCI in Japan increased labor supply, while subsequent cuts to the program reduced labor supply. In contrast to Germany, the Japanese LTCI provides only formal services and no cash allowances. Thus, incentives are clearly positive for caregivers to increase labor supply.

For Germany, Geyer & Korfhage (2018), using data from SOEP, show that the introduction of German LTCI in 1995 led to reduced labor supply of co-residential caregivers – especially for men close to the legal retirement age. Geyer & Korfhage (2015) analyze the German LTCI using a structural labor supply model. Their extended choice model includes the recipients' decision on the type of LTCI benefits they use. The authors find that benefits in kind have a small positive labor supply effect, whereas cash benefits have a non-trivial negative labor supply effect. All of those studies only consider static effects. However, if long-run consequences are also considered, the incentives set by the institutions are more complicated. The income effect that incentivizes reduced employment during the caregiving period could diminish if agents also account for reduced earning opportunities in future periods. Including public LTCI into the model allows for the *ex ante* evaluation of policy changes to the LTCI institutions. Using simulations, we show that cash transfers and pension entitlement for informal caregiving can often mitigate the negative effects of caregiving – especially for individuals at the lower end of the income distribution. We show that while both policy measures have detrimental behavioral responses with respect to labor supply, they are ultimately welfare improving.

Third, in addition to analyzing the personal consequences of the different features of the LTCI, we also simulate the fiscal implication of informal caregiving under each policy scenario. In a related paper, Geyer et al. (2017) show that informal care should be associated with sizable indirect fiscal costs due to reduced tax payments, lower social security contributions, and increased unemployment and social security benefits. In line with this literature, we show that cash transfers and pension entitlements for informal caregiving increase fiscal costs of LTCI. Thereby, about 20% of the total fiscal costs of informal LTC do not result from the payments of LTCI but rather from indirect costs to the tax and benefit system. We also show that cash benefits for informal care supply increase indirect fiscal costs of caregiving by nearly 70% as it induces negative labor supply responses.

Fourth, our paper adds to the existing literature investigating the decision on informal caregiving in light of changing social policy. Fischer & Müller (2020) and Avendano Pabon et al. (2019) show that retirement policy and changes of retirement ages might affect the caregiving choice. Barczyk & Kredler (2018) build a dynamic non-cooperative framework for long-term-care (LTC) decisions of families to evaluate potential LTC policy option for the US. They show that informal caregiving responds strongly to non-means-tested informal care and formal care subsidies but also that potential caregivers responds negatively in their labor supply to these policy options. Fischer et al. (2022) show that in the German social policy setting, unemployment can lead to increased provision of informal care as unemployment subsidies and LTC subsidies reduce opportunity costs of informal caregiving as exogenous unemployment shocks happen. The results of our policy simulations show that cash benefits for informal caregiving reduced intensive and non-intensive informal caregiving while pension entitlements for informal caregiving incentive informal caregiving only marginally.

2. Long-term care in Germany

Unlike health care, which generally aims at improving individual's health conditions, LTC aims at making the current condition of individuals more bearable. In this section we describe the available data on LTC in Germany and the institutional system that is in place to support LTC dependent individuals.

German data on LTC: For the empirical analysis in this paper, we use data from the German Socio-Economic Panel Study (SOEP), which is an annually repeated representative panel survey of households and persons living in Germany. Since 1984, it includes nearly 11,000 households and about 30,000 persons each year.[6] We use the 2002 through 2019 waves since these include information on informal care provision. More specifically, SOEP asks households about their need of care or assistance on a constant basis due to age, sickness, or medical treatment. It further asks for the specific activities he or she needs assistance with. Table A.1 summarizes SOEP with respect to caregiving. Among individuals aged 25 or older, about 2% need LTC. The majority of these individuals is older than 70, more than 60% are women. Most of them need help with multiple activities of daily living (ADLs) and multiple instrumental activities of daily living (IADL), and about 75% receive care from a family member. This corresponds with observations in other countries around the world, where most LTC is provided informally by the family (Fujisawa & Colombo, 2009).

[Table A.1 about here]

Turning to caregivers, SOEP asks how many hours respondents spend on care and support for persons in need of care on a typical weekday. This question allows us to construct a caregiving variable that captures both personal and chore care activities.[7] Following this caregiving definition, about 6% of the observed individuals report providing informal long-term care to someone within or outside the household. More than 60% of informal caregivers are women and their average age is about 57 years old. In this paper, we focus on women aged between 55 and 67 years, as they are the most likely to be informal caregivers and still able to participate on the labor market. After dropping all missing observations, we end up with 30,331 observations of which 10.9% are engaged in informal LTC.

From information in SOEP, we do not know who the respondents provide informal care to. In order to gather this kind of information, we turn to another data set, the German part of the Survey of Health, Ageing, and Retirement in Europe (SHARE).[8] In SHARE, respondents inform

[6] For a description of SOEP, see Goebel et al. (2019); Wagner et al. (2007) and `http://www.diw.de/soep`, also including detailed questionnaires.

[7] In later waves, care provided on Saturdays and Sundays is also asked about. However, to keep the panel consistent, we only use the answers for weekdays in all waves.

[8] See Boersch-Supan & Wilke (2004),Börsch-Supan & Malter (2015), Malter & Börsch-Supan (2017) for further information on SHARE.

us about the help they give to potentially several individuals that live outside their household and personal care given to people living in their household. We have information on how many people respondents provide informal care to and who these people are, respectively.[9] We find that 14.13% of women in the age-group of interest (55-67 years old) report providing informal care to at least one person (who is not a child or grandchild) at least every week, and among them, 11.5% provide care to more than one elderly person in need. Table C.12 shows main recipients of informal care for the group of caregivers of interest: We find that 15.45% provide care primarily to a spouse, 49.30% to a parent, 10.34% to a parent-in-law, 11.75% to a neighbor, 8.81% to another relative, and the residual category contains 4.34%. Figure D.5 shows that the proportion providing care primarily to a spouse increases steadily with age of the respondent while the proportion providing care to a parent or parent-in-law decreases with age of the respondent.

Table A.2 summarizes the data of the estimation sample. On average, caregivers in the sample are less often employed and work fewer hours. The lower labor supply corresponds with the empirical findings in the literature (Lilly et al., 2007; Bauer & Sousa-Poza, 2015). Further, they are more often married, their parents – especially mothers – are more often alive and often live in the same town, and their spouses are more often in bad health. Intensive care (i.e. more than 14 hours of care per week) is slightly more common than light care (55% vs 45%, conditional on any care). Observed wages are higher for caregivers, which might indicate higher reservation wages.

[Table A.2 about here]

The German Public long-term care insurance: To fill the gap of private insurance, many countries – especially in Europe – have introduced publicly provided institutions in order to insure their populations against the risk of LTC. While some provide public LTC insurance – e.g., France or Spain – others provide tax-financed LTC benefits – e.g., Sweden, Norway, Denmark, or the U.K. Even though these systems vary in terms of generosity and their exact design, they share common features: many offer cash benefits either to the care-dependent or to the informal caregiver. Furthermore, in-kind benefits are often used to (partially) provide the necessary help at home or in nursing homes. Care leave options sometimes allow informal caregivers to temporarily leave employment to provide care.

[9] See Appendix B.1 for further information about the usage of SHARE data and definitions of the variables.

Likewise, during the observation period, the German public LTCI provides benefits to individuals with permanent (at least six months) impairments in at least two ADL and one IADL.[10] Depending on the level of impairments, three care-levels are assessed by an independent institution – the Medical Service of the Health Funds. Table A.3 provides an overview of the eligibility conditions and Table A.1 describes the care levels in SOEP.[11] While about 66% of individuals with impairments are eligible for benefits from the LTCI, most have care level 1 (40%) or level 2 (20%). Only 6% have the highest care level 3.

[Table A.3 about here]

LTC comprises two parts: informal care, generally provided by nonprofessional family members, and formal care, provided by professional health care services. The public German LTCI hence offers multiple choices to the individuals eligible for care benefits. First, they can decide about the kind of benefits they prefer. Informal care benefits are given as cash transfers whereas formal care is organized as an in-kind transfer. In 2015, monthly benefits in cash for informal care ranged from 244 Euro (in care-level I) up to 728 Euro (in care-level III).[12] According to national statistics, about 70% of all recipients choose cash benefits. This number is even higher if individuals can rely on help from relatives (Geyer & Korfhage, 2015).

The German LTC system also provides pension entitlements to informal caregivers. Public pension benefits in Germany are directly linked to the individual labor market history, with individuals collecting pension entitlements for each year they are employed. The LTCI contributes to the entitlements (1) if individuals give care to a relative who is eligible for benefits from LTCI; (2) if care is provided for at least 14 hours a week; (3) if the care dependent person lives at home; and (4) if they do not spend more than 30 hours a week in paid employment. If these four conditions are satisfied, individuals can collect pension entitlements equivalent to entitlements collected on a job with 27% up to 80% of average earnings. If individuals are retired, they do not benefit from this regulation. For many women, these entitlements are not negligible as they are often higher than

[10] Rothgang (2010) and Schulz (2010) provide detailed overviews about LTC insurance in Germany.

[11] In 2017 a reform of the German public LTC insurance changed the system from three care-levels to five care grades. The reform aimed at extending the group of eligible LTC dependent individuals. For simplicity, we discard the reform in the analysis as changes to benefit levels were minor and only two years in our observation period were affected.

[12] In-kind benefits for formal care are more generous. These range from 468 Euro per month up to 1,612 Euro and are directly paid to the service provider.

entitlements collected, e.g., on an average part-time job.

3. The behavioral model

In our dynamic single agent model individuals take working and caregiving decisions. Individuals live in a world with in total T discrete time periods. At each age t they observe a vector of state variables s_t – such as socioeconomic conditions – and make decisions about their actions d_t. In general, agents can make decisions about their labor supply and whether they want to provide care to a relative. They can choose from a discrete set of choice combinations $D(s_t)$, which depends on the observed state vector. Most importantly, agents can only decide to provide informal care if they have a relative in need of care; positive working hours can only be chosen if individuals have a job offer; and retirement only becomes an option if it is legally feasible. Individuals are rational in the sense that their preferences are based on an underlying utility that is maximized by the agent. Individuals are forward looking and build expectations about future realizations of the state variables. When making their decisions, agents choose the action d_t that yields the highest current and discounted expected future utility until the terminal period T at age 85. Individuals enter the model at age 55 and decisions can be made until age 67. After age 67, all individuals are retired and cannot provide care.[13] Further, we allow for unobserved heterogeneity in the model by assuming two unobserved types $m \in \{1, 2\}$, which comprise a fixed proportion of the population (Heckman & Singer, 1984). By modeling the probability of belonging to type m as a function of the employment history at the initial age, we also account for non-random initial conditions (Wooldridge, 2005).[14] The two unobserved types enter the wage equation and utility function through utility for leisure.

In its general set up, the model builds on the structural model estimated by Skira (2015) in the U.S. context. However, some key differences exist, which should be acknowledged to understand differences in the results. Unlike Skira (2015), the model estimated in this paper considers the German tax and benefit system, inheritance as an additional channel for care supply, and retirement as an additional choice variable. On the other hand, Skira (2015) models health dynamics of the

[13] The sample descriptives show that this assumption is very reasonable with respect to working since at age 67 less than 2% of the sample is still employed. However, with respect to caregiving this assumption is more difficult to justify since many older individuals are still engaged in informal care. The reason for making this simplifying assumption is that in this paper we are mostly interested in the tradeoffs between caregiving and labor supply, which are less relevant after retirement.

[14] For further details on the initial conditions see Appendix B.15.2.

potential care recipient more comprehensively, which is not feasible using SOEP data. Furthermore, she puts a greater emphasis on labor market frictions – e.g., by including wage penalties for part-time work or by including frictions in moving between part-time and full-time work. Hence, compared to Skira (2015), the model estimated in this paper might miss the costs related to caregiving that result from the labor market. On the other hand, in this paper, decisions are more driven by non-labor income generated by social security institutions – especially pension benefits and LTCI – which gives the opportunity costs of caregiving a different interpretation. By concentrating on different channels, our model complements the results of Skira (2015).

3.1. Discrete choices

If and when individuals have a family member or friend in need of care, they decide on care provision on the intensive and extensive margin: $C_t \in \{nc, lc, ic\}$. The discrete options are no care, light care, and intensive care, representing percentiles of the care hour distribution in the sample. lc equals 364 hours a year (or 7 hours a week - the 25% percentile in the sample of caregivers). Likewise, ic equals 1,092 hours a year (or 21 hours a week - the 75% percentile in the sample or caregivers). We assign observations in the sample to caregiving choices accordingly.[15] Furthermore, individuals decide about their labor supply by choosing between no work, part-time work (1,040 hours a year, or 20 hours a week - the 25% percentile among working women), and full-time work (2,080 hours a year or 40 hours a week - the 75% percentile among working women): $H_t \in \{nw, pt, ft\}$.[16] If eligible, they can decide about retirement $R_t \in \{0, 1\}$.

3.2. Constraints

Agent's decisions are subject to several constraints. In the following we describe the job offer and care demand process before time and monetary budget constraints are explained.

[15] Women reporting to provide more than 0 but less than 728 hours of care per year (14 hours per week - the median in the sample) are assigned to provide lc while women providing at least 728 hours of informal care per year are assigned to provide hc (Appendix Figure D.7 shows the dispersion of reported hours around the discrete mass points.).

[16] See Appendix Figure D.6. Parallel to our assignment mechanism for caregiving, women in the sample who report between 10 and 34 hours of work per week (between 43 and 138 hours per month or between 516 and 1656 hours per year) are assigned to work part-time (1,040 hours a year); women reporting to work at least 34.5 hours per week are assigned to work full-time (2080 hours a year).

Job offer. Agents can only decide on positive working hours if they have a job offer. We assume that retirement is an absorbing state such that, by definition, the job offer rate is always zero once the agent decided to retire. Furthermore, we assume that all agents have a job offer with certainty if they decided to work in the previous period. We, therefore, discard the possibility of exogenous job separations. Job offer probabilities are only estimated if the agent was unemployed and not retired in the previous period. Job offer probabilities then depend on the level of education, whether the agent lives in East or West Germany, and on being below 65 years of age or older.[17]

Care demand. In the same way, agents only have to decide on care provision in case they face care demand. As we do not observe this variable in the data set, we specify a two-step process. First, agents either face no care demand ($CD = 0$) or they face care demand ($CD > 0$). This latent variable is driven by the probability that a parent has limitations with ADLs, whether at least one or both parents are alive and whether they live in the same town, whether a spouse exists and whether the agent provided any care in the previous period. Thus, agents incorporate that giving care in the previous period creates state dependence such that one needs to decide on care provision in future periods with higher probability. Conditional on care demand, we specify a second latent variable, indicating whether the agent faces light care demand or high intensive care demand. If agents face light care demand they have to decide between providing no care and providing light care. In case agents observe high intensive care demand they decide between providing high intensive, light care or no care. Whether light or high intensive care demand exists depends on the probability that a parent faces limitations with IADLs and lives close by, whether both parents are alive and whether the spouse is in bad health.[18]

In contrast to Skira (2015) agents in SOEP do not give information on functional health limitations of parents. Therefore, information on the probability whether parent(s) face limitations with ADLs or IADLs is imputed information building on parent's age and marital status as well as their daughters educational attainment. The processes are estimated outside the model on SHARE data.[19] Agents build rational expectations toward the evolution of limitations with ADLs and IADLs of parents and the impact on care demand.

[17]See Section Appendix B.2 for further information.
[18]See Section Appendix B.3 for further information.
[19]See Appendix B.14 for further information and regression results.

Time budget constraint. Yearly time available for leisure L, care C, and paid work H is limited to L_{max}, which is =4,160 hours per year - 80 hours per week. Leisure time available per period, L_t is determined by the difference between L_{max} and hours used for care and paid work.

Monetary budget constraint. Disposable income Y depends on labor income $H_t w_t$, non-labor income (spousal labor-) income SI_t, other non-labor income A_t and inheritances IH_t), as well as benefits from the public social insurances (LTC benefits CB_t, pension benefits $pension_t$, unemployment benefits UB_t and social assistance SA) and the German tax and transfer system (social security contributions SSC_t, tax payments Tax_t).[20]. As we abstract from savings, disposable income equals consumption.[21]

Labor income. Labor income depends on working hours H_t and the hourly wage w_t which is determined by human capital, approximated by work experience ($expEQ$), the level of education ($educ$), as well as by whether a person lives in East or West Germany ($region$).[22] Returns to education are allowed to vary by labor market experience. Further, the wage offer function allows for unobserved heterogeneity by including a type specific intercept $\omega_{0,m}$ with two types $m \in \{1, 2\}$ that comprises a fixed proportion of the population (Heckman & Singer, 1984).[23]

Pension insurance benefits. Pension benefits ($pension_t$) in retirement are linked to the individual labor market history and therefore incentivize individuals to work full-time and retire at discrete early and regular retirement ages (ages 60, 63 and 65 for women in the sample). Early retirement (before age 65) is connected to deductions to pension benefits. Further, times of intensive informal care provision impact pension entitlements positively as well.[24]

Public LTC insurance benefits. Public long-term care insurance benefits are at the heart of the model simulations. Individuals eligible for LTCI benefits can theoretically use them for their own

[20]See Sections Appendix B.11,Appendix B.10,Appendix B.9,Appendix B.8,Appendix B.7,Appendix B.6 for more information on other income sources.

[21]While savings are certainly important in inter-temporal decision making in general, they are less important in the German case because the public pension insurance finances the majority of old-age consumption. The public pension plan is embedded in the model.

[22]See Appendix B.4 for more information on the wage process.

[23]For further details on the initial conditions see Appendix B.15.2. When estimating the likelihood function, we follow, e.g., Haan et al. (2017) and include wage measurement error, which adds noise to sample wages but does not affect the received wages in the model. More specifically, we assume that sample log wages are given by $\ln(wage_t)+\mu_t$, where $\mu_t \sim N(0; \sigma_\mu^2)$ and is independent over individuals and years.

[24]See Section Appendix B.5 for further information.

consumption rather than for reimbursement of family caregivers. However, the law on LTCI explicitly intends cash benefits to reimburse informal caregivers[25] – which is why, e.g., Michaelis (2005) expects that cash benefits are largely transferred to informal caregivers. From SOEP data, we know that about 34% of all individuals who receive some informal care from a relative are not eligible for LTC cash benefits (see Table A.1 for the statistic probabilities). We use this information on eligibility ($P(EL)$=100%-34%) to calculate an expected value of cash benefits received for informal care provision CB_t. In the model, transferred cash benefits depend on provided informal care hours and relate to regulations of the LTCI. In the baseline model, we assume that the care-depended person meets at least the minimum criteria to be eligible for LTCI benefits. However, we decrease the expected paid-out cash benefits by $P(EL)$ to adjust for the population wide level of eligibility among care recipients. Table A.3 summarizes these eligibility criteria for each care level. For example, a person in the first care level needs 90 minutes of care each day – in care level 3 she needs 300 minutes a day.[26] To acquire this amount of care she receives a monthly cash benefit. This can be used to calculate a reimbursement rate per hour of informal care $p_t^{ic}(CL, year)$, which amounts to roughly 6.50 Euro/hour – slightly varying by year and care level.[27] That is, if individuals provide informal care in the model, the expected value of reimbursement is calculated as

$$CB_t = C_t \sum_{CL=1}^{3} P(EL) p^{ic}(CL). \tag{1}$$

In a robustness check, we discard the fixed probability ($P(EL)$ =34%) from the model but instead randomly assign a proportion of light caregivers (34% of the caregiving population) to not receive any care benefits. We report alternative estimation parameters as well as simulation results in Appendix B.16.

[25] On their homepage, the German Federal Ministry of Health (BMG) states: *"Das Pflegegeld wird den Betroffenen von der Pflegekasse überwiesen. Sie können über die Verwendung des Pflegegeldes grundsätzlich frei verfügen und geben das Pflegegeld regelmäßig an die sie versorgenden und betreuenden Personen als Anerkennung weiter."* (*"The cash benefit is transferred to the person in need of long-term care. In general, they can freely dispose of the use of the long-term care allowance and regularly pass the long-term care allowance to the caring persons as a token of appreciation."*) See `https://www.bundesgesundheitsministerium.de/`.

[26] Individuals who only receive light informal care should, by this definition, not be eligible for cash benefits. Our assumption is that the care provider modeled in the model is not the sole source of care.

[27] To keep the state space sparse, we set calendar year constant to 2014 in the model. All monetary amounts in the data set are adjusted to 2014 values. LTC cash benefit levels and other social security benefit levels represent relationships between 2014 income and benefits.

3.3. Flow utility:

Conditional on the observed state space, each period's actions yield immediate utility. Following Rust (1994), we formulate a random utility function (2) to describe current flow utility that combines a non-stochastic part with a random component $\epsilon_t(d_t)$, which cannot be observed by the researcher.[28] Following, e.g., Skira (2015) or Geyer & Korfhage (2015), utility is not only affected by consumption and leisure but also by the caregiving choice. *A priori*, the direct effect of caregiving on utility is ambiguous. On the one hand, caregiving is likely burdensome and physically demanding, thus negatively affecting utility.

On the other hand, individuals might also have an altruistic motive to be a caregiver (Johnson & Lo Sasso, 2000) or could experience *'guilt'* if they do not provide care to their parents (Li et al., 2010; Mommaerts, 2016). Moreover, the care decision can result for reasons other than income or leisure. Flow utility is summarized in the following trans-log utility function:

$$\begin{aligned} u_t(s_t, d_t, m, \theta) = \theta_1 \ln(aY_t) + (\theta_{2,m} + \theta_3(t)) \ln(L_t) \\ + \mathbb{1}(C_t > 0) \left\{ (\theta_4 + \theta_5(t)) ln(C_t) + \theta_6 \mathbb{1}(carey_t = 0) \right\} + \epsilon_t(d_t) \end{aligned} \tag{2}$$

We use the OECD equivalence scale to adjust disposable income Y_t by household size.[29] L_t indicates hours available for leisure. In line with the literature on retirement decisions, utility of leisure is allowed to vary by age (e.g., Heyma, 2004; French & Jones, 2011).[30] C_t represents yearly hours used to care for a relative. It enters the utility function in multiple ways: Besides entering as $ln(C_t)$, utility is allowed to vary by age.[31] Further, the indicator $carey_t$ states whether the individual has already provided care in the past and allows for adjustment costs to utility. Adjustment costs might result from having to get used to the new task.[32] The choice-specific error term ϵ_t can be interpreted as an unobserved state variable (e.g., Rust, 1994; Rust & Phelan, 1997; Aguirregabiria

[28] Note that for the matter of simplicity we abstract from individual indexing in all equations.

[29] $a = \frac{1}{(1+0.7x)}$, where x represents the number of additional persons in the household. This adjustment reflects economies of scale in consumption and follows e.g. Adda et al. (2017).

[30] Y_t is further normalized by 12,000 Euro per year and L_t is normalized by the maximum of leisure of 4,160 hours/year. Consequently, the less leisure a person has per period, the higher is the subtracted utility in that period if $\theta_{2,m}$ is positive.

[31] C_t is also adjusted by the maximum of leisure of 4,160 hours/year in the following way: $log(\frac{L_{max}}{L_{max}-C_t})$. In this way, high intensive care will give higher per-period utility in case θ_4 is positive.

[32] In this aspect we follow Skira (2015).

& Mira, 2010).

Further, we implement preference heterogeneity in the utility of leisure by assuming two unobserved types $m \in \{1, 2\}$ which comprise a fixed proportion of the population (Heckman & Singer, 1984).[33] Following Bellman's principle of optimality (Bellman, 1957) and Rust (1987) we solve the model by backward induction to describe state-specific choice probabilities.[34]

3.4. Transitions

The state space vector s_t contains 13 variables, which we describe in Table A.4.

[Table A.4 about here]

While some state variables are assumed to be constant over time (*educ*, *region*, *type*, *pdist*) or evolve independently of the agent's actions (*mage*,*fage*, *partner*) other state variables depend on choices: The agent's labor market experience increases deterministically by one additional year if the agent works full-time and by half a year if she decides to work part-time. Likewise, if the agent provides care for the first time, her care experience switches to one. Additional deterministic state variables are years in intensive care and years in retirement, which both increase by one if agent provides intensive care or is retired, respectively.

Other state variables are probabilistic: The probability that a spouse dies or switches between bad and good health in each period is estimated outside the model.[35] Agents build rational expectations toward the future states space in order to solve their optimization problem. They also build rational expectations toward care demand and job offer rates given the current state space and actions and incorporate potential results into their decisions.

The probability of own survival and whether parents die in the future are not estimated. For simplicity, we expect that survival probabilities follow the statistical life tables provided by European Statistics (Eurostat).[36] Naturally, the probability of survival decreases with age.

[33] For further details on the initial conditions see Appendix B.15.2.
[34] See Section Appendix B.12.
[35] See Section Appendix B.13 for information and Appendix Table C.15 for estimation results.
[36] See `http://ec.europa.eu/eurostat/data/database`.

4. Estimation

We estimate the dynamic model using maximum likelihood.[37] Our approach slightly diverges from the standard approach formulated in Rust (1994) and Rust & Phelan (1997) as the state variables *job offer* and *care demand* are unobserved. We apply a similar approach as in Iskhakov (2010) and use the probability functions (B.1) and (B.2) to integrate over the unobservables. Hence, the likelihood incorporates the probability distribution of $\{JO, CD\}$ and takes the following form

$$L(\theta,\lambda,\psi,\omega,\alpha) = \prod_{i=1}^{I}\Bigg[\sum_{m} P(m|s^i_{T^i_0-1},\alpha)\prod_{t=T^i_0}^{T^i}\sum_{(jo,cd)} q_t(jo,cd|s^i_t,d^i_t,\lambda,\psi) \\ P(d^i_t|s^i_t,m,\theta,\lambda,\psi) f(ln(wage^i_t)|m,\omega)\Bigg] \tag{3}$$

with $P(d_t)$ representing the choice probability given by equation (B.9), which is derived from the dynamic model. (jo, cd) are the elements of all possible combinations of job offer and care demand, while q_t is the probability of being in state (jo, cd), which is derived from functions (B.1) and (B.2). $P(m)$ represents the agents' probability of being the unobserved type m. This allows individuals to differ in permanent ways due to unobserved variables that are correlated to initial conditions. As individuals are observed for different time spans, T^i_0 indicates the first observation period and T^i her last observation. $f(ln(wage))$ is the density of the sample wage observation, again, conditional on the individual's unobserved type.[38] To simplify notation, $f(\cdot)$ is set to one for non-employed and retired individuals, i.e., individuals for whom the wage is not observed. The parameter vector $\{\theta, \lambda, \psi, \omega, \alpha\}$ will be estimated.[39]

Identification:. In the data, we only observe accepted job offers and care demand. This makes it hard to distinguish the labor supply and the informal care preferences from the job offer and care demand probabilities. However, the functional form assumptions in the model and the exclusion restrictions allow us to separately identify utility parameters from the parameters in the job offer and care demand functions.

[37] The authors would like to thank the HPC Service of ZEDAT, Freie Universität Berlin (Bennett et al., 2020), for computing time.

[38] Recall, that the sample log wage is equal to the actual log wage plus a normally distributed measurement error.

[39] We approximate the value function using interpolation as suggested in Keane & Wolpin (1994). We use numerical gradients but utilize the BHHH approximation of the Hessian (Berndt et al., 1974). The estimation of type probability function and the interpolation of the value function are described in detail in Appendix B.15.2 and Appendix B.15.1.

We assume that the job offer probability equals one if individuals have worked in the previous period. In addition, we do not differentiate between job offers for part-, and full-time work. Thus, the utility of leisure is separately identified from the job offer parameters by the transitions between full-time and part-time work and transitions out of labor. We only estimate job offer parameters on the group of women who are unemployed and not yet retired. Variables entering the job offer rate like educational attainment and living in East Germany do not directly impact utility and thus, serve as exclusion restrictions in estimating the job offer probability. Moreover, age enters the utility function linearly while only shifting the job offer probability if the age of 65 is reached.

We also only directly observe individuals responding to demand for care. Therefore, identifying care demand on the extensive and intensive margin is difficult. To face this issue, we introduce information on parents and the existence of a spouse as exclusion restrictions in the extensive care demand function. Further, we let caregiving in the previous period impact the extensive margin of care demand. These variables do not enter the utility function. To identify the distinction between the demand for light or high intensive care, we make several assumptions: while care demand on the extensive margin is driven by limitations with ADL, functional health limitations (IADLs) of parents drive the intensive margin of care demand. While both processes depend on the same underlying variables, they follow different exogenous functional forms. Then, functional health limitations (IADLs) of parents only increase the probability of high intensive care demand if parents live close by, and bad health of a spouse only impacts the intensive margin of care demand. In case high intensive care demand exists, agents have to choose between light and high intensive care and no care; in case of low intensive care, agents have to choose between no care and light care.

Conditional on care demand being identified by the richness of exogenous information on parents and spouses, we can separately identify utility for leisure and consumption from caregiving parameters: Women who have no parents (anymore) and/or no spouse (and thus a low probability of care demand) mostly only take labor decisions. Hence, they help identify consumption and leisure parameters. Women with a sick spouse and/or old parents will have to choose on providing care with a much higher probability. Variation in their caregiving and labor decisions conditional on age identify the utility parameters of care provision. Introducing any past caregiving in the utility function helps identify utility of caregiving further, as it shifts preferences given initial conditions.

Additionally, permanent unobserved heterogeneity helps explain differences in wages and labor and caregiving choices not explained by observable variation laid out so far. Allowing women to permanently belong to one of the two unobserved types helps the model to create persistence in choices within agents over time that is correlated with permanent differences in wages.

5. Results

In this section we present and discuss the structural model parameter results, the fit of the model regarding main choices, and care demand in the baseline and the robustness exercises. Table A.5 presents the structural model estimates for the baseline model as well as both robustness exercises.

Due to the interactions in the utility model, the coefficients in the utility function are difficult to interpret. While disposable income yields positive utility, the utility from leisure crucially depends on age and the agent's unobserved type. Ceteris paribus, caregiving hours provide negative utility in ages 55 and 56 before the positive θ_6 parameter leads to positive utility from caregiving from age 57 onward. However, providing care comes with losses in leisure time, and an increase in consumption which impacts utility. Depending on the unobserved type, the point in the income distribution, and the labor choice, high intensive or light caregiving might lead to negative or positive marginal utility. Providing care for the first time yields high negative utility, thus highlighting the costs to utility associated with adjusting to the new task. In order to assess the full utility costs of caregiving in the dynamic (long-term) setting we will analyze the full welfare effects of caregiving in Section 6.4.

The job offer probability (conditional on not working and not being retired in the previous period) is very low in the baseline (6%-9%) and decreases if agents are older than 65 or if they have *low* education. This underscores the importance of labor market frictions.

While the parameters in the care demand function are as expected, some are worth mentioning: We find that past caregiving positively impacts the probability that care demand exists in the current period. If both parents are still alive, one might be able to take care of the other and thus, it decreases the probability of intensive care demand. On the other hand, a spouse being in bad health dramatically increases the probability of high intensive care demand. Using the original data-set and parameters shown in Table A.5 (baseline model) we find that 20% of agents in the age 55 observe care demand while it is around 13% at age 67 (see Appendix Table C.13). In order to validate our estimated care demand probabilities by age externally, we use information from a special survey on subjectively observed care demand in Germany (SOEP-IS, see Section Appendix

B.18). In almost all ages, care demand probabilities from the estimated model lie within the 95% confidence interval of mean reported care demand by age from the SOEP-IS survey (see Appendix Figure D.8).

The wage offer increases with decreasing marginal returns in work experience for all individuals. The returns further vary by educational level. High educated individuals, on average, receive higher wage offers and have higher returns from work experience compared to lower educated individuals.

Most structural parameters are estimated to be significantly different from zero, except for three parameters in the care demand process (baseline): whether both parents are alive does not significantly impact extensive care demand. Fathers information (his probability of liitations with IADL and whether the father is alive) does not significantly impact the intensive care demand process.

If we include the existence of siblings in the state space and in the care demand process (see Appendix B.17), most parameters are not altered significantly (Table A.5, columns 5-6). The parameter on siblings in the care demand process is negative and significant and some parameters in the care demand process are altered slightly but not significantly. As we assign a fixed amount of non-intensive caregivers to a group that receives no cash benefits from informal caregiving (see Appendix B.16), utility parameters are slightly but not significantly altered; the same holds for the other estimated parameters (Table A.5, columns 7-8).

The discount factor β is not estimated but defined as 0.98, which is in line with the literature (e.g., Cooley & Prescott, 1995).

[Table A.5 about here]

Figure A.1 shows the fit of the model in the key outcomes of labor and informal care supply.[40] Overall, the model fits the data reasonably well. The model over-predicts unemployment in younger ages and over-predicts employment in higher ages. Appendix Figure D.9 shows the fit of the model in intensity of caregiving conditional on any care being provided. The model fits the split in non-intensive and intensive caregiving by age well. In the data and the model we find a slight transition from light to high intensive caregiving with increasing age, which reflects both, a changing demand

[40] We simulate 25 replicas of each individual from the data set given the state space variables and simulate actions according to the estimated parameters. To ensure comparability with the estimation sample, model predictions were only calculated for ages in which a person was also observed in the data.

of high intensive vs. light care and a change in utility and time availability with age.

[Figure A.1 about here]

The model should not only fit choice trajectories but also transitions in caregiving and work status. Table A.6 summarizes the transitions in the observed and in the simulated data in the baseline and both robustness checks. The model matches the high persistence of non-employment well, while it over-predicts transitions from employment into non-employment. Similarly, for caregiving the model matches persistence in non-caregiving well, but slightly over-predicts transitions from caregiving to non-caregiving and vice versa.

[Table A.6 about here]

6. Simulations

In this section, we use the structural model to simulate the costs of caregiving and the impact of the public LTC insurance in two steps: First, we simulate the impact of caregiving over the life-cycle and at ages 55, 59, and 63. Second, we simulate the impact of counterfactual policy scenarios.

6.1. Impact of caregiving on labor market outcomes

We simulate a status quo baseline data set in which women in the sample draw shocks to parental health as well as care demand shocks in the estimated model and take caregiving and labor supply decisions from the initial age (55, 59 or 63) until the final age 67. We construct 25 replicas of each observation. We compare this to two different counterfactual simulations with constant policy: First, we simulate a data set in which agents are not confronted with care demand in any age and compare the labor supply outcomes of all caregivers in the respective age between the two scenarios. This simulation helps us to understand how different caregivers' labor supply would be in the short run if caregiving was no option. We find that without caregiving at any age, women shift from unemployment and part-time work into full-time-work in the short run. This employment effect decreases at higher ages (12 percentage points (PP) more full-time at age 55, 7PP more full-time at age 60) (see Appendix Figure D.10). In the short run, retirement effects are small.

To understand the dynamic costs of caregiving, we then compare the baseline to a simulation in which care demand is set to *zero* in an initial period (ages 55, 59 or 63). The restriction on care demand is lifted after one period. Consequently, increased care provision will fade out after some time. We study consequences of caregiving for those women who take up informal caregiving in the initial period. Since the simulation affects only the part of the population that takes up care at age 55 (59, 63), comparing the scenarios yields the average responses to caregiving for the group that might actually take up care according to the model estimates. Thus, these estimates can be thought of as average treatment effects for the treated.

Figure A.2 shows the average differences in outcomes between the baseline scenario and the scenario in which care-demand is removed in an initial age. We depict short and long-term impacts of caregiving in the status quo (solid lines), without cash benefits for caregiving (dashed lines) and without pension entitlements (dottet lines).[41]

[Figure A.2 about here]

Chart (1) shows the average response in caregiving. As 10.8% of women in the baseline provide care in at age 55, the difference to the alternative (no care provision at age 55) converges toward zero because women in the alternative are allowed to provide care from age 56 onward. Interestingly, the response in caregiving is similar in each age group.

On average, women who provide care under status quo regulations reduce employment at the extensive margin (chart 2) by 5.3PP. This effect is larger at age 59 and smaller at age 63. The reason for high effects of caregiving on labor force participation at age 59 is the proximity to early retirement ages and higher utility for leisure at age 59 than at age 55. At the intensive margin, changes are less heterogeneous: Caregiving women who work at the same time reduce labor hours by 2.4 hours at age 55. The older women are, the more they reduce their working hours (chart 3) because of their higher preference for leisure. Due to labor market frictions, agents who decide to be unemployed while providing care might not receive a job offer thereafter (chart 4). Hence, some agents cannot return to employment after the care spell has ended. Even after caregiving has almost returned to the baseline level, the job offer probability is still lower on average, which translates into persistent lower employment and wages in later periods. In contrast, working hours conditional labor market participation return to pre-caregiving faster, as agents can freely choose between part-, and full-time work. Once individuals are eligible for retirement, they retire earlier

[41] Simulation results for the robustness check are describes in Appendix B.16.

on average if they provide care at age 59 (chart 5). This is driven by the lower job offer probabilities after leaving the job at age 59. Indeed, if women are eligible for retirement benefits and have no job offer, they have an additional incentive to opt for (early) retirement. At age 63, few of the women remaining in the labor force who provide care are affected by caregiving. Caregiving at age 55 does not affect retirement substantially.

We can use the rich information in our structural model and the underlying data to look at impacts of caregiving by educational attainment and marital status.[42] While lower educated women provide more informal care at age 55 (11.6PP for lower educated vs. 10.4PP for higher educated), their labor force response is lower (-4.3PP vs. -5.8PP). Negative employment responses for lower educated women are more persistent, though. This translates into larger reductions in the probability of a job offer over time and into stronger hastening of retirement.

Differentiating responses by partner status, we find that more single women than married women provide care at age 55 (11.5% vs. 8.8%).[43] However, married women respond with larger reductions in labor force participation than single women (-5.8PP vs. -5.4PP), which translates into stronger and more persistent reductions in the job offer rate for married women as well as stronger hastening of retirement. The reason is that married women can use other forms of income (e.g. spousal income) as an insurance device in times of informal care provision.

In a last step, we look at the effect of caregiving at age 55 (59, 63) if women enter age 55 with a 10PP higher labor force participation.[44] Take-up of informal caregiving is slightly higher (10.09% vs. 10.8% at age 55). The difference originates from a smaller take-up of high-intensive care. Labor market responses in this new scenario are higher as more women are now active on the labor market and respond to caregiving by reducing their labor force participation. This has stronger long lasting impacts on their job offer rates and wages. We also see a stronger hastening of retirement.

[42] Figure D.18 in the Appendix shows responses to care shocks at age 55 by educational attainment and dependent on the policy scenario.

[43] Figures D.21, D.22, and D.23 in the Appendix show differential responses for care at age 55, 59, and 63 respectively.

[44] In this scenario, we assign 10PP more women who report not having worked at age 54 to the group that had worked at age 54. In this way, more women will have a definite job offer at age 55. Of course, this does not mean a one-to-one translation into higher labor force participation at age 55, as women take this decision with regards to their full set of opportunity costs. Figure D.24 in the Appendix shows responses in caregiving and labor outcomes for the status quo and the scenario in which all women had worked at age 54. In a robustness analysis, we increase labor market experience in full-time equivalences by 10% for all women and conduct the same analysis. Appendix Figure D.25 depicts that this has negligible effect.

6.2. Impact of public LTC policies

In the following, we attempt to disentangle how different features of the German LTCI affect the choices made by the agents and their personal costs of care. That is, we repeat the same baseline and no-care-demand simulations as above but we individually remove the two specific public LTCI policies of interest: cash benefits and pension entitlements for caregiving, respectively.

If cash benefits are not provided, the situation is different for the potential caregiver because caregiving is no longer associated with an income effect from public LTCI financial compensation. This also affects the take-up of (especially high-intensive) informal caregiving at all ages (Appendix Figure D.11). Further, caregivers reduce full-time work less and retire later without cash benefits. If we discard cash benefits from the caregiving simulation at age 55 (Figure A.2), only 8.5% of women provide care.

To maintain income, about 2PP fewer caregiving women aged 55 quit employment to ease their time constraints (chart 2), and working hours conditional on working are reduced by 1hour less per week (chart 3). As a result, the influence of caregiving on labor market outcomes is less persistent as job offer probabilities are, on average, higher. The impact of cash benefits are similar for caregiving at ages 59 and 63.

Pension entitlements for informal care are similar to a cash transfer but materialize much later – after retirement. Therefore, they provide lower incentives in the current period as future benefits are discounted. Behavioral differences compared to the original simulation are much smaller, but the direction is similar to the scenario without cash benefits. We find that 0.1PP fewer women take up informal caregiving as long-run incentives are reduced.

An interesting exception occurs if care is provided at age 63. Under status quo regulations, agents can increase their future pension benefits by caregiving only if they are not yet retired at the time of caregiving. Therefore, the model predicts that under status quo regulations, retirement is postponed by some women who provide care at age 63. Without this policy, women who first provided care after the legal retirement age, retire earlier if they are not compensated with pension points for care because they can no longer postpone retirement and collect pension points (chart 5).

We find that without LTC benefits, labor market responses for both educational groups are smaller.[45] Differences in caring behavior and labor market responses are stronger for married women in the scenario in which LTC benefits are abolished. Without the cash benefits, married women show a starker decrease in care provision and reduce labor force participation much more than single women.

In a next step, we study the importance of public LTC policies for care outcomes more deeply.[46] Differences in take-up of caregiving in the initial period between the baseline scenario and the no-cash-benefit-scenario are mostly due to differences in high intensive informal care. Using our estimates for care-demand (extensive margin), we find, that agents respond to 53% of all care needs at age 55 in the baseline (62% at age 59 and 63% at age 63).[47] Without cash benefits, around 8PP less care needs are met at age 55. If we interpret high intensive care demand as 90.3 hours of care demand per week and light care demand as 30.1 hours of care demand per week, we can calculate the percentage of demanded care hours being met. This combines the (un-)met caregiving needs on the extensive and intensive margin. In the baseline, 41% of demanded care hours are provided at age 55 (47% at age 59 and 49% at age 63). Without cash benefits, this drops to 33% at age 55 (37% at ages 59 and 63), showing that cash benefits lead to reactions in care provision at the intensive and extensive margin (chart 2).[48]

6.3. Personal costs

In this section we describe short and long-term personal costs of caregiving. In a first analysis, we look at instantaneous labor earnings effects in the initial caregiving age: We find that due to reduced labor supply on the extensive and intensive margin, the average caregiving woman earns 1,700 Euro less at age 55. At age 59, instantaneous (one-period) losses in labor earnings amount to 2,039 Euro and at age 63 to 768 Euro.[49]

[45] If caregiving happens at age 59, both educational groups react similarly in take-up of caregiving. Higher educated women, however, react by decreasing employment more (-5.7PP vs. -4.3PP), with stronger effects on the job offer rate for higher educated and more persistent effects on the job offer rate for lower educated (see Figure D.19 in the Appendix). The same pattern holds if caregiving happens at age 63 (see Figure D.20 in the Appendix).

[46] Appendix Figure D.16 shows the response in overall informal caregiving in chart 1, light caregiving in chart 2, high intensive caregiving in chart 3. Chart 4 shows the difference in accumulated years in informal caregiving. While non-intensive caregiving is counted as 0.33 years of experience, intensive caregiving is counted as a full year of caregiving experience.

[47] See Appendix Figure D.17.

[48] Effects of the benefit structure on care given to care-dependent elderly individuals is beyond the scope of this analysis. It could be that more formal care is provided.

[49] This calculation does not take into account potential social insurance payments or non-labor income from spouses as well as public LTCI benefits for caregiving.

In Figure A.3, we use simulation results to calculate the consequences of caregiving on the net present value (NPV) of life-time (labor) income, pension benefits, and disposable income evaluated in the initial caregiving age, taking into account all behavioral adjustments predicted by the model until age 85. Graphs (1), (4), and (7) summarize the simulated changes of expected NPV of the remaining labor earnings at ages 55, 59, and 63, respectively.

[Figure A.3 about here]

The caregiving shock at age 55 (59, 63) results in an average decrease in discounted life-time labor earnings of 3,150 Euro (3,390 Euro, 845 Euro). These results show that instantaneous losses in labor earnings in the year of caregiving make up only around 50% (60%, 90%) of losses in NPV of life-time labor earnings. This points to the importance of incorporating long-term impacts of caregiving on labor income. Moreover, effects are higher for individuals in the middle part of the income distribution. The simulation results suggest that if a woman in the third quartile of the income distribution has to provide care at age 55, on average her NPV of labor earnings is decreased by almost 4,000 Euro. For women in the same age but in the first quartile of the income distribution, the NPV of earnings is only decreased by about 2,000 Euro. Yet, as initial earnings are also lower in the first quartile, relative changes to labor earnings are higher in this group (-15%) compared to high income individuals (-3% in the third quartile). Women in the fourth quartile less often react by decreasing labor supply as they often value full-time work. Therefore, women in the fourth quartile have lower labor income costs even though their wages are higher.

As seen above, if the shock happens at age 59, labor market responses are higher, especially for women in the higher parts of the income distribution. This translates into higher relative and absolute reductions in labor earnings. If the shock happens at age 63, fewer women are still employed and can respond with their labor supply and their affected time span before retirement is shorter. Consequently, labor earnings are less affected (in absolute Euro) if women in this age group provide care. Relative effects are large as many of those women leave the labor market and loose all remaining labor income.

Graphs (2), (5), and (8) summarize the simulated changes of expected NPV of the remaining pension benefits due to caregiving in the initial age. All women benefit in terms of pension benefits. Even though, women in all income quartiles loose labor income and therefore pay less into the pension system, the LTCI pays their pension entitlements, therefore outweighing the forgone pension points. The simulation results suggest that if a woman in the first quartile of the income distribution provides care at age 55, on average, her NPV of pension benefits is about 1,000 Euro (3%) higher compared to the baseline. For women in the middle of the distribution, pensions are affected less relatively by caregiving. This group has higher costs in terms of income and forgone pension points due to caregiving. As the amount of pension entitlements due to caregiving is flat, higher income individuals gain less from this policy in relative terms.

Higher educated women's labor earnings are impacted more by caregiving at age 55 (3,600 Euro vs. 2,900 Euro).[50] This is driven both by higher labor market effects as well as higher earnings for the highly educated. Lower educated women experience a greater increase in retirement benefits than higher educated women. Caregiving at age 59 leads to similar patterns. Married women provide less care and reduce labor supply more than single women. They still experience lower losses in NPV of labor income.[51] This is due to lower average wages for single women.

In graphs (3), (6), and (9), we show the change in expected NPV of remaining disposable income at the point of the care shock. This measure also includes non-labor income and all benefits from the social security system, such as social assistance or benefits from the long-term care insurance.[52]

As most caregivers do not adjust labor supply, on average, positive consequences of caregiving outweigh the negative effects of reduced earnings. This is true in all age groups and all income quartiles. Individuals at the lower end of the income distribution benefit more from caregiving than women in income quartiles 2 and 3, as their reduction in labor earnings is smaller than those in the middle of the income distribution. We find that the NPV of disposable income rises for both lower and higher educated women due to caregiving at age 55. The increase, however is much smaller for higher educated women (2,600 Euro) than for lower educated women (3,600 Euro). Single women experience a higher increase in NPV of disposable income as they provide more informal care and, thus, receive more benefits and pension entitlements.

On average, labor income effects are much smaller if cash benefits are not available because they provide an incentive to leave the labor market. While this is true throughout the income distribution, individuals with higher wages and higher education react less to cash benefits in their

[50]Figure D.26 in the Appendix shows heterogeneous costs by age at caregiving and policy scenario.

[51]Figure D.26 shows heterogeneous effects by marital status.

[52]It also includes inheritances, which might be higher after having provided informal care. In all graphs, the dark gray bar shows results under status quo regulations, while the lighter gray bars show changes without cash benefits from LTCI and without pension entitlements. Stars indicate percentage changes.

employment. Consequently, without cash benefits, caregivers have lower losses in collected pension points. On the other hand, individuals provide less care (especially high intensive care) and receive pension entitlements. Due to the selection effect into caregiving, without cash benefits, women have lower gains in pension benefits on average.

The total effect on disposable income combines the income (and pension benefit) effect due to adapted labor market choices with the change in income due to reduced benefits from the LTCI. If women provide care at age 55 without cash benefits, the NPV of disposable income is about 3,000 Euro lower, on average, than in the scenario in which cash benefits are available. Without cash benefits, caregiving effects on the NPV of disposable income are on average still slightly positive due to the reduced loss in labor income and the increases in pension entitlements. Overall, the positive income effect of the cash benefit outweighs the negative substitution effect into unemployment in monetary terms.

Likewise, the total effect of pension entitlements is driven by ambiguous factors. *Ceteris paribus*, the possibility to collect pension points for caregiving increases future pensions of caregivers. Yet, this feature also incentivizes reduced labor supply in that it decreases the opportunity costs of working, which also affects pension benefits, as fewer years in employment entail reduced pension point accumulation. Considering that the timing of retirement is also affected, the consequences for disposable income are even more ambiguous. The results indicate that, overall, caregiving individuals receive reduced pension benefits without pension points for care. This is true irrespective of age at caregiving or position in the income distribution. As low-income individuals are often unemployed, the additional pension points cause a real gain, while the negative secondary effects of reduced employment are less important.

Overall, on average, total NPV of disposable income still increases even without pension points for care. However, if women are confronted with care at age 55, the absence of pension entitlements leads to a loss of 1,000 Euro in the NPV of disposable income in comparison to a scenario in which pension entitlements exist.

If women enter age 55 with a higher labor force participation, they lose more labor income, gain less retirement benefits, and experience a lower increase in disposable income due to caregiving at ages 55, 59, and 63. This is driven by starker impacts in the lower part of the income distribution (see Figure D.27 in the Appendix).

6.4. Welfare effects

Using the structural model, we further evaluate the welfare implications of our simulations. We follow Skira (2015) and Coe et al. (2018) and calculate a lump-sum amount of money that is necessary to equalize an average woman's realized value function in the baseline simulation without care demand in the initial period to her realized value function in the simulation where she takes the decision to provide care. This measure does not only account for forgone income but also for consequences on leisure or (dis-)utility from caregiving in the initial age (55, 59, or 63) and expected effects until the terminal age (85). Thus, it can be interpreted as a comprehensive measure for the costs of informal care (Coe et al., 2018).[53] Again, we only analyze welfare differences between the baseline simulation without restrictions on care demand and the no-care-demand simulation for agents deciding to provide care at the initial age in the baseline. Women deciding to provide care in the baseline reveal their preference for caregiving. Thus, by construction, they experience a higher welfare in the caregiving simulation than in the simulation with restrictions on care demand.[54] Our focus lies on the analysis of heterogeneous welfare effects of caregiving and the heterogeneous welfare implications of public LTC policies.

Figure A.4 shows average welfare gains due to caregiving in terms of compensating variations. The average woman in the population is willing to pay 16,445 Euro or 1.64% of the NPV of her lifetime disposable income for providing care at age 55. While all women gain welfare from caregiving at age 55, women in the first income quartile experience the lowest gains (10,807 Euro, 7.5%). With increasing income, women gain more in the caregiving scenario (16.410 Euro in the third quartile, 21,167 Euro in the fourth quartile). The reason is threefold: While the direct utility effects of caregiving are similar, the losses in leisure due to caregiving are experienced as positive by women in the unobserved type 1 and negative by women in unobserved type 2. Women in the upper part of the income distribution are more often of unobserved type 1. Further, women in upper income groups have lower labor income losses and higher gains in disposable income over their life-cycle through caregiving.

[53] We disregard the top and bottom 5% of calculated welfare costs.

[54] Our welfare analysis is difficult to compare to those by Coe et al. (2018) and Skira (2015). Coe et al. (2018) analyze welfare effects for a woman who provides no care in the baseline but who provides care in a simulation in which she is forced to provide care. Thus, Coe et al. (2018) find negative welfare effects of caregiving in the baseline. Skira (2015) analyzes welfare effects of introducing LTC policies for a set of women providing care already without the policy. By construction, she finds positive welfare effects of the policies but compares the policies to each other in terms of welfare improvements.

If care is given at age 59 and 63, costs to welfare for the average women are slightly higher (18,712 Euro and 19,061 Euro, respectively) and less heterogeneous across income quartiles than if care is given at age 55. The reason is that utility from caregiving increases faster with age than dis-utility from forgone leisure does.

Without cash benefits for caregiving, women who provide care in the intitial age experience much lower welfare gains from caregiving. Cash benefits reduce these welfare gains on average by 4,669 Euro. Without cash benefits, caregiving women experience only very low gains in disposable income over their life-cycle. Further, cash benefits change the labor supply and labor income effect of caregiving. Women in the upper three income quartiles profit much more from LTC cash benefits in terms of welfare than women in the first income quartile. Especially women in income quartile 2 show much lower reductions in labor supply and lower labor income losses through caregiving without cash benefits. Cash benefits increase welfare gains from caregiving at ages 59 and 63. In higher ages, women provide slightly more high intensive care and receive more benefits on average.

Pension entitlements slightly increase the welfare gains from caregiving. While behavioral changes of pension entitlements are negligible, women receive increased pension benefits later on. These materialize late in life; thus, in higher ages (59 and 63), the discounted gains from pension entitlements increase welfare more.

[Figure A.4 about here]

The fact that, on average, welfare gains in monetary terms are by the factor five higher than disposable income gains from caregiving shows that for those providing care, caregiving gives high positive utility. We can also show that, all things considered, both, cash benefits from caregiving and pension entitlements are valued by caregivers, even though both policies have negative implications for life-time labor income.

6.5. Fiscal consequences

In order to evaluate public LTCI policies, it is important, on the one hand, to also know about their fiscal consequences due to direct payments (cash benefits) and pension entitlements for caregivers. On the other hand, it is misleading to only account for the direct costs. As Geyer et al. (2017) argue, informal care can induce additional (hidden, indirect) fiscal costs that result from decreased labor supply on, e.g., tax payments or social security contribution.[55]

Table A.7 shows the fiscal impacts of setting care demand to *zero* at an initial age. That is, negative numbers indicate fiscal costs and positive numbers indicate a fiscal gain of caregiving in the respective initial age.[56] If an average woman starts to be a caregiver at the age of 55, the direct cash benefits amount to 10,724 Euro more than if caregiving is allowed from age 56 onward only. The direct costs of pension entitlements amount to 351 Euro.[57] Due to the behavioral impacts of caregiving, indirect costs arise from a fiscal standpoint: without caregiving at age 55, average life-time social security contributions are 841 Euro higher. This amounts to 1.61% of overall life-time social security contributions with caregiving at age 55. We also find a 588 Euro (1.23%) decrease in tax payments due to caregiving. As caregiving women, on average, receive higher pensions, this increases the pension payout by 1,602 Euro (0.86%). The increase in pension payouts prevents some women in retirement to be eligible for social security benefits. Thus, costs for social security benefits decrease. For caregiving at ages 59 and 63, though, the effects on pension payouts are lower due to larger relative decreases in labor supply. Overall, the average fiscal costs of caregiving at age 55 amount to 13,524 Euro, which is a large amount if one considers that Germany has about 2 million female informal caregivers in 2022; a number that is expected to keep increasing. If women start to be caregivers at higher ages, the fiscal costs are lower, but still economically significant, at 12,475 Euro if care is first provided i.e., at age 59 and 9,865 Euro if care is first provided at age 63.

[Table A.7 about here]

The costs of cash benefits account for the largest fraction of the total fiscal costs. The direct fiscal costs of cash benefits account for about 78% of the total fiscal costs of informal caregiving at age 55 (79% at age 59 and 92% at age 63). Columns 3-4 of Table A.7 summarize the fiscal effect of caregiving without the cash transfer. Naturally, the largest position is the cash benefit payment itself. Additionally, the cash transfer also affects labor supply and caregiving itself, which further increases the costs of this transfer indirectly. For example, without cash benefits, the decrease

[55] If caregiving also induces negative health effects (e.g. Schmitz & Westphal, 2015) that are not accounted for in this study, the fiscal consequences of caregiving would be higher since the public health insurance would also face additional costs.

[56] We calculate costs as average costs per caregiver and aggregate the entire expected remaining costs and benefits until the caregivers' end of life.

[57] Table C.14 in the Appendix shows direct fiscal costs of pension entitlements. For Table C.14 (coloumns 3-4) we take behavior from the baseline and the no-caregiving simulation (with pension entitlements) but disregard pension entitlements for caregiving in the calculation of pension benefits.

in social security contributions by caregivers would be about 584 Euro lower for women who are caregivers at the age of 55. The same is true for social security benefits (274 Euro), tax payments (435 Euro), and pension payouts (15 Euro). Indirect fiscal costs of cash benefits amount to another 9% (12%, 4%) of overall fiscal costs of caregiving at age 55 (59, 63), showing that behavioral changes due to cash benefits matter greatly for fiscal consequences.

Compared to the costs of cash benefits, the contribution of pension entitlements for intensive caregiving is much lower. Columns 5-6 of Table A.7 show the fiscal effects of caregiving without pension entitlements. While pension entitlements increase the average total costs for pension payouts between 660 Euro (age 63) and 2,665 Euro (age 55), they only accounts for 6.9% (age 63) up to 10.8% (age 55) of the total fiscal costs of informal caregiving.

Public LTCI cash benefits increase indirect costs by 87% while pension entitlements increase indirect costs by 9%.[58] Further, the simulation in this paper suggests that about 20% of the total fiscal costs of informal care result from these indirect costs.[59]

The fiscal costs of informal care must be evaluated in the context of formal care costs. In Germany, the average price for nursing homes is about 36,000 Euro per year.[60] On average, about half of the costs are covered by LTCI or social assistance. Hence, on average, the fiscal yearly costs of formal nursing home care accounts is about 18,000 Euro. In comparison, the costs of informal care are lower on average. Yet, they are not perfectly comparable since individuals in nursing homes often have worse health conditions and often move to nursing homes once family care is no longer feasible. Nevertheless, the simulation results show that a one-to-one comparison of direct costs is likely misleading and that behavioral consequences of caregivers must be considered for a full comparison of fiscal costs between different kinds of care.

[58] Indirect costs of caregiving with LTCI cash benefits (keeping pension entitlements equal) are full costs of caregiving in column 1 minus direct costs of LTCI cash benefits. Indirect costs of caregiving without cash benefits can be seen in column 3. The same calculation applies to changes in indirect costs through pension entitlements.

[59] See column 1 of Table A.7: 79.3% of all fiscal costs of caregiving at age 55 result directly from LTCI cash benefits. Table C.14 in the Appendix shows fiscal consequences from caregiving with baseline behavior but without calculating the impact of pension entitlements on retirement benefits. We find that another 2.6% of all fiscal costs result directly from pension entitlements. The rest are indirect costs of caregiving, arising through behavioral changes.

[60] See `https://www.pflege.de/altenpflege/pflegeheim-altenheim/kosten/`, visited April 2019.

7. Conclusion and discussion

In this paper, we analyze long-run effects of caregiving and how they are affected by regulations of a long-term care insurance (LTCI). We set up a dynamic model that describes care choices, labor supply and retirement decisions of women in Germany. We estimate the model using German Socio-Economic Panel (SOEP) data covering 2002 through 2019. We concentrate on women aged 55 to 67 because individuals in this group are usually still able to be active on the labor market and are more likely to be informal caregivers. We then use the estimated model to simulate counterfactual situations that are compared to the status quo baseline. The simulations allow for calculating long-run costs of informal care accounting for labor market frictions and the tax benefit system. The costs on the individual level, measured in lifetime income and welfare, are contrasted with the fiscal consequences of caregiving measured in tax revenues and social security contributions. Furthermore, we use counterfactual policy simulations to analyze how different features of the German LTCI affect the behavior of caregivers and the resulting costs of caregiving.

The results indicate that being a caregiver has adverse effects on labor market outcomes in the short- and long-run. In line with the literature (e.g., Crespo & Mira, 2014; Skira, 2015; Schmitz & Westphal, 2017; Kolodziej et al., 2018), the model predicts negative responses in employment and working hours, which persist even after care spells have ended. The reason is that labor market frictions make it difficult to immediately adjust the employment status, e.g., if agents get no job offer and can thus not return to employment. In general, the persistent employment effects would lead to lower lifetime income and to reduced pension entitlements in the absence of social security schemes. Like childcare, the provision of informal care could, hence, be associated with significant career costs, 50% of which only arise in the long run. [61]

However, under the German public LTCI, individuals in need of care can opt for cash benefits that are intended to reimburse family caregivers. Furthermore, if individuals provide intensive informal care and work fewer than 30 hours a week, LTCI contributes to their public retirement insurance. The simulation results in this paper show that both measures can (partially) compensate for the forgone income opportunities of caregiving. The extent of compensation further depends on the caregiver's position in the income distribution. Opportunity costs of caregiving are larger for

[61] Even though they are much lower compared to the costs of childcare as LTC spells are shorter and LTC is usually provided at higher ages that are less important for career decisions. For example, Adda et al. (2017) estimate that having children might reduce the NPV of lifetime income by up to 35%.

employees with higher remuneration. As LTCI measures are not related to household earnings but only depend on the level of impairments, low-income individuals benefit (in relative terms) more from LTCI compared to individuals at the higher end of the income distribution. Particularly for individuals at the lower end of the income distribution who are not employed, it can be financially beneficial to provide care for a relative who is eligible for LTCI cash benefits. The reason is that cash transfers are not subject to income tax, and payments from the unemployment insurance are also unaffected. Moreiver, we find that while lower educated women and singles provide more care, higher educated women and women in couples show larger negative employment responses to caregiving. Thus, singles profit more from LTCI cash benefits. While cash transfers can compensate for family care at the time of caregiving, they come with long-run consequences themselves. The income effect of the cash transfer increases the negative and persistent effect of caregiving on labor supply and, thus, has negative consequences for retirement benefits. However, since the LTCI also contributes to the retirement insurance of informal caregivers, this negative effect on pension benefits can, on average, be offset for individuals with earnings below the population average, which is true for most women in the sample. Compensation described here does not imply that individuals have the same earning opportunities in informal care as they have on the labor market. On average, the additional hours in informal care are much larger than the reduced working hours. Hence, also due to cash transfers and pension entitlements, individuals might not lose in monetary terms. Our analysis, shows that caregiving has positive implications for welfare over the full life-cycle for those providing care. Positive welfare-effects of caregiving are heterogeneous along the income distribution. We also find that the public LTCI policies studies have positive welfare effects. Other studies show negative health effects of caregiving that could induce negative welfare and fiscal impacts of caregiving that our paper has to abstract from (e.g., Stöckel & Bom, 2022; Schmitz & Westphal, 2015; Hiel et al., 2015). Further, our paper abstracts from interaction effects with formal care usage and welfare of the care dependent person. Our analyses show that both LTC regulations lead to an increase of informal care provision and a higher amount of high intensive informal care. As the literature shows that informal care can have positive health effects and health behavior effects for care dependent elderly (Hu & Li, 2020; Wu & Lu, 2017; Chon et al., 2018), it could translate into lower costs of not just the LTC system but also the entire health sector. Thus, public LTCI regulations are helpful in preventing these cost spillovers.

As women are expected to increase their labor force participation in all age-groups, we find that caregiving will lead to even higher detrimental effects on labor supply and income. While more women experience the double burden of work and care in this scenario, caregiving can also counteract policies trying to increase female labor force participation and effective retirement ages. However, it is beyond the scope of this paper to understand substitution effects between informal and formal care in case higher future labor market attachment of women leads to a decrease in informal caregiving (Mommaerts, 2016; Sovinsky & Stern, 2016). Likewise, this paper does not include interactions between family members (e.g. siblings) in caregiving decisions (Barczyk & Kredler, 2018; Byrne et al., 2009). These aspects might alter reactions in caregiving if children take into account other sources of care.

The average fiscal costs of informal family care can reach up to 13,524 Euro for each caregiving woman, which is substantial given that Germany has about 2 million informal female caregivers, a number that will only increase in the future. While these costs are lower compared to the average fiscal costs for care in nursing homes (about 18,000 Euro per year), the results highlight the importance of not only considering the direct costs of transfers from the public LTCI, but also the indirect costs that result, e.g., from lower tax payments and lower contributions to the social security system. The results in this paper show that the indirect costs account for about 20% of the total costs and that the policy measures, while improving welfare and personal costs of caregiving, increase indirect fiscal costs of caregiving as they come with behavioral responses.

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Appendix A. Tables and figures in main text

Appendix A.1. Tables

Table A.1: Descriptive statistics for Long-term care in Germany

	mean
Full sample	
In need of long-term care	0.02
Provides informal long-term care	0.06
Individuals needing care	
Female	0.61
Age	72.98
Age younger 70	0.33
Age 70-80	0.25
Age 80-90	0.31
Age 90+	0.11
Care from a family member	0.75
Needs help with...	
...getting around outside the house	0.11
...household chores, preparing meals	0.26
...washing, dressing, etc.	0.40
...getting into and out-of-bed, etc.	0.23
No care level	0.34
Care level 1	0.40
Care level 2	0.20
Care level 3	0.06
Individuals providing informal care	
Female	0.61
Age	56.91
Age 25-45	0.20
Age 45-55	0.24
Age 55-65	0.25
Age 65-75	0.18
Age 75+	0.13
Observations	405,860

Note: Rows 1–2 describe individuals in SOEP, years 2002-2019, aged 25 and older. Rows 3–17 summarize characteristics of individuals needing care. Rows 18–24 summarize characteristics of individuals providing informal care.

Source: SOEP, own calculation.

Table A.2: Descriptive statistics of the main estimation sample by caregiving status

	Variable name	(1) Non-carers		(2) Carers	
		mean	sd	mean	sd
Actions					
No work	H	0.64	0.48	0.68	0.47
Part-time work	H	0.15	0.36	0.14	0.35
Full-time work	H	0.21	0.41	0.18	0.39
No care	C	1.00	0.00	0.00	0.00
Light care	C	0.00	0.00	0.45	0.50
Intensive care	C	0.00	0.00	0.55	0.50
Retired	R	0.37	0.48	0.36	0.48
State-variables					
Age	age	61.09	3.81	60.72	3.67
East Germany	region	0.26	0.44	0.30	0.46
High education	educ	0.25	0.43	0.29	0.45
Work experience	expEQ	23.75	11.42	23.14	11.07
Years of caregiving	carey	0.35	1.10	2.04	2.52
Years of intensive caregiving	ecarey	0.09	0.56	0.76	1.88
Mother alive	malive	0.27	0.44	0.55	0.50
Mother age	mage	83.90	5.32	86.08	5.00
Father alive	falive	0.15	0.35	0.18	0.38
Father age	fage	86.12	5.98	86.76	5.24
Parents live in same town	pdist	0.29	0.45	0.57	0.50
Spouse in household	spouse	0.75	0.43	0.80	0.40
Spouse in bad health	health-partner	0.06	0.34	0.18	0.57
Spouse age	sage	63.82	5.85	63.58	5.63
Number of children	children	1.84	1.19	1.78	1.13
Earning-variables					
Hourly wage in euro	wage	16.75	8.91	17.07	8.80
Spouse yearly income in euro	SI	16,477.00	10,138.34	16,768.79	10,176.20
Yearly non-labor income in euro	A	7,430.41	23,524.34	9,035.55	24,451.14
Obtains inheritance		0.02	0.13	0.02	0.12
Inheritance in euro	IH	1,088.47	12,515.67	558.92	6,380.77
Observations		27,013		3,318	

Note: Mother age, father age, spouse age, whether parents live in the same town, and spouse yearly income are conditional on the existence of mother, father, and spouse respectively; wages and inheritance are conditional on positive working hours and positive inheritance respectively. sd: standard deviation.

Source: SOEP, own calculation.

Table A.3: Eligibility criteria for LTC benefits 1995-2017

	Care level		
	I	II	III
Necessary care:	Limitations in at least two ADL (personal hygiene, feeding, mobility; so called “basic care” (*Grundpflege*) and limitations in at least one IADL. Average care needed per day of at least 90 minutes. More than 45 minutes must be necessary for basic care.	Average care needed per day of at least 180 minutes. More than 120 minutes must be necessary for basic care.	Average care needed per day of at least 300 minutes. More than 240 minutes must be necessary for basic care.

Source: Geyer & Korfhage (2018)

Table A.4: Description of state space variables

Name	Description	Values
age	Age of agent	55-67
$expFT$	Work experience in full-time equivalents	0,20,40
$yearsRet$	Year since retirement	0-6
$fage$	Age of father	-1,0,70-90
$mage$	Age of mother	-1,0,70-90
$pdist$	Parents in same town	0-1
$ecarey$	Experience in intensive caregiving	0-6
$carey$	Provided care in the past	0-1
$type$	Type of agent	1-2
$region$	East or West Germany	0-1
$educ$	High or low education	0-1
$partner$	Partner alive and health of spouse	0-2

Notes: This Table shows state space variables tracked in the value function calculation and the respective range of values.

Table A.5: Structural model parameter estimation results

		Baseline		Robustness Siblings included		Robustness Different cash benefit calculation	
Description	Parameter	Estimate	S.E.	Estimate	S.E.	Estimate	S.E.
Utility parameters							
Consumption	θ_1	2.092	0.021	2.065	0.024	2.078	0.020
Leisure hours (type 1)	$\theta_{2,1}$	-1.526	0.033	-1.608	0.032	-1.527	0.032
Leisure hours (type 2)	$\theta_{2,2}$	1.040	0.036	1.071	0.040	1.036	0.044
Leisure age trend	θ_3	0.198	0.008	0.195	0.008	0.196	0.007
Informal care hours	θ_4	-0.468	0.066	-0.576	0.066	-0.457	0.063
First period of caregiving	θ_5	-3.185	0.056	-3.086	0.046	-3.182	0.051
Informal care age trend	θ_6	0.351	0.013	0.357	0.012	0.351	0.012
Job offer probability parameters							
Intercept	λ_0	-2.606	0.050	-2.715	0.052	-2.585	0.049
Aged 65 or older	λ_1	-0.647	0.088	-0.827	0.089	-0.739	0.089
High education	λ_2	0.108	0.069	0.341	0.077	0.168	0.073
Lives in East Germany	λ_3	0.269	0.084	0.330	0.091	0.262	0.086
Care demand probability parameters							
Intercept	$\psi_{1,1}$	-3.091	0.031	-3.046	0.032	-3.096	0.030
Mother ADL if alive	$\psi_{1,2}$	1.429	0.081	1.706	0.077	1.411	0.076
Father ADL if alive	$\psi_{1,3}$	0.831	0.140	0.695	0.145	0.806	0.136
Only mother alive	$\psi_{1,4}$	0.400	0.060	0.307	0.081	0.400	0.058
Only father alive	$\psi_{1,5}$	0.379	0.102	0.486	0.119	0.362	0.101
Mother and father are alive	$\psi_{1,6}$	0.088	0.110	0.171	0.127	0.077	0.108
Parents live in same town	$\psi_{1,7}$	0.546	0.054	0.538	0.054	0.563	0.055
Spouse alive	$\psi_{1,8}$	0.549	0.031	0.531	0.033	0.548	0.031
Caregiving in previous period	$\psi_{1,9}$	2.404	0.030	2.435	0.029	2.428	0.030
Sibling alive	$\psi_{1,10}$			-0.205	0.066		
Intensive care demand probability parameters							
Intercept	$\psi_{2,1}$	1.695	0.043	1.793	0.041	1.708	0.044
Mother IADL if alive and in the same town	$\psi_{2,2}$	1.683	0.147	1.619	0.172	1.665	0.158
Father IADL if alive and in the same town	$\psi_{2,3}$	0.620	0.375	0.416	0.366	0.490	0.381
Only mother alive	$\psi_{2,4}$	-0.315	0.085	-0.426	0.078	-0.329	0.082
Only father alive	$\psi_{2,5}$	0.130	0.151	-0.098	0.137	0.169	0.159
Mother and father are alive	$\psi_{2,6}$	-0.685	0.192	-0.906	0.168	-0.727	0.175
Spouse in bad health	$\psi_{2,7}$	1.355	0.082	1.066	0.080	1.261	0.082
ln(wage) offer parameters							
Intercept (type 1)	$\omega_{0,1}$	2.174	0.020	2.171	0.006	2.174	0.022
Intercept (type 2)	$\omega_{0,2}$	1.965	0.018	1.964	0.006	1.966	0.019
Work experience with *low* education	ω_1	0.020	0.002	0.020	0.000	0.020	0.002
Work experience squared/100 with *low* education	ω_2	-0.027	0.003	-0.027	0.000	-0.027	0.003
Work experience with *high* education	ω_3	0.037	0.000	0.037	0.002	0.037	0.000
Work experience squared/100 with *high* education	ω_4	-0.064	0.001	-0.063	0.004	-0.064	0.001
High education	ω_5	0.319	0.019	0.319	0.021	0.319	0.020
Lives in east Germany	ω_6	-0.340	0.005	-0.341	0.005	-0.340	0.005
Calendar year	ω_7	0.019	0.001	0.020	0.000	0.019	0.001
Unobserved type probability parameters							
Intercept	α_0	8.028	1.008	8.035	0.981	8.031	1.004
Age in initial period	α_1	-0.231	0.020	-0.232	0.019	-0.232	0.020
Labor market experience in initial period	α_2	0.181	0.008	0.181	0.007	0.182	0.008
Number of children	α_3	0.051	0.036	0.052	0.035	0.051	0.036
Other parameters							
Discount factor (not estimated)	β			0.98			
Obs.				30,331			

Notes: This Table shows results and standard errors (S.E.) for parameters estimated in the maximum likelihood estimation using SOEP data.

Table A.6: Model fit of transitions in labor supply and caregiving decisions

	Data	Baseline	Robustness	
			Siblings included	Different cash benefit calculation
% Nonemployed who are nonemployed again next period	97.94	98.67	98.76	98.60
% Transition from employmend to nonemployment	15.94	21.0	21.17	21.59
% Transition from nonemployment to employmend	2.06	1.33	1.24	1.40
% Employed who are employed again next period	84.06	79.00	78.83	78.41
% Noncaregiver who are noncaregiver again next period	95.40	94.88	94.80	94.91
% Transition from caregiving to noncargiving	38.39	44.49	45.03	44.51
% Transition from noncaregiving to cargiving	4.60	5.12	5.20	5.09
% Caregiver who are caregiver again next period	61.61	55.51	54.97	55.49

This Table shows conditional probabilities of transitions in caregiving and labor market choices in the estimation sample and the simulated data set. The data average was calculated using the estimation sample. The model predictions were calculated using a simulated sample. The simulated sample was constructed using the dynamic model for five trajectories of action and state variables for each individual in the sample. To ensure comparability with the estimation sample, model predictions were only calculated for with simulation outcomes from ages at which a person was also observed in the data.
Source: SOEP, own calculations.

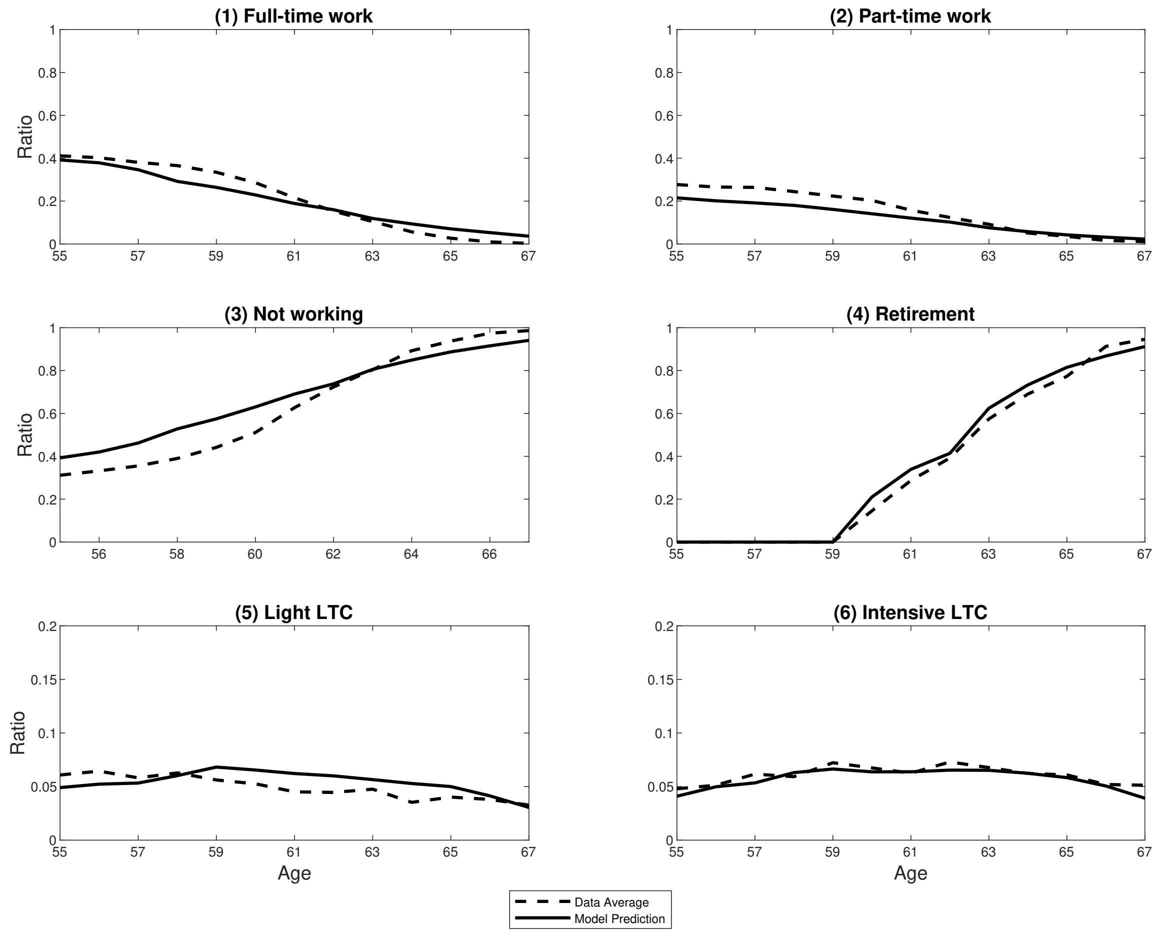
Table A.7: Fiscal consequences of LTC

	Total consequences		No Cash benefits		No pension entitlements	
	Euro	%	Euro	%	Euro	%
I Care shock at age 55						
Pension payout	−1602	−0.86	−1587	−0.86	1063	0.60
Social security benefits	231	0.57	505	1.28	−738	−1.71
LTCI cash benefits	−10724	−44.12	0	–	−10597	−44.23
Social security contributions	−841	−1.61	−257	−0.48	−983	−1.89
Income tax	−588	−1.23	−153	−0.31	−810	−1.71
Net effect	−13524	−0.09	−1493	−0.01	−12066	−0.08
II Care shock at age 59						
Pension payout	−1171	−0.73	−1269	−0.79	1066	0.69
Social security benefits	187	0.42	461	1.06	−776	−1.65
LTCI cash benefits	−9880	−52.50	0	–	−9635	−52.27
Social security contributions	−928	−3.37	−171	−0.59	−979	−3.59
Income tax	−684	−2.97	−28	−0.11	−745	−3.26
Net effect	−12475	−0.07	−1007	−0.01	−11068	−0.07
III Care shock at age 63						
Pension payout	−452	−0.33	−463	−0.34	208	0.16
Social security benefits	55	0.12	65	0.14	−217	−0.45
LTCI cash benefits	−9121	−70.84	0	–	−8817	−70.44
Social security contributions	−216	−1.71	18	0.14	−217	−1.73
Income tax	−130	−1.43	109	1.14	−144	−1.58
Net effect	−9865	−0.06	−272	−0.00	−9187	−0.05

Notes: This Table shows average fiscal consequences of caregiving for various aspects of the tax-and transfer system. Columns (3),(5) and (7) give changes in expenditure (revenue) relative to the baseline with caregiving for the respective fiscal category.
Source: SOEP, own calculations

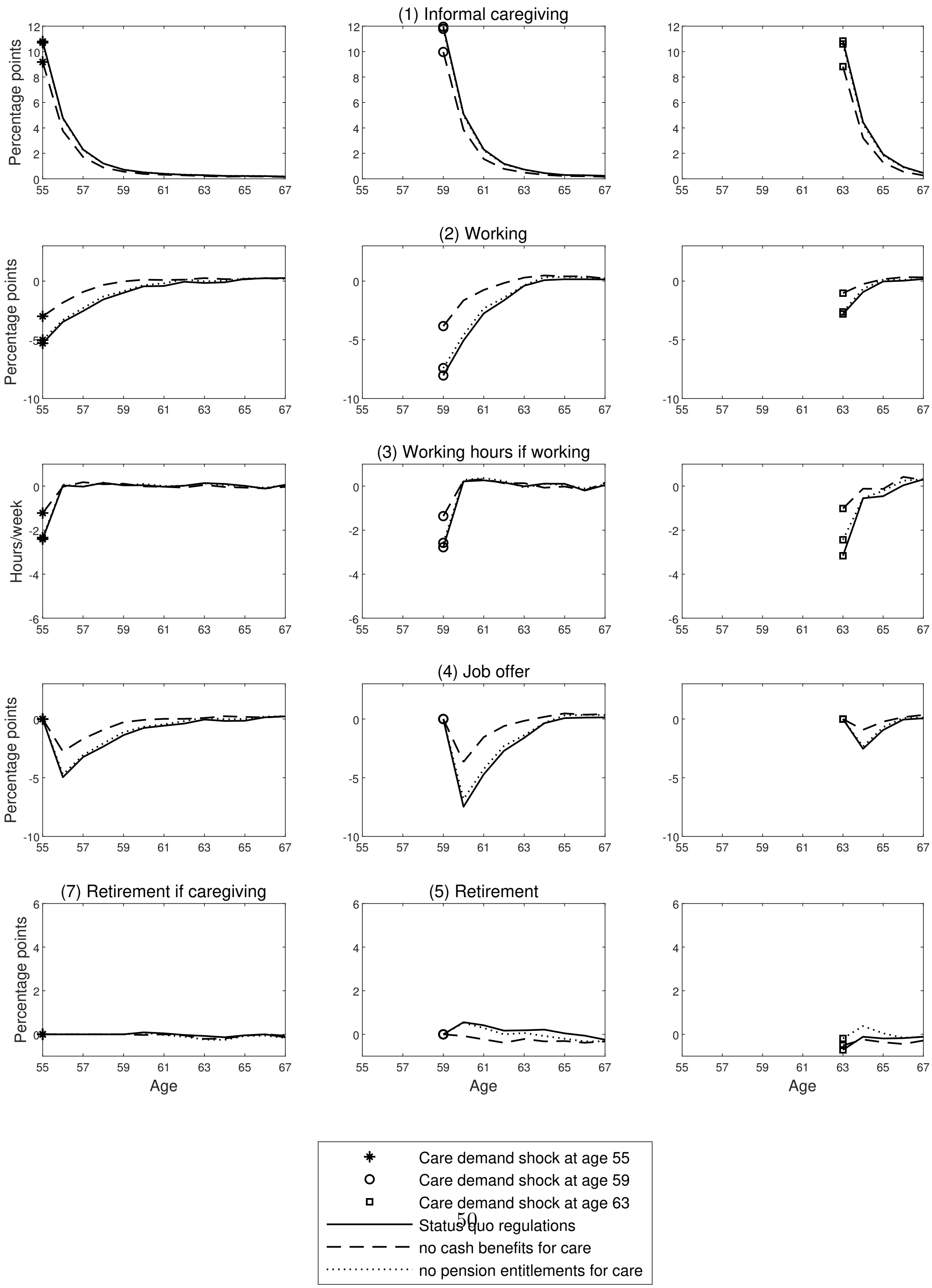
Appendix A.2. Figures

Figure A.1: Model fit of labor and care decisions



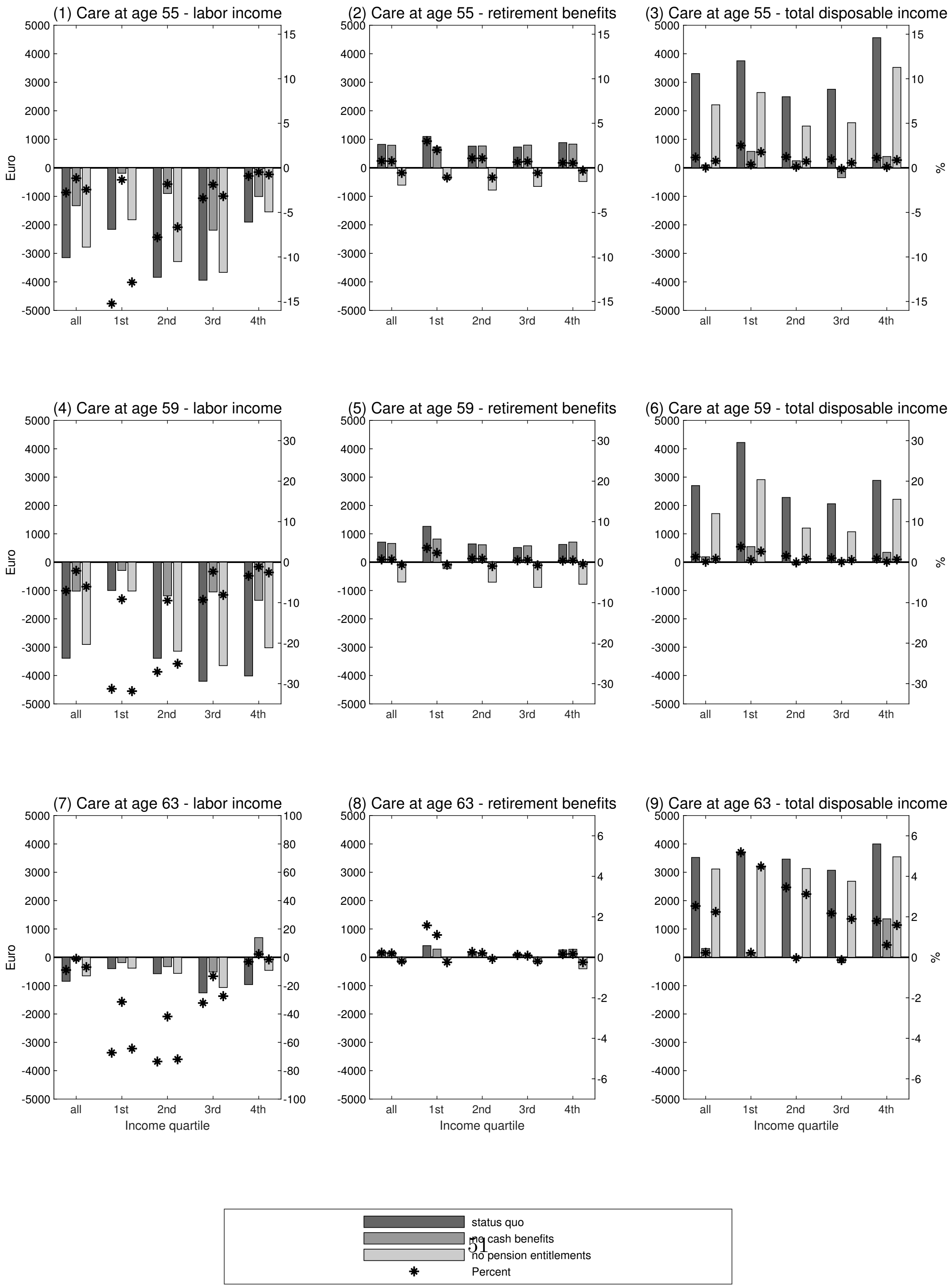
This Figure compares average decisions on labor supply and caregiving in the model and the underlying data. The data average was calculated using the estimation sample. The model predictions were calculated using a simulated sample. The simulated sample was constructed using the dynamic model for five trajectories of action and state variables for each individual in the sample. To ensure comparability with the estimation sample, model predictions were only calculated with simulation outcomes from ages at which a person was also observed in the data.
Source: SOEP, own calculations.

Figure A.2: Short and long-term labor market effects of caregiving



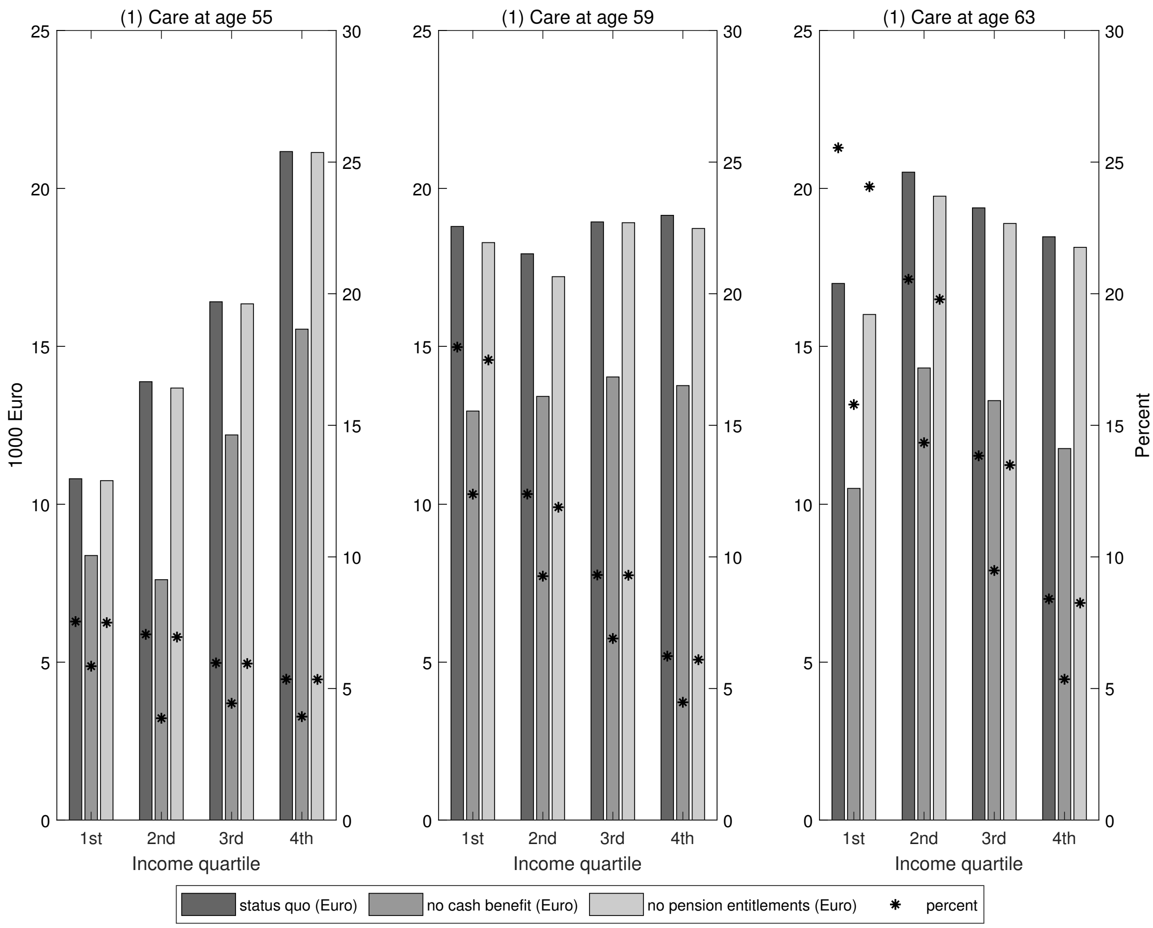
This Figure portrays effect of caregiving at ages 55 (left panel), 59 (middle panel), and 63 (right panel) on several labor market outcomes. Effects are differences between caregiving in the baseline and a simulation in which care-demand is set to 0 in the initial period (ages 55, 59, and 63). The Figure compares effects between 3 policy scenarios. *Source:* SOEP, own calculations.

Figure A.3: Caregivers' costs to lifetime income



This Figure portrays effect of caregiving at ages 55 (upper panel), 59 (middle panel), and 63 (lower panel) on the net present value (NPV) of lifetime labor income (left Figures), retirement benefits (middle Figures), and total earnings (right Figures) in Euro (left axis). The Figure also shows sizes of the effect in relative terms (percent, right axis). Effects are differences between caregiving in the baseline and a simulation in which care-demand is set to 0 in the initial period (ages 55, 59, and 63). The Figure compares effects between 3 policy scenarios. *Note: Source:* SOEP, own calculations.

Figure A.4: Caregivers' gains to welfare



This Figure shows gains of caregiving to welfare in terms of amounts of money that the average woman is willing to pay at age 55 (59, 63) in order to be as well off in the caregiving scenario and the scenario without care-demand in the initial period (ages 55, 59, and 63). The Figure shows absolute effects in 1000 Euro and relative terms and compares effects between the baseline scenario and a scenario without cash benefits for caregiving and a scenario without pension entitlements for caregiving. *Note: Source:* SOEP, own calculations.

Appendix B. Appendix

Appendix B.1. SHARE data

To gather further information on recipients of informal care provided by the group of interest in this paper (women aged 55-67), we turn to another data source: The German part of the Survey of Health, Ageing, and Retirement in Europe (SHARE). SHARE is specific to the socio-economic situation of the elder population in Europe (age 50 and older). Therefore, it contains more detailed information on informal care provision. In order to construct a variable of informal care provision that is close to the information in SOEP (the main data set), we define a women an informal caregiver if she provides help to at least one elderly person (not a child, grandchild, niece, or nephew) at least almost every week or personal care to an elderly person living in the same household. We end up with 783 informal care providers across waves 1-7 (wave 3 cannot be used as it only contains retrospective information on respondents) of SHARE among women aged 55-67. We then define the primary care recipient as the person reported as first of potentially 3 recipients who is an elder person in need who receives care at least almost every week or the person who receives personal care in the same household.

Appendix B.2. Job offer:

Individuals can only decide to work on the labor market if they receive a job offer. In the model, individuals receive a job offer with probability $P(JO_t = 1)$ that depends on the state space. While working is still possible after retirement in principle, it is uncommon in Germany. Hence, in the model, retirement is an absorbing state, meaning that agents cannot return to the labor market once retired. Consequently, the probability of receiving a job offer is *zero* once agents have retired. On the other hand, if a person was employed in $t-1$, it is likely that she will receive a job offer from the same employer once again. Therefore, we abstract from layoff and assume a job offer probability of *one* in t if a person was employed in $t-1$. Besides helping to identify the model parameters, in the German setting this assumption is reasonable due to the highly institutionalized protection against dismissal, especially at older ages. Only if the agent was not employed and not retired in the previous period are job offer probabilities estimated. We formulate logit-probabilities

(B.1)[62] that depend on Z_t: the level of education ($educ$), whether the agent lives in East or West Germany ($region$), and on being aged 65 or older ($t \geq 65$), which is the legal retirement age for most individuals in the sample.

Appendix B.3. Care demand:

Similar to the job offer, agents can only provide care if a parent, spouse or other relative depends on regular help, i.e. care can only be chosen if there is positive care demand. We formulate care demand as logit-probabilities (B.2) depending on the vector Q_t.[63] Informal care is most often provided to parents or spouses and functional health of parents is one of the most important indicators for LTC needs (e.g. Heger & Korfhage, 2018). Hence, care demand is explained by whether the mother and/or father are alive ($malive$, $falive$), their respective probability to have limitations with ADLs, whether the individuals have a spouse, and whether care was given in the previous period. The interaction indicating whether both parents are alive is included since parents might be caring for each other. Furthermore, whether parents live in the same town ($pdist$) is included as parents might be more likely to request care from children who live nearby. The parameter-vector ψ is also estimated within the likelihood function (3).

$$\begin{aligned}
\psi Q_t = \psi_0 &+ madl_t \psi_1 + fadl_t \psi_2 \\
&+ \mathbb{1}(malive_t = 1)(\psi_3 \mathbb{1}(falive_t = 0) + \psi_5 \mathbb{1}(falive_t = 1)) + \psi_4 \mathbb{1}(malive_t = 0)\mathbb{1}(falive_t = 1) \\
&+ \psi_6 \mathbb{1}(pdist_t = 1)\mathbb{1}(malive_t = 1 | falive_t = 1) + \psi_7 \mathbb{1}(partner_t = 1) \\
&+ \psi_8 \mathbb{1}(careL_t = 1) \qquad \text{(B.2)}
\end{aligned}$$

We then specify a second step of the care demand process to specify whether high or low-intensive care demand exists, depending on whether parents have limitations with IADLs (if parents live in the same town), whether one or both parents is alive and whether the spouse is in bad health

[62] The probability of receiving a job offer given that a woman is neither retired nor working in the previous period is as follows: $P(JO_t = 1) = \frac{\exp(\lambda Z_t)}{1+\exp(\lambda Z_t)}$, where λZ_t follow the following functional form:

$$\lambda Z_t = \lambda_0 + \lambda_1 \mathbb{1}(t \geq 65) + \lambda_2 \mathbb{1}(educ_t = high) + \lambda_3 \mathbb{1}(region_t = east) \qquad \text{(B.1)}$$

The parameter-vector λ will be estimated within the likelihood function given by equation (3).

[63] The probability of observing care demand follows the following function:$P(CD_t = 1) = \frac{\exp(\psi Q_t)}{1+\exp(\psi Q_t)}$

(indicated by the value 2 of the *partner* variable)):

$$
\begin{aligned}
\psi Q1_t = \psi_{1,0} &+ (miadl_t\psi_{1,1} + +fiadl_t\psi_{1,2})\mathbb{1}(pdist_t = 1)) \\
&+ \mathbb{1}(malive_t = 1)(\psi_{1,3}\mathbb{1}(falive_t = 0) + \psi_{1,5}\mathbb{1}(falive_t = 1)) + \psi_{1,4}\mathbb{1}(malive_t = 0)\mathbb{1}(falive_t = 1) \\
&+ \psi_{1,6}\mathbb{1}(partner_t = 2) \qquad \text{(B.3)}
\end{aligned}
$$

The intensity care demand process only becomes relevant if care demand exists on the extensive margin: $P(ICD_t = 1) = P(CD_t = 1) * \frac{\exp(\psi Q1_t)}{1+\exp(\psi Q1_t)}$ We estimate an alternative model in which the existence of siblings is included in the care demand function. Results for the estimation, model fit and simulation are reported in Appendix B.17.

Appendix B.4. Wage:

The wage is determined by human capital, approximated by work experience ($expEQ$), the level of education ($educ$), as well as by whether a person lives in East or West Germany ($region$). Returns to education are allowed to vary by labor market experience. Therefore, choosing positive working hours in period t has consequences for future income possibilities as well since it determines future work experience. Further, the wage offer function allows for unobserved heterogeneity by including a type specific intercept $\omega_{0,m}$ with two types $m \in \{1, 2\}$ that comprise a fixed proportion of the population (Heckman & Singer, 1984).[64] We estimate the parameters of the wage offer function ω inside the maximum likelihood function.

$$
\begin{aligned}
\ln(wage_t) = \omega_{0,m} &+ \left(\omega_1 expEQ_t + \omega_2(expEQ_t^2/100)\right)\mathbb{1}(educ_t = low) \\
&+ \left(\omega_3 expEQ_t + \omega_4(expEQ_t^2/100)\right)\mathbb{1}(educ_t = high) \\
&+ \omega_5\mathbb{1}(educ_t = high) + \omega_6\mathbb{1}(region_t = east) \qquad \text{(B.4)}
\end{aligned}
$$

[64]For further details on the initial conditions see Appendix B.15.2. When estimating the likelihood function, we follow, e.g., Haan et al. (2017) and include wage measurement error, which adds noise to sample wages but does not affect the received wages in the model. More specifically, we assume that sample log wages are given by $\ln(wage_t)+\mu_t$, where $\mu_t \sim N(0; \sigma_\mu^2)$ and is independent over individuals and years.

Appendix B.5. Pension benefits:

Public pension benefits in Germany are directly linked to the individual labor market history and the age of retirement. Individuals' pensions are calculated following the German pension formula

$$pension_t = (PenP_t) \times AF_t \times PV_{year}, \tag{B.5}$$

where $PenP_t$ denotes the sum of accumulated so called pension points at a given age t, AF_t denotes a retirement age factor, and PV denotes a year-specific pension value. Individuals accumulate pension points for every year of employment. These depend on personal labor earnings as well as on the mean gross population earnings in the period of employment. They are calculated as $\min\{H_t w_t / \overline{H_t w_t}, Max_t\}$, where $\overline{H_t w_t}$ denotes the mean gross labor earnings in period t and Max_t denotes a year-specific cap on pension points, which varies roughly around two. If an individual earns exactly as much as the population average, she will receive exactly *one* pension point in that year. The mean gross earnings in East Germany are adjusted to account for lower salaries in that region. In the model, we use estimated wages and work experience years to approximate the pension points collected by individuals.[65]

Importantly, age-based criteria regulate access to pension benefits and its generosity. The most important age-based parameter is the full pensionable age. At this age, the age factor (AF) is equal to *one* and individuals can receive a publicly provided pension with a value proportional to the sum of pension points accumulated until retirement. For the individuals under study, the full pensionable age varies between 65 and 67. Individuals can decide to retire up to 5 years before the full pensionable age – the AF is 0.003 lower for each month prior the full pensionable age. If individuals retire at higher ages the AF increases by 0.005 for each month after the full pensionable age. The highest possible AF is 1.3 which is reached after 5 years. Importantly, the AF is determined in the first year of retirement and does not change afterward. That is, if a person retires early, pensions stay depreciated until the end of life. Factors other than the employment history can impact pension points as well. Most notable for this paper is the treatment of time used to care for relatives.[66]

[65] We use the number of years of work experience in full-time equivalences and the estimated wage in the year of observation to calculate the number of pension points collected by each agent. In this sense, the calculated pension benefits assume that the working biography was relatively smooth with respect to variation in wages.

[66] Further examples are children and maternity leave, education, and military service. The model abstracts from

In the model, individuals collect 0.5 $PenP_t$ if they do not work full time, provide intensive care, and are not retired.

The pension value PV_t is set each year to reflect wage developments in Germany, inflation, and demographic trends in the population.[67] Even though the German system does not provide a guaranteed minimum pension, individuals can apply for social assistance, if their pensions alone fall short to match the social assistance level.

Appendix B.6. Unemployment insurance and basic social security:

The German system distinguishes between two different kinds of unemployment benefits: ALG1 and ALG2. After losing a job, non-employed individuals receive the first kind of unemployment benefits (ALG 1), which provides benefits of 60% of previous net earnings (capped at 1,880 Euro per month) and are paid up to 12 months.[68] If individuals depend on benefits for longer than 12 months or if they are not eligible for other reasons, they receive the means tested ALG2. Within the observation period it increased from about 606 Euro in 2000 to 712 Euro in 2016. In the model, we abstract from ALG1 and imply that unemployed individuals always receive ALG2 if they pass the means test. If individuals are not capable of working – e.g., for health reasons – or if their pensions are below the basic social security level, they receive social security payments similar to ALG II. As both institutions provide very similar benefits, we treat them as one interchangeable benefit in the model.

Appendix B.7. Inheritance:

Individuals might obtain an inheritance in each period, mostly from parents. Informal caregiving might also be a relevant determinant for inheritances. Groneck (2017) finds evidence that parents might use bequests to compensate their children who provided needed care. Further, if parents do not receive informal care from their children, they would have to opt for more expensive formal care, which wears down their resources. Lockwood (2018) argues that parents have an incentive to hold on to assets to self-insure against long-term care risks. If parents move to a nursing home, in Germany,

these factors.

[67] We assume that individuals expect the cohort-specific rules that define the public pension system will be maintained in the future. We assume that this modeling approach does not neglect any important anticipated future changes in the public pension system.

[68] Unemployed individuals who are older than 50 years can receive unemployment benefits up to 24 months if they had been employed for more than 48 months.

on average, they have to provide about 1,500 Euro/month out of pocket for accommodation.[69] We model inheritances in two steps. First, in each period individuals can receive a positive inheritance with probability $P(IH_t > 0)$.

$$P(IH_t > 0) = Z_0 + Z_1 t + Z_2(t^2/100) + Z_3 \mathbb{1}(region_t = east) + Z_4 \mathbb{1}(educ_t = high) + Z_5 carey_t + Z_6 deathL_t + Z_7(carey_t * deathL_t) \quad (B.6)$$

Second, the amount of the inheritance is estimated conditional on a positive inheritance.

$$\ln(IH_t) = \zeta_0 + \zeta_1 t + \zeta_2(t^2/100) + \zeta_3 \mathbb{1}(region_t = east) + \zeta_4 \mathbb{1}(educ_t = high) + \zeta_5 carey_t + \zeta_6 deathL_t + \zeta_7(carey_t * deathL_t), \text{ if } IH_t > 0 \quad (B.7)$$

Both equations depend on age (t), region, education ($educ$), informal care years ($carey$), and on whether a parent has died in the previous period ($deathL$). If a parent has died since the last period, bequests come from a parent with a higher probability. In this case, the functional form specifically allows for higher bequests if the agent had given informal care previously. We estimate equation (B.6) in a logit regression and equation (B.7) in a linear regression outside the likelihood function.[70]

Appendix B.8. Spousal income:

If married couples share their joint household income, an important source of additional income results from the spouse. In a sub-sample of all spouses, spousal income is estimated dependent on education, whether the agent lives in east or west Germany, and age of the agent following a linear regression estimated outside the likelihood function.[71]

Appendix B.9. Non-labor income:

Finally, we use information on assets, rental, and private retirement insurance income to generate additional non-labor income. To describe non-labor income in the model, we estimate a linear

[69] See https://www.pflege.de/altenpflege/pflegeheim-altenheim/kosten/ for an overview of costs in nursing homes.

[70] The full regression results can be found in Tables C.8 and C.9 in Appendix C.

[71] The full equation is as follows: $\ln(SI_t) = \kappa_0 + \kappa_1 \mathbb{1}(educ_t = high) + \kappa_2 \mathbb{1}(region_t = east) + \kappa_3 t + \kappa_4(t^2/100) + \kappa_5 \mathbb{1}(t \geq 65)$ The full regression results are presented in Table C.10 in Appendix C.

regression dependent on age of the agent, education, whether she lives in east or west Germany, and whether she has a spouse outside the model.[72]

Appendix B.10. Social security contribution:

Each individual's income is subject to social security contributions (SSC) for public health, LTC, unemployment, and retirement insurances. The contributions total to about 20% of gross earnings. Pensions are also subject to SSC but only for health and LTC insurance. Further, the SSC is capped. This cap is higher in West Germany than East Germany (6,200 Euro/month compared to 5,400 Euro/month in 2016).

Appendix B.11. Income tax:

Income tax is calculated on an annual basis and follows a smooth progressive income tax function (§32a EStG). Taxable income is defined as the sum of gross income from employment above an exemption threshold.[73] Up to a maximum amount, SSC are deducted. Between 2000 and 2016 the yearly tax-free allowance increased from 6,902 Euro to 8,652 Euro. The top marginal tax rate decreased from 51% to 45%. In addition to income tax, individuals have to pay an extra tax of 5.5% to finance the costs of German reunification (*Solidaritätszuschlag*). In the model, we specify the basic German tax formula as it is given by law.[74]

Appendix B.12. Dynamic programming problem:

In response to the realization of the state vector s_t, the agent makes a choice d_t per period in order to maximize the expected discounted lifetime utility, given by

$$\max_{d_t \in D(s_t)} E_d \left\{ \sum_{j=t}^{T} \rho_t \beta^{j-t} u_j(s_j, d_j, \theta) | d_t, s_t, m, \epsilon_t \right\}, \tag{B.8}$$

in which ρ_t is an age-specific survival probability and β is a discount factor. Following Bellman's principle of optimality, the optimization problem can be stated as a two-period problem taking only into account the flow utility in t as well as expected value of discounted utility in $t+1$ (Bellman, 1957). Furthermore, if the utility function is additively separable in ob-

[72] The full equation is as follows: $\ln(A_t) = \eta_0 + \eta_1 t + \eta_2 (t^2/100) + \eta_3 \mathbb{1}(educ_t = high) + \eta_4 \mathbb{1}(region_t = east) + \eta_5 \mathbb{1}(spouse_t = 1)$.The full regression results are presented in Table C.11 in Appendix C.

[73] Gross income from assets and income from renting are not considered in the model

[74] Nevertheless, we cannot account for specific exceptions in the model.

servable and unobservable components, the elements in ϵ_t are conditionally independent so that $F(s_{t+1}, \epsilon_{t+1}|s_t, d_t, \epsilon_t) = G_\epsilon(\epsilon_{t+1})F_s(d_t, S_t)$ and have an extreme value type 1 distribution,[75] then Rust (1987) shows that the agent's value function has a closed form solution

which can be solved by backward induction.[76] Thereby $p_t(\cdot)$ is a Markov transition probability function representing agents' beliefs about future states. For each feasible choice d_t, choice probabilities can thus be calculated by

$$P(d_t|s_t, m, \theta, \lambda, \psi) = \frac{\exp\{v_t(s_t, d_t, m, \theta, \lambda, \psi)\}}{\sum_{d'_t \in D(s_t)} \exp\{v_t(s_t, d'_t, m, \theta, \lambda, \psi)\}}, \tag{B.9}$$

where d'_t represents the other feasible choices. λ and ψ are parameter-vectors determining job offer and care demand probabilities that will be estimated.

Appendix B.13. Partner and partner's health:

In this section we describe the evolution of partner's health and death in the model and the results from the underlying regression based on SOEP data. In the state space the variable $partner_t$ can take on three values: $0, 1, 2$, where the value 0 stands for no spouse, the value 1 stands for partner in good or medium health and the value 2 stands for partner in bad health. We use the SOEP data set and estimate the probability of transitions between the states given the information on previous health (existence) of a partner, and educational attainment and age of the agent (the woman of interest in the model) in the following multinomial logit estimation equation:

$$partner_t = \beta_0 + \beta_1 partner_{t-1} + \beta_2 age_t^{spouse} + \beta_3 education_t^{spouse} + \epsilon \tag{B.10}$$

We do this in a group of all women in the final estimation data set. The base category is that a partner is in good or medium health.

C.15 gives the estimation results.

Appendix B.14. Parent's instrumental health:

In the state space we track parent's age and death as well as the agent's education. In the care demand function(s) we use imputed information on parent's instrumental health using information

[75]CDF: $G(\epsilon_t|s_t) = \prod_{d \in D(s_t)} \exp\{-\epsilon_t(d) + \gamma\} \exp\{-\exp[-\epsilon_t(d) + \gamma]\}, \gamma = 0.577$

[76]The closed form of the agent's value function can be seen in Appendix B.15.

on parent's age and daughters education. We use the SHARE data set to estimate the imputation parameters on the probability that a parent has limitations with ADLs or IADLs, where the existence of limitations with ADLs impacts the probability that a daughter observes any care demand and the existence of limitations with IADLs impacts the probability that a daughter observes high intensive care demand. We take into account that the existence of limitations with ADLs and IADLs is not independent over time and both processes may be correlated with each other. To estimate these processes separately by parent's gender, we follow Baltagi & Wu (1999) and estimate a random effects time series regression models where the disturbance term, ϵ_{it} is first-order autoregressive:

$$y_{it} = \alpha + \beta X_{it} + \nu_i + \epsilon_{it} \tag{B.11}$$

, with

$$\epsilon_{it} = \rho \epsilon_{i,t-1} + \eta_{it}, \tag{B.12}$$

and where $|\rho| < 1$ and η_{it} is independent and identically distributed (i.i.d.) with mean 0 and variance σ^2_η. Table C.16 gives the results that are used in the model.

Appendix B.15. Closed form solution of the agent's value function

The agent's value function can be written in a closed form solution if certain assumptions hold. The closed form is given by:

$$\begin{aligned} v_t(s_t, d_t, m, \theta, \lambda, \psi) &= u_t(s_t, d_t, m, \theta) \\ &+ \rho_t \beta \sum_{s_{t+1}} \log \left[\sum_{d_{t+1} \in D(s_{t+1})} \exp\{v_{t+1}(s_{t+1}, d_{t+1}, m, \theta)\} \right] p_t(s_{t+1} | s_t, d_t, \lambda, \psi) \end{aligned} \tag{B.13}$$

Appendix B.15.1. Approximation of the value function

Instead of solving the value function at the entire state space, we approximate the value function using interpolation as suggested in Keane & Wolpin (1994). That is, starting at the terminal age T, we calculate the value functions at a subset of the state space. This grid includes four values of labor market experience (0, 15, 30, 45), two values of years in retirement (0, 6), years in care (0, 6), years in intensive care (0, 5), father's age (70, 90), and mother's age (70, 90). Further, it includes states that are not interpolated. I.e., individuals' type (1, 2), father died last period (0, 1), mother died last period (0, 1), father alive (0, 1), mother alive (0, 1), spouse (0, 1), education (low, high), and regions (East, West). This results in a total of 8,192 grid points. While solving the model recursively, we use a linear interpolation function to predict the value function at values of the state variables that are not included in the grid. We use numerical gradients but utilize the BHHH approximation of the Hessian (Berndt et al., 1974).

Appendix B.15.2. Unobserved type probability

The probability of belonging to type m is modeled conditionally on working experience and on age in the initial period T_0. As additional exclusion restriction, we further use the number of children a woman has, which should also affect the labor market history. The probability is estimated within the structural model.

$$P(m=1) = \frac{\exp(\alpha M_{T_0})}{1+\exp(\alpha M_{T_0})}$$
$$\alpha M_{T_0} = \alpha_0 + \alpha_1\ age_{T_0} + \alpha_2\ expEQ_{T_0} + \alpha_3\ children_{T_0} \tag{B.14}$$

By making the type probability function conditional on state variables in the initial period, we account for non-random initial conditions at the initial period. This approach follows Wooldridge (2005). It requires that the initial condition is random conditional on working experience in the initial period, number of children when entering the model, and initial age.

Appendix B.16. Robustness check: Assignment of cash benefits for light care provision

In this section, we describe how results for structural parameter estimates as well as simulation results change in the robustness check. In this robustness check, we randomly assign some individuals who report providing light care to a group that does not receive cash benefits for informal caregiving. This might be realistic as from descriptive statistics we know that around 34% of all care dependent individuals receive care without being eligible for cash benefits from the LTCI. Table A.5 shows resulting structural parameter estimates in coloumns 5-6. Estimates are hardly significantly different from the main estimation results reported in Table A.5. The parameter on utility from consumption is slightly smaller while leisure time is valued less by both unobserved types. Utility parameters for caregiving are similar; the same is true for further estimates. Figure D.12 and Table A.6 (column 4) report model fit with respect to labor and caregiving decisions by age as well as transitions in this robustness check. We find that the model fit and the parameter estimates are not sensitive to this specification change. Figure D.14 shows main simulation results as described in section 6. On first sight, effects of caregiving are similar to those in the baseline specification. This is true for all ages. However, we find slightly higher caregiving in all ages than in the baseline. Further, the effects of abolished cash benefits for caregiving are bigger on both caregiving and labor market outcomes.

Appendix B.17. Specification check: Inclusion of siblings

In this section we describe how results for structural parameter estimates as well as simulation results change if we include siblings in the model. We add the existence of at least one sibling into the state space. It is used in the specification of the care demand function: We include an interaction term that is one if at least one parent is alive and at least one sibling is alive:

$$\begin{aligned}\psi Q_t = {} & \psi_0 + madl_t\psi_1 + fadl_t\psi_2 \\ & + \mathbb{1}(malive_t = 1)(\psi_3\mathbb{1}(falive_t = 0) + \psi_5\mathbb{1}(falive_t = 1)) + \psi_4\mathbb{1}(malive_t = 0)\mathbb{1}(falive_t = 1) \\ & + \psi_6\mathbb{1}(pdist_t = 1)\mathbb{1}(malive_t = 1|falive_t = 1) + \psi_7\mathbb{1}(spouse_t = 1) \\ & + \psi_8\mathbb{1}(careL_t = 1) \end{aligned} \tag{B.15}$$

Therefore, we allow for the possibility that a sibling takes care of a sick parent. Table A.5 shows resulting structural parameter estimates in columns 3-4. Estimates are hardly significantly different from the main estimation results reported in Table A.5. The parameter ψ_{10} for the influence of siblings on care demand is very small and not significant. Figure D.13 and Table A.6 (column 3) report model fit with respect to labor and caregiving decisions by age as well as transitions in this robustness check. We find that the model fit and the parameter estimates are not sensitive to this specification change. Including siblings into the care demand function does not play a role in explaining caregiving. However, as some respondents in SOEP have missing information on existence of a sibling, the number of observations is reduced from 23,429 to 22,511. Figure D.15 shows main simulation results as described in section 6. Effects of caregiving are similar to those in the baseline specification. This is true for all ages and the influence of the LTCI regulations. As the inclusion of siblings has no explanatory power for caregiving and does not alter simulation results, we decided to not include siblings in the main specification of the model. The reduction in sample size for estimation outweighs the value of siblings in the model.

Appendix B.18. External care demand information: SOEP-IS

In order to gather information on potential care demand for women in the age-group of interest we turn to the SOEP Innovation Sample (SOEP-IS) 2016, "Informal Care Outside the Household".[77] In this special survey, individuals were asked whether they knew someone who was in need of LTC.[78] Individuals were then asked whether this person lived in the same household, another household or an institutional care facility. We disregard those living in institutional care facilities as we take the decision to move into a care home as predetermined in this study. Due to the small sample size in the SOEP-IS module (3,868 people were asked in 2016), we merge information given by male and female repsondents. We then arrive at an average of 20% of individuals in the age range of interest (55-67 years of age) who report to know someone with care needs living in the same or another household. Figure D.8 shows the percentages and 95%-confidence interval by age.

Appendix C. Additional tables

Table C.8: Logit regression: probability of positive inheritance

	P(inheritance>0)	
Age	0.524	(0.450)
Age^2/100	−0.463	(0.370)
Region=East	−0.537***	(0.118)
(1/3) years light care + years inten. care	0.141***	(0.027)
Parent's death in $t-1$	1.134***	(0.173)
Interaction death of parent and experience in care	0.080	(0.067)
Education=high	0.582***	(0.097)
Constant	−18.693	(13.643)
Obs.	23429	
Pseudo R^2	0.033	

∗ p <0.10, ∗∗ p <0.05, ∗ ∗ ∗ p <0.01
Source: SOEP, own calculation.

[77] See Richter & Schupp (2015); Berlin et al. (2017) and http://companion-is.soep.de/Innovative%20Modules/index.html for further information on the SOEP-IS modules.

[78] The exact question was: "Does a person within your circle of relatives, friends or close acquaintances need care or help because of age, disease or disability? This person can live in your household or outside."

Table C.9: Regression: inheritance conditional on positive inheritance

	ln(inheritance)	
Age	0.368	(0.577)
$Age^2/100$	−0.294	(0.475)
Region=East	−1.237***	(0.151)
(1/3) years light care + years inten. care	0.087**	(0.042)
Parent's death in $t-1$	−0.215	(0.224)
Interaction death of parent and experience in care	−0.059	(0.089)
Education=high	0.248**	(0.124)
Constant	−1.211	(17.452)
Obs.	507	
R^2	0.13	

∗ p <0.10, ∗∗ p <0.05, ∗ ∗ ∗ p <0.01
Source: SOEP, own calculation.

Table C.10: Partner income regression

	ln(partner income)	
Education=high	0.139***	(0.014)
Region=East	−0.152***	(0.013)
Age	−0.087	(0.082)
$Age^2/100$	0.045	(0.069)
Age≥65	0.058*	(0.030)
Constant	10.584***	(2.447)
Obs.	18,111	
R^2	0.03	

∗ p <0.10, ∗∗ p <0.05, ∗ ∗ ∗ p <0.01
Source: SOEP, own calculation.

Table C.11: Non-labor income regression

	ln(non-labor income)	
Age	0.423***	(0.127)
$Age^2/100$	−0.287***	(0.104)
Spouse	1.360***	(0.031)
Education=high	0.693***	(0.032)
Region=East	−1.173***	(0.030)
Constant	−11.080***	(3.852)
Obs.	23,195	
R^2	0.15	

∗ p <0.10, ∗∗ p <0.05, ∗ ∗ ∗ p <0.01
To control for outliers the top 1% of the wage distribution is dropped.
Source: SOEP, own calculation.

Table C.12: Proportions of care receivers among female caregivers aged 55-67 in SHARE data.

Recipient group	Frequency	Percent
Spouse	121	15.45
Parent	386	49.30
Parent-in-law	81	10.34
Other relative	69	8.81
Neighbour	92	11.75
Other	34	4.34
Total	783	100.00

Source: SHARE, own calculation.

Table C.13: Estimated care demand probabilities by age in the data-set

Age	55	56	57	58	59	60	61	62	63	64	65	66	67
Light CD	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.02
Intensive CD	0.17	0.16	0.16	0.16	0.16	0.16	0.15	0.14	0.14	0.13	0.12	0.12	0.11
Sum	0.19	0.20	0.20	0.20	0.19	0.19	0.18	0.17	0.17	0.16	0.15	0.14	0.13

Note: CD: care demand; This Table shows care demand probabilities by age and intensity in the data using estimated parameters.

Source: SOEP, own calculation.

Table C.14: Direct fiscal consequences of LTC in the status quo and without pension entitlements (no behavioral changes to LTCI benefits)

	Total consequences		No pension entitlements	
	Euro	%	Euro	%
I Care shock at age 55				
Pension payout	−1602	−0.86	−1185	−0.64
Social security benefits	231	0.57	235	0.58
LTCI cash benefits	−10724	−44.12	−10724	−44.12
Social security contributions	−841	−1.61	−880	−1.68
Income tax	−588	−1.23	−619	−1.30
Net effect	−13524	−0.09	−13173	−0.09
II Care shock at age 59				
Pension payout	−1171	−0.73	−724	−0.45
Social security benefits	187	0.42	41	0.09
LTCI cash benefits	−9880	−52.50	−9880	−52.50
Social security contributions	−928	−3.37	−968	−3.53
Income tax	−684	−2.97	−709	−3.08
Net effect	−12475	−0.07	−12240	−0.07
III Care shock at age 63				
Pension payout	−452	−0.33	−376	−0.28
Social security benefits	55	0.12	32	0.07
LTCI cash benefits	−9121	−70.84	−9121	−70.84
Social security contributions	−216	−1.71	−223	−1.76
Income tax	−130	−1.43	−136	−1.48
Net effect	−9865	−0.06	−9824	−0.06

Source: This table shows fiscal consequences of caregiving at ages 55 (59, 63) in the baseline (columns 2-3) and with baseline behavior but no pension entitlements (columns 4-5). Columns (3), and (5) give changes in expenditure (revenue) relative to the baseline with caregiving for the respective fiscal category. SOEP, own calculations.

Table C.15: Estimation results, health transitions of partner's health

	(1)
	Partner_n
Partner does not exist	
Partner_n_1	2.474***
	(0.126)
Age	-0.004
	(0.013)
Educ	-0.193*
	(0.116)
Cons	-6.760***
	(0.809)
Partner in bad health	
Partner_n_1	3.760***
	(0.064)
Age	0.000
	(0.008)
Educ	-0.308***
	(0.074)
Cons	-7.444***
	(0.494)
N	35837

Standard errors in parentheses
* p¡0.10, ** p¡0.05, *** p¡.01

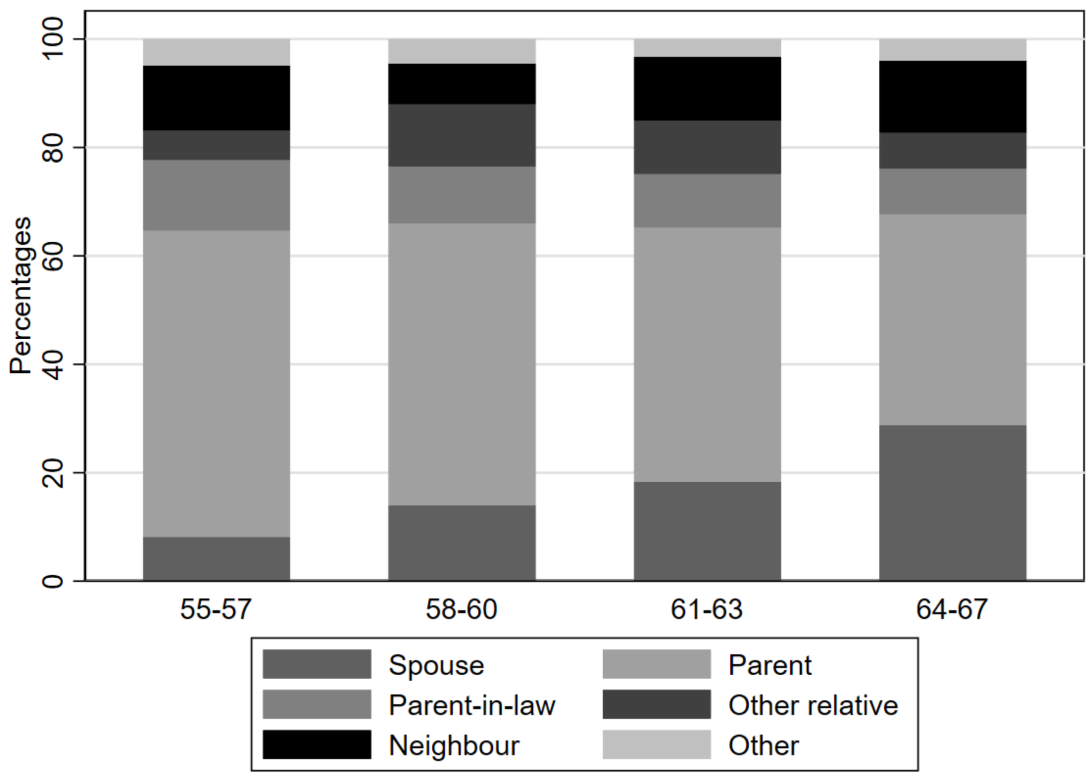
Table C.16: Estimation results, ADL and IADL tansitions of parents

	(1)	(2)	(3)	(4)
	ADL		IADL	
	Father	Mother	Father	Mother
Age	-0.114***	-0.119***	-0.044*	-0.142***
	(0.036)	(0.034)	(0.024)	(0.023)
Age squared	0.001***	0.001***	0.000**	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)
Married	0.009	0.062***	0.015	0.036***
	(0.022)	(0.019)	(0.014)	(0.013)
Highly educated	-0.049**	-0.033	-0.023	-0.022
	(0.022)	(0.026)	(0.015)	(0.018)
Cons	3.755***	4.010***	1.354	5.144***
	(1.412)	(1.357)	(0.933)	(0.897)
N	3487	3452	3487	3452
ρ	0.37	0.39	0.42	0.46
$sigma_u$	0.19	0.19	0.12	0.12
$sigma_e$	0.34	0.36	0.22	0.23

Standard errors in parentheses
* p¡0.10, ** p¡0.05, *** p¡.01

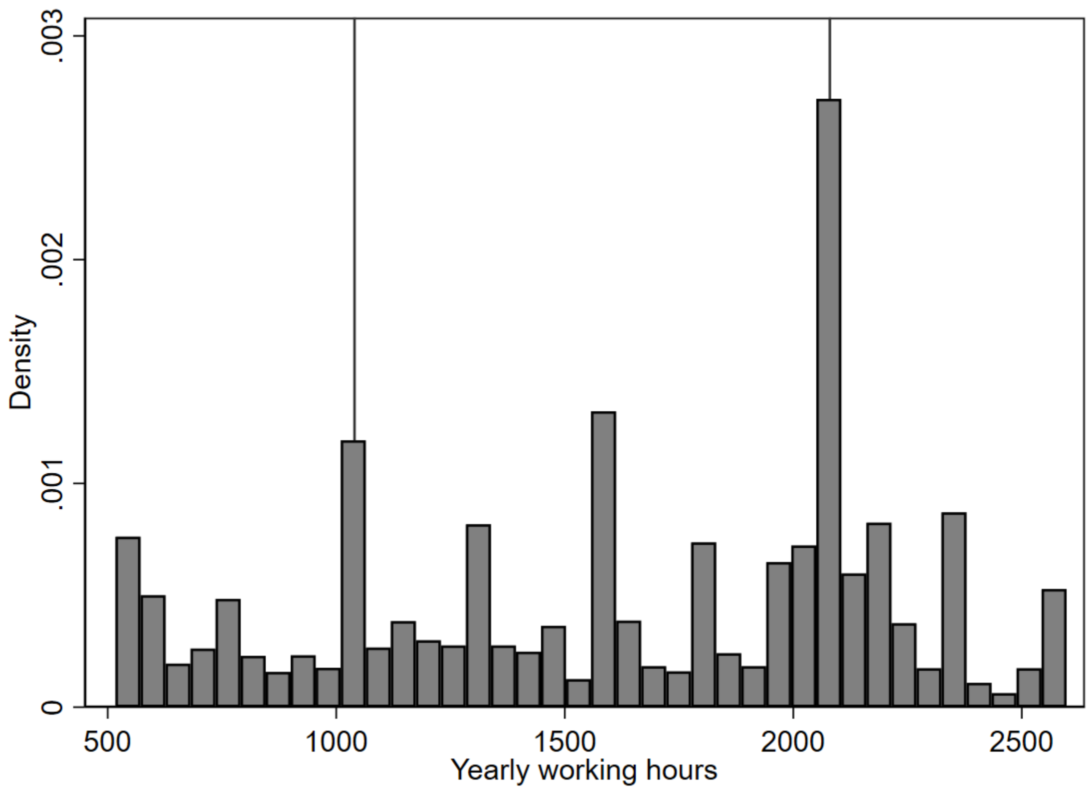
Appendix D. Additional figures

Figure D.5: Proportion of care recipients by age of caregiver (women aged 55-67) in SHARE.



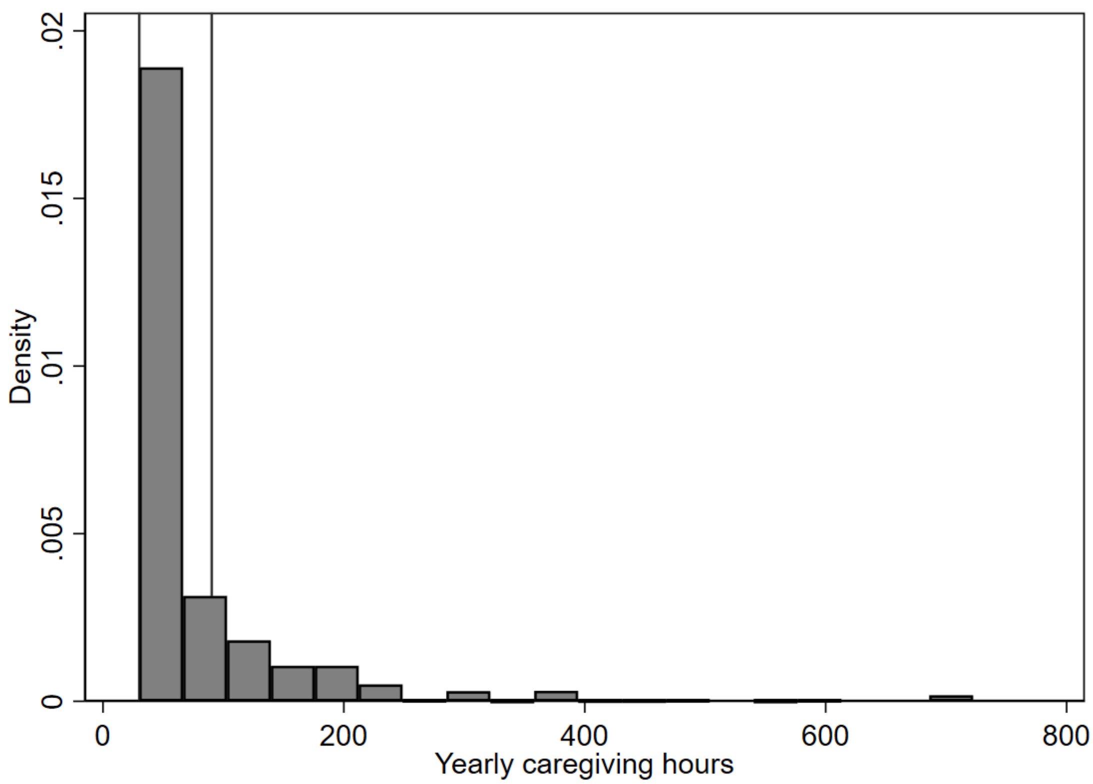
Note: Source: SHARE, own calculations.

Figure D.6: Dispersion of reported working hours around the discrete mass-points (women aged 55-67) in SOEP.



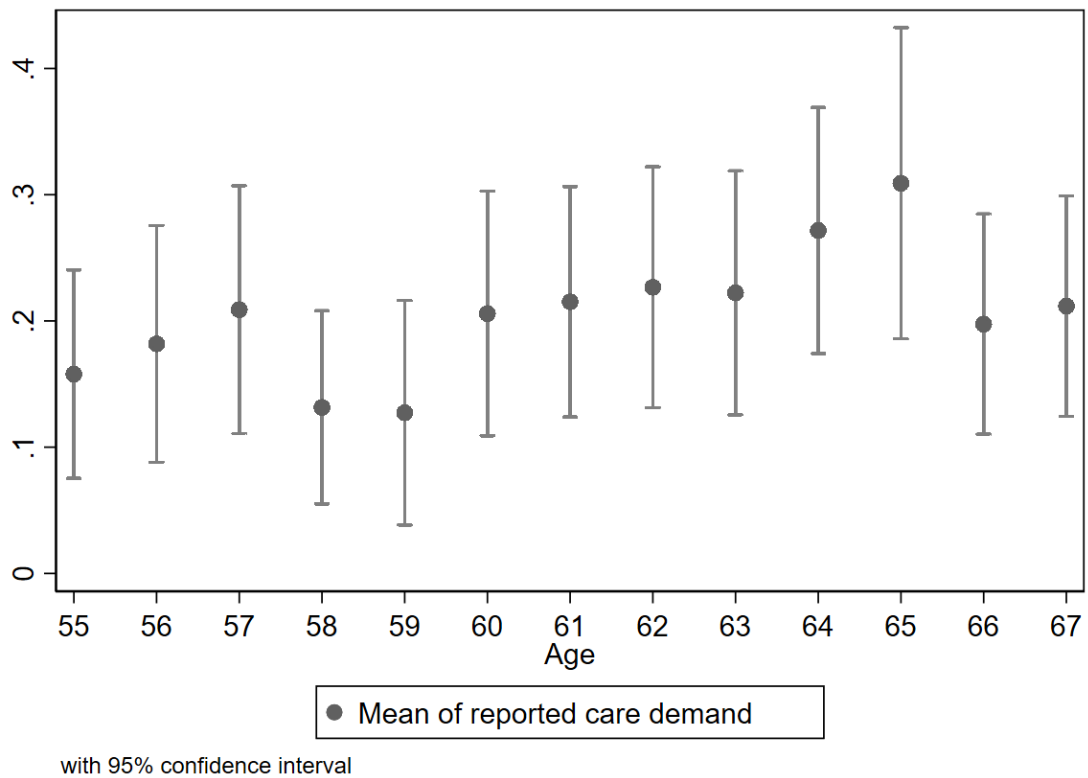
Note: Source: SOEP, own calculations.

Figure D.7: Dispersion of reported caregiving hours around the discrete mass-points (women aged 55-67) in SOEP.



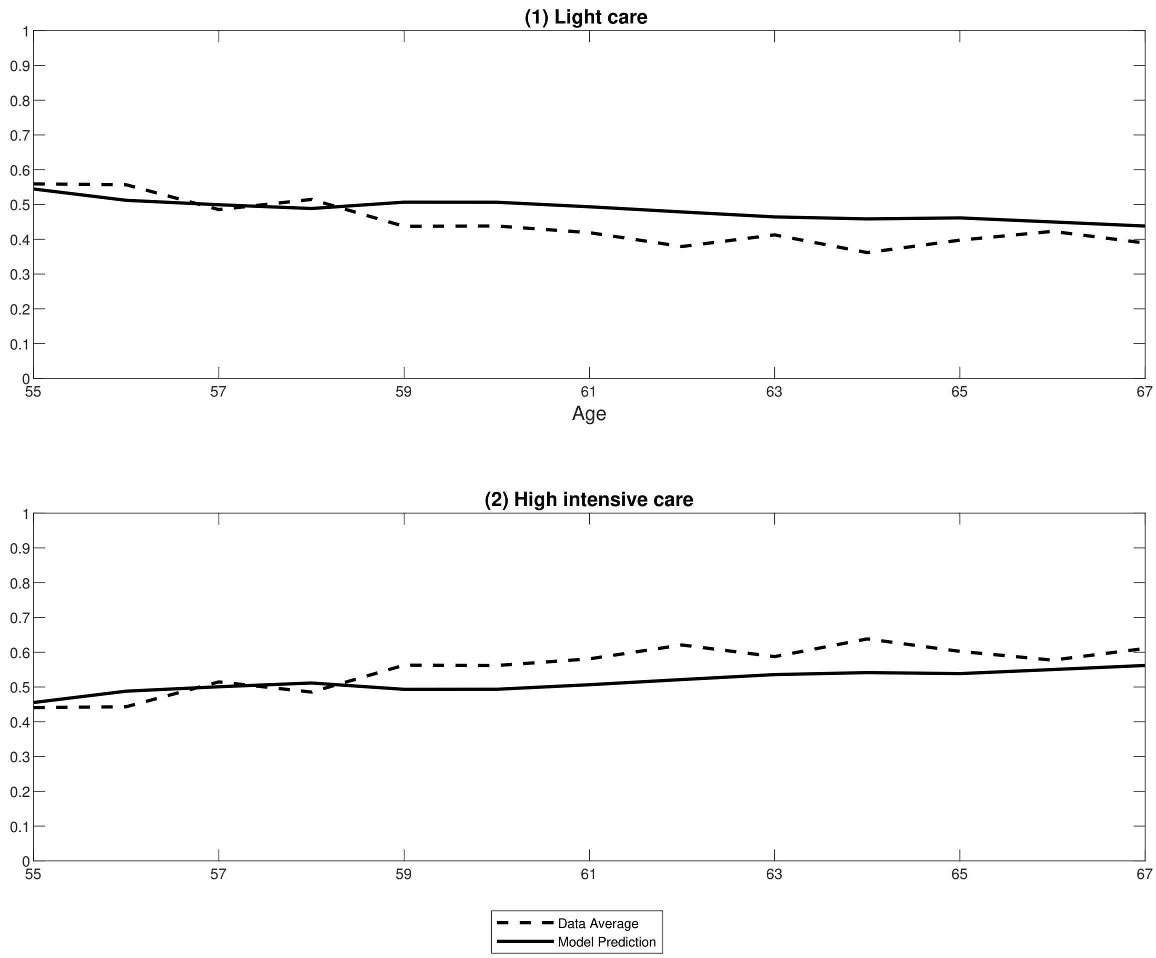
Note: Source: SOEP, own calculations.

Figure D.8: Reported care demand in SOEP-IS 2016



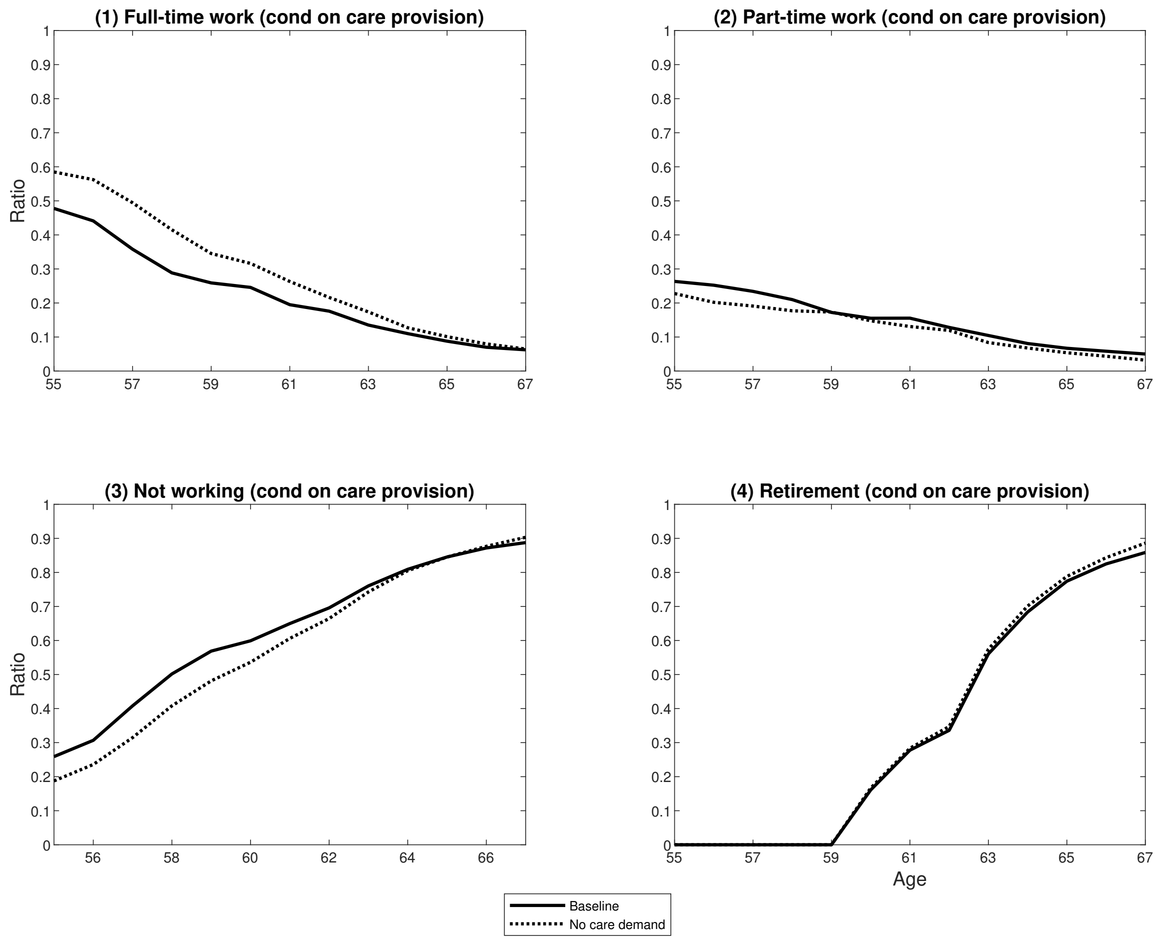
This figure depicts the percentages of individuals reporting to know a care-dependent person in the same or another household by age of the respondent. We also report 95%-confidence intervals of the mean by age. Source: SOEP-IS 2016, own calculations.

Figure D.9: Model fit of care decisions conditional on positive care hours



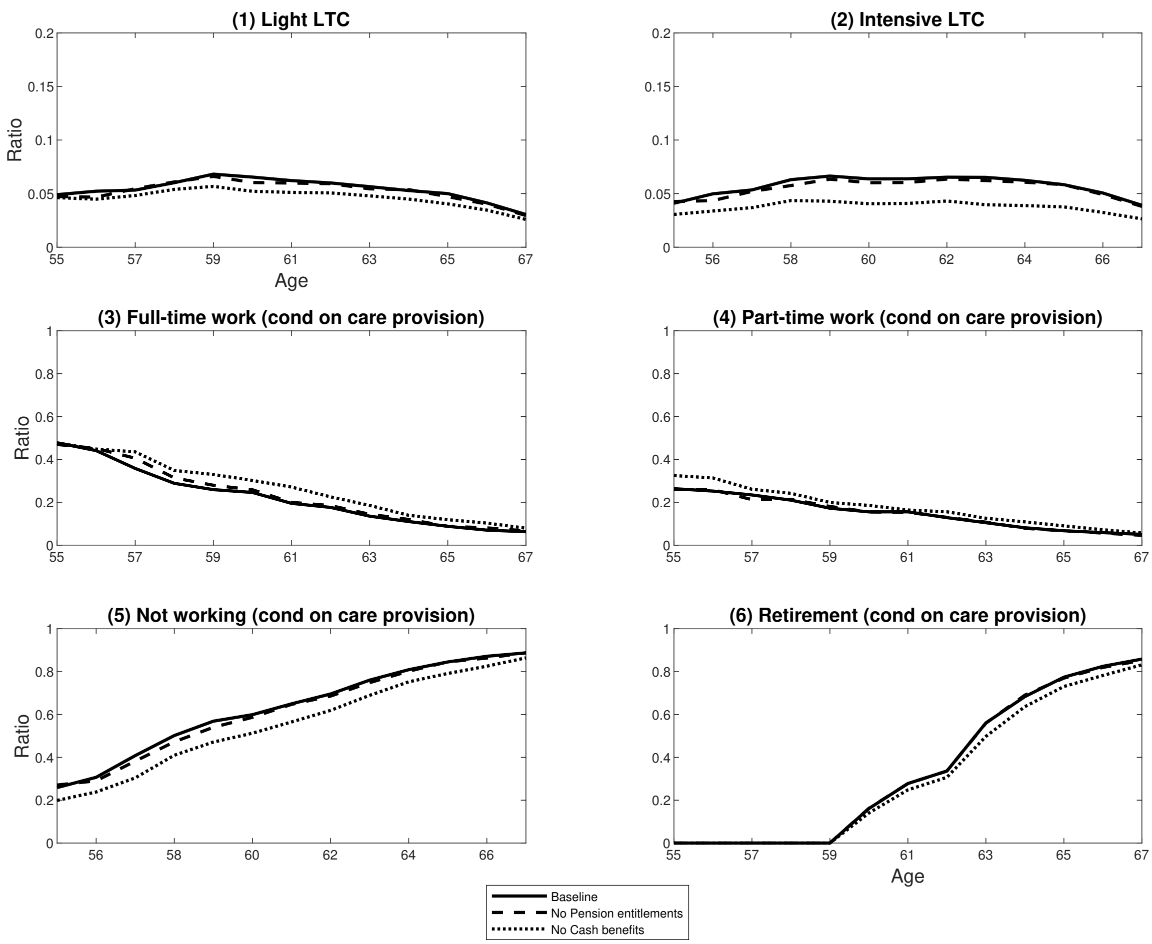
This figure compares average decisions on caregiving in the model and the underlying data conditional on care being given. The data average was calculated using the estimation sample. The model predictions were calculated using a simulated sample. The simulated sample was constructed using the dynamic model for five trajectories of action and state variables for each individual in the sample. To ensure comparability with the estimation sample, model predictions were only calculated with simulation outcomes from ages at which a person was also observed in the data.
Source: SOEP, own calculations.

Figure D.10: Effects of caregiving over the life-cycle



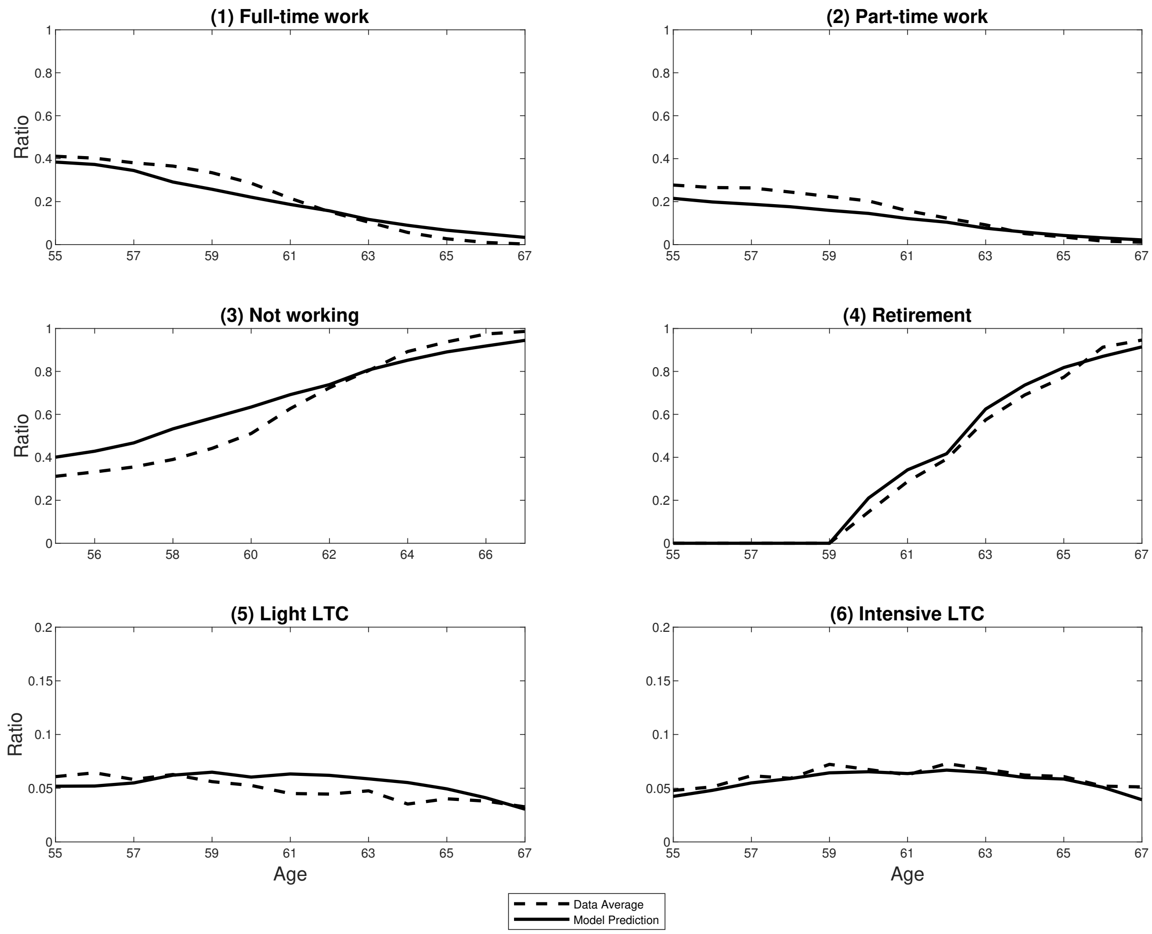
This figure portrays effect of caregiving at on several labor market outcomes for those providing care in the baseline. Effects are differences between caregiving in the baseline and a simulation in which care-demand is set to 0 in all ages. *Source:* SOEP, own calculations.

Figure D.11: Effects of caregiving over the life-cycle without cash benefits or pension entitlements



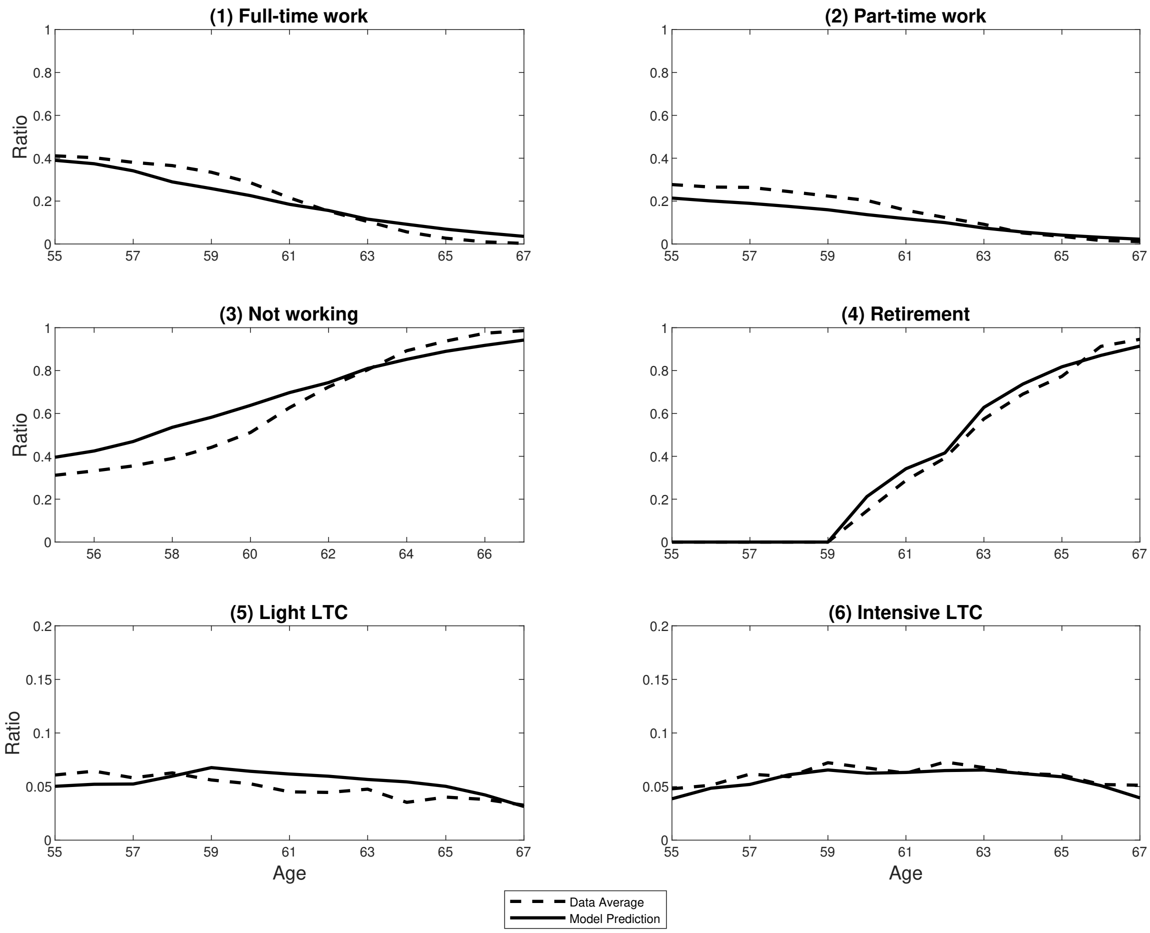
This figure portrays effect of caregiving at on several labor market outcomes if cash benefits or pension entitlements were removed for those providing care in the baseline. Effects are differences between caregiving in the simulation without cash benefits/pension entitlements and care demand and a simulation in which care-demand is set to 0 in all ages. *Source:* SOEP, own calculations.

Figure D.12: Model fit of labor and care decisions. Robustness check: assignment of care benefits



This figure compares average decisions on labor supply and caregiving in the model and the underlying data. The data average was calculated using the estimation sample. The model predictions were calculated using a simulated sample. The simulated sample was constructed using the dynamic model for five trajectories of action and state variables for each individual in the sample. To ensure comparability with the estimation sample, model predictions were only calculated for with simulation outcomes from ages at which a person was also observed in the data.
Source: SOEP, own calculations.

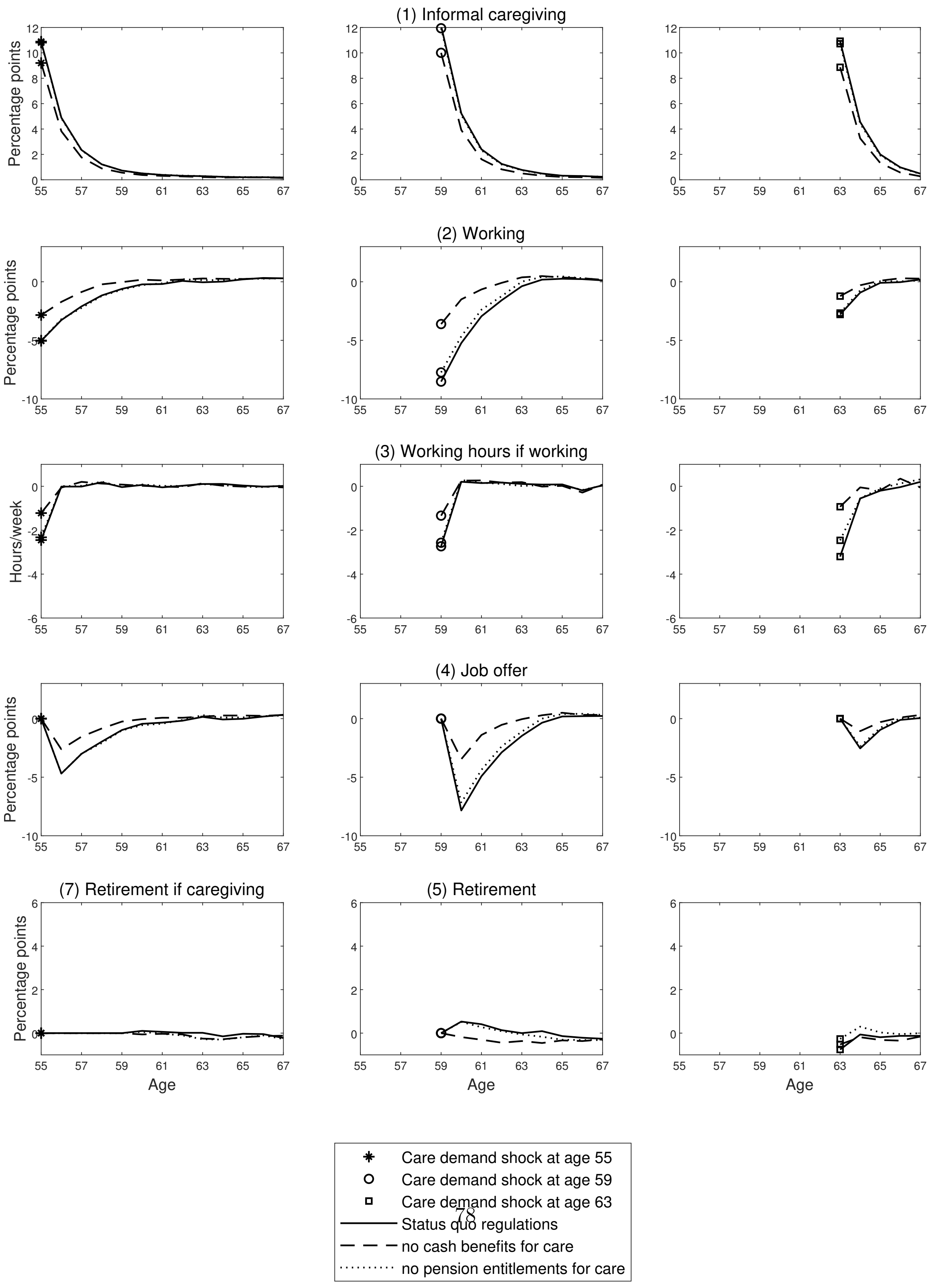
Figure D.13: Model fit of labor and care decisions. Specification check: siblings included



This figure compares average decisions on labor supply and caregiving in the model and the underlying data. The data average was calculated using the estimation sample. The model predictions were calculated using a simulated sample. The simulated sample was constructed using the dynamic model for five trajectories of action and state variables for each individual in the sample. To ensure comparability with the estimation sample, model predictions were only calculated for with simulation outcomes from ages at which a person was also observed in the data.

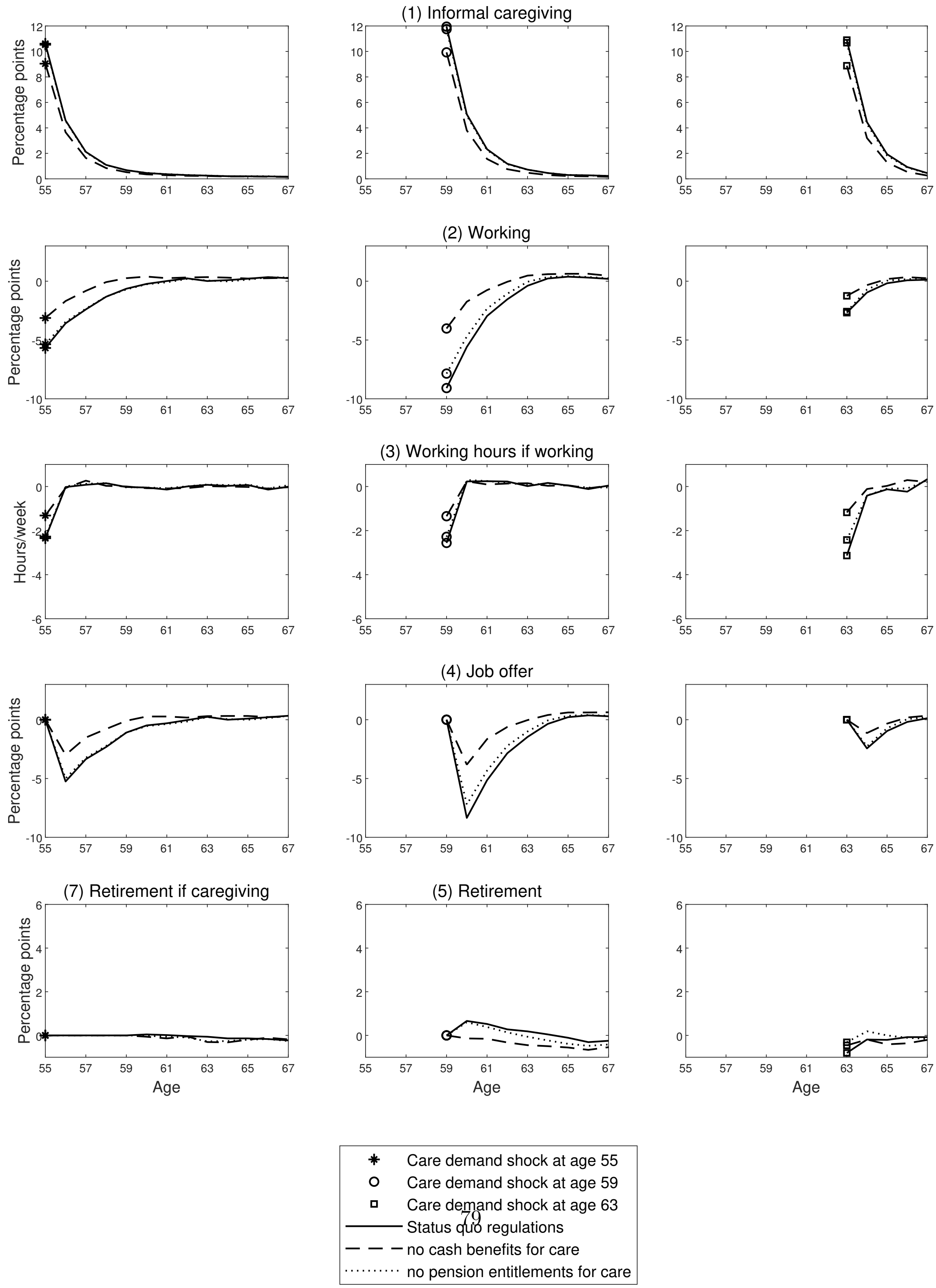
Source: SOEP, own calculations.

Figure D.14: Short and long-term labor market effects of caregiving. Robustness check: assignment of care benefits



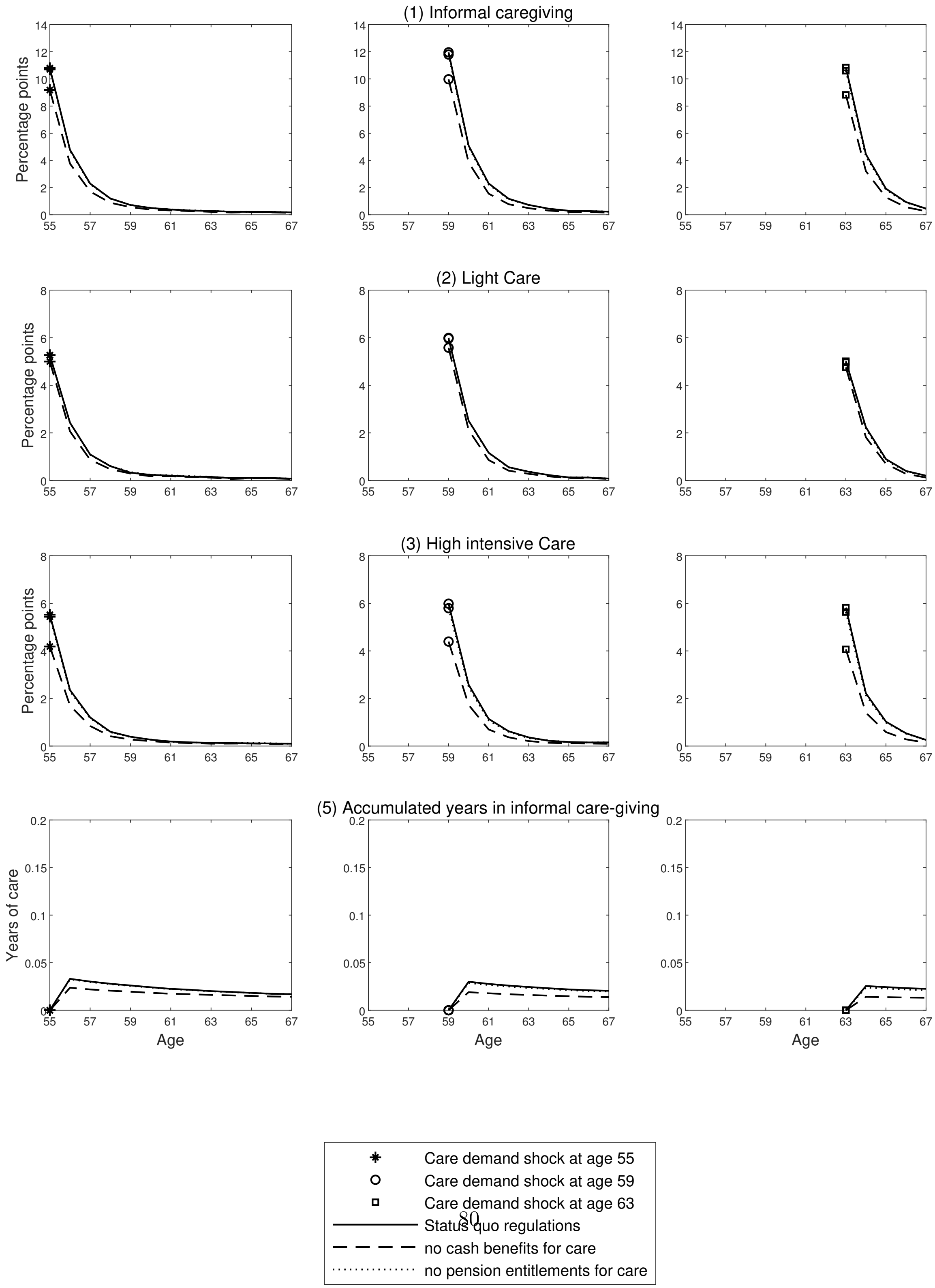
This figure portrays effect of caregiving at ages 55 (left panel), 59 (middle panel), and 63 (right panel) on several labor market outcomes. Effects are differences between caregiving in the baseline and a simulation in which care-demand is set to 0 in the initial period (ages 55, 59, and 63). The figure compares effects between 3 policy scenarios. *Source:* SOEP, own calculations.

Figure D.15: Short and long-term labor market effects of caregiving. Specification check: siblings included



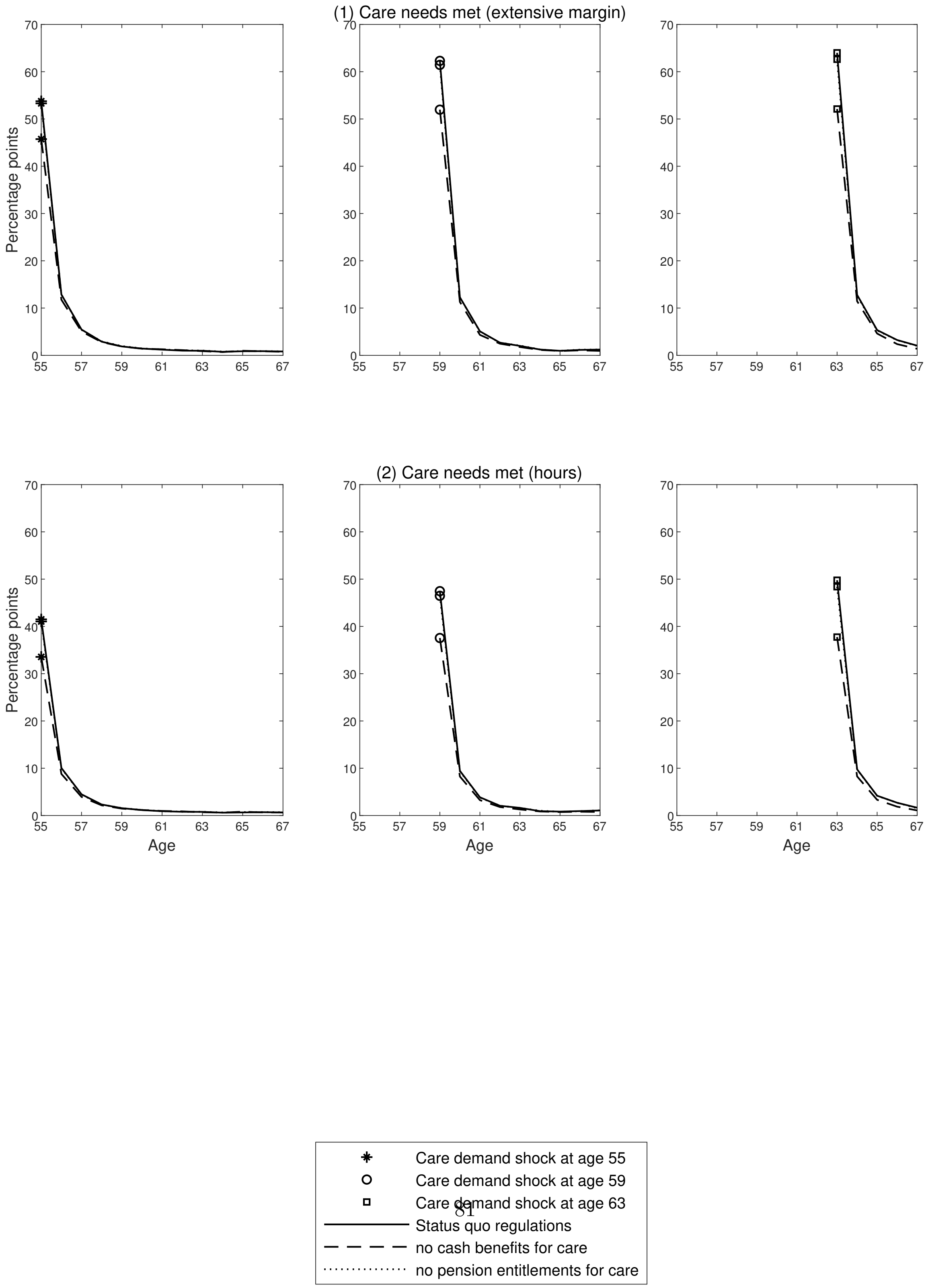
This figure portrays effect of caregiving at ages 55 (left panel), 59 (middle panel), and 63 (right panel) on several labor market outcomes. Effects are differences between caregiving in the baseline and a simulation in which care-demand is set to 0 in the initial period (ages 55, 59, and 63). The figure compares effects between 3 policy scenarios. *Source:* SOEP, own calculations.

Figure D.16: Response to care provision (care outcomes)



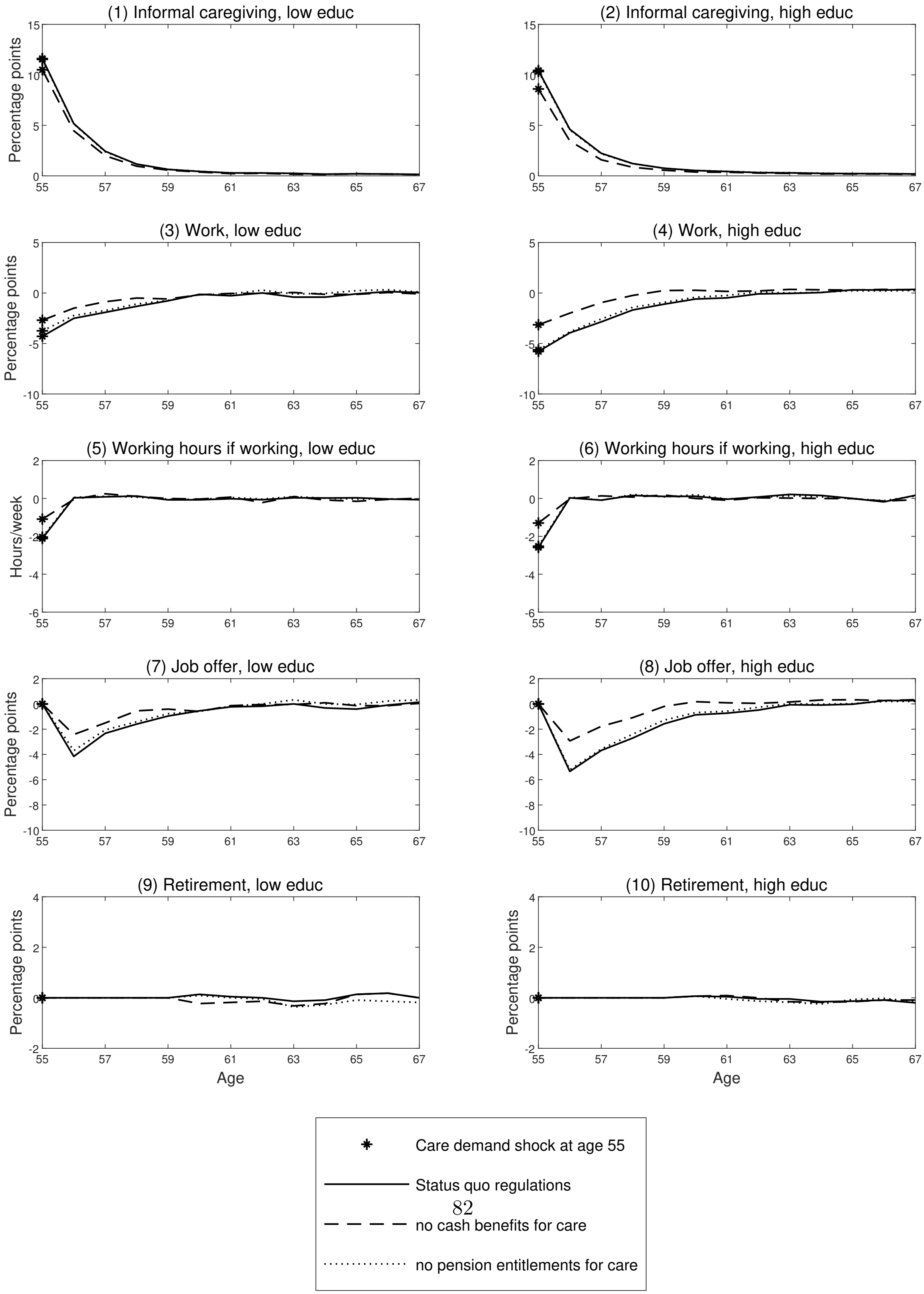
Source: SOEP, own calculations.

Figure D.17: Care needs met



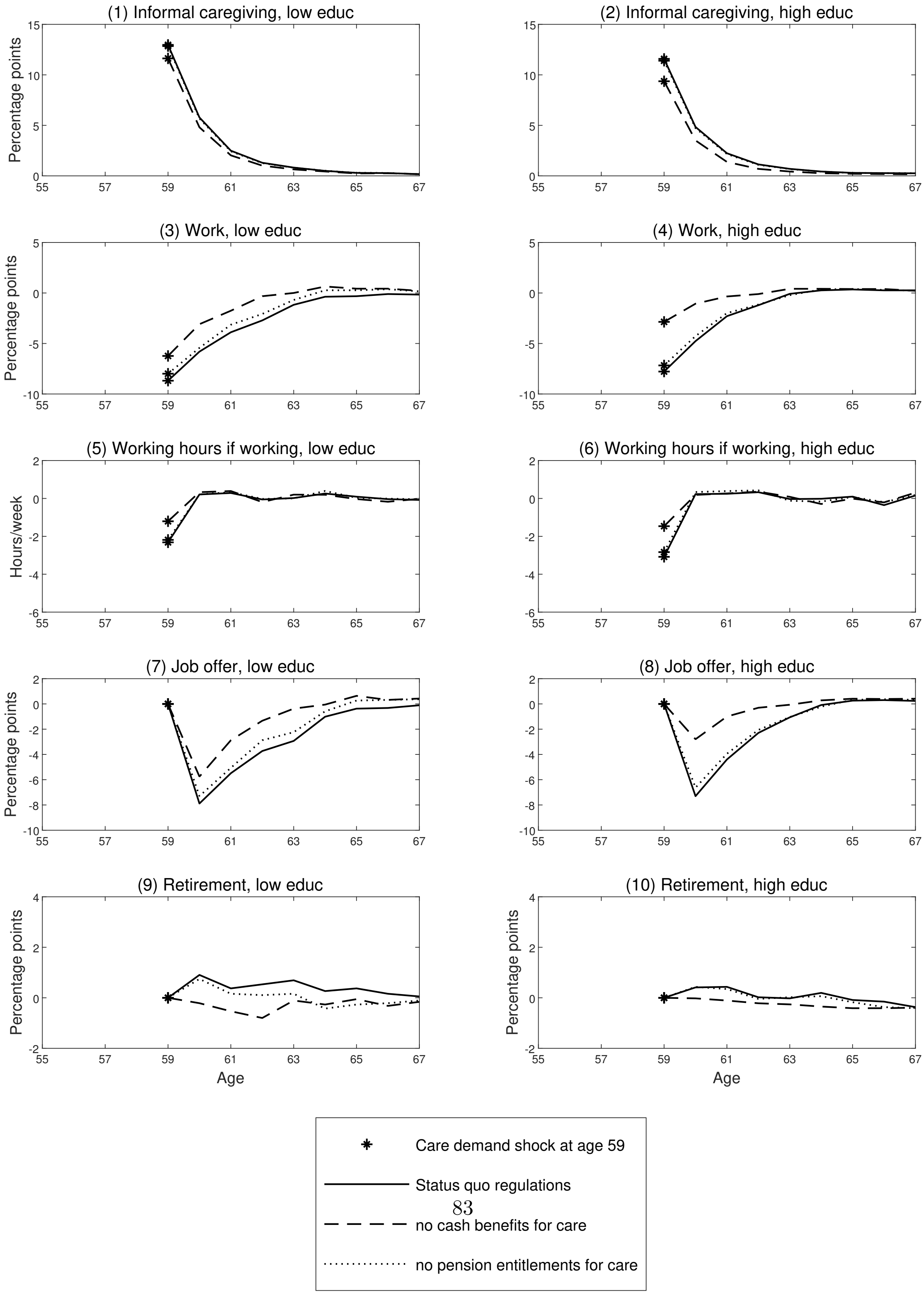
Source: SOEP, own calculations.

Figure D.18: Response to care provision (labor outcomes), heterogeneity by education, care shock at age 55



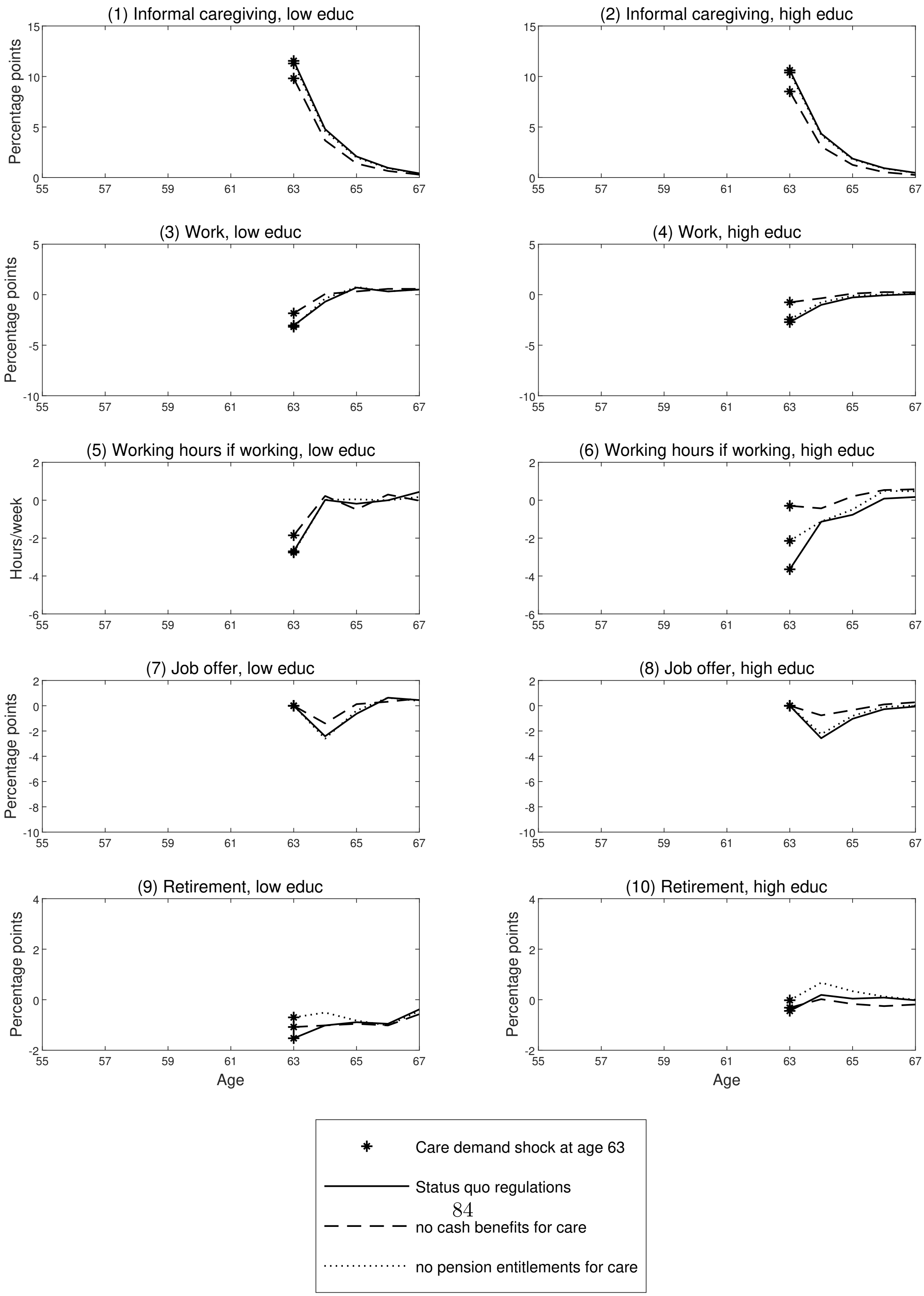
This figure portrays effect of caregiving at ages 55 on several labor market outcomes by educational attainment. Effects are differences between caregiving in the baseline and a simulation in which care-demand is set to 0 in the initial period. The figure compares effects between 3 policy scenarios. *Source:* SOEP, own calculations.*Source:* SOEP, own calculations.

Figure D.19: Response to care provision (labor outcomes), heterogeneity by education, care shock at age 59



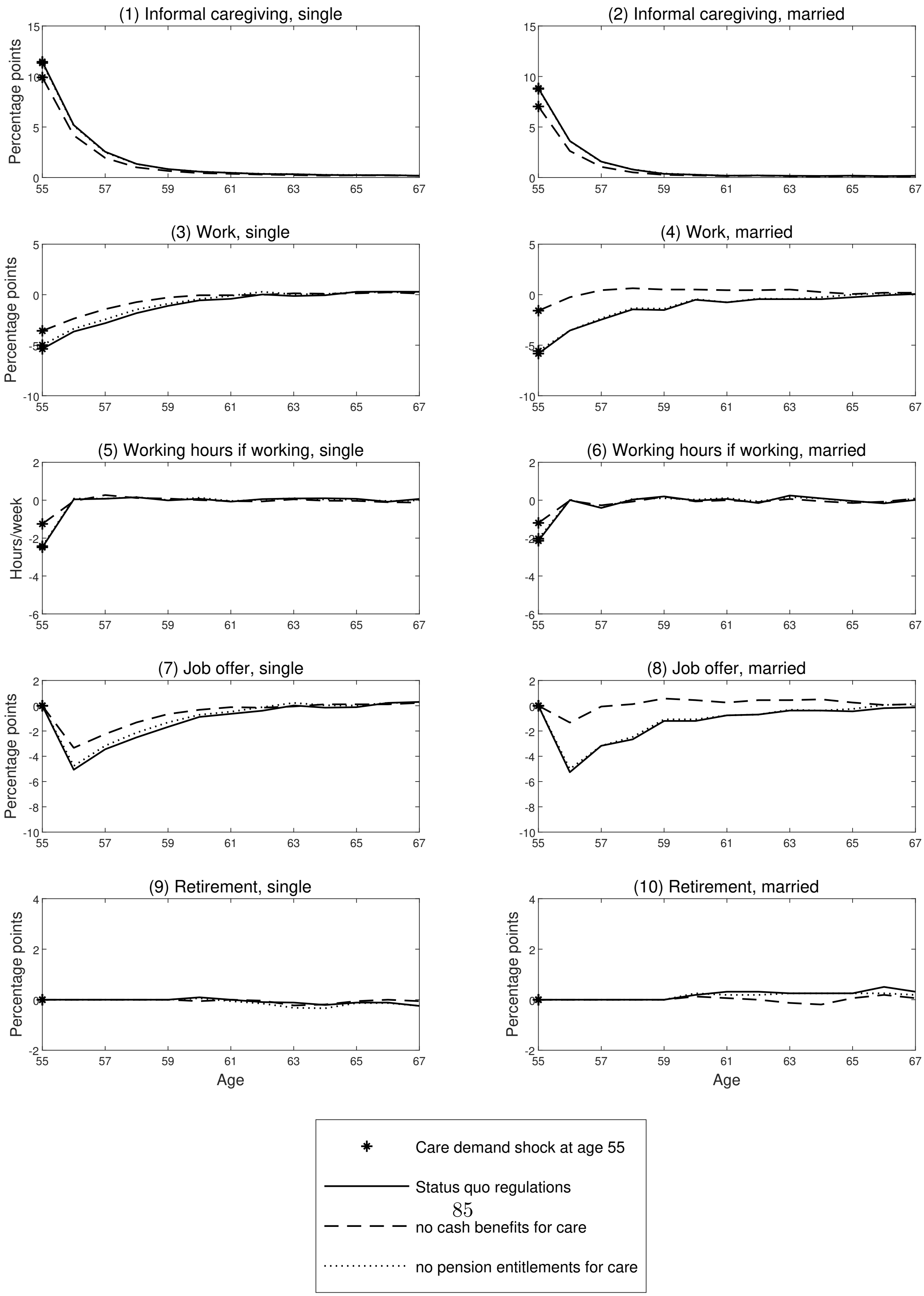
This figure portrays effect of caregiving at ages 59 on several labor market outcomes by educational attainment. Effects are differences between caregiving in the baseline and a simulation in which care-demand is set to 0 in the initial period. The figure compares effects between 3 policy scenarios. *Source:* SOEP, own calculations. *Source:* SOEP, own calculations.

Figure D.20: Response to care provision (labor outcomes), heterogeneity by education, care shock at age 63



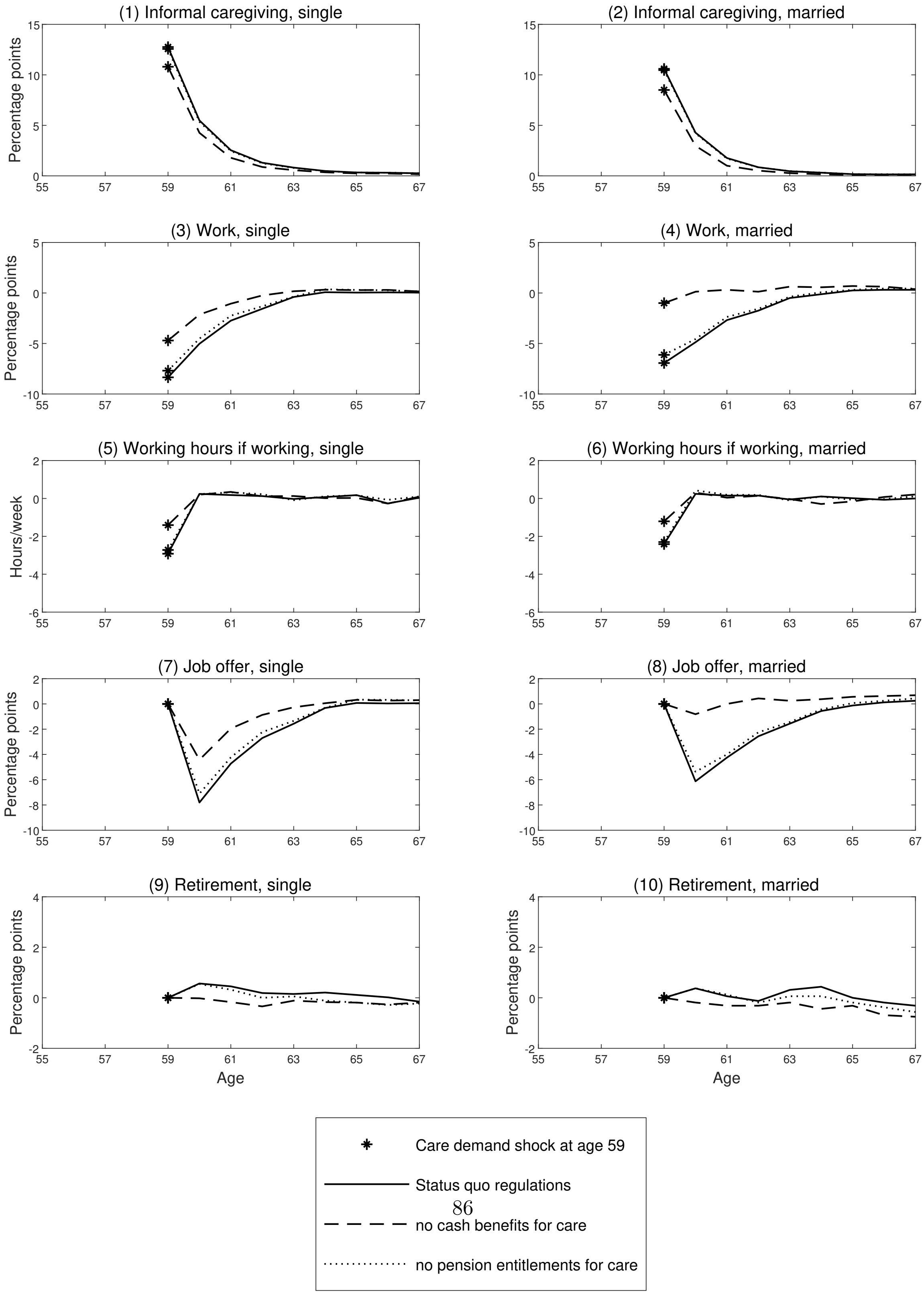
This figure portrays effect of caregiving at ages 63 on several labor market outcomes by educational attainment. Effects are differences between caregiving in the baseline and a simulation in which care-demand is set to 0 in the initial period. The figure compares effects between 3 policy scenarios. *Source:* SOEP, own calculations. *Source:* SOEP, own calculations.

Figure D.21: Response to care provision (labor outcomes), heterogeneity by partner status, care shock at age 55



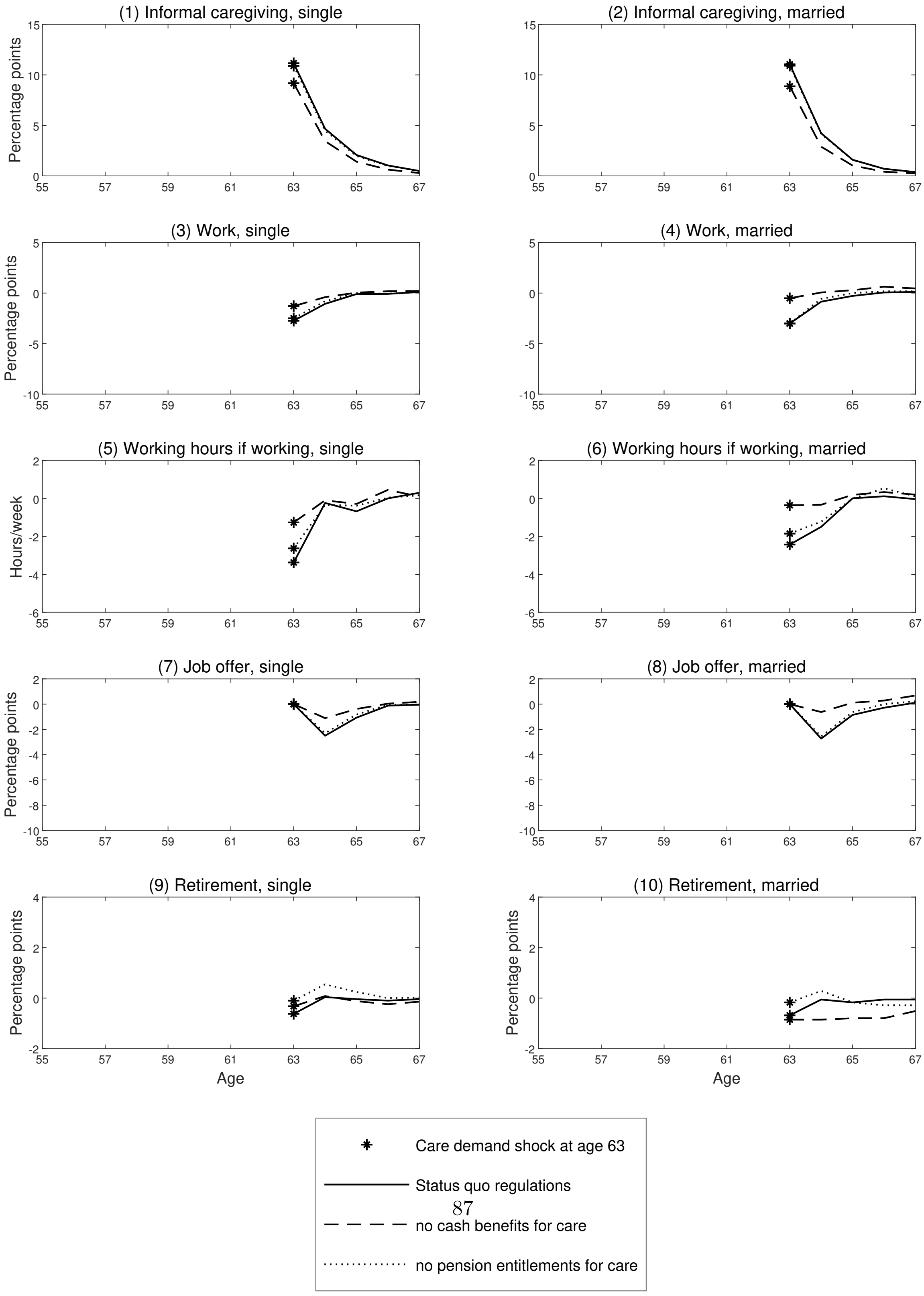
This figure portrays effect of caregiving at ages 55 on several labor market outcomes by marital status. Effects are differences between caregiving in the baseline and a simulation in which care-demand is set to 0 in the initial period. The figure compares effects between 3 policy scenarios. *Source:* SOEP, own calculations. *Source:* SOEP, own calculations.

Figure D.22: Response to care provision (labor outcomes), heterogeneity by partner status, care shock at age 59



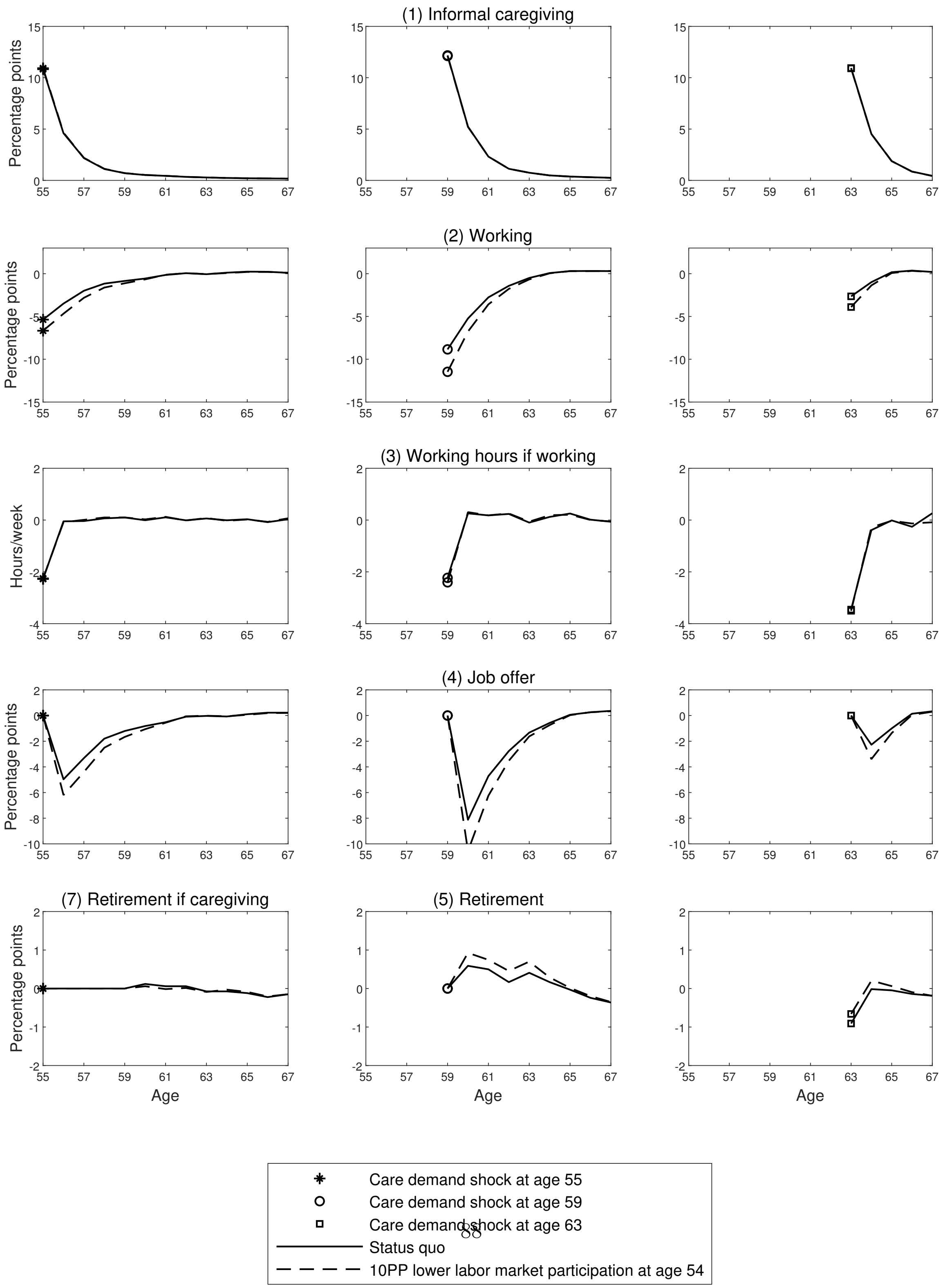
This figure portrays effect of caregiving at ages 59 on several labor market outcomes by marital status. Effects are differences between caregiving in the baseline and a simulation in which care-demand is set to 0 in the initial period. The figure compares effects between 3 policy scenarios. *Source:* SOEP, own calculations. *Source:* SOEP, own calculations.

Figure D.23: Response to care provision (labor outcomes), heterogeneity by partner status, care shock at age 63



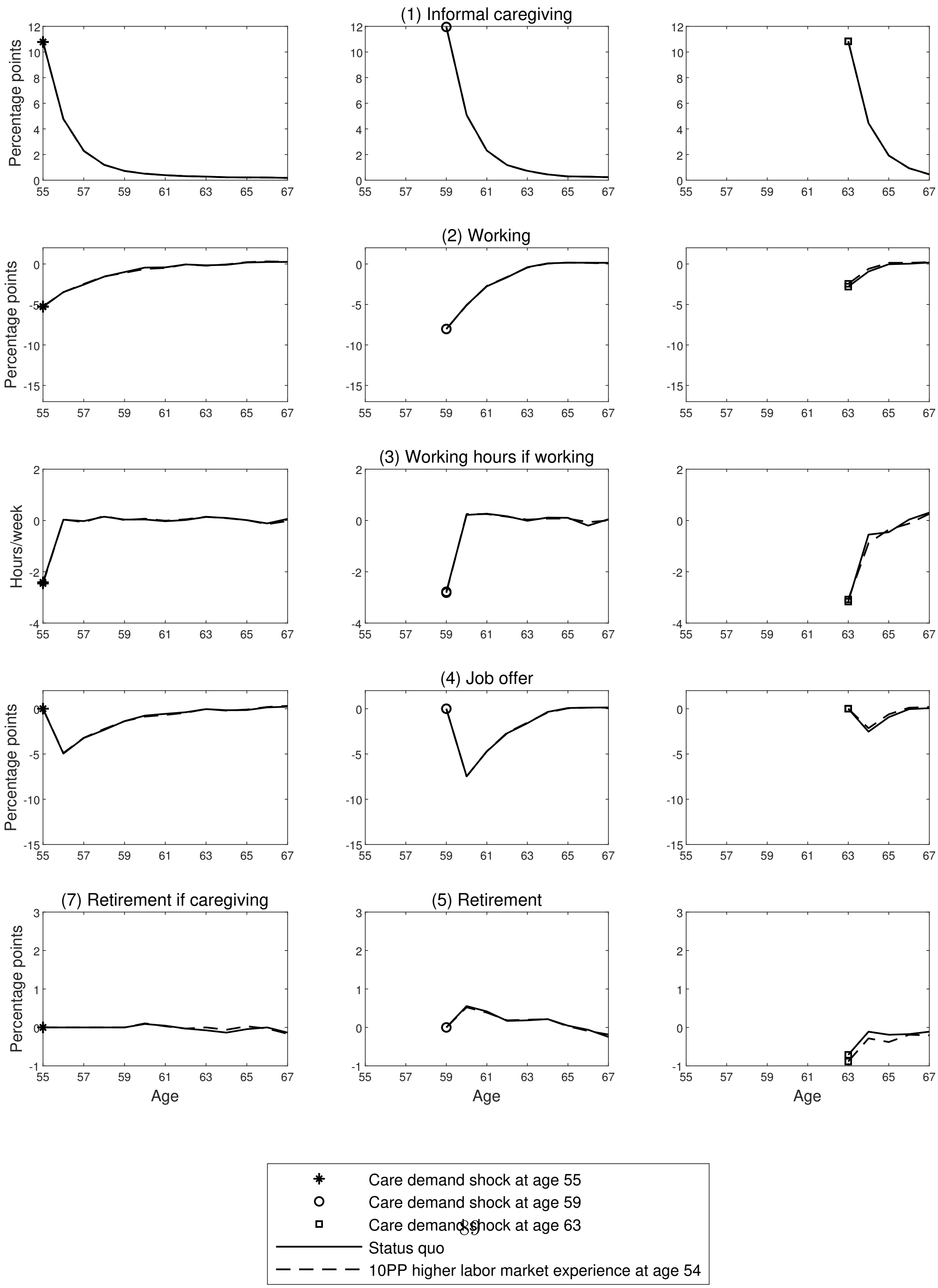
This figure portrays effect of caregiving at ages 63 on several labor market outcomes by marital status. Effects are differences between caregiving in the baseline and a simulation in which care-demand is set to 0 in the initial period. The figure compares effects between 3 policy scenarios. *Source:* SOEP, own calculations. *Source:* SOEP, own calculations.

Figure D.24: Response to care provision (labor outcomes), status quo and 10PP higher labor market attachment



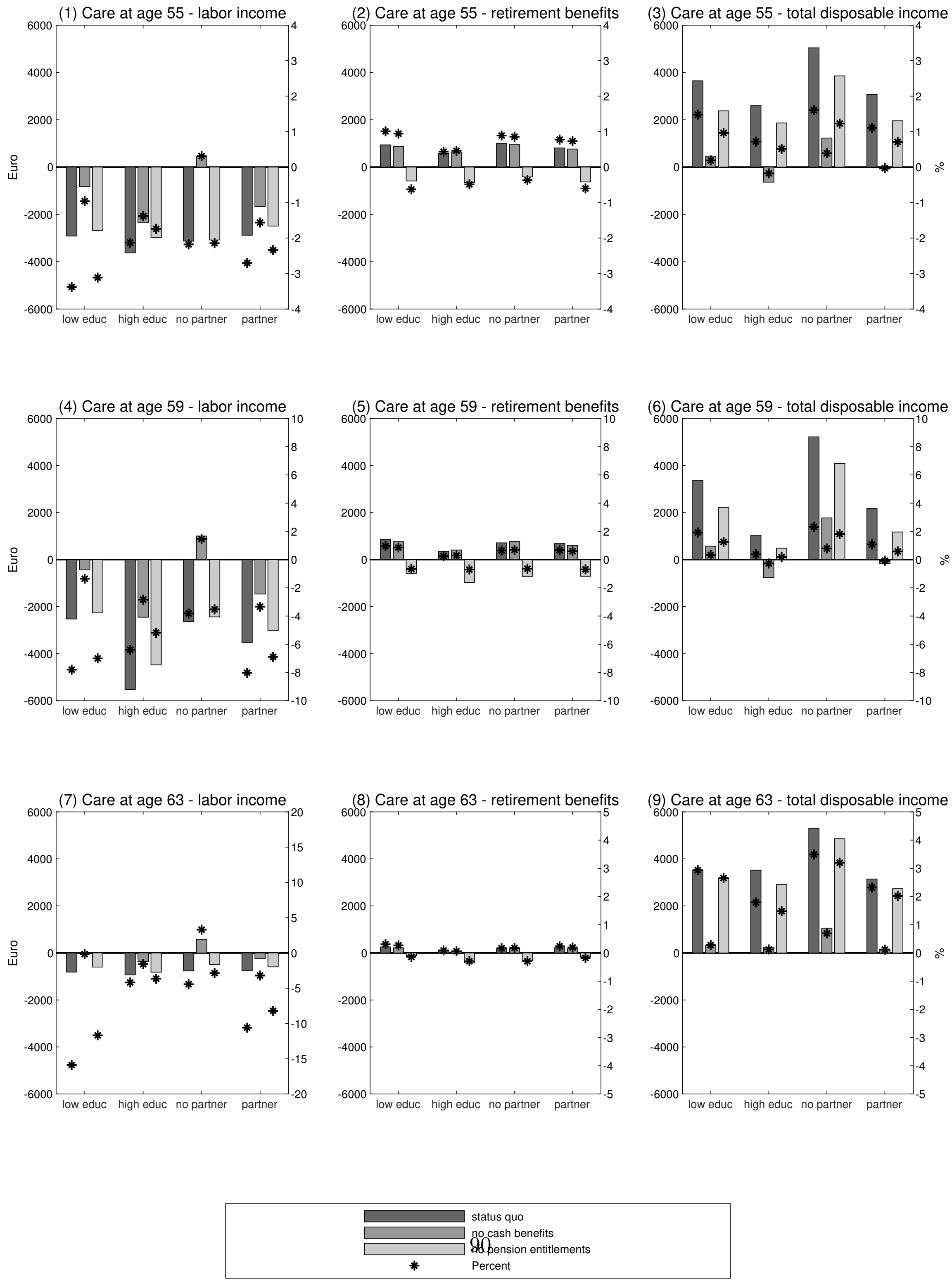
Source: SOEP, own calculations.

Figure D.25: Response to care provision (labor outcomes), status quo and 10PP higher work experience- robustness



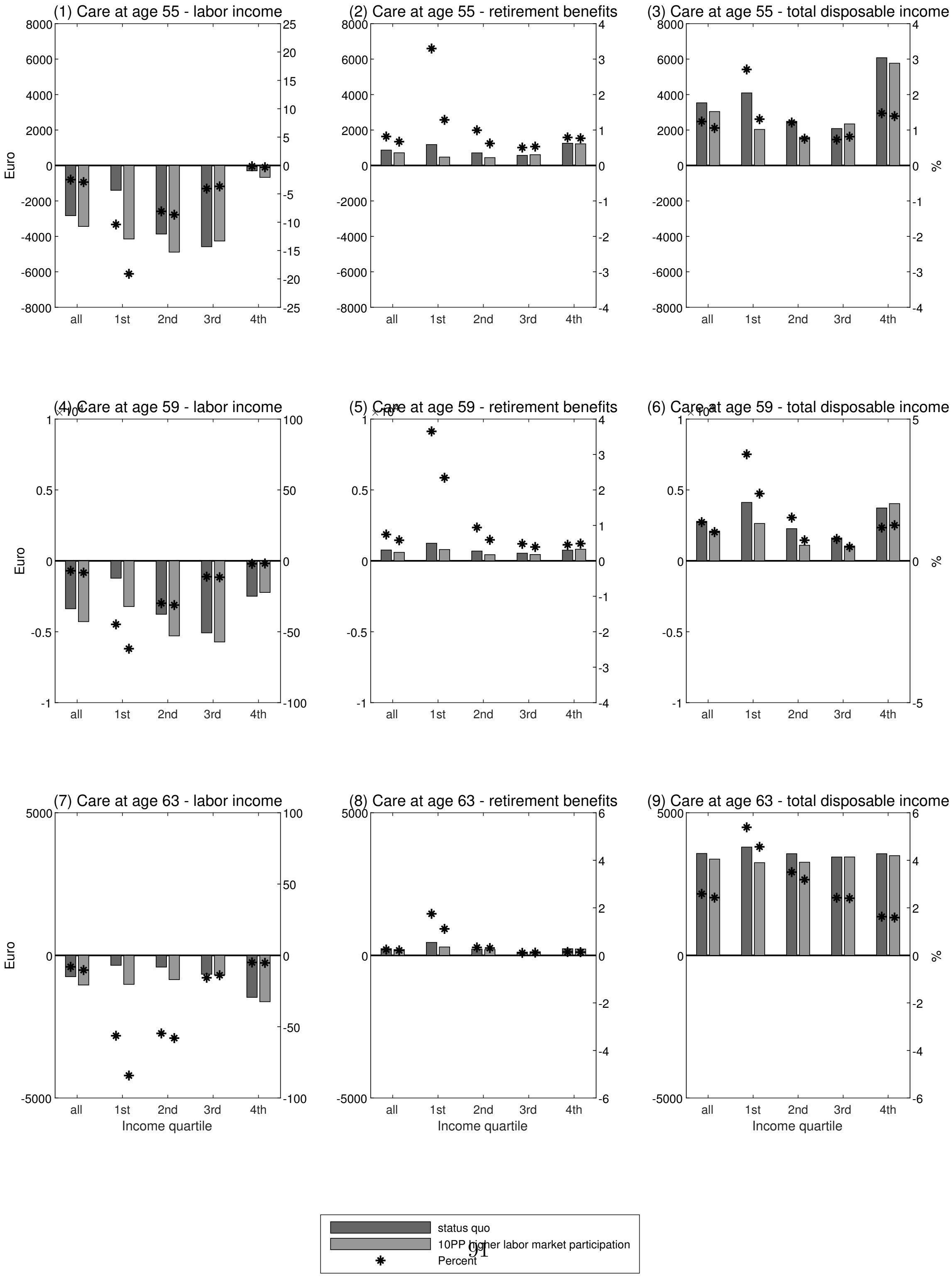
Source: SOEP, own calculations.

Figure D.26: Caregivers' costs to lifetime income, heterogeneity analysis



Note: Source: SOEP, own calculations.

Figure D.27: Caregivers' costs to lifetime income, status quo and 10PP higher labor force participation



Note: Source: SOEP, own calculations.