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The prospects of the Baby Boomers: Methodological challenges in projecting the lives of an aging cohort

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The Prospects of the Baby Boomers:

Methodological Challenges in Projecting the Lives of an Aging Cohort

Christian Westermeier¹, Anika Rasner, Markus M. Grabka

Abstract: In most industrialized countries, the work and family patterns of the baby boomers characterized by more heterogeneous working careers and less stable family lives set them apart from preceding cohorts. Thus, it is of crucial importance to understand how these different work and family lives are linked to the boomers' prospective material well-being as they retire. This paper presents a new and unique matching-based approach for the projection of the life courses of German baby boomers, called the LAW-Life Projection Model. Basis for the projection are data from 27 waves of the German Socio-Economic Panel linked with administrative pension records from the German Statutory Pension Insurance that cover lifecycle pension-relevant earnings. Unlike model-based micro simulations that age the data year by year our matching-based projection uses sequences from older birth cohorts to complete the life-courses of statistically similar baby boomers through to retirement. An advantage of this approach is to coherently project the work-life and family trajectories as well as lifecycle earnings. The authors present a benchmark analysis to assess the validity and accuracy of the projection. For this purpose, they cut a significant portion of already lived lives and test different combinations of matching algorithms and donor pool specifications to identify the combination that produces the best fit between previously cut but observed and projected life-course information. Exploiting the advantages of the projected data, the authors compare the returns to education - measured in terms of pension entitlements - across cohorts. The results indicate that within cohorts, differences between individuals with low and high educational attainment increase over time for men and women in East and West Germany. East German boomer women with low educational attainment face the most substantial losses in pension entitlements that put them at a high risk of being poor as they retire.

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Keywords: Forecasting Models, simulation methods, SOEP, baby boomers, education, public pensions

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1 Introduction

With the baby boomers approaching retirement in many industrialized countries, these cohorts gain attention of policymakers and researchers alike. This attention is mainly due to the sheer cohort size of the baby boomers whose transition into retirement will start in about ten years - at least in Germany. In other countries, such as the U.S., baby boomers are about to retire. With the transition, the retired portion of the population relative to the number of working-age individuals will increase substantially (Smith and Toder 2005), which poses a challenge for pension systems around the world. The anticipated shifts in the demographic make-up of Germany have triggered a multitude of reforms that already have and further will alter the system of old-age provision (Goebel and Grabka 2011). These reforms aim at reducing pension generosity, prolonging the time individuals stay in the work force, and changing the public-to-private mix thereby mitigating the strong reliance on Germany's public pension scheme (Rasner 2011).

The baby boomers will be the first to fully experience the effects of these reforms, which will have marked repercussions for the distribution of pension benefits of future retirees. In this policy context, it becomes crucial to understand, whether the baby boomers are better or worse off than previous cohorts in terms of their material well-being and their prospects upon retirement? Furthermore, questions arise about whether the baby boomers save and accumulate enough (pension) wealth to maintain their standard of living as they retire (Coppola 2012).

However, the baby boomers are not only in the center of attention because of their financial situation, but also because of the work and family patterns that set them apart from older cohorts. For one, these differences are a consequence of the unique historical context in which the baby boomers grew up and matured in. But it is also the cohort size that was large enough for them to initiate lasting changes of the social structure (Uhlenberg 1996). These two entangled processes result in different employment and marital trajectories for these cohorts. The new work patterns are more heterogeneous and involve greater flexibility, and hence for some individuals more economic risks. Family lives are less stable with the share of continuously married individuals decreasing, but divorces being on the rise.

Against the background of changing biographies, it is of crucial importance to understand how the employment and family lives of the baby boomers are linked to their prospective material well-being as they retire. Understanding this link allows us to assess, whether current public policies, in particular the system of old age provision, are still effective or whether these policies are out of tune with peoples' lives.

With the German boomers being in their mid-40s to mid-50s today, they still have some years to go until they retire. In order to compare their retirement prospects with those of previous cohorts requires the use of projection techniques that predict the lives of the baby boomers through to retirement.² The completion of the boomers' life-courses also allows for analyses of the confluence of recent pension reforms and changes in employment patterns and demographic behavior on projected retirement security.

This paper presents an innovative approach of a matching-based projection of the life courses of the German baby boomers. Unlike model-based dynamic micro simulation that age the data age year by year (Favreault and Smith 2004), we use sequences from older birth cohorts to complete the life courses of statistically similar baby boomers until they retire. With the statistical matching, we compare each incomplete life course with complete life courses of previous birth cohorts and select the most similar in terms of family and employment history as well as age-specific earnings. This procedure implies that we assess multiple processes simultaneously, thereby assuring the consistency of projected sequences in itself.

The remainder of this paper is organized as follows: Section 2 sets out the specific characteristics of the baby boomer cohorts and how they matter for the organization of the system old-age provision. Section 3 describes the methodological challenges and requirements

² The present analysis was conducted within the framework of the research project *Life Course, Aging and Well-Being* (LAW). This research project is carried out by three cooperating institutions: German Socio-Economic Panel (SOEP) at the German Institute for Economic Research (DIW Berlin), the German Centre of Gerontology (DZA), and the German Federal Pension Insurance (DRV). It is financed by the Volkswagen Foundation (2009-2012). More information is available at www.law-project.org.

for the projection of the old-age provision of future retirees, presents available micro-simulation models in Germany, and outlines the idea of the LAW-Life projection model. Section 4 presents the base sample for the projection, identifies potential matching variables and specifies the donor pool for the matching-based projection. In Section 5, we apply the projected data to analyze the relationship between educational attainment and the process of pension building over the life-cycle and across cohorts. Section 6 summarizes the idea of the matching-based projection and gives an outlook on future enhancements of the model.

2 The Baby Boomers

2.1 The Post-War Baby Boom in Germany

In Germany, the baby boomers are the birth cohorts born between 1956 and 1965.³ These cohorts are exceptional, because of their cohort size that was unprecedented when compared to older, but in particular to younger birth cohorts that followed. *Figure 1* illustrates this special role baby boomers play in Germany's demographic makeup. The cohorts born immediately after the end of the Second World War were small as a consequence of the World Economic Crisis in the 1930s and the depletion of cohorts in their reproductive ages during wartime. Also, many women postponed births because of the political instability and economic insecurity. In the mid-1950s, above average fertility rates started the baby boom. This trend lasted until the mid- to end-1960s. Obviously, this baby boom was not the first period with above average fertility, but it was longer and more pronounced than previous periods with above-average replacement fertility.⁴ During the baby boom in the mid-1950s to mid-1960s, the total fertility rate (TFR) ranged between 2.3 and 2.5 children per women; the peak of the German baby boom was in the year 1964 with almost 1.4 mil-

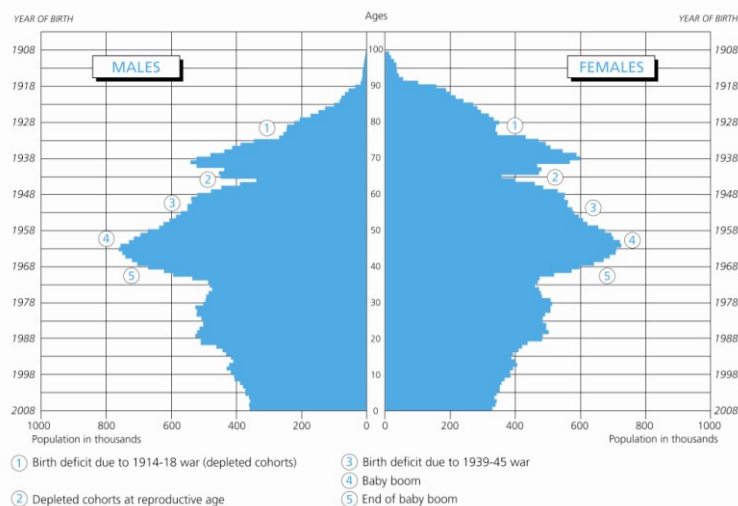
³ Almost all industrialized countries that were actively involved in World War II experienced a baby boom. However, countries differed in terms of timing and length. For example, the U.S. baby boom set in earlier, was more pronounced and lasted longer than in Germany (Menning and Hoffmann 2009; Phillipson 2007).

⁴ Replacement level fertility is the level of cohort fertility at which women have enough children to replace themselves (Weeks 2011).

lion babies born.⁵

Macro- and micro-level factors explain the baby boom: Political stability and economic prosperity certainly contributed to a sense of security in the population. The shortage of labor following World War II gave the small cohorts entering the labor market good economic prospects leading to higher fertility rates (Easterlin 1976).⁶ At the micro-level, returning soldiers from the war led to increases in marriage rates (also at younger ages) and higher fertility. Certainly, women who previously postponed having children now became pregnant and gave birth. As a consequence, the share of women who remained childless decreased significantly.

Figure 1 Population by Age and Sex, Germany 2008



Source: Statistisches Bundesamt 2009

The period of above average fertility rates ended in the late 1960s, when Germany experienced significant decreases of the TFR. Demographers refer to this period as the so-called *baby bust* (Statistisches Bundesamt 2008). Economic growth has leveled off and the labor

⁵ The total fertility rate is the average number of children that would be born to each woman if the current age-specific fertility rates remained constant and each woman lived throughout her reproductive years.

⁶ Easterlin explains the baby boom and the following baby bust with the income potential and aspirations concerning the expected standard of living of cohorts (Pampel 1993).

market prospects were no longer as promising as in the postwar years. Another major factor was the use of contraceptives and the rise in abortions that gave women more control over their fertility preferences. The availability of contraceptives and abortion went along with a change in attitudes and norms with a preference for smaller families that caused fertility rates to plummet permanently.⁷

2.2 Baby Boomers and the System of Old-Age Provision

The differences in cohort size illustrate why the baby boomers are of special interest. With the baby boomers' transition into retirement, the age-structure of the population, in particular the ratio of the economically active working age population to the inactive retiree population will change significantly (Mermin et al. 2007). More specifically, population projections show that the old-age dependency ratio will increase from 33.7 to 52.8 between 2008 and 2030, which will result in an accelerated aging process of the German population (Statistisches Bundesamt 2009).⁸ These changes in the age-composition have noticeable policy consequences. The main focus in the public debate surrounding the nearing retirement of the baby boomers is on the financial strains this transition involves when it comes to the sustainability of the welfare state, mainly the viability of large-scale social insurance programs such as the public pension scheme but also the statutory health and long-term care insurance.

In this paper, we focus on the effects the transition of the baby boomers has for the system of old-age provision. In a pay-as-you-go system such as the German public pension scheme, individuals currently in the workforce pay contributions that finance the pensions of current retirees. With the ratio of contributors and beneficiaries changing, this financing scheme comes under pressure. Additional financial strains result from the increase in the number of years individuals draw benefits from the public pension scheme. With the con-

⁷ It is important to note differences in fertility rates in East and West Germany. Because of pro-birth policies in East Germany, fertility was always higher than in West Germany until German reunification.

⁸ The old-age dependency ratio reflects the number of individuals aged 65 and older for every 100 individuals aged 20 to 64.

tinuing rise in life expectancy (Oeppen and Vaupel 2002), the average duration of pension receipt increases as well – unless of corresponding raises in the statutory retirement age. In the 1960s, individuals received pension benefits for an average of 9.9 years compared to 18.4 years in 2010 (Deutsche Rentenversicherung 2011). In the light of the fiscal pressures resulting from the demographic shift, policymakers have three major options to counteract the challenge. The reform activities during the last two decades reflect these options.

The first option is to increase the statutory as well as the effective retirement age in order to prolong the individual's working life and shorten the prospective period of inactivity and pension receipt.⁹ Policymakers halted the trend toward early retirement through the introduction of actuarial adjustments and gradual raises of the statutory retirement age (Brugiavini 2001; Gruber and Wise 1999). Preferential treatments such as pension types with special eligibility rules (e.g. old-age pension for women -*Altersrente für Frauen*) that allowed for early retirement or the so-called 58-years rule (*58er Regelung*) were phased out.¹⁰ Ideally, this policy mix keeps older employees and therefore contributors to the public pension scheme in the labor force for a longer time (Börsch-Supan 2000). However, if these older workers are unable to stay employed (Mümken et al. 2011) and are therefore forced to withdraw early from the labor market they have to accept financial penalties in benefit levels (Brussig 2010).

The second option policymakers have to respond to the demographic challenge is to increase the social insurance contributions. Although this policy measure instantaneously results in more revenues, policymakers in Germany refrained from this option for various reasons (Bundesministerium für Gesundheit und Soziale Sicherung 2003). Increasing social insurance contributions for the working population (and employers) in order to pay for

⁹ The statutory retirement age is the age at which all individuals can retire without any deductions for early retirement. The effective retirement age is the average at which individuals retire in a given year.

¹⁰ Individuals who fall under the 58-years rule receive unemployment benefits (*Arbeitslosengeld*) without being available for the labor market. Benefits are paid until the person can retire without actuarial adjustments. Hence, it works as a bridge between the labor market and the retirement system and prevents individuals from being disproportionately penalized.

the benefits of retirees was not considered to be fair in terms of intergenerational equity (Barr and Diamond 2008). The increase would also go along with a hike in nonwage labor costs which is typically opposed by employers who fear a comparative disadvantage in selling and producing goods (Aguilar and Rendon 2010). Therefore, policymakers opted for keeping contribution rates stable in the public pension scheme, but promoted investments in private pension funds (the so-called *Riester-Rente*) through subsidies and tax breaks (Berner 2006). Clearly, this paradigmatic move away from the strong reliance on the public pension scheme to a multi-tier system shifts the burden to the employees as it involves a partial privatization of old-age provision (Hagen and Kleinlein 2011).¹¹

The third option policymakers have to counteract the demographic challenge is to cut benefit levels. The so-called sustainability factor, introduced in 2004, reduces the average net replacement level according to the changing ratio of contributors and beneficiaries within the statutory pension insurance. Because of the modified indexation formula, benefits no longer grow in line with gross earnings (Börsch-Supan et al. 2003). With inflation being high, the slower growth in pension benefits implies falling purchasing power of the retirement income of the elderly, especially if pension adjustment is adjourned.¹² Further cuts will arise from the deferred taxation for all types of retirement income introduced with the Old-Age Income Law (*Alterseinkünftegesetz*) in 2005 (Fehr and Jess 2007).¹³

The reform activities during the last two decades will alter the German system of old-age provision substantially. When compared to today's pensioners, future retirees with the same life cycle labor supply will render less pension benefits. In addition to the direct effects resulting from past pension reforms, changes in the employment, marital and fertility patterns - particularly among the baby boomers - will have repercussions for the individu-

¹¹ Employees receive the maximum government subsidy and tax break if they invest four percent of their annual gross wage. Hence, even if policymakers kept the contribution rates to the public pension scheme stable, the partial privatization is tantamount to an implicit increase in the contribution rate born by employees alone.

¹² Between 2003 and 2006 pensions were not adjusted (Deutsche Rentenversicherung 2011).

¹³ Additional reforms of the disability benefit scheme also reduced benefit generosity.

al's ability to accumulate pension benefits as well.

2.3 The Lives of the Baby Boomers

According to Uhlenberg (1996) aging is considered to be “*a dynamic process of cohorts moving through the life course in historical time*” with each cohort being embedded “*in a social structure that regulates how it ages and the social structure changes as the cohort advances through the life-course over time*”. When compared to their parents and grandparents generation, the historical context in which the baby boomers are aging is special. First, the baby boomers were the first who did not experience the same deprivations and struggles (e.g. World War II and Great Depression) as previous generations did. Second, the baby boomers were the first to benefit from the expansion of higher education as well as the expansion of the welfare state. And third, the baby boomers spent their childhood, adolescents and early adulthood in years of economic growth with historically high incomes and good labor market prospects (Easterlin 1987). Last but not least, the baby boomers grew up or matured during a period of significant cultural and political change (Giugni et al. 1999) that culminated in various social movements between the late 1960s and early 1980s, such as the German student movement (68er Bewegung), the anti-war movement or the feminist movement that brought lasting changes to German society. As a consequence, normative conventions that had shaped the life-courses and determined the timing of demographic events of previous cohorts, were challenged by the baby boomers in the course of the widespread political and cultural turbulences (McAdam 1999).

Starting in the late 1960s and accelerating during the 1980s, we have seen a trend towards more heterogeneous work and family patterns (Frick et al. 2012). The *new* working patterns involve a greater heterogeneity and pluralization with less continuous full-time careers - particularly among men (Brenke 2011). The greater heterogeneity spans over all stages of the adult life, starting with the school-to-work transition. In this early stage of the individual's life-course, those with low educational attainment have difficulties to find a steady job, whereas a still increasing number of adolescents that enter higher education and therefore postpone their transition into the labor market (Brzinsky-Fay 2007) face good job prospects from the outset of their career.

Labor market legislation aimed at reducing the persistently high unemployment rates by promoting employer and employee flexibility (Eichhorst and Marx 2011). These changes result in greater job insecurity, less social protection and an increase in the share of low wage earners (Kalina and Weinkopf 2010). A growing share of employees works in fixed-term contracts or suffers from longer and recurring episodes of unemployment. More flexibility in the labor market but also personal preferences for a better work-life balance result in a higher prevalence of (marginal) part-time employment, particularly among women (Holst 2010).¹⁴ Taken together these changes lead to an erosion of standard work patterns (Diekmann and Jann 2004). This process has been accelerated for the baby boomers (Simonson et al. 2011a; Simonson et al. 2011b). An adverse effect of changes in employment patterns has been that workers following more flexible paths usually accumulate less pension wealth and wind up retiring with lower benefits than they would have reaped had they been continuously full-time employed. Therefore, a declining number of individuals meet the pension insurance's paradigm of the *standard pensioner*.¹⁵

At the same time, family lives became less stable for the baby boomers. The share of continuously married individuals is steadily decreasing, because more and more couples terminate their marriages. These marriages start at higher ages and last less long than those of preceding cohorts. Consequently, the share of single-headed households (never married and divorced) is on the rise (Frick et al. 2012). Less stable family lives in the context of a stronger individualization of old-age provision (Frericks et al. 2007) requires both partners to save for retirement. Divorce ends the sharing of financial resources in couples not only during working life but also in retirement (Ginn and Price 2002). Women in particular, can no longer expect to share in the higher pension benefits accumulated by their husbands or to

¹⁴ Differences in the preference for part-time work persist between women in East and West Germany (cp. to Holst 2010)

¹⁵ The standard pensioner is a statistic, which describes the relative income position of pensioners compared to the average income of the workforce in a given year. It assumes that the pensioner's wage was equal to the average wage earned in Germany each year for the last 45 years.

be entitled to his survivor's pension in case he dies.¹⁶ For this reason, it is necessary for women to accumulate more pension entitlements on their own.

3 Projecting the Lives of the Baby Boomers

The sea change in the system of old-age provision in Germany paired with new work and family trajectories calls for the implementation of a projection model that forecasts the life-courses and the pension-relevant earnings of the baby boomers until they reach the retirement age (or even a few years beyond). Such data allows for the analysis of the interplay between institutional settings and individual life trajectories not only within cohorts but also between cohorts. This type of research is relevant because *“structural or institutional arrangements operate to stratify cohorts as they allocate differential opportunities for the accumulation of value and reward”* (O'Rand 1996). So far, only a small number of studies in Germany make use of projection techniques to assess the baby boomers' preparedness for old-age when compared to previous birth cohorts. Our main objective of the projection of life-courses is to gain knowledge about the retirement prospects of future retirees, more specifically about their financial resources in old-age and the prevalence of old-age poverty. Alternatively, these data may be of use for the simulation of the (potential) distributional consequences of pension reforms or reform proposals.

3.1 Challenges and Requirements

Grabka and Rasner (2012) identify a minimum of six requirements that have to be satisfied in order to make meaningful projections of life courses that allow for distributional analyses of the material wellbeing of future retirees.

¹⁶ Unlike other industrialized countries, Germany introduced the splitting of pension entitlements in case of a divorce. Germany introduced the property settlement of pension entitlements as an element of the new divorce law that came into effect in 1977 (Bundesgesetzblatt I vom 15. Juni 1976).¹⁶ This new law considered the financial effects on both partners and introduced the splitting of pension rights earned within the statutory pension insurance during the marriage. The partner that earned higher pension rights has to transfer half of the difference in entitlements to his/her former spouse. In practice, women are the principal beneficiaries of pension splitting.

1. A population representative database large enough to allow for the analysis of relevant subpopulations (e.g. civil servants, self-employed, migrants or disability pensioners);
2. Modeling of demographic processes to consider changes in the population structure over time (e.g. marriage, divorce, widowhood, mortality and migration);
3. Detailed longitudinal information on family and employment biographies as well as life-cycle earnings. The biographical information should also cover pension-relevant activities because they matter for the pension benefit calculation in Germany. The information should range from age 15 (the year in which compulsory school attendance ends) to the statutory retirement age or even a few years beyond;¹⁷
4. The projection of coherent and consistent marital, employment and earnings-trajectories (ideally in the household context).
5. Detailed information on pension entitlements in public, occupational and private pension schemes;
6. Consideration of all relevant pension rules and regulations as well as changes thereof that might be phased in the future (e.g. changes in the taxation of old-age income, cutbacks in replacement levels, and increases of the statutory retirement age).

3.2 Available Projections in Germany

In Germany, the number of studies using micro-simulation or projection techniques is limited. Among other factors, this limitation is a consequence of the lack of adequate data that could serve as a basis for such projections.

The most prominent micro-simulation study Old-Age Provision in Germany (*Altersvorsorge in Deutschland*, henceforth AVID) deals with the old-age-income provision of future retirees (Heien et al. 2007a; Heien et al. 2007b). The most recent study from 2005 simulates a sample of German citizens (and their spouses) aged 40 to 60 years.¹⁸ The roughly 14,000 respondents are recruited over an access panel that consists of a self-selected group of individuals who have a high readiness to participate in surveys, which potentially compromises the generalizability of results (Göritz 2007). For them, data from the survey is

¹⁷ Retirement is no longer an absorbing state and individuals opt to return to work even after they are officially retired (Michaud and Rohwedder 2008)

¹⁸ This sample specification excludes migrants, which leads to an upward bias in the projected retirement income, because migrants typically accumulate less pension rights than Germans.

merged over the social security number with information from their personal pension records, which are maintained by the statutory pension insurance (*gesetzliche Rentenversicherung*). The AVID micro simulation model projects three quantities: 1) the individual's employment biography up to the statutory retirement age; 2) pension coverage, benefit payments, and pension assets accumulated until retirement; and 3) the tax and health/long-term care insurance contribution burden on the projected retirement income. Beyond that the database can be used for the simulation of reform proposals and the estimation of their distributional effects. The forecast is limited to economic events, such as the employment status, taxable income, and the weekly hours of work. Despite its limitation to only three factors, the model is highly complex. For the projection of the employment status alone, the AVID estimates a total of 840 multi-state/multi-event hazard rate models. The respective properties of each model are not published in detail, but not all models converged which required additional calibration (Schatz 2010). The projection follows a sequential design projecting one year and process at a time up to age 65, which implies that the simulated life-courses are not necessarily consistent. Demographic processes such as deaths, marriages, and divorces but also in- and out-migration are not considered in the simulation model. The decision not to simulate marital biographies implies that the model does not account for potential behavioral effects on labor supply that might follow from changes in the marital status (e.g. marriage → divorce).

The input data covers the years 1992 to 2001, which includes the historically unique transformation process in East Germany. The choice of this period implies that the unfavorable labor market situation feeds into the projection, which means that it does not appropriately account for possible improvements of the labor market prospects thereafter. Because of the rather short documentation of the simulation model, it is difficult to assess to what extent the implicit assumptions drive the general findings.¹⁹ This knowledge is crucial because

¹⁹ Given that AVID micro data is not available to researchers outside of the two funding institutions (the German Statutory Pension Insurance and the Federal Ministry of Labour and Social Affairs) it is impossible for the scientific community to reanalyze the data and reproduce the AVID findings.

the assumptions have potentially strong effects on the projection results. The reference year is 2002, which implies that the AVID study does not model the effects of pension reforms that will be gradually phased in over the projection period. These reforms, such as the introduction of deferred taxation of retirement income or changes in the benefit formula are likely to have adverse effects for future benefit payments.

A recent micro simulation study from Geyer and Steiner (2010) analyzed the effect of changing employment patterns on future pension benefit levels for the birth cohorts 1937 to 1971. Input data comes from the Scientific Use File Sample of Active Pension Accounts 2005 (*SUF Versicherungskontenstichprobe 2005*, henceforth SUF VSKT 2005), an administrative dataset maintained by the Data Research Centre of the Statutory Pension Insurance (*Forschungsdatenzentrum der Deutschen Rentenversicherung*, henceforth FDZ-RV). The authors link the SUF VSKT 2005 with the German Socio-Economic Panel (SOEP), a population representative panel survey of persons living in private households in Germany by propensity score matching.²⁰ To obtain estimates of future benefit payments, the micro simulation models the individual's employment biography, earnings and the resulting pension entitlements. As for demographic events, the model uses *static aging* techniques.²¹ For this purpose, the authors estimate a set of separate *tobit models* for men and women, in East and West Germany, respectively. The simulated employment paths for men are limited to two states: fulltime employment and unemployment. According to the authors, the prevalence of part time and non-employment is more prevalent among women and therefore only considered for them. This decision neglects the growing pluralization of employment patterns that also affects men in the younger birth cohorts. Similar to the AVID study, the input data for the micro simulation of employment trajectories covers the early 1990s, thereby simulating the unfavorable labor market situation in East Germany at that time. Consequently, East

²⁰ It is questionable whether propensity score matching is an adequate technique to link the two data sources. For a detailed discussion of the reasons see Rasner et al. (2011).

²¹ The TRIM3 project website provides a comparison of static and dynamic aging micro simulation models (trim3.urban.org, downloaded on January 25, 2012).

Germans are likely to fare worse in the employment projections than it might actually turn out in the future. An advantage of the study is that it takes prospective changes of the rules and regulations of the pension system, such as the increase in the statutory retirement age into account. A relevant shortcoming is the assumption that household structures stay constant over the projection period, thereby ignoring the trend towards more single-headed households. Also, the study excludes the group of civil servants who fare much better in comparison to blue- and white-collar workers.

The projection of future levels of old-age poverty is the primary objective of a study of Kumpmann et al. (2012). Applying the longitudinal design of SOEP data, the authors make use of information given in 1992 from respondents aged 65 to 70 years in 2008. Based on this information, they estimate a regression function that identifies which employment-specific variables in 1992 determine the retirement income level in 2008. The point estimates were then applied to individuals aged 50 to 55 years in order to project their future retirement income in the year 2023. The main result of this out-of-sample prediction is that future retirees bear an increased risk to become poor in old-age, which is a consequence of changing employment patterns after German reunification. Overall, the study suffers from a number of methodological shortcomings. More than half of the 2008 respondents lack information for the year 1992, because the SOEP added additional samples over time (Wagner et al. 2008). Multiple imputation was applied to complete missing information, however, observations were excluded if their residuals exceeded a certain threshold relative to the standard error (Kumpmann et al. 2012, p. 70). In addition, the choice of the reference year might add a downward bias to the results. In 1992, the East German labor market was particularly tight, which makes it an inappropriate year for an out-of-sample prediction, especially since the authors' assume stable underlying relationships between employment and retirement income. This assumption is bold given the dramatic transformation process in East Germany. Plus, it is arguable, whether basing the prediction on a single year instead of a longer time period is the best choice.

An expert report on the old-age income situation of future retirees with a focus on private pension assets performs two simulations (Viebrok 2004). For four typical, yet stylized employment biographies, the study compares retirement outcomes before the 2001 pension

reform and after the Old-Age Sustainability Law (*Rentenversicherungs-Nachhaltigkeitsgesetz*) in order to assess their distributional effects.²² The author argues that the four stylized biographies cover the large majority of employment biographies in Germany. Even if this assertion is correct, the simulation potentially dismisses individuals with discontinuous and unstable work patterns that run greater risk to end up poor as they retire. In order to assess, the reforms' effects for different birth cohorts (1936 to 1955), the author simply shifts the biographies along the time axis (Viebrok 2004, p.32). This approach ignores that employment patterns become more heterogeneous over time (e.g. spells of unemployment or longer educational episodes), in particular for younger birth cohorts (Simonson et al. 2011a; Simonson et al. 2011b) than among the older birth cohorts that served as a basis for the stylized biographies used in the simulation. Furthermore, the study does not consider changes in pension rules that will be phased in gradually and affect younger birth cohorts to a greater extent. Concerning the private pension assets (e.g. *Riester-Rente*), the study presumes that all individuals invest a total of four percent of their annual gross wage, the amount policymakers strived for when they passed the law. Viebrok admits that this assumption is unlikely to hold especially for low income individuals and families with young children, who won't have the resources to save the full amount.

Stylized biographies are also the basis for the simulation of tax liabilities on deferred pensions as introduced by the Old-Age Pension Assets Law in 2005 (Grub 2004). The study performs the simulation for four biographies without acknowledging differences by gender, marital status or the number of children. In addition, it assumes that all individuals retire at age 65. Clearly, this approach dismisses the heterogeneity in working patterns as observed in survey data. Therefore, it can only give rough estimates of the distributional effects of deferred pension taxation.

²² The stylized employment patterns were extracted from the AVID 1996 (Viebrok 2004).

3.3 The LAW-Life Projection

This overview of available simulation analyses in Germany illustrates the full range of options. Some studies apply simplified assumptions, by shifting observed employment patterns into the future, whereas other studies develop complex micro simulation models that *age* multiple processes, such as employment biographies or earnings trajectories through time in order to create a synthetic micro data file for the analysis of the retirement income of future retirees. Whether simple or complex, all approaches have their respective merits and drawbacks. Even the most complex study currently available – the AVID 2005 – has its shortcomings and fails to take certain relevant factors into account, such as property wealth and financial assets or changes in living arrangements.²³ One option to overcome these drawbacks is to develop an even more complex micro-simulation model. However, the higher the complexity of the micro simulation model, the more time consuming and resource intensive the projection is in terms of manpower and time, which adds another challenge.

In our case, time and manpower are limited, which motivates us to elaborate an innovative and unique simulation model, the so-called LAW-Life projection. Its primary objective is to obtain consistent individual work-life, earnings and family histories from age 15 to 67 for each individual in our sample. The LAW-Life projection makes use of statistical matching techniques. More specifically, we apply Mahalanobis distance matching in order to project the life-courses with complete sequences of statistical twins of older birth cohorts.²⁴ The underlying algorithm calculates a Mahalanobis distance d_{ij} comparing each incomplete observation i_A to each complete observation j_B based on a vector of common X -variables. The statistical donor minimizes the distance d_{ij} between the complete and incomplete observa-

²³ Complex micro simulation studies, such as the Urban Institute’s DYNASIM simulate events in three sectors: demographics, economics, taxes and benefits (Favreault and Smith 2004), which goes well beyond the AVID micro simulation.

²⁴ See Rasner et al. (2011) for another application of the Mahalanobis distance for statistical matching purposes.

tions.²⁵ The statistical donor then gives the missing sequences of the work-life history as well as the corresponding relative earnings to the incomplete record. This procedure guarantees that the projected life-courses are consistent, because all information, whether the employment and marital history or the corresponding earnings, come from the same donor and therefore produce consistent life-courses.

This approach has a comparative advantage over other micro simulation models. For our purpose, a model-based projection is inadequate because it typically ages the data year by year, instead of projecting complete life-course sequences (Sackmann and Wingens 2003). Unlike other micro simulation studies that keep relevant life-course processes that are not (statistically) independent of each other separate, the LAW-Life projection aims for internally consistent life-courses, that project employment and family biographies as well as earnings trajectories simultaneously. Unlike other micro simulation models that estimate large numbers of multi-state/multi-event hazard rate models that bear the risk to compromise the goodness of fit or to produce non-converging logistic regression models which require additional normative calibrations, the LAW-Life projection strives for a statistically sound and comprehensible approach that takes differences by gender, cohort and region (East vs. West Germany) into account and explicates the underlying assumptions. Furthermore, unlike other micro simulation models the LAW-Life projection does not reduce complexity by only projecting a reduced number of employment states (e.g. employment and unemployment) therefore limiting heterogeneity in life-courses beforehand, but all relevant employment states are taken into account (e.g. schooling, training, part-time, full-time, etc.). Unlike other studies that exclude relevant subgroups from the micro simulation such as migrants or civil servants, the LAW-Life projection is based on a population-representative sample of individuals (by explicitly considering relevant subgroups, such as migrants, civil servants, self-employed) that allows for statistical interference and subgroup analyses.

²⁵ Unlike the Euclidean distance, the Mahalanobis distance score incorporates both correlations between matching variables and differences in variances.

4 Implementing the Matching-Based LAW-Life Projection

To the best of our knowledge there is no study available that makes use of matching-based projection techniques. It is therefore necessary to implement an approach that allows us to assess its validity and quality. For this purpose, we have to take three steps. First, identify suitable matching variables that help us to find the best donor. Ideally, these matching variables should be good predictors for the sequences of the life-courses that have to be projected. Second, specify the donor pool. Under the matching-based projection, the specification of the donor pool has an impact on the projected heterogeneity in the life histories. Third, verify the projection quality. For this purpose, we test the performance of the matching-based projection under three different techniques.

4.1 The Base Sample

We start out with a population representative sample from the longest running longitudinal survey in Germany, the Socio-Economic Panel (SOEP). The SOEP is a broad interdisciplinary household panel study that was initiated in 1984 (Wagner et al. 2008). It covers a representative sample of the total population living in private households in Germany. The most recent accessible data was collected in 2010 with 10,840 households and about 19,000 persons being interviewed. The micro-data provide detailed information on individuals, households, and families, enabling researchers to monitor stability and change in living conditions over time.

The reference year for our analysis is 2007. We distinguish a total of three cohorts: The baby boomer cohort (BB) covers individuals born between 1956 and 1965 ($n=4,201$). They are compared to two reference cohorts: The first reference cohort (RC I) covers individuals born between 1946 and 1955 ($n=3,485$), the second (RC II) individuals born between 1936 and 1945 ($n=3,382$). For these cohorts, we have consistent work-life histories at hand based on 27 waves of available data. These work-life histories include data on employment status and job history, marital history as well as the fertility and child history, which are collected retrospectively on an annual basis. Thus, changes that occur during the year might be underestimated. The life histories start at age 15 and reach until the latest available interview in 2010. We can further extend these data by the full array of information available in the

survey, for instance information on financial assets and wealth or on other life domains such as expectations or values.

4.1.1 Treatment of Gaps and Overlaps in SOEP Life-History Data

Like other survey data, SOEP life-history data suffer from various measurement issues, such as gaps and overlaps. As for the work history for the years prior to the first interview, the SOEP collects biographical information retrospectively on an annual basis by means of a calendar. For each year the respondent participates in the survey, he/she gives information on the preceding year. Whether annual or monthly information, respondents report all the activities that occurred during the respective period. Ideally, these data are available for the complete work-life-cycle, but a significant number of records suffer from gaps, both small and large. Depending on the type of gap, these were filled following a set of pre-specified rules. Gaps of one year were bridged with the status of the preceding year. For gaps that lasted longer than one year we used the two anchor points of the gap. The gap was split in two halves, the first of which was filled with the last status before the gap, the second half with the first status after the gap. Exceptions to this rule applied to the status *unemployment* and *military/civil service*. If these states occurred, they were the dominant states to fill the gap, because they typically suffer from underreporting in survey data. If the status *other* was one of the anchor states, then the other available anchor was chosen to fill the gap. In case the gap occurred at the end of the work-life-cycle up to the actual margin of the data, the last observed state was applied to bridge the gap.

In order to keep the complexity of the LAW-Life Projection manageable, each year of the work biography has to consist of an unambiguous employment state.²⁶ For this purpose, overlaps were recoded according to a hierarchy that distinguishes dominant and recessive employment states. Again, *unemployment* and *military/civil service* were dominant over all other

²⁶ The original spell data distinguishes the following employment states: school, training/apprenticeship, military/civil service, full time employment, part time employment, unemployment, home production, other, and retired.

employment states, because of supposable underreporting and in order to preserve these rather rare events – rare at least for the majority of the labor force. If overlaps involved the states *homeproduction* and *other*, then these states were recessive relative to the simultaneous state. If these recessive states occurred together, then priority was given to the status *other*. Overlaps of the states *education* and *apprenticeship/training* were recoded to the latter. Overlaps of the states *full time* and *part time* employment were recoded to full time employment.²⁷ Overall, the treatment of gaps and overlaps results in an underestimation of the level of mobility in individual work trajectories.

4.1.2 Augmenting SOEP Life-History Data with Administrative Pension Records by Statistical Matching

Unlike the work and family histories, it is impossible to reconstruct complete life-cycle earnings from SOEP data. First, earnings information is missing for the years prior to the first interview because respondents were not asked to report their earnings retrospectively because of likely recall errors (Ferber and Birnbaum 1979). Second, gaps in information occur because respondents fail or refuse to report their earnings in the years they were surveyed. For the latter type of earning gaps in the SOEP, we impute missing information starting in 2007 and going backwards to 1984 for West Germany and 1991 for East Germany. The imputation makes maximum use of all available longitudinal income information since the respondent's initial participation in the survey.²⁸ For missing earnings data prior to the first interview, SOEP earnings data was augmented with pension-relevant from administrative pension records, more specifically the *Sample of Active Pension Accounts* (*Versicherungskontenstichprobe*, henceforth SAPA) by means of statistical matching (for a detailed account see Rasner et al. 2011).

In order to consider group-specific differences in old-age provision behavior and differential

²⁷ For a detailed account on how gaps in the marital and fertility history were treated see Frick et al. (2012)

²⁸ This reverse completion of income information was necessary, because otherwise cases with missing values are excluded from the matching process. Furthermore, it improves the efficiency of the projection assuming sufficient quality and representativeness of the imputed income data.

treatment of East and West Germans as well as migrants in pension legislation, the statistical matching algorithm minimizes the distance function within six separate matching strata (West German men, East German men, West German women, East German women, male migrants, and female migrants).²⁹ The distance function includes annual earnings information for the years 1983 to 2007³⁰, the number of pension-relevant years³¹, child care credits (for women only) and age.

SAPA is an administrative dataset maintained by the statutory pension insurance that covers a representative sample of active pension accounts (Stegmann 2008).^{32,33} SAPA contains demographic and detailed benefit information. The longitudinal files provide monthly information on earned pension entitlements (based on earnings that are subject to social insurance contributions) starting at age 14 for each individual. Beyond these life-cycle pension rights, the data provide longitudinal information on the individual's employment situation, unemployment spells, periods of child care and long-term care, etc.³⁴ However, additional context information, such as the marital history or earned entitlements in pension schemes other than the statutory pension insurance as well as periods during which individuals worked as self-employed or civil servant are not available in SAPA data.

²⁹ Due to the small number of migrants in East Germany, a further differentiation of the migrant population by region was infeasible.

³⁰ For East Germans, earnings information starts in 1990.

³¹ Pension-relevant episodes (e.g. care giving) count towards the final pension benefit.

³² For the purpose of the research project *Life Course, Aging and Well-Being (LAW)*, the statutory pension insurance issued a special version of SAPA data (*LAW_VSKT_2002_2005_2007*) that covers the cohorts of interest ($n=205,828$). These records are representative of all individuals holding a pension account.

³³ The term *active pension account* typically refers to individuals in the workforce or recently retired (e.g. within the last three years). This project-specific dataset also includes older birth cohorts who entered retirement more than three years ago. A personal pension account is conditional on having at least one event over the life-course that constitutes rights in the statutory pension insurance. More than 95% of all men and women of the cohorts born 1942-1961 have a personal pension account (Heien et al. 2007a; Kruse 2007).

³⁴ For the purpose of the LAW project, data were further augmented with information from the German Aging Survey (*Deutscher Alterssurvey*), a nationwide representative cross-sectional and longitudinal survey of the German population aged over 40 (Motel-Klingebiel et al. 2010).

4.2 The Input Data

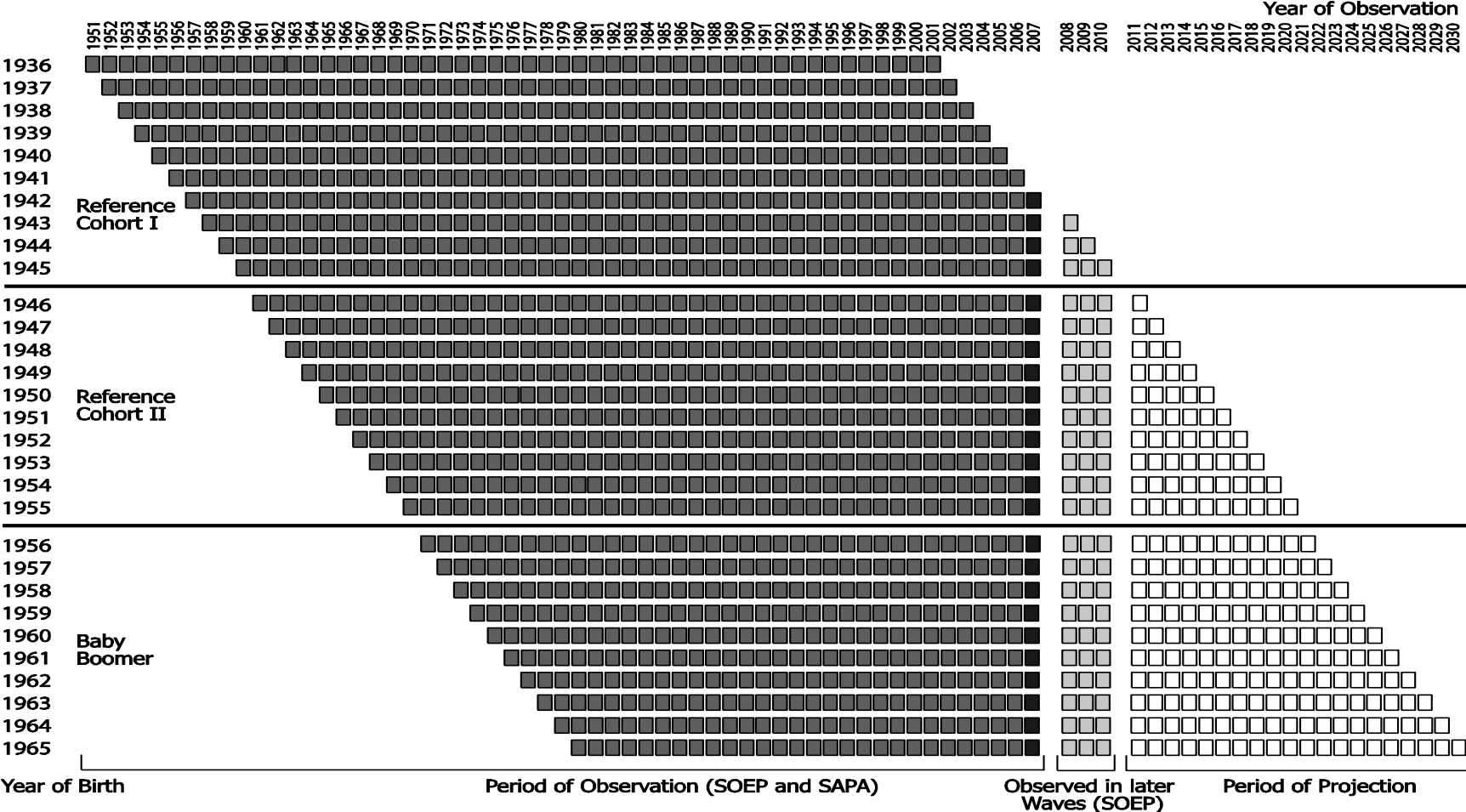
The goal of the projection is to obtain complete work-life histories and lifecycle earnings trajectories for the baby boomers and the two reference cohorts ranging from age 15 to age 65 or 67, respectively (depending on the effective retirement age for each birth cohort). After the treatment of gaps and overlaps, the data consist of complete work-life histories, family biographies and earnings trajectories at least up to the age of 45 for the baby boomers and up to age 71 for the oldest reference cohort in the observation year 2007.

Figure 2 displays the structure of the available data, with calendar years along the horizontal axis and birth cohorts along the vertical axis. We break the data down into three periods: observation period (1951-2007), observation period in subsequent waves past the reference year (2008 - 2010), and the simulation period (2011 - 2032). For the years 1951 to 2007 (horizontal axis), complete and unambiguous annual information on work-life histories and earnings is available (dark grey shaded cells). Therefore, we have full information for the birth cohorts 1936 to 1942. Between 2008 and 2010, we can draw on information from later waves of the SOEP (light grey shaded cells), thereby completing the trajectories of the birth cohorts 1943 to 1945.³⁵ An additional advantage of this strategy is that it allows us to follow the baby boomers up to age 45 which means that the large majority of female boomers have completed their reproductive years. The simulation period starts in 2008 with the birth cohort 1943 (light grey cells). Their official retirement age is 65 which will be achieved in 2008, thus the simulation period covers one year only.³⁶ The simulation period increases by one year per cohort. For the 1965 cohort, the simulation period extends over a maximum of 20 years until 2030, the year in which the youngest birth cohort of the base sample will turn 65 years.

³⁵ However, information in the semi-solid cells is only available if respondents continue to participate in the survey. Panel attrition can lead to missing information between 2008 and 2010.

³⁶ The projection for the birth cohorts 1943-1945 does only pertain to the earnings history given that for these groups information about employment and family status is still available in the SOEP. For latter cohorts the complete biographical information has to be projected.

Figure 2 Observed and Projected Years of Population-Representative LAW Sample



Source: Authors' Illustration

4.3 Identify Matching Variables

The Mahalanobis distance matching identifies the best statistical donor for the projection of work-life histories and corresponding earnings based on a set of common X -variables. Starting with the 1943 birth cohort, the first cohort with one year of information missing, we calculate a Mahalanobis distance matrix that compares each incomplete observation (*recipients*) with a (yet to define) *donor pool* of complete life-courses. The calculation of the distance matrix draws on a set of predefined matching variables (X -variables). The matching variables serve the primary purpose of finding the best statistical donor for the projection of future life-course sequences of recipients. Beyond that, these variables should also be good predictors for the missing portion of the life-course.

The matching-based projection makes use of categorical *slice* and *continuous* matching variables.³⁷ Slice variables partition the data to only match individuals within certain predefined strata. The partitioning avoids matches of individuals that are sufficiently dissimilar, especially if these groups are believed to differ in terms of their work-life histories and the accumulation of pension entitlements as it applies to men and women in East and West Germany. The statistical matching occurs within 280 imputation classes that are based on five slice variables.³⁸ Most importantly these variables include gender and region.³⁹ Additional slice variables provide information on whether a person is self-employed or not, the individual's labor force/employment status and the marital status. The latter variables all refer to the last available year of information, typically the year 2007.⁴⁰ Including the last

³⁷ There are numerous names for this type of variables (also *cohort* or *stratification* variables). In the remainder of this paper, the authors use the term *slice* variables the groups are named matching strata or imputation classes.

³⁸ Not all imputation classes matter in the statistical matching because cells are empty in the recipient data.

³⁹ The region dummy variable indicates whether a person lived in East or West Germany in October 1989, which allows us to consider the differences in living and working conditions before German reunification.

⁴⁰ In theory, one could think of additional slice variables, such as the individual's immigrant status. However, researchers face a trade-off. More imputation classes assure that matching partners are sufficiently similar in terms of their demographics. However, more imputation classes might prevent observations from the recipient file to find the best matching partner in the donor data in terms of the continuous matching

observed status as a slice variable guarantees an internal consistency of the projected life-courses and does not produce artificial transitions at the intersection of the observed and matched, hence projected portion of the life-course. For example, the matching-based projection produces inconsistent life-histories if the last observed marital status of a recipient is *divorced* and the best statistical donor is *never married*.

The calculation of the distance matrix that determines the best donor of incomplete observations in each imputation class draws on a set of *continuous* matching variables. The individual's annual public pension entitlements dominate the matching-based projection. Individuals accumulate pension entitlements primarily through gainful employment by paying social insurance contributions from their monthly wages. However, certain forms of non-employment (e.g. child caring, caretaking, unemployment) matter in terms of pension entitlements as well. The detailed, longitudinal information on pension rights comes from the administrative pension records. The entitlements are measured as so-called *earning points* that reflect the individual's income position relative to the average nominal earnings of all individuals who pay social insurance contributions to the public pension insurance in a given month. Earning points allow for comparisons between individuals and across time. For the purpose of the matching-based projection, we generate age-group-specific earning point aggregates (for the following age groups: 15 – 24, 25 – 34, 35 – 39, 40 – 44, 45 – 49 ...).⁴¹ The five-year moving aggregates serve the purpose of smoothing individual income histories. Only for West Germany, we add a variable that calculates the difference between earning points from employment and total earning points that also include pension entitlements from non-employment.⁴² Because German pension law treats earnings in East and

variables, because they belong to different imputation classes. In practice, additional slice variables could result in computational problems, for example if a *recipient* observation belongs to an imputation class that has zero observations in the set of potential donors. In our application, the large number of imputation classes was driven by the analytical interest to project consistent life-courses.

⁴¹ For later analyses, it is possible to convert the earning points in nominal or real incomes.

⁴² The inclusion of this variable for East Germans leads to a systematic bias in the matching-based projection. One possible explanation for this bias might be differential treatment of East Germans in pension law. For this reason, the variable does not enter the matching algorithm.

West Germany differently, the age-group-specific earning point aggregates enter the calculation of the distance matrix separately for East and West.

Cross-sectional information that pertains to the individual's marital and work history also enter the matching-based projection. As for the demographic information, the projection includes, if applicable, the age at birth of the first and second child, the total number of children, the age at first/second marriage and the age at first divorce. Additional demographic information sums up the number of years married and divorced.⁴³ As for the work history, we count the number of years in full-time and part-time employment, unemployment and the years in school or training. For women, we also include the number of years spent in home production. Given that the German public pension scheme excludes certain occupational groups, such as civil servants, certain chambered professions (e.g. lawyers or medical doctors), and the self-employed required a special treatment in the matching-based projection. In order to find a better statistical donor, the matching distance matrix considers additional variables for the self-employed: age-group specific aggregates (for the following age groups: 15 – 24, 25 – 34, 35 – 39, 40 – 44, 45 – 49 ...) of the logged self-employed income⁴⁴, the logged income from dependent employment, the ratio of income from self-employment and regular employment (not logged)⁴⁵, and the number of years in self-employment. For civil servants, the age-group-specific earning points are equal to zero, because as civil servants they don't pay contributions to the public pension scheme. In their job history, civil servants have the status of full-time or part-time employment, which is a unique combination when compared to other occupational groups.⁴⁶ For civil servants, the

⁴³ Repeated marriages and divorces are observable in the data, but we refrain from including these variables in order to stabilize the donor pool. However, this decision does not imply that repeated marriages and divorces cannot occur in the LAW-Life projection.

⁴⁴ Unlike the earning points, information on self-employed income is only available from the year 1983 on as it originates from the SOEP survey.

⁴⁵ A certain share of individuals receives income from self-employment and a regular job. Since they accumulate pension entitlements in different pension schemes, it is relevant to include the ratio of regular and self-employed income in order to find the best matching partner.

⁴⁶ The original SOEP-SAPA matching could not use the status "civil servant" as a slice variable, because this type of information is not available in the administrative data. For this reason, it is possible that a civil

LAW-Life projection aims at obtaining consistent work-life and family histories. Taken together, these matching variables are well-suited summary measures for the individual life-course and are therefore likely to be good predictors for the remaining portion of their lives that are the subject of the matching-based projection.

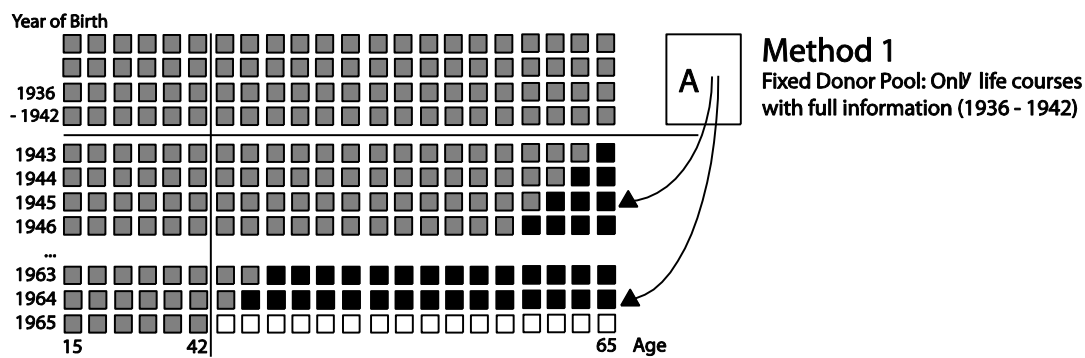
4.4 Specify the Donor Pool

In addition, to the identification of matching variables, it is also important to specify the pool from which the best statistical donor can be chosen. The specification of the donor pool matters, because it makes a difference, whether the donor pool only covers fully observed records (from the birth cohorts 1936 – 1945) or whether the donor pool grows with each age group that runs through the matching-based projection cycle.⁴⁷ The size of the donor pool and its composition has a direct impact on the heterogeneity in the projected life histories. This aspect is of particular relevance given one of our key assumptions, namely that baby boomers have increasingly heterogeneous and destandardized life-courses when compared to older birth cohorts (Frick et al. 2012; Scherger 2007). Because we cannot draw on experiences of earlier matching-based projections, we need to test the effects of differently specified donor pools on the projection results. For the purpose of this paper, we test three specifications. *Figure 3* displays the first specification, where the donor pool (*box A*) is fixed. In this method, only the oldest birth cohorts (1936 – 1945) serve as donors for the incomplete life-course that enter the matching-based projection cycle.

servant and a dependent employee are the best matching partners with the dependent employee having age-specific earning point information greater than zero. For these observations, we set the earning-point information to zero.

⁴⁷ The matching-based projection cycle starts with those individuals born in 1943 (for whom there is one year of information missing) and runs consecutively to the youngest individuals in the sample born in 1965. For each age group, the number of years to be projected increases by one.

Figure 3 Fixed Donor Pool for Projection (Method 1)



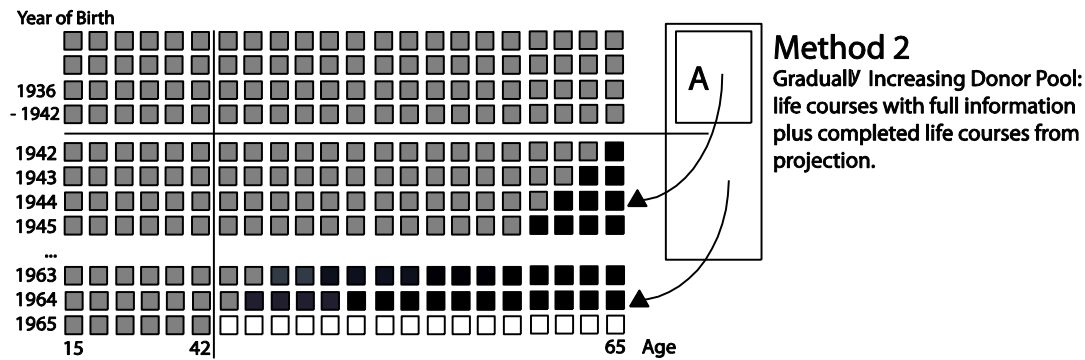
Source: Authors' Illustration

Based on the assumption that pluralization and heterogeneity in life-courses increases over time, the first method will render the most conservative projection. If the matching assigns life-course sequences and corresponding earnings only from the oldest cohorts in order to complete the lives of the young, it is unlikely that the projected lives will fully capture the level/degree of pluralization. Plus, this method bears the risk that it matches one donor multiple times, thereby decreasing the variance. This problem applies in particular to life-courses with special patterns that are likely to be chosen over and over again.⁴⁸

Under the second specification, the donor pool gradually increases with every projected age group (cp. to *Figure 4*). According to this method, each age group that runs through the projection-cycle becomes part of the donor pool for the next age group.

⁴⁸ The matching-based projection allows for matching with replacement, which implies that one observation can be a multiple donor.

Figure 4 Gradually Increasing Donor Pool for Projection (Method 2)



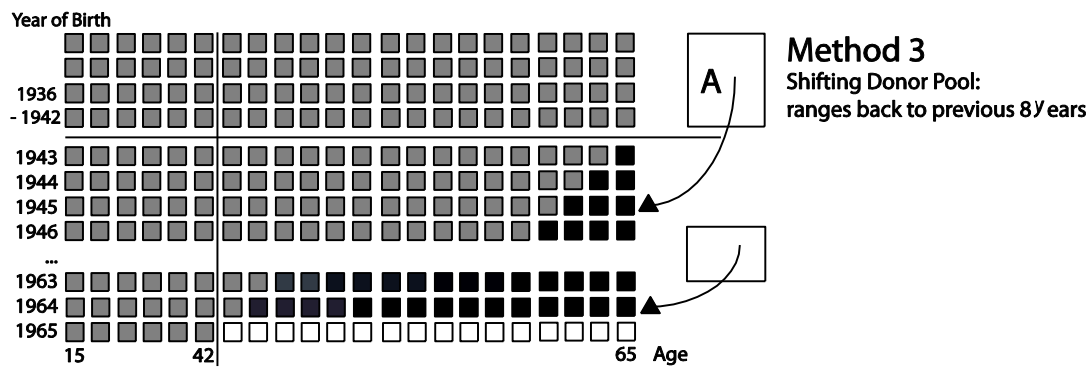
Source: Authors' Illustration

Under this method, the number of potential donors increases year by year and therefore also the probability to find a better matching/projection partner. Compared to the first method, this method is more likely to carry the increasing heterogeneity in life-courses forward which becomes more and more relevant across cohorts. Furthermore, it reduces the risk of multiple matches and the resulting reduction of variance in the distribution of the parameters of interest. A possible downside of this method and a consequence of the sequential projection design is that projected biographies can consist of several “life-course pieces” coming from different donors. For example, this situation emerges if an observation from Reference Cohort II, whose biography was completed with information from an observation in Reference Cohort I serves as a donor for the life-course of a Baby Boomer.

Under the third method, the matching-based projection selects donors from a shifting donor pool (cp. to *Figure 5*). Each age group selects the matching/projection partner from the previous eight years.⁴⁹ Hence, individuals who were born in 1943 select their partner from individuals born between the years 1936-1942. In turn, individuals of the youngest age group of the sample who was born in 1965 select their partner from the birth cohort 1957 – 1964.

⁴⁹ The choice of an eight years threshold is data driven. Individuals born in 1943 are the first to enter the projection cycle can select their matching partner from eight older cohorts (1936 – 1942). In order to keep the donor pool stable, in terms of the number of birth years, matching partners always come from individuals born in the previous eight years.

Figure 5 Shifting Donor Pool for Projection (Method 3)



Source: Authors' Illustration

In this method, the pool of potential statistical donors changes from year to year. Due to the larger cohort size of the post war cohorts, the donor pool becomes larger for the youngest cohorts, but it is still smaller than under the second method. The use of the previous eight age groups assures that the projection better carries forward the expected pluralization and heterogeneity in life-courses. However, as a downside to the third method, it is more likely that one donor serves as a matching/projection partner multiple times thereby reducing the variance or bringing in a systematic bias in the projected lives. This problem is particularly relevant for imputation classes with a limited number of matching partners. Also under this third method, projected life-courses can consist of life-course segments from different donors.

4.5 Verify Projection Accuracy

The next analytic step aims at identifying the specification of the donor pool that brings about the most accurate and valid projection results. A modified version of the base sample that covers the birth years 1936 to 1953 serves as the basis for this benchmark analysis. For the analysis, we assume that it is 1994 and therefore delete all the information for the years 1995 to 2007. For the reduced data, we replicate the structure of the original data with respect to the relation between observation and projection period, which requires a shift of the cohort bounds in order to maintain the proportions between the three cohorts (cp. to Figure 6). Applying the matching-based LAW-Life projection, we then test the performance of all three donor pool specifications based on the trimmed dataset to project the work-life and family histories and the earning-point trajectories for the years 1995 to 2007. This

benchmark analysis allows for the comparison of the (deleted) observed and the newly projected information for the birth years 1948 to 1953. For this cohort, the length of the projection period of the biographies (nine to fourteen years) proportionally equals the length of the projected portion in the *real* LAW-Life projection. Accordingly, these changes require a new specification of the donor pool for the third method that only reaches back five instead of eight years to find the best matching partner.

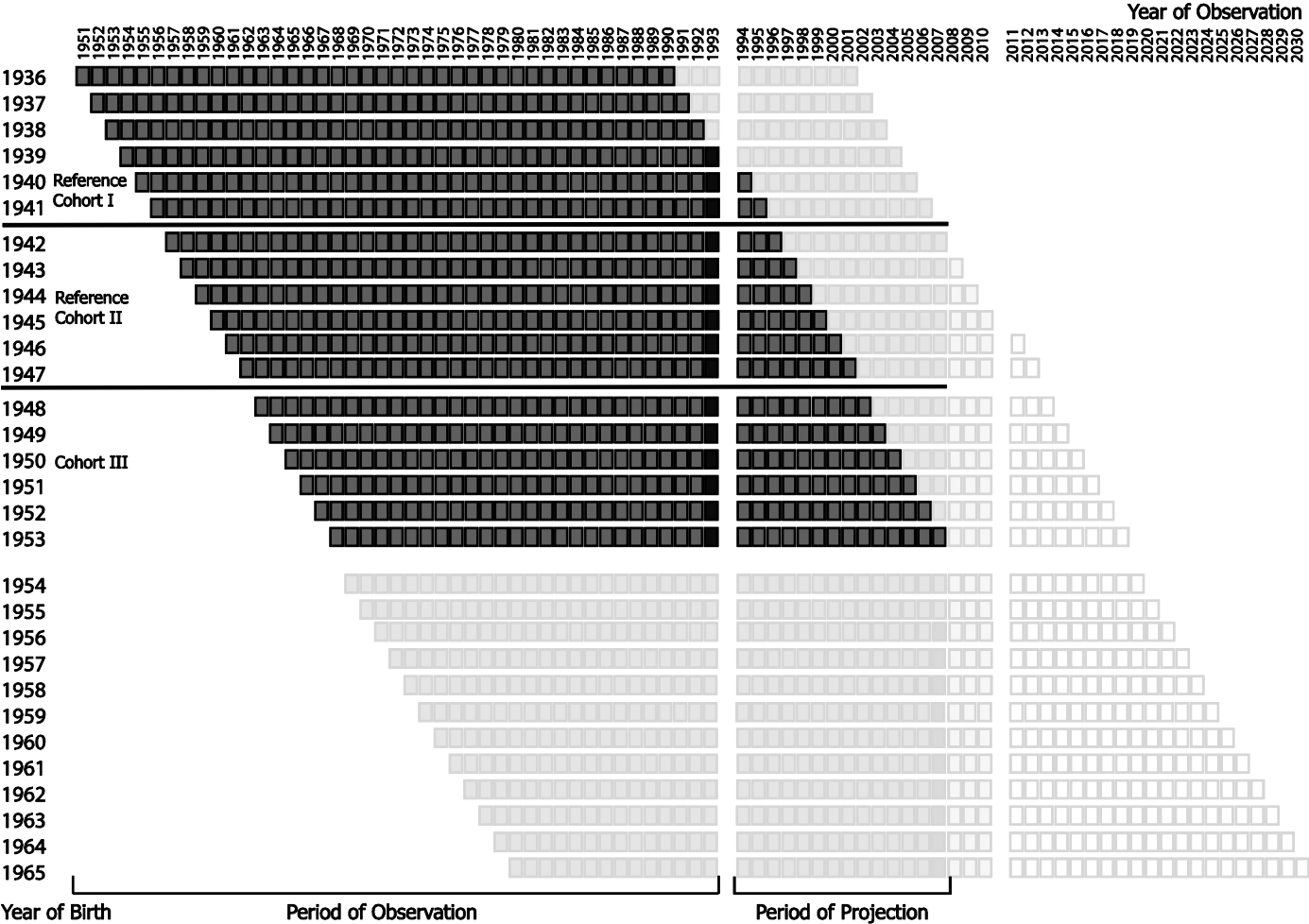
Table 1 Comparison of Base Data for LAW-Life Projection and Benchmark Analysis

	Real LAW-Life Projection	Benchmark Analysis
Cohort I	1936-1945	1936-1941
Cohort II	1946-1955	1942-1947
Cohort III	1956-1965	1948-1953
Observation Period	1951-2010	1951-1994
Projection Period	2011-2030	1995-2007
Ratio Projected/Observed Years	1:3	1:3
Size of Shifting Donor Pool (Method 3)	8 years	5 years

Source: Authors' Illustration

In order to assess which donor pool specification produces the most accurate and valid projection results, the benchmark analysis applies three indicators to compare the projected and the observed, but deleted information of the individual's life-course. These indicators are aggregate descriptive measures of the work-life and family history, the earning-point trajectories and the distribution of earning points for various demographic groups.

Figure 6 Trimmed LAW Data for Assessment of Projection Accuracy

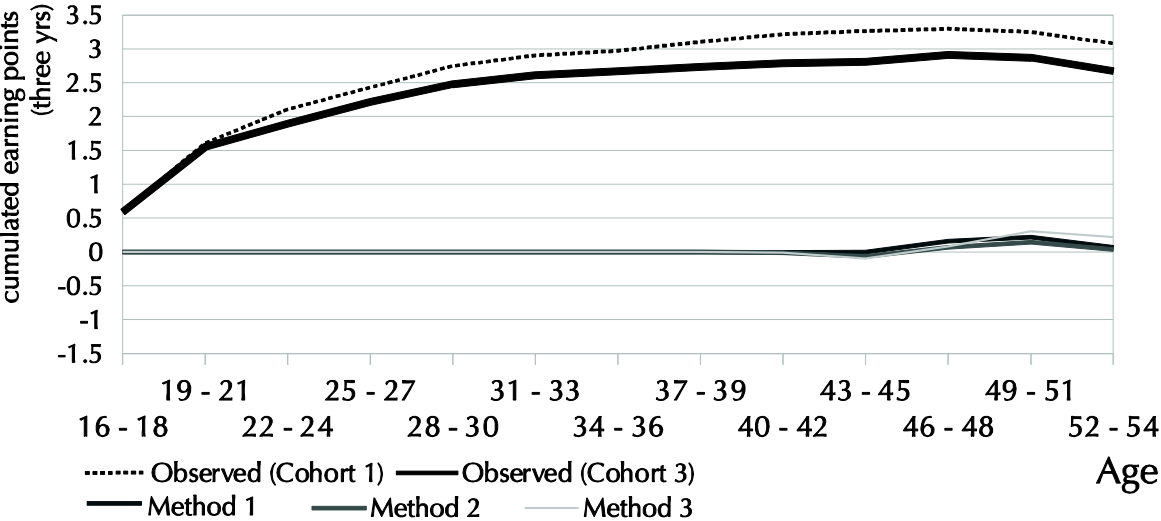


Source: Authors' Illustration

Figure 7 and Figure 8 illustrate selected results of the LAW-Life Projection with cumulated earning points (sum of three years) along the vertical axis and age groups along the horizontal axis. The two upper lines compare the observed earning point trajectories of Cohort I and Cohort III based on the trimmed LAW dataset. The three lines at the bottom compare the performance of the projection for the three donor pool specifications (method 1 - method 3) representing the difference between the observed and projected earning points trajectory of Cohort III. The difference is equal to zero between ages 16 to 42 because this is the observation period. For the ages 43 and higher, the lines deviate from zero indicating how far off the projection is from the observed pattern.

For men in West Germany, all three methods perform fairly well. The projection has an upward bias, which results in a slight overestimation of pension entitlements for this demographic group. The deviations that never come even close to the 0.5 earning point line are negligible. It is important to note that the deviations are a three-year summary measure. Comparing the performance of the projections in Figure 7 by the method of donor pool specification shows that Method 2 performs best when compared to the other two specifications. The gradually increasing donor pool brings about the best matching partners for the youngest cohort.

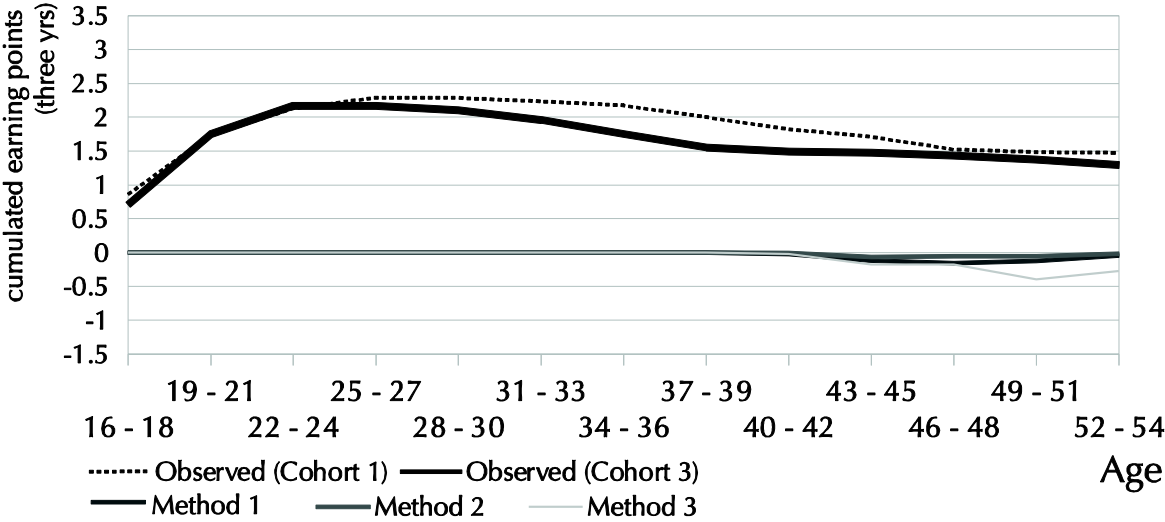
Figure 7 Performance of Three Donor Pool Specifications in LAW-Life Projection, West German Men



Source: LAW-Life, Authors' Calculations

The results for women with high educational attainment show larger deviations (cp. *Figure 8*). The level of cumulated earning points is significantly lower than for West German men. The third cohort falls behind the observed earning points for the first cohort. For women with high educational attainment the results show an underestimation of projected earning points. For Method 1 and Method 2, the deviations are not significantly different from zero, but the projection under Method 3 with the shifting donor pool falls clearly behind. Possibly, the donor pool is not sufficiently large, so that certain women can only choose a second best matching partner. This problem might be aggravated in the benchmark setting because under the third method the donor pool reaches back for five instead of eight years.

Figure 8 Performance of Three Donor Pool Specifications in LAW-Life Projection, Women High Education

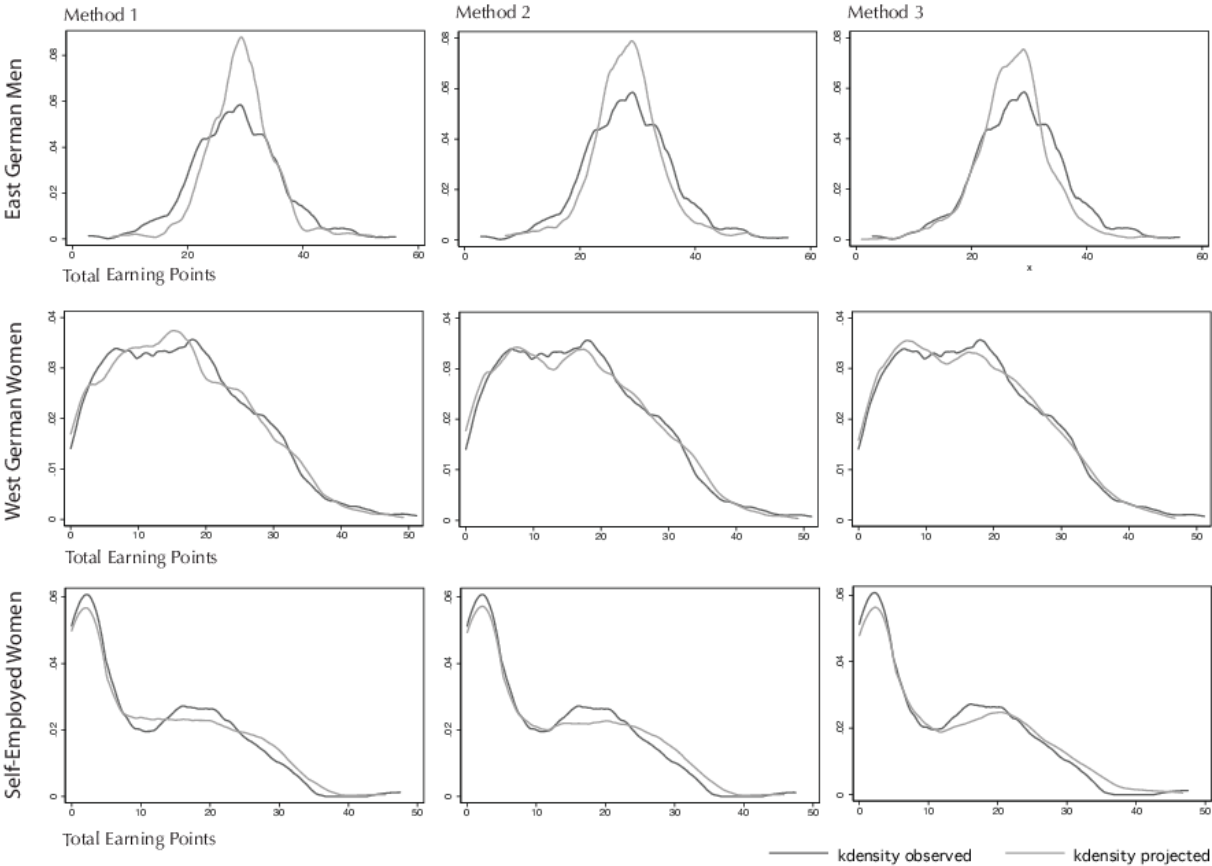


Source: LAW-Life, Authors' Calculations

The second indicator for the projection quality is a comparison of the observed and projected distribution of earning points under the three donor pool specifications. We randomly delete half of the observations per birth year and then project the data under each donor pool specification. This procedure serves the test, of whether the projection is robust or whether it produces a systematic bias. The comparison of three different donor pools helps us to identify, which specification produces the highest systematic bias in the projection- particularly in imputation classes with a small number of observations. *Figure 9* compares the distribution of earning points across donor pool specifications for three selected demographic groups with densities along the vertical axis and the sum of earning points

along the horizontal axis. The upper panel shows the results for East German men. Method 2 performs best for this group because it produces the smallest deviations between observed and projected earning points. For West German women, all donor pool specifications perform fairly well showing a high accordance of the observed and projected earning point distributions. The second Method appears to be a step ahead because this projection better captures the two peaks in the observed distribution.

Figure 9 Distribution of Earning Points under Three Donor Pool Specifications, East German Men (Upper Panel), West German Women (Middle Panel), Self-Employed Women (Bottom Panel)⁵⁰



Source: LAW-Life, Authors' Calculations

Method three produces systematically lower earning points in the projection with the dis-

⁵⁰ The lines that depict the observed distribution of earning points differ across the donor pool specifications. These differences result from the random selection of observations into the donor pool.

tribution being slightly shifted to the left. The bottom panel best illustrates the problem related to a small donor pool. For the group of self-employed women, the projection under Method three produces a systematic upward bias in the earning point distribution. The same applies to the results under Method one. The second donor pool specification performs best in the projection of earning points for this very small subgroup of the population.

Based on these results, we opt for the second donor pool specification. Due to the gradually increasing donor pool, this second method has the greatest flexibility and therefore allows recipients to choose from a larger set of potential matching partners.

4.6 Discussion

To the best of our knowledge, the use of statistical matching techniques in the projection of work-life, pension rights and family histories is unique so far. Even though the LAW-Life projection already considers a multitude of aspects, such as the differential treatment of occupational groups in the system of old-age provision or differences between East and West Germany, certain issues remain yet unsolved or have to be refined in future enhancements of the model. Among other things, these issues concern demographic developments in the base sample during the projection period, reforms of the system of old-age provision that come into effect during the projection period, and differential treatments of occupational groups or special groups such as disability pensioners.

Demography: The LAW-Life projection keeps the 2007 demographic structure of the population fixed. The projection model ignores differential mortality. It is safe to assume that mortality rates are relatively low up to age 67; however, it is a well-known fact that some socio-demographic groups have higher mortality risks than others (Brockmann and Klein 2004; Wunsch et al. 1996). As a possible solution to this shortcoming one might predict deaths in a given year based on a set of individual characteristics (Favreault and Smith

2004).⁵¹ Concerning fertility, we assume that all individuals in the base sample are past their reproductive period. Hence, no babies are born in the projection period. Therefore, LAW-Life does not consider fertility after age 45, which leads to a small, but negligible error.⁵² As for migration, the model assumes a closed system that rules out in- and out-migration beyond the reference year of 2007. Hence, we project the life-courses of those immigrants who are in the base sample of the data and dismiss that these immigrants might leave the country during the projection period. Immigrants who come to Germany after 2007 cannot be considered in the projection as well.

Marriage, divorce and remarriage: The accurate projection of marriage, divorce and remarriage is vital as it matters for the demographic structure of the population and economic processes. The decision on who enters a marriage, who experiences a marital split, and who matches and forms new families has repercussions in terms of male and female labor force participation, but also in terms of eligibility for retirement and survivor's benefits. Unlike other micro-simulation studies that assign probabilities of marriage to unmarried individuals (for example from discrete time logistic hazard models), the LAW-Life projection allows for marriage, divorce or remarriage only in the course of the matching-based projection process. Hence, if the respective matching partner (*donor*) married, divorced or remarried after 2007 then this/these transition(s) equally apply to the recipient observation. This approach might have several drawbacks: Across cohorts, the matching-based projection model carries the increasing trends in divorce and remarriage rates forward, which implies that a potential reversion of the trend cannot be adequately considered (or is not possible). Another problem related to the projection approach results in inconsistencies in couples, because the assignment of matching partners occurs at the individual- but not at the household-

⁵¹ The DYNASIM micro-simulation model predicts deaths based on a complex multi-stage process, thereby making use of micro-level data for the estimation of within-cohort sex group differentials. For the estimation of differences in age-race-sex-specific trends and levels in mortality the model uses aggregate-level data (Favreault and Smith 2004).

⁵² Certainly men are more likely to become late fathers than women to become late mothers. However, labor supply responses to fatherhood are positive (Lundberg and Rose 2002) and there is no reason to believe this would be different in older men.

level. For example, in a couple that is married in 2007 the matching partner of the wife might experience a divorce between aged 45 and 67, whereas the husband's matching partner is continuously married. In this case, the marital trajectories of the married couple are incompatible in the projection period. One way to solve this issue is to only allow remarriage for individuals who were not married (including never married, divorced, and widowed) in the base sample.⁵³

Institutional Settings of the Public Pension Scheme: For the LAW-Life projection model, we hold rules and regulations concerning the pension benefit calculation constant and apply the 2007 pension framework. This decision implies that we maintain the institutional separation and differential treatment of East and West Germany also during the projection period. Most importantly, the model applies the 2007 pension values for East and West Germany, which implies that pension benefits won't increase over time.⁵⁴ Furthermore, the special treatment of earnings in East Germany will persist in the future, which applies to the upgrade of East German earning points to compensate for differences in wage levels between the two parts of Germany. The upgrading of earning points was introduced after German reunification to acknowledge differences in wage levels between East and West Germany. The assumption to maintain this special treatment is certainly debatable if one expects East Germany to catch up in terms of living standards and wages.

Transition into Retirement: Various pension reforms were passed in the last two decades that aimed at prolonging the time individuals stay in the workforce, such as increases in the retirement age and the introduction of actuarial adjustments to penalize early retirement. Not all of these reforms did come fully into effect yet, but will be phased in gradually. For

⁵³ One could follow the approach of the mate-matching module of DYNASIM: Here, they have a list of males and females in the marriage market, with the lists being ordered at random. Mate matches can only occur within specified strata (by age, education, and race).

⁵⁴ In 2007, the actual pension value (*aktueller Rentenwert*) amounts to 26.27 Euro for West Germany and 23.09 Euro for East Germany, respectively (Deutsche Rentenversicherung 2011). The pension value matters for the pension benefit calculation. It is subject to an annual indexation. The final monthly pension benefit equals the product the actual pension value and the sum of individual earning points.

example, the law that raised the statutory retirement age (*RV-Altersgrenzenanpassungsgesetz*) was passed in 2007 and will fully come into effect for the birth cohort 1964 who retires in 2031. Over time, the reforms will result in behavioral changes when it comes to the transition into retirement, especially if workers expect to have inadequate retirement savings. However, knowledge is limited as to how policy changes effect behavioral responses (Brugiavini 2001). For this reason, we apply simplified assumptions about the transition into retirement: all individuals work until they reach the statutory retirement age for their birth year. This assumption leads to an upward bias in estimated pension rights for the baby boomers; because it dismisses that a significant share of workers leaves the workforce early with corresponding cuts in their pension benefits. Future enhancements of the LAW-Life projection models plan to develop different scenarios for the retirement decision of the baby boomers to obtain a more realistic picture of this transition and the related financial effects.⁵⁵

Taxation of Benefits: The taxation of retirement benefits is another important factor that calls for inclusion, but is not yet adequately considered in the LAW-Life projection model. Two aspects of taxation matter: First, the differential taxation of retirement income across occupational groups; and second, the deferred taxation of pension benefit which has been introduced in 2005. Unlike retirement income from the statutory pension insurance or from private annuities, the pensions of civil servants were always fully taxed (Fehr and Jess 2007). With the 2005 law (*Alterseinkünftegesetz* - AltEinkG), deferred taxation of pensions was introduced with the goal of harmonizing the tax treatment across all occupational groups.⁵⁶ In 2005, the taxable share of pensions was increased from 31 to 50 percent for pensions from the statutory pension insurance or from private annuities and further increases by

⁵⁵ We plan to distinguish three scenarios: one optimistic, one pessimistic and a conservative scenario. The *optimistic scenario* assumes that all individuals react to the increase in the retirement age and work until the statutory retirement age. The *pessimistic scenario* assumes no behavioral effects with respect to the increase in the statutory retirement age with the distribution of the retirement age being equal to the current distribution. The *conservative scenario* is the middle course between the optimistic and pessimistic scenario with a model-based prediction of the statutory retirement age.

⁵⁶ For an overview pre- and post-reform taxation of pensions see Fehr and Jess (2007).

two percent per year until 2020 and an additional percent per year until 2040. The taxable share of pension income therefore depends on the year in which a person draws a pension for the first time (§22 of the German Income Tax Act [*Einkommensteuergesetz*]).⁵⁷ For each occupational group, the respective 2007 tax rate applies.⁵⁸

5 Application: Educational Attainment and Pension Building

We now apply the projected LAW-Life data to analyze the relationship between educational attainment and the accumulation of pension rights over the life cycle. We focus on two questions: First, do individuals with high educational attainment accumulate higher pension entitlements than individuals with low educational attainment (within-cohort differences)? And second, do the expected differences between individuals with high and low educational attainment grow across cohorts? To answer these questions, the following analyses compare cumulative earning point trajectories for men and women in East and West Germany across the three cohorts. The earning points are a good proxy for the individual's life-cycle labor market attachment. Another advantage of the earning points is that the measure is adjusted to average nominal earnings of the insured that allow for comparisons across cohorts. The cumulated earning points will be compared for ages 15 to 58. The upper age limit factors out possible effects of differences in the statutory retirement age, the minimum age at which the transition into retirement is possible, and actuarial adjustments in case of early retirement that differ across cohorts.

As for the first question, we expect that positive returns to education not only apply to wages, but likewise to earning points. Hence, individuals with high educational attainment

⁵⁷ For example, the taxable share for first-time pensioners in 2007 is as high as 54 percent. With each additional year, the share increases to 80 percent by the year 2020 and to 100 percent by 2040 for pensions paid for the first time.

⁵⁸ By applying the current individual tax rate, a relatively high tax burden is assumed for active insured persons. The actual tax burden would, however, have to be simulated separately for each age cohort at the time of entry into retirement. Because of the recently introduced deferred taxation, however, such a simulation requires major assumptions about the future income situation of the persons in question, which clearly goes beyond the scope of this paper.

are better able to accumulate pension entitlements than individuals with low levels of education. In contrast, one might argue that individuals with higher educational attainment enter the labor market at higher ages than individuals who don't spend much time in the education system and therefore have less time to accumulate pension entitlements. As for the second question, we expect differences between individuals with low and high educational attainment to grow across cohorts. From life-course research on the cumulative disadvantage (Dannefer 2003; DiPrete and Eirich 2006; O'Rand 1996), it is well-known fact that individual life trajectories are closely related to the institutional context in which the lives are embedded in. Given that the institutional settings allocate different opportunities to members of the same cohort, we expect a growing heterogeneity within cohorts. With the growing importance and valuation of education, education becomes one of the key determinants of inequality.

Figures 10-13 compare the outcomes of cumulative advantage and disadvantage over the life-course in terms of earning points for men and women in East and West Germany. The three lines represent different levels of educational attainment: low, medium and high. Low educational attainment (light grey dashed line) stands for lower secondary school (*Hauptschule*) or less, medium educational attainment (black dotted line) refers to intermediate secondary school (*Realschule*), and high educational attainment (black solid line) reflects the A-levels or higher (*Gymnasium* or *Fachoberschule*). Each figure distinguishes between the three LAW cohorts: Reference Cohort I (born 1936-1945), Reference Cohort II (born 1946-1955) and the Baby Boomers (born 1956-1965).

The results support the expectation that individuals with high educational attainment have higher pension entitlements than those with low educational attainment. This pattern applies to almost all demographic groups and all cohorts. The only exceptions are East German women in Reference Cohort I, where women with a medium level of education end up with more earning points than women with high educational attainment. However, differences across educational categories are negligible for East German men and women in this oldest cohort. This finding might be a consequence of restricted opportunities in the GDR economy. Trappe mentions that women were far less likely to acquire occupational qualifications or to improve these qualifications during their work life in the socialist re-

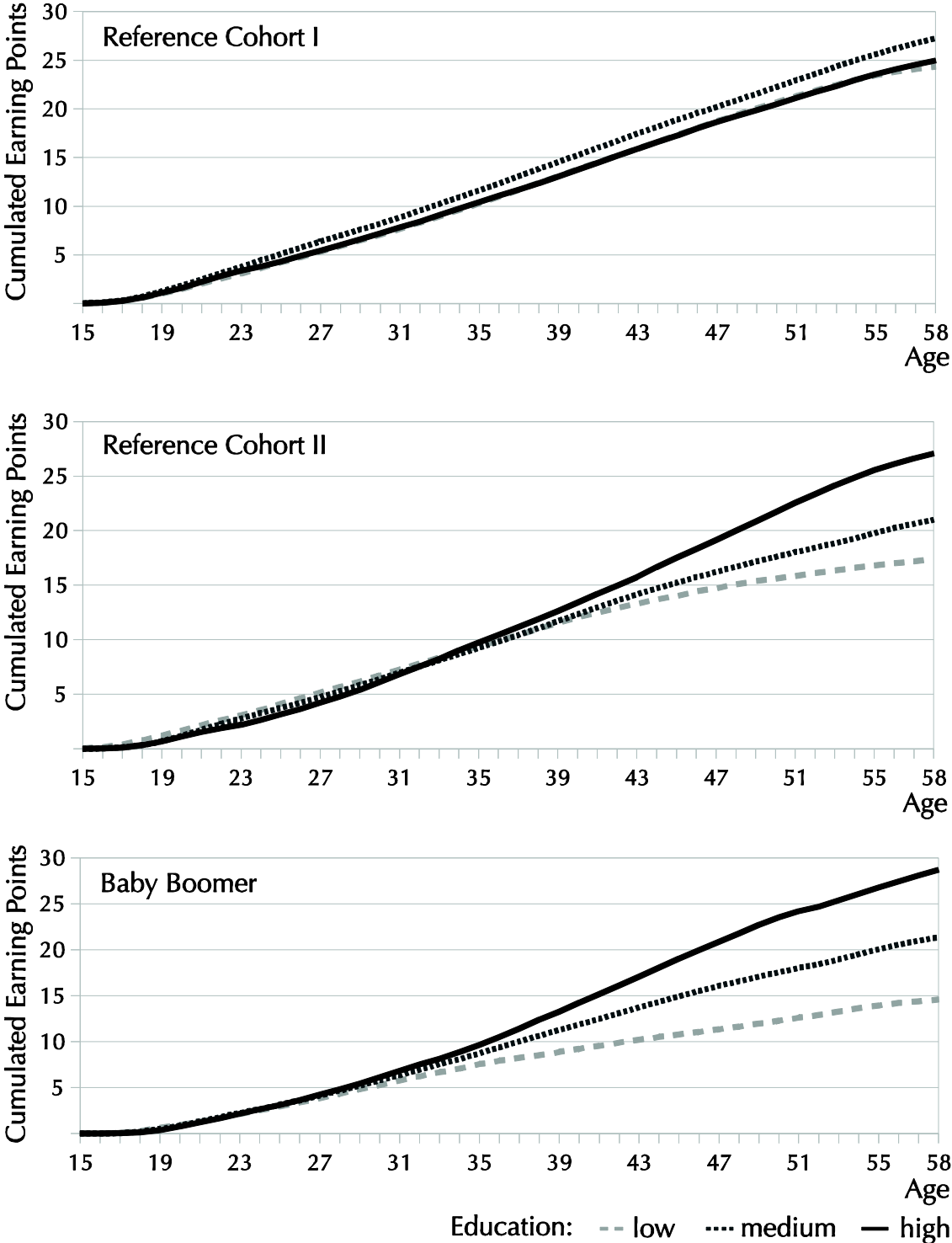
gime (Trappe 2006). The lack of occupational qualifications might be one reason for why we don't observe significant differences across different levels of educational attainment in the oldest cohort. For West Germans, we find differences in earning points by educational attainment levels. Highly educated individuals end up with the highest pension entitlements, low educated individuals with the lowest entitlements.

The cross-cohort comparisons indicate a downward trend in the average number of earning points accumulated until age 58. This decline is particularly obvious for East German men. In the first reference cohort, East German men with high education accumulated 35 earning points, whereas highly educated baby boomers end up with an average of 29 earning points. The decline is even more drastic for low educated East German men. In the oldest reference cohort, they achieved an average of 34 earning points, whereas in the baby boomer cohort they only accumulate 21 earning points. Multiplied with the actual pension value for East Germany (amounts to 24.37 Euros), 21 earning points reflect a pension benefit of 511 Euro. It is, however, important to keep in mind that the analysis only goes up to the age of 58. The only demographic group that improved its earning point position over time is East German women with high educational attainment. In the oldest cohort they accumulated an average of 27 earnings points, compared to 29 earning points in the baby boomer cohort. Similar to East German men, baby boomer women with low educational attainment in East Germany lose ten earning points or 40 percent in pension entitlements when compared to the oldest reference cohort.

For West Germany, differences between the baby boomers and the two older reference cohorts are less striking. For West German women, we observe almost no changes across cohorts, but pension entitlements remain at an alarmingly low level. Even the pension rights of women with high educational attainment don't exceed the threshold of 20 earning points, which equals a pension benefit of 550 Euro. Without the financial support of a husband, these benefits are too low to make a living in old-age. The downward trend in the average number of earning points accumulated over the life course also applies to West German men. However, their pension rights are still at a comparatively high level. While highly educated men in the oldest reference cohort end up with an average of 51 earning points, male baby boomers in West Germany have an average of 44 earning points. Multi-

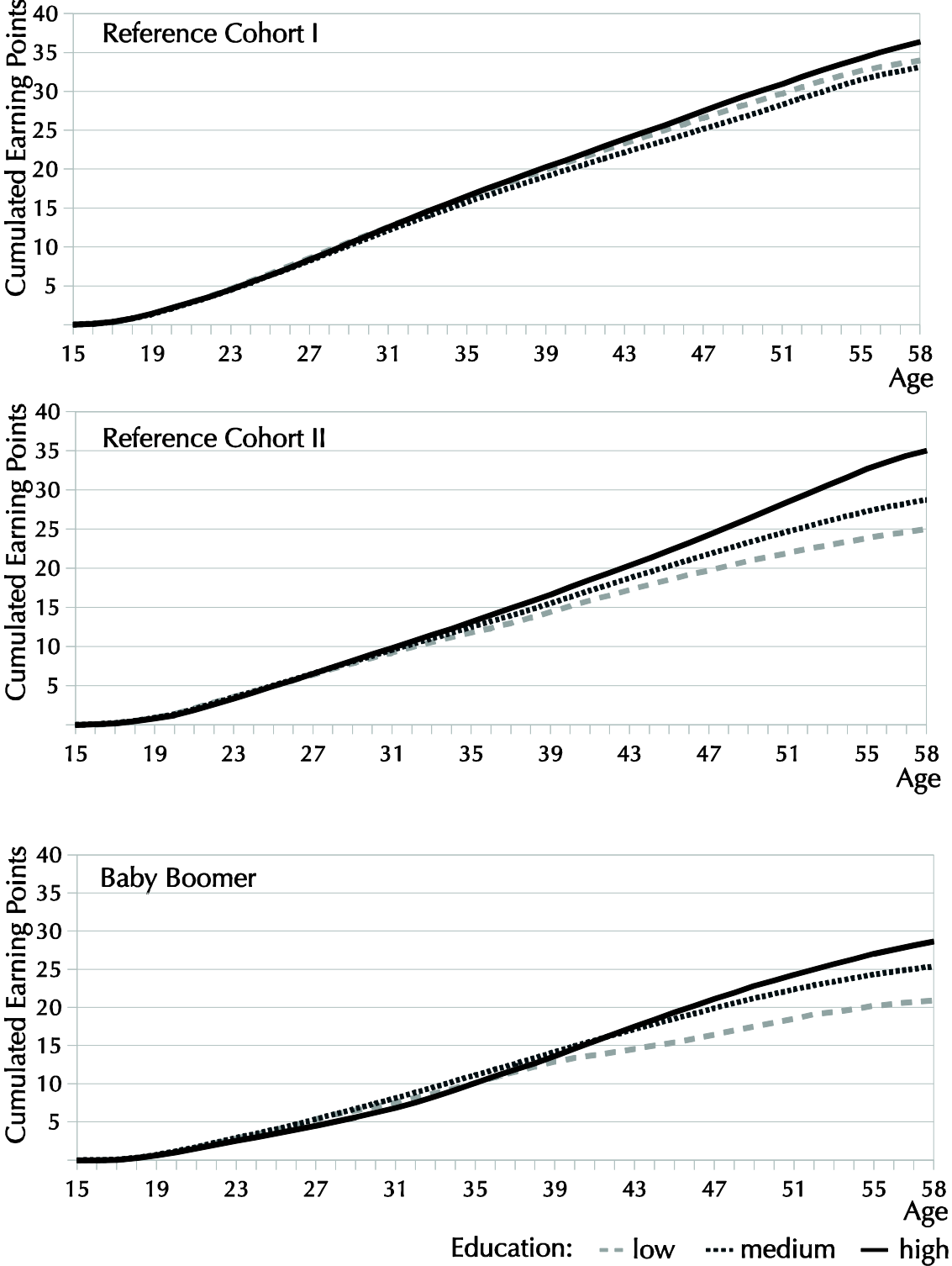
plied with the actual pension value of 27.47 Euros for West Germany, this amounts to monthly a pension benefit of 1200 Euros.

Figure 10 Educational Attainment and Pension Entitlements across LAW Cohorts, East German Women



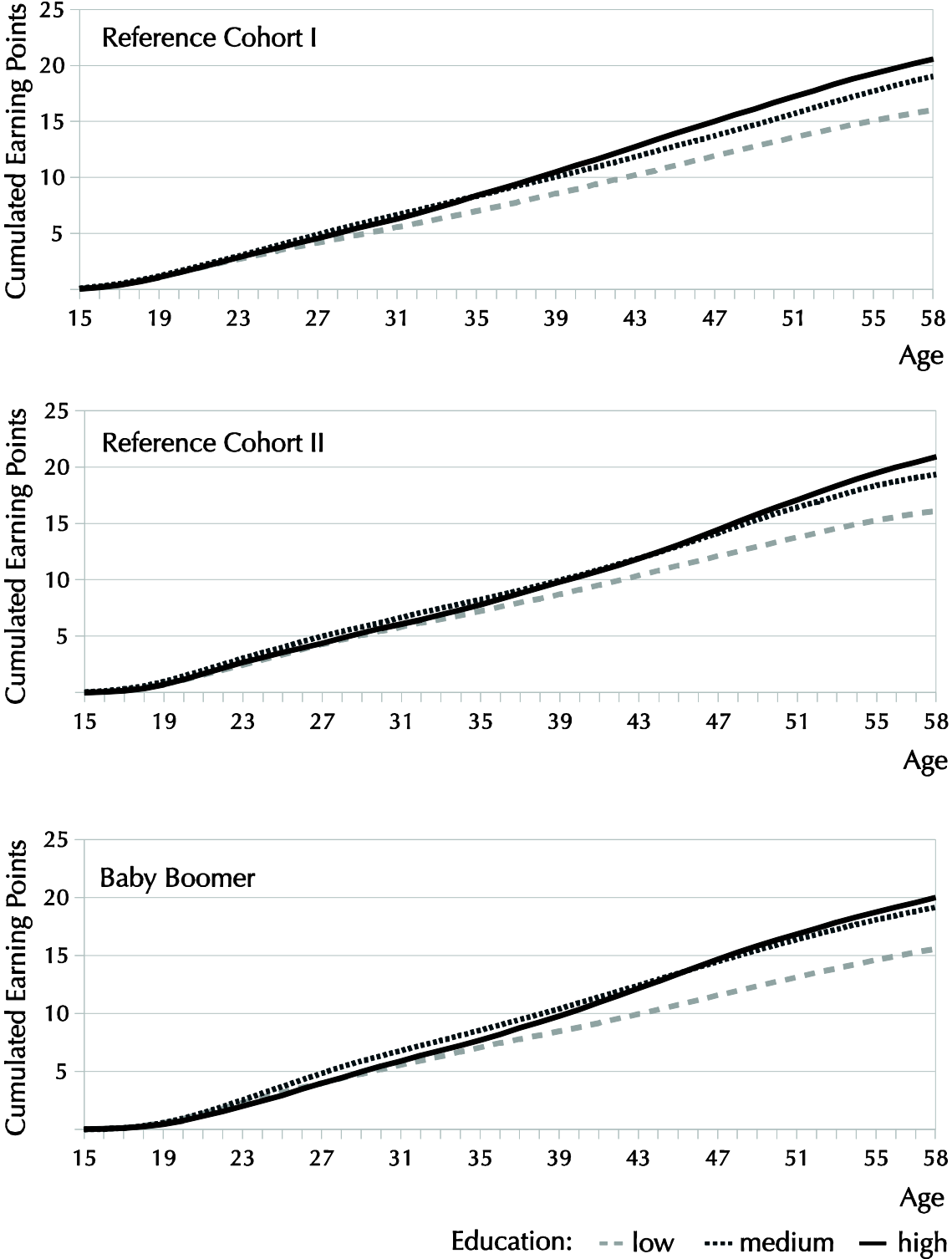
Source: LAW-Life, Authors' Illustration

Figure 11 Educational Attainment and Pension Entitlements across LAW Cohorts, East German Men



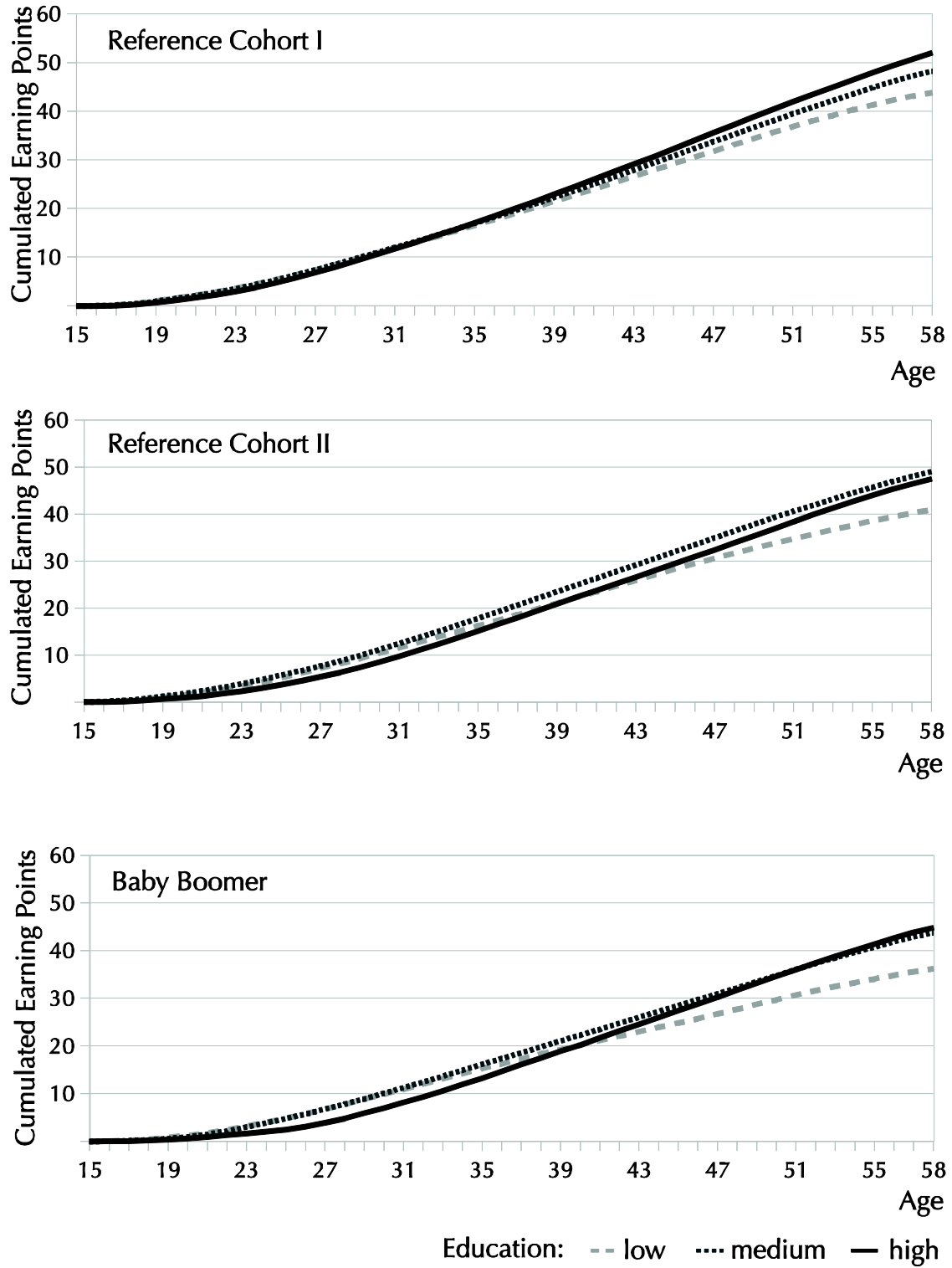
Source: LAW-Life, Authors' Illustration

Figure 12 Educational Attainment and Pension Entitlements across LAW Cohorts, West German Women



Source: LAW-Life, Authors' Illustration

Figure 13 Educational Attainment and Pension Entitlements across LAW Cohorts, West German Men



Source: LAW-Life, Authors' Illustration

Concerning the question of a growing gap between individuals with low and high educational attainment in terms of pension entitlements, the results are mixed. For men and women in East Germany, it becomes most obvious that heterogeneity and inequality increase with age and across cohorts. In the oldest reference cohort, pension rights at age 58 were quite similar when comparing different levels of educational attainment. For the baby boomers in East Germany, the gap between low and high educated individuals grows substantially. For men, the gap amounts to 9 earning points, for women even to 14 earning points. Hence, low educated baby boomer women in East Germany lose the biggest share in terms of pension rights. For West Germany, we observe no changes across cohorts for women, and even a narrowing gap in absolute terms for West German men. A possible explanation for this finding might be that well-educated West German men often chose to become self-employed or work as civil servants and therefore are no longer part of the public pension insurance scheme.

Taken together, the analysis of the relationship between educational attainment and the process of pension building over the life course provides interesting insights, especially when it comes to the projected pension rights of the baby boomers. Nevertheless, it is important to acknowledge that the projections for the baby boomers hold the largest uncertainties because the projection period is longest. Concerning the alarming results for East Germany, it is possible that the projection carries forward the unfavorable labor market situation and high unemployment of the post-reunification years, which possibly leads to an understatement of pension entitlements for male and female boomers in East Germany.

6 Summary

The baby boomers are approaching retirement and pose a threat to the financial sustainability of the system of old-age provision. Policymakers reacted to this challenge by passing several reforms that aimed at reducing pension generosity, prolonging the time individuals stay in the work force, and changing the public-to-private mix thereby mitigating the strong reliance on Germany's public pension scheme. These reforms will have repercussions for the distribution of the retirement income of the baby boomers and questions whether they are fully prepared for the changes ahead. At the same time, the work and

family patterns of the boomers set them apart from older cohorts. These new work patterns are more heterogeneous and involve greater flexibility, and hence for some individuals more economic risks. Family lives are less stable with the share of continuously married individuals decreasing, but divorces being on the rise. Against the background of changing biographies, it is of crucial importance to understand how the employment and family lives of the baby boomers are linked to their prospective material well-being as they retire. Understanding this link allows us to assess, whether current public policies, in particular the system of old age provision, are still effective or whether these policies are out of tune with peoples' lives

In order to allow for statements about the future well-being of the baby boomers in the light of sea changes in the system of old-age provision paired with new work and family patterns, this paper presents an innovative and unique approach for the projection of the life courses of the German baby boomers. Unlike model-based dynamic micro simulation that age the data age year by year (Favreault and Smith 2004), we use a matching-based projection that forecasts sequences from older birth cohorts to complete the life courses of statistically similar baby boomers until they retire. An adequate matching-based approach requires the identification of appropriate matching variables and the correct donor pool specification in order to find the best matching partner for the completion of coherent biographies of the baby boomers, because work-life, family and earnings trajectories all come from the same donor. Extensive robustness tests proved the accuracy and validity of projection results and underline that the matching-based LAW-Life projection is a feasible alternative to model-based projections.

The analysis of the returns to education shows that higher educational attainment goes along with higher pension rights across all demographic groups and cohorts. Furthermore, the analysis provides evidence that the baby boomers fare worse in terms of pension rights when compared to the two older reference cohorts. The baby boomers will also be the first to fully experience the effects of pension reforms that were passed in the last two decades, for example the financial penalties for early retirement. Concerning the growing gap between individuals with high and low educational attainment, results are most striking for baby boomers in East Germany. Men and women with low educational attainment fare

worst in terms of accumulated pension rights and lose most when compared to the older reference cohorts.

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