DISCUSSION PAPER

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Money Also is Sunny in a Retiree's World

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Money also is sunny in a retiree´s world

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Abstract

This paper shows that labor income plays an important positive role for the decision to work after retirement. Especially individuals who have the chance to substantially supplement their pension entitlements have a higher earnings elasticity. Men are more attracted by earnings incentives than women. Also individuals who work until retirement can easier be attracted by financial incentives to work after retirement than those with bridge options. Our analysis is based on a representative and large administrative individual career data set that includes employer information. We use an endogeneity correction model to estimate labor and non-labor financial determinants of labor market participation after retirement.

JEL-Codes: J14, J22, J26

Key Words: Work after retirement, labor and non-labor financial incentives, empirical study

1 Introduction

Labor force participation of retirees increased strongly in most European countries in recent years (Eurofound, 2012). On average, the employment rate for individuals aged between 65 and 74 years has risen from 5.2% in 2002 to 8.7% (an increase of 67%) in 2014 in the EU-15 Countries (Rhein, 2016).[2]

Individual, social and work-related push and pull factors have been put forward as drivers of post-retirement employment (Anger et al., 2018; Büsch et al., 2010; Burkert and Hochfellner, 2017; Cahill et al., 2015; Fasbender et al., 2016; Maxin and Deller, 2010; Micheel et al., 2010; Pleau and Shauman, 2013; Wang et al., 2008; Westermeier, 2019). Besides education and health, the individual financial situation is frequently highlighted as a key driver of work after retirement (Kim and Feldman, 2000; Larsen and Pedersen, 2017; Wang et al., 2008). When looking closer at the measurement of the financial situation of retirees, it however becomes evident that so far no contribution on work after retirement made a distinction between labor and non-labor earnings. Some papers include non-labor income after retirement such as pension entitlements (Hochfellner and Burkert, 2013). Other papers bundle up non-labor and labor income after retirement by for example using household income after retirement (Anger et al., 2018; Micheel et al., 2010; Pfarr and Maier, 2015). A last group of papers looks at wealth or the subjective economic status before retirement (Fasbender et al., 2016; Wang et al., 2008).

Empirical approaches that do not separate labor and non-labor earnings after retirement may however report biased results on financial determinants of work participation after retirement. According to standard labor supply theory, labor earnings are assumed to increase work participation and non-labor income is assumed to decrease it (Cahuc et al., 2004). When work has a higher reward, workers substitute leisure against work. An increase in non-labor income has a negative effect on work participation or working hours. The income effect induces workers to reduce work because they can maintain a target standard of living with lower labor burden. This paper for the first time distinguishes between income and substitution effects of work and non-work income after retirement on work participation and shows the empirical relevance of both drivers.

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[2] Also in Germany, the labor force participation rate of people aged 65 to 74 increased to 9.6% in 2014 from 4.2% in 2002, implying a rise of almost 140% (Rhein, 2016).

The extensive labor supply margin response on marginal work income changes depends on the density of the distribution of reservation wages around the economy´s equilibrium. This density is small for the entire working-age population because relatively few people voluntarily do not work (Chetty et al., 2011). It is therefore hard to estimate reliable earnings elasticities on labor supply for the entire population. Relatively many employees at the end of their career are closer to the margin of re-entering the labor force for available earnings opportunities, however. As the previous labor contract ends when entering retirement, all employees close to retirement have to decide whether to work in a new labor contract or not besides receiving retirement benefits. Upon retirement, labor re-entry incidence and extensive margin responses to earnings options therefore are relatively high in comparison to the earnings elasticity for the entire population (Rogerson and Wallenius, 2009).

Analogously to people close to retirement, all women with a small child have to decide whether to work again or continue to provide full time childcare. As a consequence, also the extensive margin response to earnings incentives is relatively high (and easier to measure) for women with small children. The empirical literature on mothers with young children shows that besides non-labor financial means such as household income, childcare costs or public transfers such as parental allowance, also (potential) labor earnings are an important driver of labor market re-entry (Allègre et al., 2015; Borra, 2010; Connelly, 1992; Del Boca and Vuri, 2007; Ribar, 1992; Viitanen, 2005). The empirical identification strategy on financial incentives for the labor force participation of mothers after their parental leave period therefore can be transferred to the labor supply decision of old workers after their retirement. As a consequence, we assume that also for retirees, (potential) labor earnings are an important driver for work after retirement besides non-labor earnings.

The main aim of this paper is to estimate the percentage change in labor force participation after retirement in response to a percentage change in the financial reward from labor and non-labor income. For individuals not working beyond retirement, potential earnings are estimated using Heckman´s (1976; 1979) approach to correct for sample selection. We show that (potential) labor earnings are an important pull factor for the decision to engage in employment beyond retirement. We also find that there is a sizeable negative pension entitlement (non-labor income) effect on the probability of working after retirement. As a consequence, the higher the ratio between expected post-retirement labor earnings and pension entitlements, the larger the likelihood of post-retirement employment. The empirical analysis also provides evidence of heterogeneous earnings elasticities between retiree groups.

More specifically, we show that women are less responsive to higher labor earnings than men. Especially men with low earnings before retirement have high earnings elasticities. We in addition find that individuals who use the bridge options partial retirement or unemployment before early retirement are less responsive to higher labor earnings after retirement than their counterparts who work until retirement.

This paper makes the following contributions to the literature on empirical determinants of work beyond retirement: First, the importance of labor earnings for work beyond retirement is established for the first time. Second, large-scale and representative administrative social security panel data from the Institute for Employment Research (Sample of Integrated Labor Market Biographies (SIAB7514)) are used. Studies on the relationship between financial incentives and work beyond retirement previously typically relied on small-scale and potentially specific sub-populations (Kim and Feldmann, 2000; Saba and Guerin, 2005; Torka et al., 2012) or on survey-based data that may be affected by self-selection and measurement error in key variables (Anger et al., 2018; Büsch et al., 2010; Dittrich et al., 2011; Pfarr and Maier, 2015, Saba and Guerin, 2005). Our data include reliable information on daily earnings and individuals' employment histories beyond the statutory retirement age of 65. Third, a rich set of employer characteristics allows us to control for additional determinants on the decision on working beyond retirement. Fourth, based on hypotheses we show heterogeneities in labor earnings elasticities between selected employee groups.

The paper is organized as follows. In Section 2, a theoretical model is presented and the theoretical predictions how individuals respond to financial incentives are derived. In Section 3, the data set is introduced and descriptive statistics of differences between employees who continue and who do not continue to work beyond retirement are provided. In Section 4, the empirical method is described and the empirical results are presented in Section 5. Finally, Section 6 concludes the analysis.

2 Theoretical considerations

2.1 Basic model

According to the standard labor supply model, retirees maximize their utility by comparing consumption made possible by labor and non-labor income with leisure (Cahuc et al., 2004). In doing so, they face the decision of whether to work or not. Figure 1 shows different possible budget lines as well as the retirees´ corresponding indifference curves. The slope of

the indifference curves (U_A, U_B, U_C, U_D) defines the marginal rate of substitution between consumption and leisure. Their shape corresponds to consumption and leisure being defined as "normal" goods with decreasing marginal returns.

In this model, individual income consists of non-labor income (for example pension entitlements) *V* and labor earnings *W*. The earnings derived from work after retirement correspond to the opportunity costs of leisure. The point where one of the retiree's indifference curves tangents the budget line is the combination of earnings and leisure with which the retiree maximizes utility under the budget constraint.

Figure 1 shows that if potential hourly labor earnings after retirement are too low, the individual does not work after retirement. The maximum indifference curve, U_A crosses the budget line at point *A* and the retiree consumes only non-labor earnings V_0. If hourly labor earnings and accordingly the slope of the budget line increase, utility is maximized at point *B* with $U_B > U_A$. The retiree therefore decides to work after retirement (substitution effect) and we can derive the following hypothesis:

Hypothesis 1: The higher the (potential) labor earnings after retirement, the greater the likelihood to work after retirement.

An increase in non-labor income from V_0 to V_1 results in a parallel shift of the budget line. With higher non-labor income, labor force participation decreases because the retiree can now consume the same quantity of goods when working less (income effect). In Figure 1, this is depicted by steeper indifference curves at a given leisure level with increasing V. Thus, an increase in the pension entitlements decreases the opportunity cost of leisure. In Figure 1 this effect is illustrated as a shift from point *B* to point *C*. Note that with an increase in *V* that is strong enough, at a given labor earnings level, pensioners may decide to stop working. Therefore, the following hypothesis is derived:

Hypothesis 2: The higher the pension entitlements (non-labor income), the lower the likelihood to work after retirement.

Figure 1: Labor supply model of retirees.

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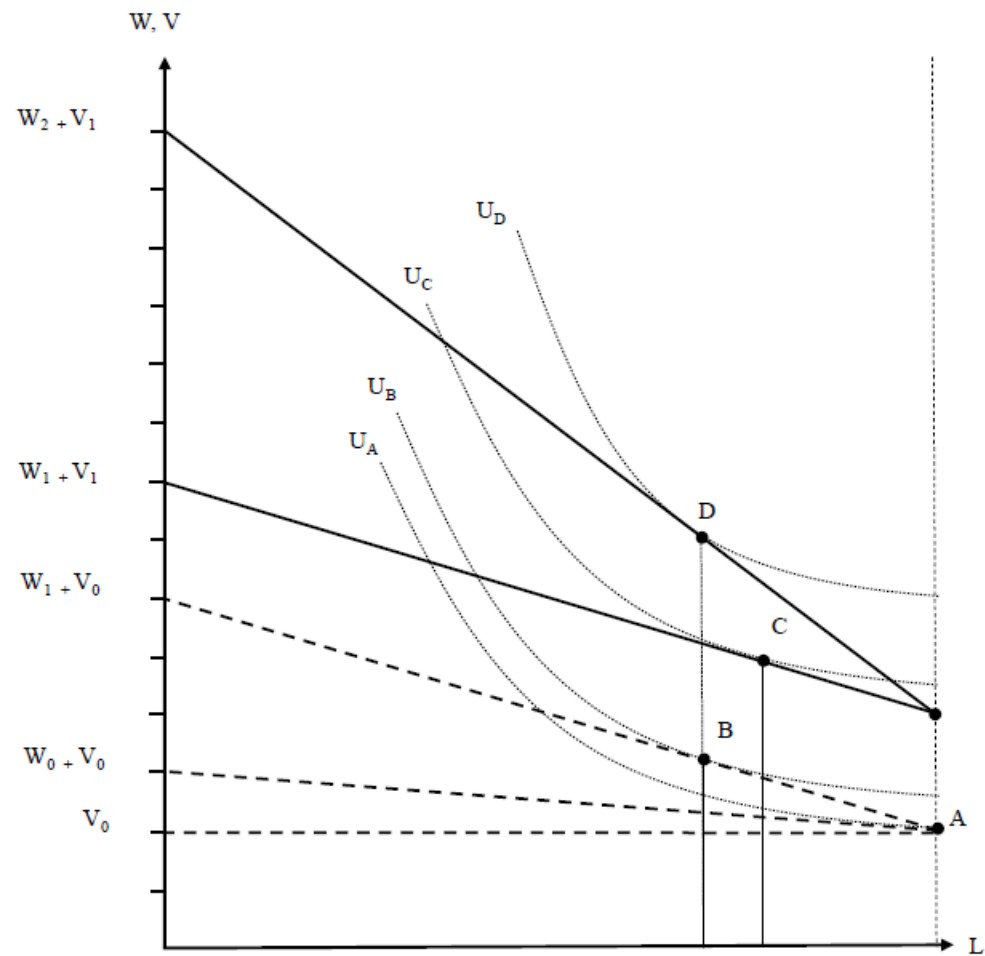
Given the higher pension entitlement, V_1, higher potential labor earnings (W_2 instead of W_1) are needed to incentivize the retiree to work as much as in point B (point D, for example). A higher substitution effect has to compensate for a higher income effect for labor market participation after retirement. Hypothesis 3 combines the first two hypotheses:

Hypothesis 3: The higher the ratio between the (potential) labor earnings after retirement and non-labor income, the greater the likelihood that the retiree works after retirement.

2.2 Heterogeneous responses to financial incentives

We now derive factors that explain differences in labor earnings elasticities for the labor force participation between retiree groups. Arguments concerning different responses of individuals to financial incentives from labor supply theory and existing empirical results on post-retirement employment are built upon to derive hypotheses that can be tested in the empirical analysis.

In the labor supply literature, a robust finding is that earnings elasticities of women exceed that of men (Bargain et al., 2014; Evers et al., 2005; Meyer and Rosenbaum, 2001). The difference between gender groups is explained by the division of labor within the family. According to Blau and Kahn (2007) and Mincer (1962), women substitute their time between market work, home production, and leisure, whereas men primarily substitute their time between market work and leisure. As women have closer substitutes for market work than men, they are expected to have larger earnings substitution effects. The literature stresses that household production increases the elasticity of labor supply because home-made goods are substitutes for commercial goods (Cahuc et al., 2004; Mincer, 1962).

At first sight, these general labor supply mechanisms also apply for women and men after their retirement. The share of older women engaged in household production (e.g., care of relatives, childcare of grandchildren) is higher than the comparable share of men (Hank and Buber, 2009). In addition, there is a second spike in household production after age 60 that is larger for women than for men, compare Vargha et al. (2017). There is a decisive difference for the calculation of employment earnings elasticities between the average labor supply decision and that for work after retirement, however. Until retirement, the share of men who do not work is much smaller than the share of women (Blau and Kahn, 2007). The labor market attachment of men who potentially can join the workforce therefore may be lower than that of women – earnings elasticity of a group in general is negatively related to its prior labor

market participation (Bastani et al., 2020). On day one after retirement, labor market participation of men and women is set to zero, however. As a consequence, the density at the earnings margin to re-enter employment may be higher for male retirees than for female retirees given the higher home production duties of women that make labor market participation less attractive or impossible for them. Therefore, it is assumed that the labor earnings elasticity for old women is lower than that for old men:

Hypothesis 4: Women have lower post-retirement labor earnings elasticities than men.

In Germany, there are various ways to transit from employment to retirement (Rasner and Etgeton, 2014). A substantial portion of older workers use a so-called bridge option (Brussig, 2015), i.e. unemployment between work and retirement and partial retirement.[3] Both bridge options can be used by employees after 15 contribution years to pension retirement and at least 8 years of contributions periods in the last 10 years before retirement. They therefore are not viable for employees with large labor market gaps and a low labor market attachment in general. In both bridge options, employees usually have to accept financial disadvantages in comparison to their other (early) retirement options, but they can exit employment already before their retirement date. Indeed, labor market exit age on average is between one to two years earlier for those using partial retirement or retirement after unemployment than for those who use the early retirement options that also would have been available for those who used bridge options (Geyer et al., 2019).[4] We therefore assume that employees who use a bridge option put a relatively high value on leisure at old age and they therefore are less inclined to work after retirement. A lower inclination to work after retirement also has been found for those who do not work full time until retirement (Burkert and Hochfellner, 2013; Maestas, 2010; Smeaton and McKay, 2003) – those who use the so-called continuous model of partial retirement are a case in point for part-time work before retirement.

The argument that employees who select partial retirement have a higher value of leisure seems to be obvious because workers have to give their consent for trading earnings against an earlier employment exit (Wanger, 2009). Employers therefore are more successful in nudging employees with a lower labor market attachment at old age into partial retirement.

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[3] Please note that the concept of bridge employment in Germany differs from that used in the US (Beehr and Bennett, 2015). In Germany, bridge employment means that employees exit employment earlier then retirement or reduce their working time *in* their career job or they exit into unemployment from their career job before they enter retirement. In the US, bridge employment usually means taking another job a*fter* their career job.

[4] Almost all employees in bridge options in the cohorts we look at also are entitled to use other early retirement options such as the pension for women and the pension for the long-term insured. Indeed many employees in bridge options use these alternative early retirement options after their bridge option.

The group of employees who bridge the time between employment and retirement by unemployment may mainly consist of workers who have been dismissed against their wills and therefore their value of leisure is unclear. We however have to take into account that older employees in Germany are very well protected against dismissals (Schmähl, 2003). They usually obtain substantial severance payments (Grund, 2006). The severance payments however are subject to individual bargaining between employer and employee. Therefore employers may pick employees with a relatively strong preference for leisure at old age because dismissing them may be cheaper. The fifth hypothesis therefore is:

Hypothesis 5: Individuals using bridge paths into retirement have lower earnings elasticities than individuals who are employed until retirement.

Individuals with different places of work and residence before retirement have commuting costs. According to labor supply theory, at given earnings, commuting costs reduce the opportunity cost of leisure and may reduce labor supply (Cogan, 1977; 1981). We therefore assume that individuals whose place of work is not the place of residence before retirement are less attracted by financial incentives to work after retirement:

Hypothesis 6: Individuals whose place of work and residence is in the same region before retirement have higher earnings elasticities than individuals who have to commute.

Our last hypothesis concerns heterogeneity by income quartile before retirement. Bastani et al. (2020) show that earnings elasticity decreases with potential earnings. They argue that those with low potential earnings have a lower labor market attachment and therefore their potential for entry into the labor market is higher. For our group of old workers who have to decide whether to re-enter employment after labor market exit before retirement, this argument is not valid. We however argue that the risk of having pension entitlements below the target level of earnings after retirement ("old-age poverty") is higher for those with low earnings before retirement (Burkert and Hochfellner, 2017) and the financial aspect of work after retirement may play a larger role for those who earned less before retirement (Fasbender et al., 2016):

Hypothesis 7: Individuals with lower earnings before retirement have higher earnings elasticities.

3 Data

Our analysis is based on a large, representative, and high-quality administrative dataset provided by the Federal Employment Agency in Germany (*Bundesagentur für Arbeit*). The data comprise a sample of 2% of employees from the Integrated Employment Biographies from 1975 to 2014 (SIAB, 1975–2014)[5]. The data provide daily information about earnings and employment as well as receipt of benefits according to German Social Books II and III. We also know whether an employee is marginally employed or not. Approximately 80% of all employees are in marginal employment[6] after retirement. The share of women who work more than in marginal employment is with 18% somewhat smaller than the share of men (22%). Moreover, an extensive set of establishment information from the IAB Establishment History Panel is linked to the individual employment history.

We know daily earnings of employees after retirement. Earnings from marginal employment and pension entitlements are income tax free and do not require social security contributions in contrast to labor earnings beyond marginal employment.[7] We want to have comparable earnings indicators for employees in marginal employment and employees who work more than that. We argue that disposable income is more relevant for the decision whether to work or not than gross earnings. Therefore, we use net earnings without taxes and social contributions for labor earnings above the marginal employment threshold. More specifically, we deduct earnings taxes for earnings tax class 1, the solidarity surcharge, church tax and social security contributions to health and nursing care insurance.

We know the day at which employees exit from the last employment subject to social insurance contributions before retirement.[8] Individual and company-specific characteristics are measured at this point in time.

We do not observe pension entrance directly and therefore define two groups with post-retirement employment. First, individuals who have a labor market spell after their normal retirement age (NRA) of 65. Second, individuals who already started a marginal employment

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[5] A detailed description of the SIAB can be found in Antoni et al. (2016).

[6] Marginal employment is defined as dependent employment with a maximum monthly salary of 400 EUR (raised to 450 EUR in 2013).

[7] Tax and deduction exemptions on marginal employment were abolished just in 2012.

[8] In Germany, it is compulsory to report the end of employment to the social insurance system after the statutory retirement age. In the case of employment after retirement, the employer must provide a new contract and submit a new declaration to the social insurance, even if the employee was already employed by the company. Thus, employment is interrupted after pension entry by one day (Burkert and Hochfellner, 2017; Antoni et al., 2016).

before the age of 65 that extends beyond the age of 65 without interruption and who are eligible for early retirement[9]. We may incur three sources of measurement errors. First, there may be individuals who work longer than NRA without receiving a pension. People born after 1940 who retire after the NRA receive a 6% increase in pension entitlements each year. This option was available from the year 2005 onwards but the share of employees who postponed their entry into retirement after NRA was negligible ever since.[10] We include these individuals as employed after NRA but assume that they also draw pension benefits after 65. Second, there may be individuals who receive pensions besides working but stop to work before age 65. We cannot observe this group of people and therefore our results only cover all individuals who work besides receiving retirement benefits after NRA. The third group works more than marginally before NRA in addition to receiving pensions. This group again is negligibly small because earnings beyond the threshold of marginal employment strongly reduce pension claims (Westermeier, 2019). Unfortunately, there are no statistics on the incidence of this group, however.

3.1 Estimation sample

Our estimation sample consists of women and men born between 1935 and 1947. For each birth cohort, post-retirement employment is observed for a maximum of two years after the NRA. As work incidence quickly declines with age after 65 in Germany (compare for example Pfarr and Maier, 2015), we are confident that we do not miss any retirees who start to work in retirement after their 67th birth day. We restrict our sample to West-German[11] men and women with a strong labor market attachment in old age. More specifically, all individuals in the sample must be employed subject to social security at least once after the age of 55[12] and they must be active in the labor market (employed, in partial retirement, or unemployed) at age 59.[13] The reason for these sample restrictions that reduce our sample by about 30% is to obtain a relatively homogeneous sample of employees who in principle all

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[9] The SIAB data do not include relevant characteristics of the pension insurance, such as pension entitlements or eligibility. Therefore, individual pension entitlements are calculated and eligibility criteria for old age pensions and the corresponding statutory retirement dates NRA and ERA are identified according to Pfister et al. (2018) and Lorenz et al. (2018). We are grateful to Philip vom Berge and Dana Müller from the FDZ at the IAB for merging the day of birth as part of the Custom Shaped Administrative Data for the Analysis of Labor Market (CADAL) project because the calculation of pension entitlements requires the exact birth date.

[10] Bäcker et al. (2017) for example report that in 2014, from about 825.000 retired individuals only about two percent or 22.000 individuals received a bonus.

[11] Labor market careers are only available for East Germany after January 1, 1991 (Antoni et al., 2016).

[12] This sample restriction was also made by Hanel (2010) and Geyer et al. (2019).

[13] We also exclude seamen and miners (less than one percent of women and of men) because they have special protection of legitimate expectation rules for retirement that cannot be identified in the dataset.

have the option to work after retirement. It is relatively hard in Germany to return to the labor market after larger labor market gaps at higher age – in the group of employees excluded from our sample, the share or employees who work after retirement accordingly is less than one percent.

After the sample restrictions we are left with 30,784 women and 44,887 men. In the sample, 6,273 women and 9,549 men continue to work after retirement, corresponding to an average of 20% for women and 21% for men.[14] Across cohorts, the share of individuals who work beyond retirement has risen slightly. The number of observations and the share of individuals who continue to work after retirement by birth cohort are shown in Appendix Table A.1.

3.2 Descriptive statistics

Our analysis focuses on financial incentives for employment beyond retirement. The following descriptive statistics accordingly show average daily earnings, average pension entitlements, and the average share of labor earnings in pension entitlements by gender and type of employment after retirement (Table 1). The average daily net earnings after retirement are 14 EUR for women and 20 EUR for men.[15] For those who are marginally employed, daily earnings for both sexes are around 9 EUR. Pension entitlements of women who continue to work after retirement are on average 40% lower than those of men. Of particular interest is the share of labor earnings after retirement in total income. This share is with 66% for women and 53% for men substantial in comparison to pension entitlements. For employees in marginal employment, the proportion of the post-retirement earnings in disposable income is 47% for women and 27% for men. We therefore conclude that earnings after retirement are an important additional source of income for securing the standard of living in old age.[16]

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[14] The proportion of employees who continue to work after retirement is slightly lower than that calculated by Anger et al. (2018). In their study, however, employment after retirement is identified from survey answers.

[15] Women have no earnings after retirement above the social contribution earnings threshold and for men the proportion with earnings above the earnings threshold is 0.3%. We therefore do not have to correct for censored earnings.

[16] Please note that we cannot take into account other sources of income, such as private pensions, capital rents or savings.

Table 1: Summary statistics on work and non-work earnings.

	Women	Men	Women	Men	Women	Men
	Daily net labor earnings (EUR)		**Daily pension entitlements (EUR)**		**Share of net labor earnings in disposable income (%)**	
All employees who work after retirement						
Mean	14.013	19.770	23.016	39.122	65.94	52.97
SD	14.037	24.660	9.210	11.737	60.68	65.59
N	6,273	9,549	6,273	9,549	6,273	9,549
Employees with marginal employment after retirement						
Mean	9.406	9.514	22.637	38.510	46.93	27.06
SD	3.416	3.453	8.643	10.584	24.70	15.28
N	5,175	7,350	5,175	7,350	5,175	7,350

Note: SD: standard deviation. *Data*: SIAB 7514, own calculations.

We also can show that those who continue to work after retirement on average have a significantly lower pension entitlement than individuals who do not work after retirement (Appendix Table A.2). This finding corresponds with the negative correlation between non-labor earnings and re-entry into employment after retirement found in most of the literature (Burkert and Hochfellner, 2017; Büsch et al., 2010; Dittrich et al., 2011; Hochfellner and Burkert, 2013; Kim and Feldmann, 2000; Micheel et al., 2010).[17] Appendix Table A.2 also summarizes differences in individual and establishment characteristics prior to retirement between employees who continue to work after retirement and those who do not. It shows, for example, that there is a negative correlation between work after retirement and employer size as well as the share of highly skilled workers.

4 Estimation strategy

We propose an empirical choice model to examine the employment decision after retirement. The decision to participate in the labor market is estimated based on a linear probability model using the employment status after retirement as the outcome variable:

$$\text{LFP}_i = \beta_0 + X_i\beta_x + Z_{j(i)}\beta_z + \gamma pe_i + \delta\widehat{wage}_i + \varepsilon_i \qquad \text{LFP} = 1 \text{ if } \text{LFP}^* > 0$$

$$\text{LFP} = 0 \text{ if } \text{LFP}^* = 0 \qquad (1)$$

The labor force participation variable (LFP) is a dichotomous variable with a value of zero for non-participation and a value of one for post-retirement employment. The latent variable LFP* reflects the utility difference between non-participation and participation in the labor market

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[17] Two studies however show that employees with higher financial means are more likely to work beyond retirement (Anger et al., 2018; Pfarr and Maier, 2015).

beyond retirement. Our main variables of interest are the log disposable pension entitlements *pe* (non-labor earnings) and the net (potential) labor earnings *wage*. [18]

Labor earnings after retirement may be endogenous because they also reflect time allocation decisions, that is, they are only observed for those who work after retirement. In order to circumvent this endogeneity problem, predicted daily labor earnings after retirement $\widehat{wage}$ are estimated for all individuals in an auxiliary estimation. The standard Heckman sample selection approach (Heckman, 1976; 1979) is used to predict the earnings of post-retirement employment. More specifically, we first estimate a reduced-form employment participation Probit for all individuals in the sample. We use the Probit parameters from this participation equation to generate the inverse Mills ratio. Including this ratio controls for possible sample-selection bias in the wage equation. We then take the results of the wage equation to generate values of the predicted wage for all individuals in the sample (Borra, 2010).

Technically, this type of selectivity corrected model can achieve identification by functional form assumptions (Cameron and Trivedi, 2002). In practice, nonetheless, most researchers feel more comfortable if at least one regressor in the participation equation is excluded from the labor earnings equation (Connelly and Kimmel, 2003). We therefore include in the reduced form labor participation equation the accumulated pension entitlements. Pension entitlements indicate the negative income effect in the participation equation and therefore are strongly related with labor participation. Pension entitlements are an indicator of past labor market performance. Given that all employees obtain a new labor contract, usually entailing less labor hours and new tasks, previous labor market performance seems to be hardly related to (potential) earnings after retirement and it therefore can be excluded from the earnings equation.

Besides the exclusion restriction in the participation equation and the Mills ratio in the earnings equation, we include core individual characteristics that have been used in the literature as determinants of work after retirement (Anger et al., 2018; Brenke, 2013; Brussig, 2010; Burkert and Hochfellner, 2017; Engstler and Gordo, 2017; Fasbender et al., 2016; Micheel et al., 2017; Rhein, 2016; Westermeier, 2019). We keep the auxiliary regressions parsimonious in order to avoid multicollinearity problems in our main labor participation

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[18] In a further estimation specification, instead of the expected earnings and the pension entitlements, the ratio of the (potential) earnings in pension entitlements is included in the equation.

regression (Borra, 2010). More specifically, we include education, occupation[19], accumulated labor market gaps until age 65 in months[20], and the year of labor market exit.

In the main labor participation equation, we include all explanatory variables used in the auxiliary participation equations and potential labor earnings. In addition, we include dummies that equal one if an individual uses the bridge option partial retirement or unemployment because labor market gaps before retirement negatively affect the continuation of employment after retirement (Anger et al., 2018; Burkert and Hochfellner, 2017; Schellenberg et al., 2005; Smeaton and McKay, 2003; Westermeier, 2019). We also include several characteristics of the last employer before retirement. Previous studies have shown that employees in small establishments have a higher probability of working beyond retirement (Anger et al., 2018; Burkert and Hochfellner, 2017; Micheel et al., 2010). In addition, Brussig and Bellmann (2008) show that attitudes towards hiring older workers differ among companies. For example, employees in companies with a high proportion of older employees have a higher chance of being hired after their retirement than those in companies with a high proportion of employees in partial retirement and severance payments. Moreover, some studies also include the general economic environment as a determinant of employment after retirement. We therefore include the mean imputed earnings of all full-time employees, economic sector, establishment size, share of employees in partial retirement, share of highly qualified employees, share of employees aged 55–59, share of employees aged 60–64, and the share of employees aged 65 and older.

We take into account that the decision to work after retirement is fundamentally different between men and women because the non-market production situation usually differs. We therefore estimate all earnings and participation equations separately by gender.

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[19] The Blossfeld classification of occupations is intended to form occupational groups as homogeneously as possible with regard to average educational and vocational background and professional fields of activity (Blossfeld, 1985).

[20] An alternative for the aggregated gaps in the labor market before the age of 65 is the exit age from employment before the statutory retirement age. The results are robust. It is not possible to include both variables in the estimations because they are strongly correlated. Early retirement is associated with more gaps in the labor market before the age of 65.

5 Estimation results

5.1 Employment decision to work beyond retirement

The first estimation step, the calculation of the Heckman selection earnings equation, is shown in Appendix Table A3. The Hausman specification test indicates that the pension entitlements variable is a valid instrument to control for endogeneity. We present our estimation results of the decision to work beyond retirement in Table 2, separately for women (column I) and men (column II). The OLS estimates suggest a substantial positive effect of the (potential) earnings on labor supply for women and men. According to hypothesis 1, an increase in (potential) labor earnings by one percent significantly increases the probability of being active in the labor force by 0.056 and 0.246 percentage points, respectively. According to hypothesis 4, labor earnings elasticity is much higher for men than for women.[21] Consistent with hypothesis 2, an increase in pension entitlements significantly reduces the employment probability by 0.055 percentage points for women and 0.165 percentage points for men. A higher pension entitlement leads to a stronger reduction in labor market participation for men than for women.

Also the individual characteristics show the expected signs on employment after retirement. Employees who use bridge paths have a significantly lower probability to work and therefore labor market gaps before retirement have the expected negative correlation with labor market participation after retirement. Academics work less after retirement than skilled employees (also compare Burkert and Hochfellner, 2017). Prior occupations hardly have an influence on working after retirement, however.[22]

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[21] We obtain larger coefficients for the estimated earnings variables in the labor participation equation if we drop the endogeneity correction (Mills ratio) in the earnings estimation step. (Potential) earnings however remain significant and larger for men than for women.

[22] All results remain robust when only individual characteristics are included in the participation equation and employer characteristics are not controlled.

Table 2: Linear probability model of labor force participation.

Dependent variable: labor force participation	Women	Men
Individual characteristics		
Estimated earnings (log)	0.056*	0.246**
	(0.019)	(0.055)
Pension entitlements (log)	-0.055**	-0.165**
	(0.006)	(0.008)
Bridge option: partial retirement	-0.078**	-0.060**
	(0.007)	(0.005)
Bridge option: unemployment	-0.323**	-0.266**
	(0.006)	(0.005)
No degree	ref.	ref.
Vocational training	0.032**	0.025
	(0.006)	(0.013)
University degree	0.005	-0.075*
	(0.012)	(0.031)
Manufacturing occupations	Ref.	Ref.
Service occupations	0.011	-0.021
	(0.008)	(0.014)
Administrative occupations	-0.010	-0.042**
	(0.008)	(0.012)
Accumulated labor market gaps prior to age 65 in months	-0.006**	-0.001
	(0.0007)	(0.001)
Employer characteristics		
Firm size: <10 employees	Ref.	Ref.
10 to 100 employees	-0.027**	-0.019**
	(0.006)	(0.007)
>100 employees	-0.044**	-0.059**
	(0.007)	(0.008)
Mean imputed earnings of all full-time employees	-0.0004**	-0.000006
	(0.00009)	(0.00006)
Share of highly qualified employees	-0.027	-0.112**
	(0.016)	(0.016)
Share of employees in partial retirement	-0.204**	-0.128**
	(0.061)	(0.049)
Share of employees aged 55–59	-0.030	-0.013
	(0.017)	(0.017)
Share of employees aged 60–64	-0.033	-0.065**
	(0.023)	(0.021)
Share of employees aged 65 and older	0.514**	0.527**
	(0.048)	(0.051)
N	30,784	44,887
R^2	0.307	0.210

Notes: Additional controls: year of employment exit, and economic sector of the employer. Standard errors in parentheses are computed by bootstrapping with 200 repetitions and are clustered on the individual level. * $p < 0.05$, ** $p < 0.01$. *Data*: SIAB 7514.

The effects of the establishment characteristics of the last employer prior to retirement on the labor market decision of the retiree are also according to expectations. Workers who are employed in firms with more than ten employees prior to retirement show a lower labor force participation after retirement. Furthermore, there is a negative correlation between mean earnings of all full-time employees, the share of highly qualified employees, and the share of employees in partial retirement and work after retirement. The higher the share of employees who work after retirement at the last employer, the higher is the probability of being employed after retirement.

Note that the (potential) labor earnings regressor is generated because it has been estimated in a separate step with uncertainty (Borra, 2010). Therefore, the standard errors of this variable are bootstrapped. A bivariate Probit model is used to verify the results of the linear probability model presented in Table 2. The results of both estimation models are consistent with each other.

The estimation equation in Table 3 replaces the separate labor earnings and pension entitlement variables by the share of expected earnings in disposable income. This variable has a substantial positive impact on the extensive margin of labor supply. An increase in the share of (potential) labor earnings in disposable income after retirement by one percentage point increases the probability of working beyond retirement by 0.22 percentage points for women and 0.82 percentage points for men. This result supports hypothesis 3.

Table 3: Linear probability model of labor force participation with the share of estimated earnings in disposable income.

	Women	Men
Share of estimated earnings in disposable income	0.222**	0.816**
	(0.054)	(0.057)
N	30.784	44.887
R^2	0,306	0,206

Notes: Same list of covariates as in Table 2. Standard errors in parentheses are computed by bootstrapping with 200 repetitions and clustered on the individual level. * $p < 0.05$, ** $p < 0.01$. *Data*: SIAB 7514.

5.2 Heterogeneity in earnings elasticities

Table 4 shows differences in the estimated elasticity of labor force participation with respect to (potential) labor earnings between employees who use bridge paths versus those who do not use bridge paths prior to retirement. In line with hypothesis 5, the estimates suggest a higher positive earnings effect on labor supply for employees without bridge paths than for

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employees with bridge paths. The earnings elasticities for employees without a bridge path are twice as large for women and 50% larger for men than those for employees with bridge paths. Employees without bridge paths therefore seem to derive lower utility from leisure and they are more responsive to financial incentives when deciding about employment after retirement.

Table 4: Extensive margin of labor supply for employees with and without bridge paths.

	Women		Men	
	Bridge paths			
	No	Yes	No	Yes
Estimated earnings (log)	0.095**	0.057*	0.307**	0.244**
	(0.024)	(0.029)	(0.095)	(0.064)
N	19,887	10,897	19,223	25,664
R^2	0.407	0.067	0.287	0.071

Notes: Same list of covariates as in Table 2. Standard errors in parentheses are computed by bootstrapping with 200 repetitions and clustered on the individual level. * $p < 0.05$, ** $p < 0.01$. *Data*: SIAB 7514.

In a next step, we compare earnings elasticities between employees who have to commute to work to a different region in their last employment prior to retirement and those who live and work in the same region. We use the approach proposed by Kropp and Schwengler (2016) to delineate 50 functional West German labor market regions based on commuting flows.[23] The dummy has value one if an employee commutes to a workplace outside the own labor market region. Our results do not support hypothesis 6: there are practically no differences between commuters and non-commuters for females and the differences between both employee groups are small for men.[24]

Table 5: Extensive margin of labor supply for employees whose region of residence is the same as or different from the place of work.

	Women		Men	
	Region of residence is same as region of work			
	No	Yes	No	Yes
Estimated earnings (log)	0.062**	0.080	0.163**	0.234*
	(0.026)	(0.083)	(0.084)	(0.146)
N	19,080	2,289	25,799	6,769
	0.313	0.315	0.239	0.233

Notes: List of covariates is the same as in Table 2. Number of observations lower than in Table 2 because region of residence not reported for all employees. Standard errors in parentheses are computed by bootstrapping with 200 repetitions and clustered on the individual level. * $p < 0.05$, ** $p < 0.01$. *Data*: SIAB 7514.

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[23] The labor market regions are defined based on the place of work and the residential region is defined based on the place of residence at the last employment prior to retirement.

[24] The results remain robust when the information about place of work and place of residence are directly used from the dataset instead of the approach proposed by Kropp and Schwengler (2016).

Our last sample split differentiates employees according to their earnings situation before exiting the labor market into retirement. According to hypothesis 7, we find a higher elasticity of men in the lowest earnings quartile in comparison to men in the highest earnings quartile. For women, the lowest and highest earnings quartiles both have lower elasticities than the second and third earnings quartiles and therefore hypothesis 7 is not supported for women.

Table 6: Extensive margin of labor supply for employees with low and high earnings before retirement

	Women		Men	
	Earnings before retirement			
	Low earnings	High earnings	Low earnings	High earnings
Estimated earnings (log)	0.084	0.063	0.384**	0.097
	(0.045)	(0.039)	(0.129)	(0.110)
N	7,441	7,441	10.706	10,706
R2	0.365	0.273	0.283	0.171

Notes: High earnings are defined as earnings from the last employment subject to social insurance contributions with earnings above the 75th percentile of all last earnings of employment subject to social insurance contributions. Low earnings are defined as earnings from the last employment subject to social insurance contributions with earnings less than 25th percentile of all last earnings of employment subject to social insurance contributions. List of covariates is the same as in Table 2. Standard errors in parentheses are computed by bootstrapping with 200 repetitions and clustered on the individual level. * $p < 0.05$, ** $p < 0.01$. Data: SIAB 7514.

7 Conclusions

This paper provides a labor supply model for retirees and according empirical assessments based on a large administrative labor market history data set. We hereby for the first time use detailed information about labor earnings and non-labor income of a representative sample of all employees in Germany. We concentrate on the effect of labor earnings on the labor force participation beyond retirement and take endogeneity of the labor decision and heterogeneities between different employee groups into account. We first establish that labor earnings achieved by pensioners after retirement constitute a substantial part of disposable income. The share of post-retirement earnings in disposable income is more than 60% for women and 50% for men.

Based on labor supply theory and existing empirical results for post-retirement employment, we show that men are more responsive to financial incentives after retirement than women. A one percent increase in post-retirement labor earnings increases the employment probability

of pensioners by 0.246 percentage points for males and by 0.056 percentage points for females. Earnings options therefore have a strong incentive effect for work after retirement. Higher pension entitlements however lead to a comparable negative labor participation effect. We analogously find that the higher the share of labor earnings in disposable income of the retiree, the higher is the labor force participation of the individual. We also find that individuals who work until retirement instead of using the bridge options unemployment or partial retirement and men with low earnings prior to retirement are stronger attracted by financial earnings incentives to work after retirement. Having to commute before retirement in contrast to residing in the same region as the place of work does not influence work participation after retirement, however. Our analysis therefore shows that tax incentives or higher earnings offers by employers are most effective to stimulate labor market participation after retirement for males who earned not much before retirement and did not use bridge options. However also female retirees can be attracted to work again after retirement if they obtain better earnings offers.

Our paper uses the empirical identification approach developed for the employment decision of women with small children (Allègre et al., 2015; Borra, 2010; Ribar, 1992; Rammohan and Whelan, 2007; Viitanen, 2005). This literature mainly uses structural estimation models in the absence of quasi-natural experiments.[25] Also for the literature on determinants for working after retirement, there are hardly any quasi-natural experiments that can be exploited to obtain causal relationships between financial incentives and the employment decision (Chetty et al. 2011). The main reason for the dearth of quasi-experimental evidence is that there were hardly any changes in the rules for labor earnings after retirement. In Germany, earnings beyond marginal employment have to be taxed at the common rates, marginal employment is tax free and the maximum earnings level for marginal employment hardly changed.[26] In 2005, a pension supplement of 6% per year of retirement after NRA was introduced for all pension entitlements. This option was used by a negligible share of retirees, however.

In future work, retiree´s labor supply should be analyzed with respect to the number of hours worked conditional on employment (intensive margin). Our data set does not report hours worked and we therefore only could analyze the extensive margin. In addition, besides the pension entitlements, additional non-labor earnings during retirement such as rent from

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[25] A notable exception is Bastani et al. (2020) who analyze the impact of a change in labor market participation tax rates on labor supply of secondary earners.

[26] The maximum earnings level for minimum employment was increased on 1 January 2013 from 400€ to 450€, but further unchanged during our observation period.

wealth or real estate should be included. Moreover, decisions about labor supply after retirement may result from bargaining involving additional members of the household. Therefore, it is likely that earnings elasticities of retirees are also influenced by the financial situation of the partner or the household.

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Appendix

Table A.1: Number of individuals and share of individuals who work beyond retirement by birth cohort.

Birth	Women		Men	
	N	Share	N	Share
cohort	2,056	0.193	3,180	0.205
1935	1,934	0.192	3,075	0.204
1936	1,992	0.202	3,142	0.215
1937	2,384	0.206	3,586	0.178
1938	2,675	0.197	3,933	0.207
1939	2,582	0.206	4,091	0.193
1940	2,807	0.174	4,306	0.200
1941	2,783	0.192	4,052	0.196
1942	2,336	0.194	3,292	0.201
1943	2,330	0.204	3,334	0.215
1944	2,418	0.208	3,201	0.206
1945	1,775	0.235	2,551	0.254
1946	2,264	0.223	2,934	0.261
1947	2,504	0.229	3,390	0.265

Data: SIAB 7514.

Table A.2: Sample characteristics.

	Women			Men		
	Work beyond retirement					
	No	**Yes**	**Diff.**	**No**	**Yes**	**Diff.**
Employee characteristics prior to retirement						
Pension entitlements	790.119	696.246	93.872**	1283.311	1183.442	99.869**
	(314.7)	(278.6)	(4.354)	(414.2)	(355.01)	(4.641)
Share of unemployment bridge path	0.258	0.159	0.099**	0.409	0.250	0.160**
	(0.438)	(0.365)	(0.006)	(0.492)	(0.433)	(0.006)
Share of partial retirement bridge path	0.136	0.045	0.091**	0.223	0.109	0.114**
	(0.342)	(0.207)	(0.005)	(0.416)	(0.312)	(0.005)
Manufacturing occupations	0.175	0.143	0.033**	0.550	0.468	0.082**
	(0.380)	(0.350)	(0.006)	(0.498)	(0.499)	(0.006)
Service occupations	0.308	0.356	0.048**	0.188	0.289	0.101**
	(0.462)	(0.479)	(0.007)	(0.390)	(0.453)	(0.005)
Administrative occupations	0.517	0.502	0.015*	0.262	0.244	0.019**
	(0.500)	(0.500)	(0.007)	(0.440)	(0.429)	(0.005)
Accumulated labor market gaps prior to age 65 in months	32.777	4.309	28.468**	19.575	3.438	16.137**
	(25.380)	(13.736)	(0.332)	(22.322)	(11.382)	(0.236)
Characteristics of last employer prior to retirement						
Firm size	681.909	366.367	315.5*	1788.5	952.760	835.7**
	(2400.6)	(1549.8)	(31.885)	(5732.3)	(4163.6)	(62.703)
Mean imputed earnings of	89.652	80.465	9.188**	108.250	96.706	12.54**
all full-time employees	(33.863)	(32.472)	(0.475)	(44.180)	(38.056)	(0.495)
Share of highly	0.116	0.088	0.029**	0.131	0.098	0.033**
qualified employees	(0.162)	(0.145)	(0.002)	(0.161)	(0.144)	(0.002)
Share of employees	0.015	0.008	0.007**	0.022	0.015	0.007**
in partial retirement	(0.038)	(0.028)	(0.0005)	(0.045)	(0.043)	(0.0005)
Share of employees	0.133	0.120	0.012**	0.121	0.113	0.008**
aged of 55 to 59	(0.135)	(0.134)	(0.002)	(0.110)	(0.110)	(0.001)
Share of employees	0.059	0.083	0.024**	0.057	0.077	0.020**
aged of 60 to 64	(0.105)	(0.137)	(0.002)	(0.098)	(0.123)	(0.001)
Share of employees	0.012	0.032	0.020	0.009	0.028	0.020**
aged 65 and older	(0.039)	(0.081)	(0.0007)	(0.036)	(0.078)	(0.0005)
N	25,511	6,273	30,784	35,338	9,549	44,887

Notes: Mean is given for continuous variables. Standard deviations of the continuous variables and standard errors for the mean value differences are given in parentheses. *Data*: SIAB 7514

Table A3: Auxiliary estimations

	Women				Men			
Observations	30,784				44,887			
Censored observations	24,511				35,338			
Uncensored observations	6,273				9,549			
Log likelihood	-11,791.378				-19,581.156			
Chi2(9)	7,545.47				7,300.83			
Prob > chi2:	0.2424				0.000			
	Labour force participation		**Log Wage**		**Labour force participation**		**Log Wage**	
	Coef.	**SE**			**Coef.**	**SE**		
Constant	1.292**	0.176	-0.637**	0.201	1.186**	0.0171	-1.320**	0.211
No degree	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Vocational training	0.227**	0.027	0.231**	0.041	0.378**	0.028	0.231**	0.043
University degree	0.043	0.049	0.351**	0.062	0.149**	0.034	0.566**	0.046
Manufacturing occupations	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Service occupations	0.228**	0.029	0.261**	0.046	0.253**	0.018	0.223**	0.029
Administrative occupations	0.096**	0.028	0.239**	0.037	0.073**	0.018	0.198**	0.023
Acc. labor market gaps until 65 in months	-0.033**	0.0006	-0.035**	0.004	-0.031**	0.0005	-0.022**	0.002
Pension entitlements (log)	-0.275**	0.025			-0.494**	0.024		
Lambda			1.205**	0.157			0.705**	0.084
Hausman test								
Chi2(8)	57.73				69.00			
Prob > chi2:	0.0000				0.0000			

Notes: In both equations, year of employment exit prior to the age of 65 is controlled for. SE: standard error. * p < 0.05, ** p < 0.01. *Data*: SIAB 7514.

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