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Measuring accrued-to-date liabilities of public pension systems – method, data and limitations

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Abstract

This paper introduces the approach of the Freiburg model to quantify accrued-to-date liabilities (ADL) of public pension schemes. The presented framework has been applied to carry out benchmark calculations for 19 EU member states on behalf of the Eurostat/ECB Contact Group on Pensions. We will show that the Freiburg model represents a valuable instrument to calculate pension schemes' ADL on a relatively small data base. Furthermore, limitations and possible extensions of the model will be outlined.

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1 Introduction

Demographic developments present a major future risk for the public pension systems of most developed countries. Continuously increasing life expectancy and large age groups of the so-called baby-boomer generation in combination with low fertility rates since the mid-1970s will cause considerable enhancements of the old-age dependency ratio which means that public pension systems organized on a pay-as-you-go (PAYG) principle will be forced to either raise contribution rates or taxes, or shorten future replacement rates. This trend raises two important issues both of which address the topic of projecting future pension payments. The first issue refers to the consequences of the demographic development for future retirees and contributors and examines the sustainability of the pension scheme by confronting the present value of future pension payments – which can be regarded as open-system gross liabilities (OSGL) – with the present value of future contributions. The result can be considered as the open-system net liabilities (OSNL) of a pension system.

The second issue refers to the question of measuring the public pension entitlements of private households until today. From a fiscal perspective, these entitlements are equal to the accrued-to-date liabilities (ADL) of a public pension system. These liabilities are not an indicator of fiscal sustainability, but they display the cost of terminating a PAYG pension scheme.[1] Furthermore, they can be used as a tool to quantify the impact of pension reforms on private households' pension entitlements.

Various estimates of pension liabilities have been conducted in the past, both on an international and on a national level. Hagemann and Nicoletti (1989), van den Noord and Herd (1993) and Kuné et al. (1993) belonged to the first to present pension liabilities on an international level, followed by Chand and Jaeger (1996) and Fredriksen (2001). One of the latest international estimates was presented by Holzmann et al. (2004) who examined the public pension systems of 35 low and middle income countries by applying the Pension Reform Option Simulation Toolkit (PROST) developed by the World Bank. On a national level, several surveys have been published for the case of German pension liabilities. Werding (2006), Ehrentraut (2006) and Heidler (2009) show pension liabilities for the

[1] See Franco (1995), p. 3.

German statutory pension scheme,[2] Besendorfer et al. (2006) and Braakmann et al. (2008) calculate pension liabilities for the civil servants pension schemes.[3]

In this paper we will concentrate on the second of the two concepts mentioned above, the calculation of ADL of a pension scheme. These specific pension liabilities become increasingly important not least because of the recent update of the 1993 System of National Accounts (SNA). According to this new legislation – approved by the UN Statistical Commission in February/March 2007 – (implicit) pension liabilities of social security pension funds have to be recorded in a supplementary table of the National Accounts.[4] Against this background, the Research Center for Generational Contracts of Freiburg University (RCG) carried out benchmark calculations of public pension liabilities for 19 member states of the European Union. The respective survey on behalf of the Eurostat/ECB Contact Group on Pensions has been finalized in January 2009.[5] With this paper we want to introduce the applied model of this study.

We will proceed as follows: In section 2, we provide a detailed description of the so-called Freiburg model which has been developed by the RCG in order to estimate the ADL of a pension scheme. This section also contains a detailed explanation of the differences between accumulated benefit obligations (ABO) and projected benefit obligations (PBO) and how these differences have been implemented in the model. Section 3 describes the data necessary for the application of the Freiburg model and introduces the basic assumptions. In section 4 we specify the limitations of the Freiburg model and show possible extensions. The paper finishes with a summary of our findings and a short outlook for future research.

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[2] Werding (2006) calculates both accrued-to-date and open-system net liabilities, while Ehrentraut (2006) and Heidler (2009) focus on open-system net liabilities.

[3] It has to be pointed out that Besendorfer et al. (2006) estimate liabilities only for the pensions of the civil servants of the federal states and the municipalities in Germany (ADL as well as OSGL), whereas Braakmann et al. (2008) present figures for the civil servants of the central government only (ADL). Therefore the findings of these two surveys should not be compared.

[4] Within the EU, it is also planned to produce a specific section on pensions in the revised 1995 European System of National and Regional Accounts (1995 ESA) which shall follow the updated 1993 SNA. For a description of the recent steps taken to reform the 1993 SNA see Mink (2007), p. 203 et seq. For a short portrayal of the reasons to change the 1993 SNA see Mink and Rother (2007) or Semeraro (2007).

[5] See Müller et al. (2009). For further information on the background of the Contact Group see Eurostat/ECB Contact Group (2009), p. 4 et seq.

2 The basics of the Freiburg model

In this section we explain the methodology of the Freiburg model step-by-step.[6] Furthermore we draw the attention to the difference between ABO and PBO; we will show that the size of ADL considerably depends on the choice between these two concepts.[7]

2.1 The methodology of the Freiburg model

The starting point for the Freiburg model is the method of generational accounting.[8] In general this method can be used for a wide variety of purposes. For this project, the method is applied for public pension schemes[9] in isolation and for the group of existing retirees and current contributors (future retirees) only.[10] Additionaly, the standard method is modified in order to account for the accrued-to-date amount of benefits instead of considering future pension benefits in total. Our calculations include old-age pensions, disability pensions and survivor pensions. Any kind of means-tested social existence is excluded – as far as feasible.

The core presumption is a projection of per capita future pension benefits based on today's existing retirees' benefits. We outline below the entire calculation procedure in five steps.

Step 1: First of all, age-sex-specific projections of base year's population need to be calculated. The demographic model used to generate these projections is based on a discrete and deterministic formulation of the cohort component method.[11]

The three major determinants of future population changes are in general fertility, mortality and migration. Since ADL regard only rights accrued by existing and former

[6] The original version of the Freiburg model has first been introduced in Heidler et al. (2008), p. 5 et seq.

[7] At this point it has to be emphasized that we actually do not measure pension entitlements of private households in a sense of dues which can be legally claimed by a single individual. We rather derive the extent of liabilities from the amount of expected future pension expenditures.

[8] This method was developed by Auerbach et al. (1991, 1992 and 1994). See Raffelhüschen (1999) and Bonin (2001) for a detailed depiction of theory and application as well as limitations of the method of generational accounting.

[9] The terms "public pension scheme", "government pension scheme" and "pension scheme in general government" are used as synonyms. However, we differentiate between two different types of schemes. The government employer pension scheme indicates a pension scheme for civil servants, whereas a social security pension scheme describes a general pension scheme. For a discussion of the definition of government pension schemes see Eurostat/ European Central Bank Task Force (2008), p. 20 et seq.

[10] For a close look on the application of generational accounting to public pension schemes see Ehrentraut (2006) and Heidler (2009) who employed the concept of open-system net liabilities to investigate the sustainability of the German statutory pension scheme.

[11] For a detailed description of the demographic model applied see Bonin (2001), p. 245 et seq.

workers until the base year, migration of the base year population is irrelevant.[12] The development of survival rates is considered by adjusting the initial set of survival rates with an exponential adjustment procedure.[13]

Step 2: We start with the estimation of the average age-sex-specific existing retirees' benefits in the base year. As mentioned before, the projection of these pension benefits is the centre piece of the calculations since we develop the accrued-to-date claims by modification of the existing retirees' benefits. It has to be emphasized that in our calculations we only look at average individuals within the respective age groups, i.e., we do not separate into varying income groups. In fact, we separate the calculation of age-sex-specific benefits into existing and future retirees, assuming that an average representative of an age group is to some extent an existing and a future retiree in every year of his or her life-cycle.

Before going further into detail we briefly sketch out the projection approach for existing retirees' benefits. First of all, the benefits are calculated by distributing the aggregated amount of today's pension expenditures to the different cohorts in retirement age. By this procedure we create an age-sex-specific benefits' cross-section profile generated from the budget and micro data of the observed country.[14] This profile includes payments regarding old-age pensions, disability pensions and survivor pensions.[15] Secondly, these average existing retirees' benefits are projected into the future by assuming them to remain constant over time except for indexation of the benefits.[16]

Formally, the estimation of the existing retirees' benefits is based on the following identity:

$$P_b = \sum_{k=b-D}^{b} p_{b,k} c_{b,k} \tag{1}$$

[12] In the pilot study of this project fertility rates were set to zero as well (see Heidler et al. (2008)). However, from our current point of view this is not an adequate procedure as it disregards orphan's pensions. Furthermore, there are regulations in certain pension schemes which make it necessary to include assumptions regarding fertility rates into our calculations (e.g. the sustainability factor in Germany, see section 2.1). Therefore fertility has been implemented in our model. One may interpose that future migration could also have an impact on regulations in certain pension schemes. Following this argument, in schemes where this might be the case (again, e.g. the sustainability factor in Germany), future migration has been taken into consideration.

[13] This procedure is suggested by Pflaumer (1988). See also Bonin (2001), p. 248.

[14] The general data sources will be introduced in section 3.1 of our paper.

[15] In doing so, we are able to take into account survivor pensions in a rather accurate way, compared to most other surveys dealing with the measurement of pension liabilities.

[16] Most former surveys apply one constant average retirement age for their calculations instead of an age-sex-specific pension profile. From our point of view, this approach represents an oversimplification of retirement behaviour and leads to inaccurate results.

This identity states that the sum of age-specific individual pension benefits $p_{b,k}$ (in the base year b of the cohort born in k) weighted with the cohort size $C_{b,k}$ must equal the corresponding macroeconomic pension, denoted by P_b.[17] The problem of equation (1) is that it holds only in theory. While macroeconomic data, typically taken from national accounting statistics, is relative exact, micro data is in general difficult to gather and tends to be afflicted with inaccuracies. To resolve this problem generational accountants estimate re-scaled age-sex-specific benefit profiles.

This is done in two steps. First, age-sex-specific information regarding per capita pension benefits has to be collected in order to capture the relative fiscal position of different age groups as accurately as possible. The vector of relative pension benefits by age taken from the statistics, $(\tau_{t,t-D}, \ldots \tau_{t,k}, \ldots, \tau_{t,t})$, is then denoted by $\tau_{t,k}$.[18] Note that this vector is supposed to show only the relative pension position in period t of an individual born in the year k and thus imposes less restriction on the accuracy and availability of micro data on the absolute level. Second, the estimated relative age distribution is tallied with the corresponding aggregate pension benefit P_b by application of a proportional, non-age-specific benchmarking factor, denoted by φ. The relative distribution of pension payments is re-evaluated according to

(2) $$p_{b,k} = \varphi \tau_{b,k}$$

for all living generations $b\text{-}D \leq k \leq b$, where φ is defined by

(3) $$\varphi = \frac{P_b}{\sum_{k=b-D}^{b} \tau_{b,k} C_{b,k}}.$$

Equation (3) assures that equation (1) is finally satisfied such that the expenditures to existing retirees are assigned with age-sex-specific profiles to the base year population.

Finally, the resulting rescaled average age-sex-specific existing retirees' benefits are projected according to the indexation rules of the respective country:

(4) $$p_{t,k}^{exis} = p_{b,k}(1+g)^{t-b},$$

for all cohorts $b\text{-}D \leq k \leq b$ living in the base year.

This equation states that an individual already retired in base year b receives the same pension in a specific year t as in the base year b, only corrected by the indexation g of

[17] Please note that D represents the maximum age of an individual which is 100 years by our assumption.

[18] For ease of notation we drop the sex-specific notation as from now on.

pension in payment. Furthermore equation (4) implies a "phasing out" of the stock of existing pension benefits since it holds only for all living generations. Thus all existing retirees' pensions of the base year will have disappeared at latest when the youngest existing retiree of the base year is dead.

Step 3: The age-sex-specific pension profile for future retirees, which is the basis for the estimation of accrued-to-date entitlements, is calculated by manipulating the base year existing retirees' benefits. This is done in three steps. First, the difference of the existing benefits for a consecutive age year (during the base year) provides the pension benefits for new retirees.[19] These are valorised for a specific year *t*. Second, if necessary, a deduction factor is used (defined by a reform or for instance inherent like in NDC systems)[20]. Third, the (cumulated) average future retirees' benefits are calculated by summing up year-by-year the new retirees' benefits and thus accounting for the fact that an individual can receive on average for any future year *t* a new retiree benefit.[21]

Formally, the new retirees benefit $p_{t,k}^{new}$ in a specific year *t* for a cohort *k* is developed firstly by calculating the absolute change in existing retirees benefit of the cohort *b-(t-k)* (the cohort with the same age *(t-k)* in the base year *b)* to the cohort one year younger in the base year, namely *b-(t-1-k)*.[22] After that this base year payment is valorised with $\left(1+v\right)^{t-b}$ where *v* is the valorisation rate according to the benefit formula. On top on that the new retirees' benefits are diminished according to a deduction factor $\theta_{t,k}$ of the benefit formula. Equation (5) sums up:

(5) $$p_{t,k}^{new} = \theta_{t,k}\left[p_{b,b-(t-k)}^{exis} - p_{b,b-(t-1-k)}^{exis}\right]\,(1+v)^{t-b},$$

for all living cohorts $b\text{-}D \leq k \leq b$.

Finally, the future (existing) retirees' benefits need to be calculated. This is done by cumulating year-by-year the $p_{t,k}^{new}$ according to equation (5). Therefore, the age-sex-specific future retiree pension benefits for a specific year *t* of the cohort *k* are defined by:

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[19] Note that new retirees' benefits represent those benefits that are paid for the first time upon retirement in a specific year *t>b*.

[20] For a closer look on the basic structure of notional defined contribution (NDC) pension systems see Palmer (2006).

[21] The separation of existing pensions and future pensions (pensions paid out first in the base year or later) bears one big advantage: In case of a pension reform which affects only future pensions, only these pensions are changed while existing pensions are held constant.

[22] Changes after the age of 67 years are generally set to zero since new retirees' old-age benefits after the age of 67 are negligible. The only exception from this rule is widow's pensions.

(6) $$p^{fut}_{t,k} = p^{fut}_{t-1,k}(1+g) + p^{new}_{t,k},$$

for all cohorts $b\text{-}D \leq k \leq b$.

From this equation it follows that the average individual born in the year k receives a future benefit in the year t ($t>b$) which is composed of the pension payment one period earlier (t-1) corrected by the growth rate g plus the pensions paid to new retirees in this year. Thus, the age-sex-specific benefit profile for future retirees builds up step by step.

Step 4: Now, in order to meet ADL, only the part of the future pension benefits (of current workers) has to be considered which is earned until the base year. This means in turn that $p^{new}_{t,k}$ must be cut by a factor $\lambda_{t,k}$ representing the cohort-specific amount of entitlements of current contributors in relation to the full entitlements.[23]

Future pension benefits are thus finally defined by

(7) $$p^{fut}_{t,k} = p^{fut}_{t-1,k}(1+g) + \lambda_{t,k} p^{new}_{t,k},$$

for all cohorts $b\text{-}D \leq k \leq b$.

Note that the accrued-to-date concept requires a definition of the valorisation and accruing process for the entitlements. As a matter of principle there are several possibilities to account for. Section 2.3 defines the two approaches applied in this survey.

Step 5: Finally, the ADL of the pension scheme are calculated by discounting and summing up the above projected pension benefits over the cohorts living in the base year.

Thus, the ADL_b (accrued-to-date liabilities of the baseyear b) can be expressed like the following:

(8) $$ADL_b = \sum_{t=b}^{b+D} \sum_{k=b-D}^{b} \frac{(p^{exis}_{t,k} + p^{fut}_{t,k})}{(1+r)^{t-b}} C_{t,k}$$

This means that every period t the existing retirees pension benefits ($p^{exis}_{t,k}$) and the pension rights accrued until the base year ($p^{fut}_{t,k}$) – which are both discounted by the factor *(1+r)* for every future year *(t-b)* – are multiplied with the number of members of this age cohort $C_{t,k}$. This is done for every age-group, beginning with the ones born in $k=b-D$, which goes back 100 years prior to the base year.

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[23] The calculation of the factor $\lambda_{t,k}$ requires the knowledge of the average age-sex-specific wage distribution. Many other surveys work with one single average wage over the whole career which leads to different results.

2.2 Distinguishing between ABO and PBO

First of all, it has to be made perfectly clear that the difference between ABO and PBO only refers to the question of how to project entitlements of individuals not yet retired into the future. This means that entitlements of individuals already receiving pensions in the base year – and therefore disposing of full pension rights – are not influenced by the choice between ABO and PBO at all.

When we speak of ABO, what we mean is ABO indexed for prices.[24,25] Supposing that somebody has worked 20 out of 40 years given the benefit formula is expressed in terms of final pay (wage or salary) and years worked, ABO is half of the present value, given the discount rate, of what the end-40 years' entitlement would be if no allowance was made for possible future pay increases, whether from promotions or general increases in real pay rates. The real value of the entitlement accrued to date is preserved at the time of maturity. It follows that I) either estimates of price-indexed ABO must project future price increases and in doing so, they discount projected final price-indexed pay of 20 years ahead to the present, using a nominal interest rate which includes the same expectation of inflation or, alternatively, II) one must use today's real pay as the projected real pay in 20 years' time, and discount back by a real interest rate.

PBO is defined in the following way: It represents the entitlement today based on a projection of eventual entitlements at retirement. Thus, after 20 years out of 40 years' service, the pension amount induced by the projected final pay level after 40 years of service including the impact of likely promotions as well as general wage growth is calculated, halved (20 out of 40 years), and today's entitlement is expressed by discounting it. In addition to promotions, the projection of eventual entitlements takes into account projected real increases in pay at the current grade and other grades, up to the time of retirement. Increases to reflect inflation are taken out, if the discount rate is expressed in real terms, otherwise they are included in both projected final pay levels and the discount rate.

[24] This definition is adapted from John Walton (member of the Eurostat/ECB Task Force) who kindly took stand to the difference between ABO and PBO. He points out that “ABO indexed for prices” is often referred to as IBO (indexed benefit obligations). But due to the fact that IBO is also regarded as another form of PBO in some cases, we work with “ABO indexed for prices” which in the following shall be called “ABO” for simplification reasons.

[25] Please note that the explanations for both ABO and PBO are based on a benefit formula which depends on the final pay before retirement only. We are well aware of the fact that most of the European pension systems take into consideration a longer history of contributions when it comes to the calculation of first paid pensions. In this case, the difference between ABO and PBO also depends on how former contributions are considered in relation to present contributions, or in other words: How are former contributions valorised at the point of retirement.

This means that when referring to PBO the only factor that reduces the employee's pension entitlement in comparison with the retiree's pension entitlement is the smaller amount of years into service – in our example 20 out of 40 years. When applying ABO, not only the smaller amount of working years is considered, but also the generally lower payment in that time period, regardless if it stems from personal or general wage increases. This leads to the assumption that PBO entitlements will in most cases be higher than ABO entitlements, simply because ABO does not allow for future personal or general wage increases.[26]

Implementation of ABO and PBO in the Freiburg model

As described previously in this chapter, we estimate pension entitlements by calculating future pension payments. This is – simplistically said – done by projecting present age-sex-specific pension payments into the future, taking into account the indexation of the respective pension scheme as well as any pension reforms which have been decided already and will have an impact on future pensions. In order to receive the ADL of a pension scheme, it is crucial to divide the beneficiaries of future pension payments into two groups: The first group consists of persons who receive pension payments already today. The members of this group dispose of full pension entitlements due to the fact that they have already retired and are not able to increase their pensions by paying contributions.[27] It follows that in our model the pension payments of this group – the "existing retirees" (or more precisely: persons who are already in retirement in the base year) – are projected in line with the relevant indexation until the last retiree dies.

The second group consists of persons who do not receive pension payments yet. They have earned some kind of pension entitlements in the past – regardless if they just took up employment one year ago or if they are close before retirement – and will probably earn more pension entitlements in the future, up to that point of time when they will retire. It follows that this group does not dispose of full pension entitlements yet. The ADL approach includes entitlements earned up to the base year only, therefore the projected future pension payments of a "future retiree" (or more precisely: a person who will retire

[26] In an unlikely case of zero future wage increases – neither from promotions nor from increases of the general wage level – ABO and PBO entitlements would be the same. Moreover, there are situations imaginable where ABO entitlements could exceed PBO's. This would be the case if either the general future real wage growth is assumed to be negative or if personal wage developments will decrease due to smaller wages for senior employees.

[27] This counts only for pension schemes which do not allow their beneficiaries to increase their pension after retirement, i.e. by taking up employment, paying contributions and thus augmenting their pension entitlements.

after the base year)[28] has to be reduced. Here the question of ABO versus PBO enters the scene:

In a first step, we will distance ourselves from the accrued-to-date idea, just as it is exercised in the model primarily. In every single year after the base year, new pensioners will enter the pension scheme. The question to be answered first is what the amount of the first paid benefit will be in relation to the new pensioners' benefits in the base year. Let the amount of first paid pension – sometimes referred to as the primary insurance amount (PIA) – in the year t be $x(t)$ and the constant per-capita wage growth in real terms be g. When applying the PBO approach, the first paid pension will be defined like the following:

(9) $$x_{t+1} = x_t(1+g)$$

Since g is assumed to be constant over time, the first paid pension can also be expressed subject to the base year b.

(10) $$x_{t+1} = x_b(1+g)^{t-b}$$

Changing to the ABO approach, one has to bear in mind that no allowance is made for future pay increases. In the current case, only the general wage growth is observed. It follows that the first paid pension of a future year t in the ABO approach changes to:

(11) $$x_t = x_b$$

The difference between equations (10) and (11) can be explained by the different approaches of ABO and PBO. PBO takes into account general future wage growth while ABO does not consider any future changes of wage; the wage level of the base year is held constant in real terms.[29]

The second difference between ABO and PBO can be observed when reducing the primarily calculated full benefits of "new pensioners" according to the concept of ADL. The full benefits are reduced by a vector – the "accrued-to-date vector" –, which expresses the share of entitlements earned until the base year to the amount of entitlements which qualifies for a full pension. This share is given for every projection year. It is straightforward that the share decreases from a value close to one for primary pensions paid out shortly

[28] Please note that "future retirees" involve all individuals that retire after the base year. In contrast to this, "new retirees" indicate individuals who retire in a certain year x in the future. Those individuals who retire in the year x will in that year enter the group of "future retirees". In the year x +1 they will still be "future retirees" but not "new retirees" anymore.

[29] It is crucial that this only counts for the calculation of the first paid pension or PIA. When projecting a benefit which has already been paid out before, i.e. the indexation of existing benefits, a constant real wage growth is assumed. In this regard the ABO approach displays a schizophrenic world where in one situation future wage growth is considered and in the other it is not.

after the base year up to a value of close to zero for primary pensions paid out in the far future. This vector is multiplied with the respective accounts of full pension entitlements and the outcome is the amount of pension entitlements earned up to the base year for every projection year, the accrued-to-date entitlements. The difference between ABO and PBO in this regard is given by the different consideration of personal wage increases during working life. Generally, the wage at the beginning of a career is less than the average wage and turns out somewhere above average closer to retirement – PBO takes this effect into account, ABO does not.

Regarding the accrued-to-date vector in the PBO approach, only the missing amount of contribution years has to be taken into account, due to the fact that the full pension primarily calculated by the model includes assumptions for personal and general wage growth. Let the average age of entering the work force and collecting first pension entitlements be 20 years, and the average retirement age 60 years. It follows that for an individual aged 35 in the base year, the PBO accrued-to-date entitlements add up to 15/40 of the full pension. According to this, the PBO accrued-to-date vector should show a value of 15/40 for this age group.

Referring to the same example for the ABO approach, one does not only need to consider the 25 missing years up to the point of retirement, but also the wage (which has not developed up to the point of retirement) has to be taken into account. This means that in most cases the entitlements of an individual aged 35 in the base year will be less than 15/40 of the full pension. The question of how large the difference between the ABO and PBO accrued-to-date vector will be is answered by age-specific wage profiles from the respective country which show the development of an average career's wage.

In summary, the difference between ABO and PBO consists of two parts. The first part is the general wage growth, in most cases connected to general economic growth. The second part is the development of wage during an average career.

3 Data and Assumptions

When calculating the ADL of a pension scheme, a comprehensive data set and a number of assumptions are needed. This section aims to introduce both the data (3.1) and the assumptions (3.2) to deploy the Freiburg model. In addition, we show an example of how the pension profiles used in the Freiburg model are calculated (3.3). We start by describing the essential data supply.

3.1 Necessary data

In general, four types of data are needed for the application of the Freiburg model. These types are given by population data, age-sex-specific pension benefits, aggregated pension expenditures for a certain base year and general characteristics of the pension scheme to be examined.

Population data

Projections of the base year population by age and sex should reach as much as a maximum of 100 years into the future.[30] Most EU member states publish population projections conducted by their national statistical bodies. However, these official estimates typically cover only a time span of 30 to 50 years and thus are not far-sighted enough to meet the requirements of ADL. Therefore, it is necessary to conduct our own projections which prolong official forecasts. The starting point of the population projections used in this study is the population structure by age and sex observed at the start of the respective base years 2005, 2006 and 2007; the respective data is taken from Eurostat. This also counts for fertility and mortality rates in the base year.[31]

Age-sex-specific pension benefits

This data is normally taken from micro-data surveys such as the Survey on Household Income and Wealth (SHIW) in Italy or the Socio-Economic Panel Study (SOEP) from the DIW (German Institute for Economic Research) in Berlin, Germany. However, in many cases the administration body of the pension scheme provides age-sex-specific data regarding the recipience of pension payments. As this data encompasses the full category of persons in question instead of a (representative) sample, it is used preferably. In the case of our calculations[32] by order of the Eurostat/ECB Contact Group mentioned above, age-sex-

[30] This corresponds to the assumption that the maximum age is *D=100*.

[31] As we point out in section 2.1, migration may be disregarded when accounting for ADL; thus it is generally assumed to be zero. However, for pension schemes enhancing regulations which also depend on future migration, the respective migration is taken from Eurostat as well.

[32] See Müller et al. (2009).

specific pension benefits have been supplied by national central banks or national statistical bodies.

Pension expenditures

As explained in step 2 of section 2.1 of this paper, the pension scheme's expenditures of the base year are necessary to re-scale the age-sex-specific pension profiles. These budget figures are generally taken from national accounts' statistics.

Characteristics of the pension scheme

The design of a pension scheme represents a crucial point when calculation its ADL. This involves the following main issues:

- Classification of the pension scheme (DB, NDC, hybrid system)
- Consideration of past contributions
- Indexation of existing pensions
- Necessary years of service to receive a full pension
- Regulations regarding early and late retirement

The sources of these pieces of information are manifold; both international pension surveys[33] and country-specific pension literature contain comprehensive descriptions of the constructions of the various pension schemes. Furthermore, experience shows that the support of national experts is a vital source, too.

3.2 General assumptions

As stated above, a whole set of assumptions has to be taken when computing pension liabilities. The possibly strongest assumption states that fiscal policy will not change over time. In other words, the design of the pension scheme to be examined will stay indefinitely constant at the status quo of the base year including all the settings which have been displayed in section 3.1. The remaining assumptions used in the Freiburg model will be introduced here:

Growth rate and discount rate

The projection of future age-specific pension benefits demands an assumption regarding the annual rate of wage growth. Since any long-term forecast of future growth must remain arbitrary, we do not make use of sophisticated forecasts. Instead, a supposedly constant rate of wage growth is applied in all future periods. The growth rate is set to approximate the average long-term rate of productivity growth observed in the past.

[33] See for example European Commission (2007), MISSOC (2009) or OECD (2007).

Considered that the correct value of the growth parameter is uncertain, we have not attempted to design specific growth patterns for the individual EU member states. We employ a growth rate of 1.5 per cent per annum in real terms. However, this procedure is open for discussions, and by using varying wage growth paths for different countries one might be able to show the impacts of diverging economic developments on the pension liabilities of the different countries in a more adequate way.

Similar to the growth rate parameter, forecasts regarding the prospective interest rate development are uncertain. Therefore, irrespective of national peculiarities, we apply a single uniform discount rate to take all pensions back to the base year. A reasonable range of interest rate assumptions is determined by the fact that public expenditures are significantly more uncertain than non-risky long-term government bonds on the one hand, but not as volatile as the return on risky assets on the other hand.

We generally opt for the lower bounds of the discount rate. Therefore we normally choose a standard real discount rate of three per cent per annum, which reflects the ten-year average of Euro area ten-year government bond yields.

At this point it is worth mentioning that the use of a constant discount rate as well as a constant wage growth rate implies a serious simplification. In general, more comprehensive sensitivity analyses could take account for possible variations of these parameters. This also counts for the other key economic parameters (unemployment rates and participation rates respectively), or changes in the behaviour of economic actors.[34]

Fertility, mortality and migration

Following the component method, the age composition of the population is updated in each year by first subjecting the initial population structure to age-sex-specific mortality. Subsequently, the respective age-specific birth rates are applied for every projection year. The implementation of the component method requires assumptions with respect to the future development of age-specific mortality. The country-specific mortality rates are parameterised according to the assumptions of the baseline variant of the Eurostat population projection (EUROPOP). Fertility rates are assumed to be constant, and migration is disregarded due to reasons explained in section 2.1.

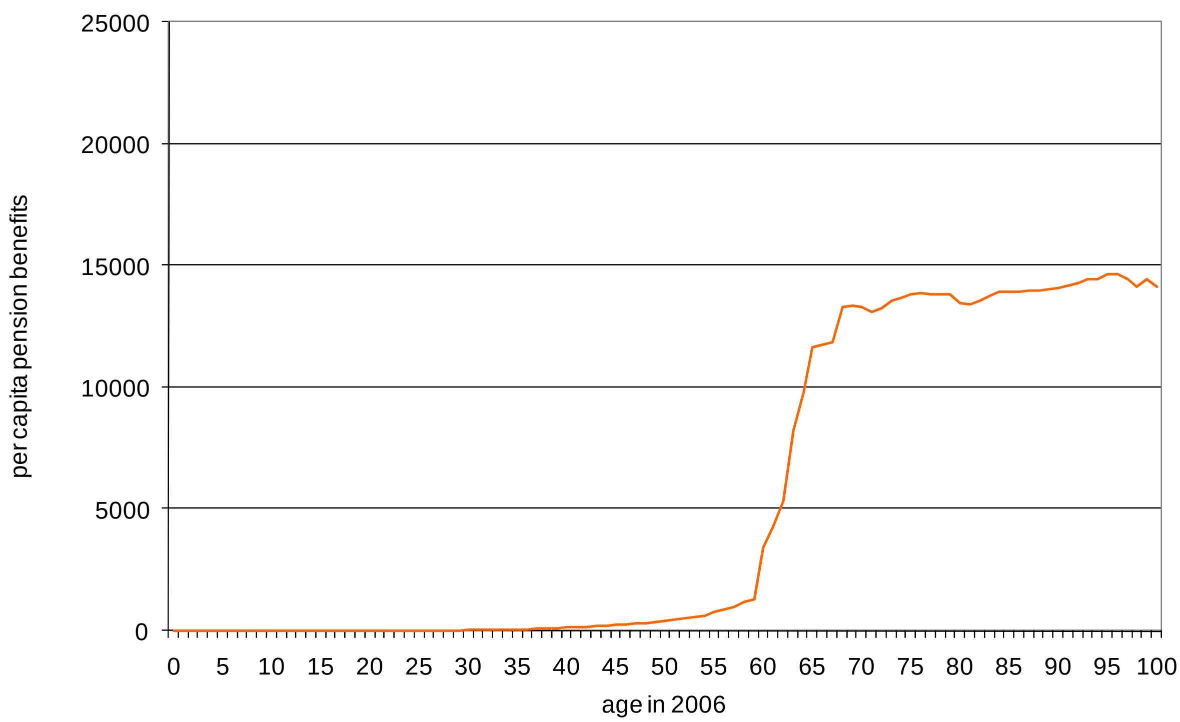
[34] We will discuss this issue in further detail in section 4.

3.3 Case study for calculating age-sex-specific pension profiles

For an ease of understanding, in the following we show a case study for the calculation of age-sex-specific pension profiles by demonstrating step 2 to 5 of section 2.1 for the case of the social security pension scheme in Germany for average males (see Figure 1 to Figure 5).[35]

As outlined in section 2.1, the estimation of the base year average existing retirees' benefits by age is the centre piece of the projection. This is done by aggregating a benefit profile by age and sex over the base year population and then re-evaluating it in a way that the aggregates based on micro-profiles and population data correspond to the respective government budget aggregates in the base year.[36]

Figure 1: Rescaled profile of average existing retirees' benefits in 2006 (here: Social security Germany, male, in Euro)



Source: Own calculations

Figure 1 shows an average rescaled profile of existing retirees' benefits for the living male cohorts in the year 2006. The increasing profile after the age of 50 years reflects an

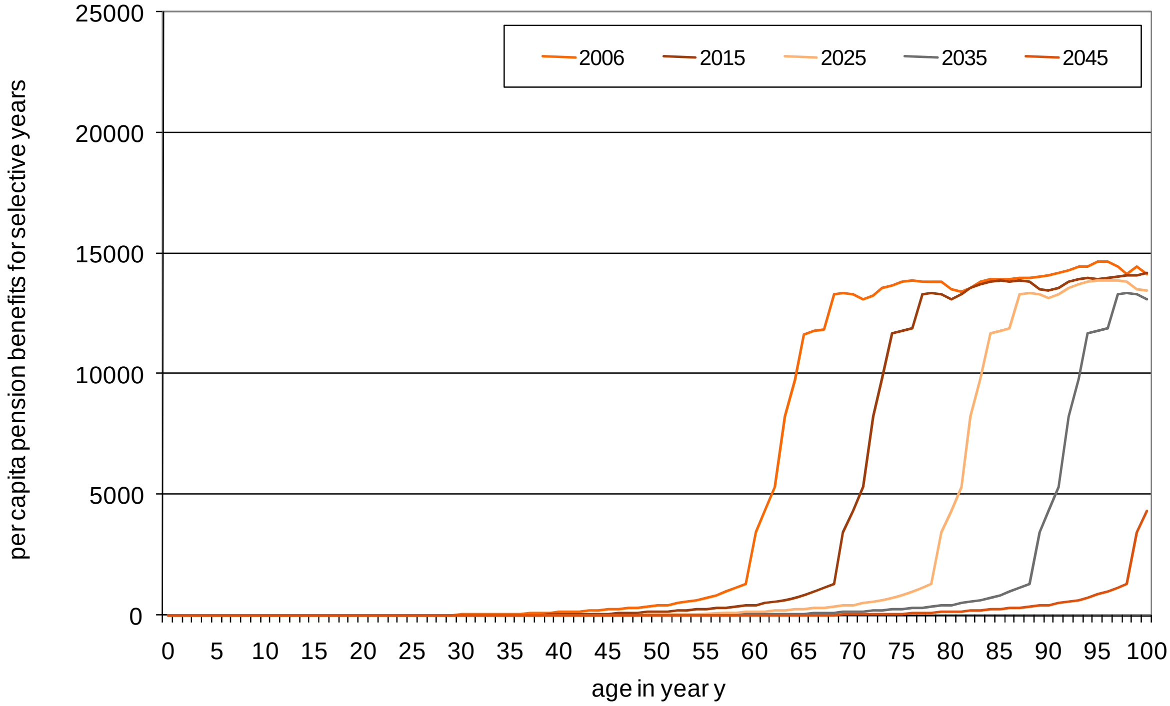
[35] Please note that in this case study wage growth rates have been set to zero.

[36] Since our projection method does not correct aggregates for business cycle effects, base year economic performance is perpetuated indefinitely. This may lead to a bias. Nonetheless this effect seems not as critical in case of considering pension expenditures only since they are for the most part dominated by demography.

increasing share of pension cases. The decreasing profile for older cohorts results from past differences in working careers and indexation rules.[37]

To account for future cohort-specific development of existing retirees pension benefits, we phase out year-by-year the rescaled age-sex-specific existing retirees' profile and index the pension benefits according to the benefit formula (see Figure 2).

Figure 2: Phasing out of average existing retirees' benefits profile from the year 2006 to 2045 (here: Social security Germany, male, in Euro)



Source: Own calculations

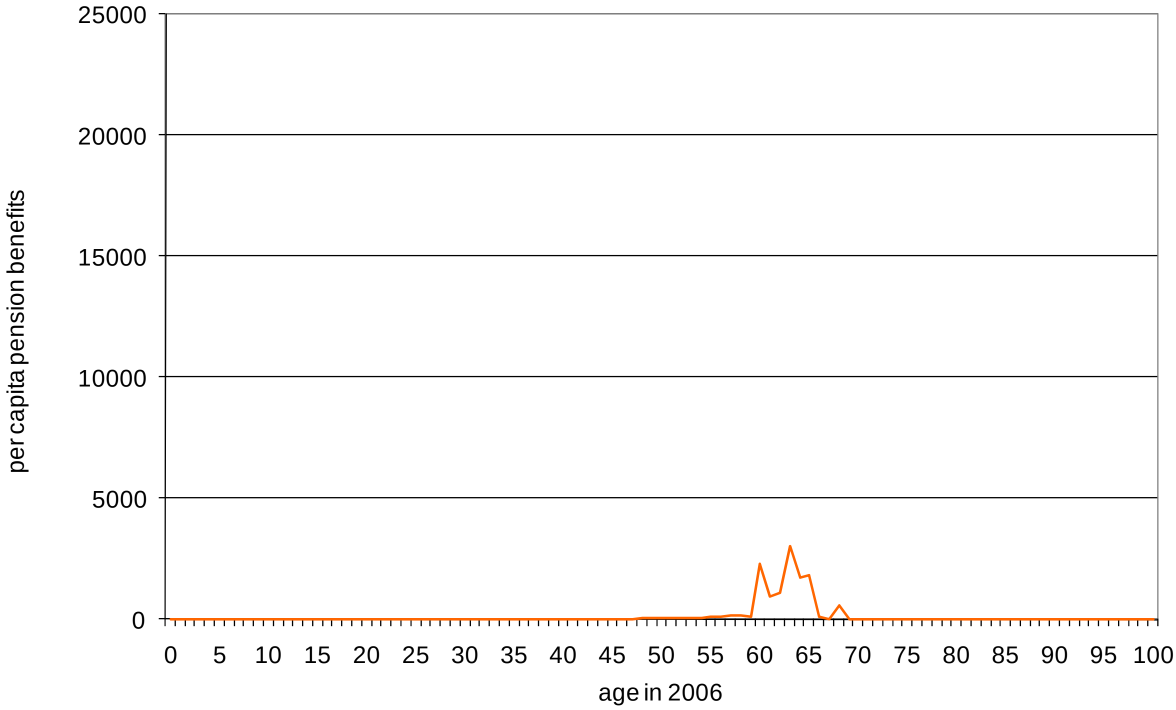
As an intermediate step we develop the annual new retirees' benefits by taking the difference of the rescaled base year profile of the existing retirees pension benefit. We do this until the age of 67 because after this age-year, new retirees' benefits are negligible (see Figure 3).[38] This treatment allows designing maturation effects for future retirees' cohorts and is necessary since the existing retirees' benefit profile after the age of 67 is not a good predictor for future retirees' benefits. This is due to the fact that both average benefits and the share of pension cases vary substantially across existing retirees cohorts reflecting past differences in working careers. Note that this proceeding nonetheless maintains base year economic structures for new retirees indefinitely. In particular, the analysis thus abstracts

[37] At this point it is worth mentioning that we employ age-sex-specific pension data which is broken down into one-year intervals. Most former surveys use five-year interval data which can lead to inaccuracies especially when looking at the cohorts retiring in.

[38] Please note that this does not count in case the age-sex-specific survivor pensions are available. In this case we consider the difference of the rescaled base year profile until the age of 90 in order to take into account widow's pensions in a more accurate way. After this age, the data usually is non-representative due to small numbers of cases in the age cohorts above 90.

from changes in labour force participation and unemployment rates for future new retirees’ benefits.

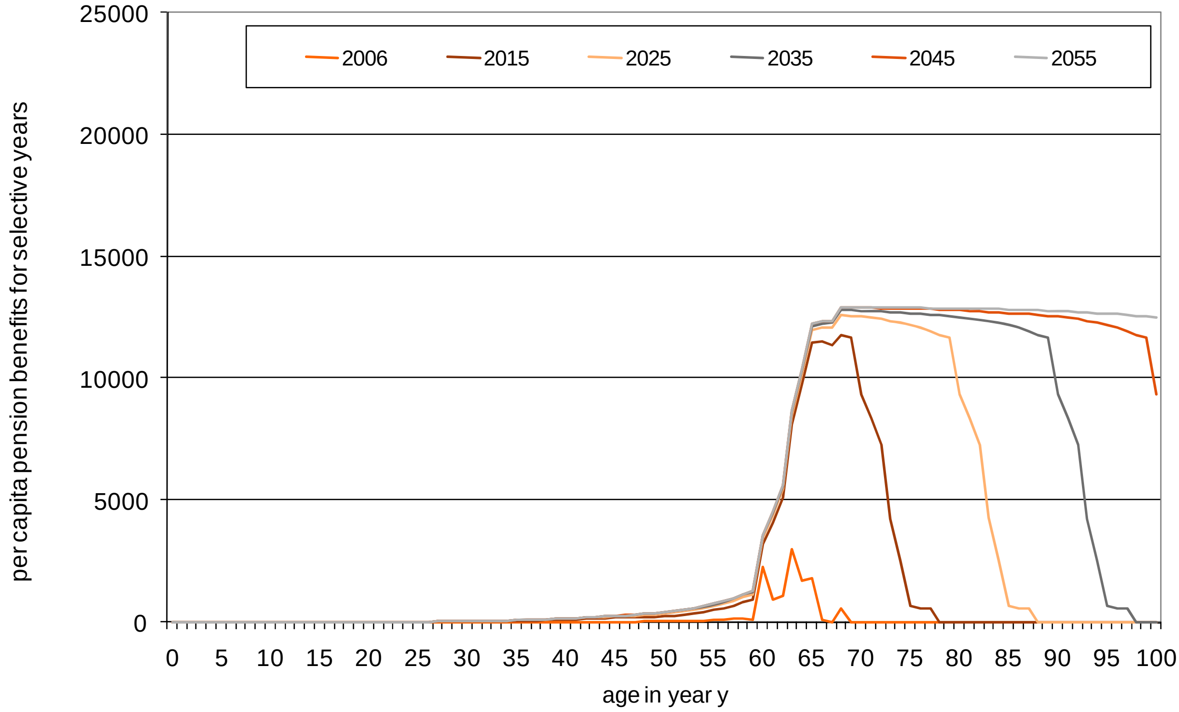
Figure 3: Rescaled profile of average new retirees’ benefits for 2006
(here: Social security Germany, male, in Euro)



Source: Own calculations

These average new retirees’ benefits are finally built up year-by-year to project future retirees’ benefits. At the same time the payments firstly need to be valorised and secondly, upon retirement, indexed according to the benefit formula. Thirdly, the level effects of legal amendments which had been passed into law in or prior to the base year but not yet come into full fiscal effect are taken into account. Figure 4 shows the development of future retirees’ pension benefits for selective years. As can be seen after being built up almost completely (year 2055), in the case of Germany the profile is considerably lower as the existing retirees profile (see Figure 4). This is due to reforms which are explained in detail in Müller et al. (2009).

Figure 4: Build-up of average future (existing) retirees' pension benefits profile from year 2006 to 2055 (here: Social security Germany, male, in Euro)

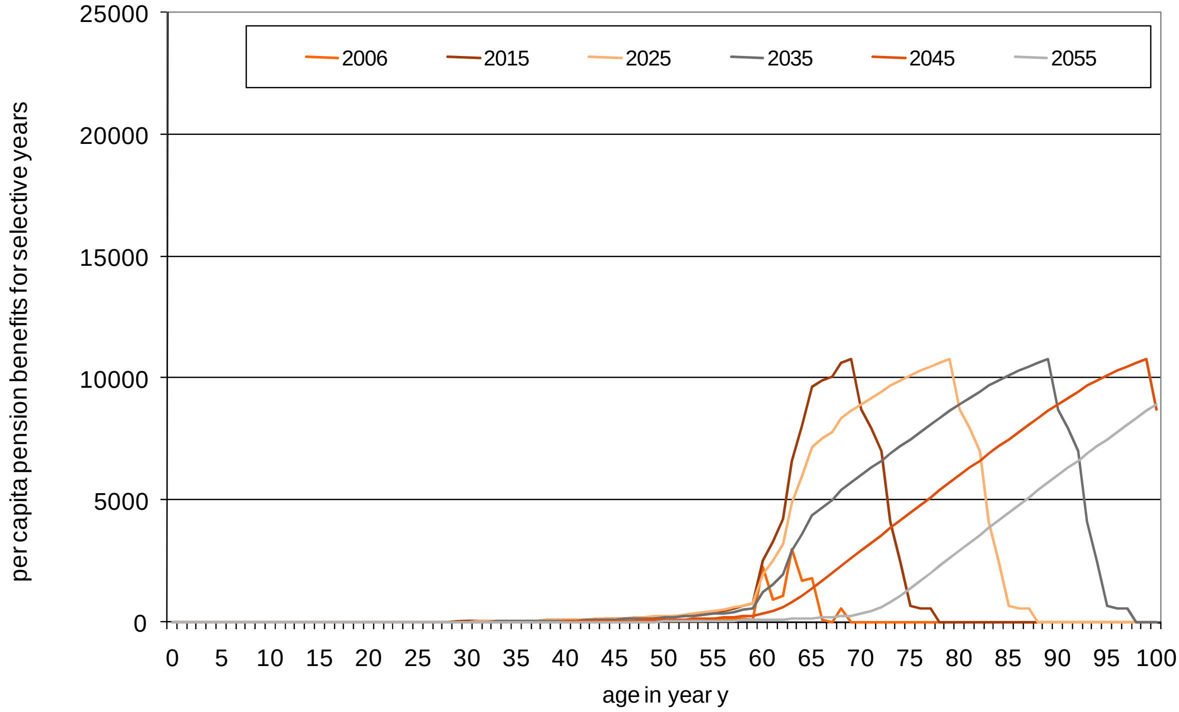


Source: Own calculations

In a final step Figure 5 reduces the future retirees' benefits to account for the accrued-to-date part only. Due to the fact that in this case PBO is applied to, we cut the benefits linearly according to the ratio of (years in the job until base year) to (average years in the job).[39]

[39] For further explanations see section 2.2.

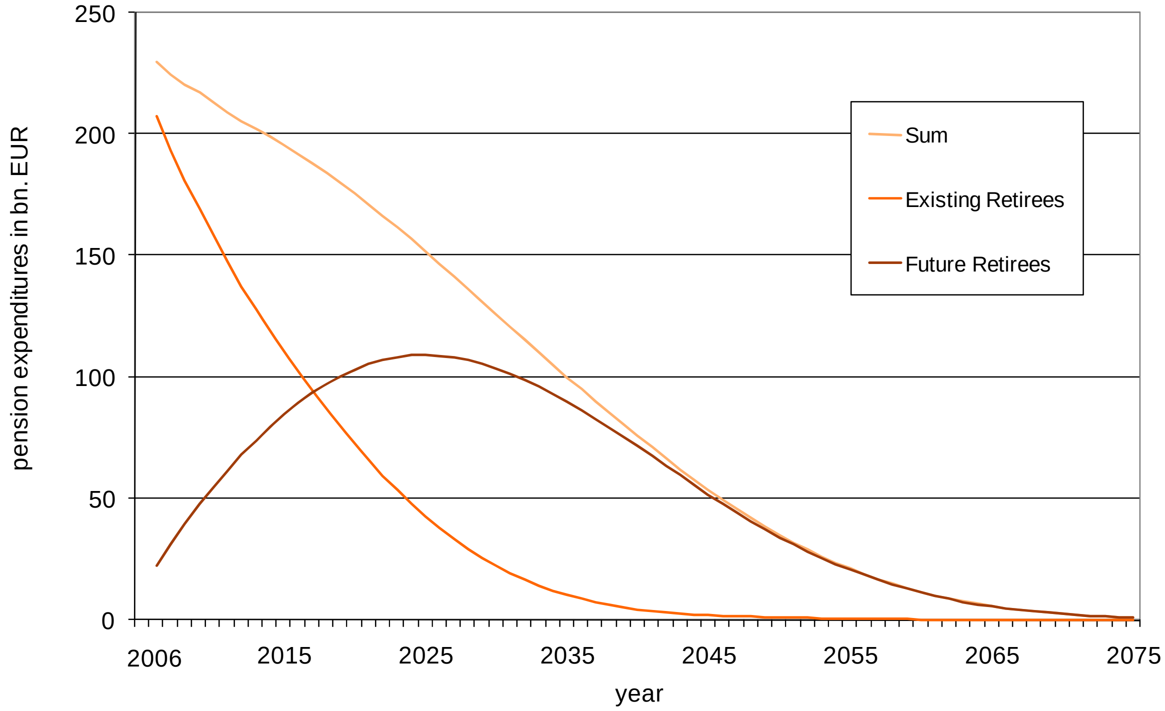
Figure 5: Accrued-to-date amount of average future retirees' pension benefits profile from 2006 to 2055 (here: Social security Germany, male, in Euro)



Source: Own calculations

For ease of understanding we add at this point Figure 6 showing the development of the projected aggregates. The sum of the existing retirees benefits decreases due to the phasing out of the profiles. In contrast to this, the aggregated future retirees' benefits show an inverse u-shaped pattern. This is due to the fact that the future retirees' benefits initially increase as a result of the building up of the profile. However, these benefits are reduced accordingly since only the accrued-to-date amount is considered.

Figure 6: Future pension expenditures
(here: Social security Germany, present value in 2006, in Euro)



Source: Own calculations

4 Limitations and possible extensions

When setting up a model one is confronted with the classical trade-off between simplicity and accuracy. On the one hand the model should reflect reality as precise as possible. On the other hand models are by definition abstractions of reality; and therein lies one of their major strengths. They display a complex phenomenon in a simple and clear manner and therefore have to leave out irrelevant information. Hence, the crucial question when setting up models is: What are the relevant input factors to be chosen? We have answered this question with the description of assumptions and input data in section 3. In the following we will take a closer look on the resulting limitations of the Freiburg model. In this context, we give various examples taken from our survey to the Eurostat/ECB Contact Group.[40] Furthermore, a divergent answer to the above raised question shall be given and possible extensions of the model – i.e. additional relevant input factors – shall be considered.

To understand the outcomes of the model it is essential to grasp the channels which lead to the respective results. In this context it is of interest how the outcomes change if one varies the assumptions taken. Sensitivity analyses which assess the robustness of a model are useful tools for this purpose. They give an indication to which extent the model is driven by the taken assumptions.

Table 1 illustrates the respective sensitivity analysis for the ADL of the German public pension system (base year 2006). Looking at these results a significant limitation of the Freiburg model becomes obvious. Given a small alteration of the assumed interest rate (r) from three to two percent the outcome changes considerably by 21 percent (using the PBO approach). Also the level of the growth rate (g) has a sensitive impact on the results of the Freiburg model – as shown in Table 1. Since the future is uncertain by nature, this constraint of the model cannot be overcome. Nevertheless, the sensitivity analysis demonstrates once again the importance of choosing appropriate assumptions.

[40] See Müller et al. (2009).

Table 1: Sensitivity analysis of the German social security pension scheme (ADL)

Parameters		Amount of ADL (relative deviation to standard scenario)
r	g	
2.0%	1.0%	9.6%
2.0%	1.5%	21.0%
2.0%	2.0%	34.2%
3.0%	1.0%	-8.5%
3.0%	1.5%	0.0%
3.0%	2.0%	9.8%
4.0%	1.0%	-22.1%
4.0%	1.5%	-15.6%
4.0%	2.0%	-8.2%

Source: Own calculations

Noting that the taken assumptions have a large influence on the results, the question arises which level of interest and growth rate should be chosen when examining different countries – as done in Müller et al. (2009). The choice lies in heterogeneous or homogeneous presumptions.

The former option is supported by the fact that countries widely differ in their development and therefore can be assumed to follow different growth and interest paths in the future. Nevertheless, we choose equal assumptions for all countries examined in our EU-comparison. Two main arguments play a role for this decision: *predictability* and *comparability*. Forecasting the demographic development for the coming decades is relatively straightforward since the future population can be assumed to be compounded to a large degree of the present population. However, *predicting* the development of economic growth and interest rates is rather demanding and connected with a great deal of uncertainty. Not only do economic indicators depend on numerous variables – and are therefore difficult to predict – but also do they feature a large volatility.[41] Hence, the lack of ability to predict the future development of economic growth and interest rates is one important rationale for choosing identical assumptions in our cross-country comparison. Another reason in favour of homogeneous assumptions across countries is an enhanced comparability of results.[42] Heterogeneous assumptions which are often based on national forecasts – and which themselves are often based on dissimilar presumptions – would

[41] For an overview on the main determinants of economic growth see Mankiw et al. (1992) or Barro and Sala-i-Martin (2003).

[42] See Franco et al. (2004), p. 16.

make the outcomes less comparable and therefore more vulnerable in the political discussion. Since the calculation of pension liabilities represents a highly political issue – especially in the context of the Maastricht treaty and the current discussion of government insolvency – the political dimension of calculating pension liabilities should not be neglected. Nevertheless, homogeneous interest and growth rates limit the model to the extent that country-specific particularities cannot be accounted for.

Current research indicates and quantifies that the ageing process has a significant and heterogeneous impact on economic growth in EU-countries.[43] As pointed out before, the future ageing development can be predicted relatively well. Therefore, the Freiburg model could be extended taking ageing-specific growth forecasts into account. However, in this context it is necessary to ensure that such growth-predictions are detached from policy considerations and that the agencies assigned to produce such forecasts represent independent bodies.

A further limitation to mention is straightforward and counts for every model: the model can only be as accurate as the given input data. This aspect represents a constraint especially for the calculation of pension reforms and of cohort-specific pension levels.

Particularly when modelling pension reforms commonly a lot of information is required. A short example shall illustrate this: Several pension systems in Europe implemented changes regarding the amount of the maximum pension. For example in Portugal a pension ceiling was introduced with the reform of 2006. Bulgaria on the contrary decided to let the maximum pension limit expire after the year 2009. In order to model such reforms comprehensive data about the distribution of reference earnings is necessary. Unfortunately, in many cases such detailed information is not available. As a consequence, various reforms cannot be accounted for accurately – or sometimes not at all – in our calculations due to the limitation of input data.[44]

The same counts for possible side effects of pension reforms. Various countries enacted pension reforms in the recent years which significantly lower future pension levels. However, such reductions of pension levels can be significantly cushioned by the existence of minimum pensions. In other words, a pension reduction can be limited to the extent that pension levels in some countries cannot fall under a certain threshold, given by the

[43] It can be assumed that economic growth per capita in the EU25 will be lowered by roughly one third due to the ageing process in the coming decades. However, this effect varies between each EU-country. For an extensive view on the long term economic growth in the EU25 see Carone et al. (2006).

[44] Changes in the recognized insurance periods – such as crediting for child care or education periods – could not be considered in our calculations either due to a lack of data.

amount of the minimum pension.[45] Since we normally do not have information about the distribution of pension levels we are not able to implement this side effect. A possible future extension of the Freiburg model could implement probabilities of receiving a minimum pension in the calculations. But it has to be stated once again that such an extension greatly depends on the quality of data supply.

Moreover, due to a lack of input data cohort effects cannot be considered in the Freiburg model either. Within our concept of measuring pension liabilities we take a look at the past, due to the fact that pension data reflects the insurance history of pensioners – such as past employment rates, business cycles and wages. However, we usually have no information about the insurance history of cohorts which are presently contributing into the system. In this sense the approach of the Freiburg model is comparable to an observation of planets located a long way off in the universe. While observing these planets we actually get a view of previous times – since the light takes a long time to reach the earth from these far away celestial bodies.[46]

Due to the limit of input data we have to assume that the pension level of future pensioners – or in other words of present contributors – will be the same as the pension level of new pensioners in the base year. As a result the pension level of future pensioners will only differ from the new pensioners' pension level in the base year due to pension reforms and indexation rules. Summarizing, the above outlined characteristic – one could call it the distant planet characteristic – of the Freiburg model confines the accuracy of the calculations by ignoring cohort effects. But this limitation can also be interpreted as its strength since it significantly limits the amount of information necessary for the calculation. Therefore, the model fits very well if only a limited amount of data can be provided – as it is mostly the case when undertaking large country comparisons.

There is also another significant limitation to be mentioned: The introduced model does not take into account future behavioural changes. So far we suppose that future

[45] We assume that pension reductions of the latest pension reform particularly in France, Hungary and Portugal will be cushioned due to existing minimum pensions.

[46] Cohort effects should play a more significant role for the ADL the longer the reference contribution period in a pension system is – i.e. the further away the observed planet – and the more the present pension data reflects the further past. Another example shall illustrate this: German pensions are based and calculated on the entire career history. Therefore, for a present new pensioner his entire contributions over the last approximately 40 years are considered in the pension calculation. Of course, also periods of unemployment or self employment are reflected in the pension level. Due to increasing unemployment and self employment rates in recent decades the level of future pensioners can be expected to differ from the present values (see SVR (2007), p. 195). We assume that the more the pension system is based on the principle of equivalence – for example taking into account a long reference contribution period – the more the level of pensions for each age group will differ. In some countries such cohort effects however only play minor roles, for instance in the Netherlands. The calculation of Dutch pensions does not depend on the level of past income but only on the periods of residence in the Netherlands between the age of 15 and 65. For a description of the Dutch pension system see MISSOC (2009).

pensioners will take the same retirement decisions as their present counterparts.[47] But what happens if future new pensioners will change their behaviour and retire significantly later (earlier) than today? The answer to this question depends on respective pension scheme examined. If the pension increments (decrements) for late (early) retirement can be considered actuarial neutral the behavioural changes should have no impact on our results.[48] However, as Queisser and Whitehouse (2006) indicate numerous pension systems in the OECD cannot be considered actuarial neutral. A substantial number of countries does subsidize early retirement and penalize late retirement since pension decrements as well as increments are lower than an actuarial neutral rate. As a consequence, we would overestimate (underestimate) pension liabilities if future pensioners will decide to retire later (earlier) than today. In Table 2 we demonstrate the impact of a change in pension behaviour for the case of Germany. As illustrated, a postponement of the retirement by one (two) year(s) lowers the ADL for Germany by 2.7 (5.2) per cent.[49] Consequently, a possible extension of the Freiburg model could take into account predictions of future pension behaviour – similar to Berkel and Börsch-Supan (2004). However, we suppose the data basis to forecast pension behaviour within a large cross-country comparison is presently not available.

Table 2: Impact of a change in retirement behaviour on ADL

Behavioural change	Amount of ADL (relative deviation to standard scenario)
Postponed retirement by one year	- 2.7 %
Postponed retirement by two years	- 5.2 %

Source: Own calculations

Another possible extension of the Freiburg model concerns the inclusion of employment rates. Applying the ABO approach we account for different age-specific gross wages over the life cycle – as it has been outlined in section 2.2. However, pension entitlements depend not only on gross wages over the life cycle but also on the periods in which these

[47] In addition, in case of pension reforms which lead to an increase of the statutory retirement age we assume that the pension behaviour is unaltered, effective retirement age stays constant and the respective retirees put up with resulting pension decrements. However, an exemption is made when the minimum retirement age is increased within the framework of a pension reform – for example in Austria (with the reforms of 2000 and 2003) or in the UK (with the reform of 2007). In such cases we increase in our calculations also the effective retirement age by the respective years.

[48] Actuarial neutrality in the context of pension systems means that the present value of accrued pension benefits does not change due to an earlier or later pension start date. For a detailed description of this concept see Queisser and Whitehouse (2006).

[49] For the calculation of these figures we assumed that from the year 2010 onwards all future new retirees aged 60 to 67 will postpone their retirement by one (two) year(s). The outcome greatly depends on the country-specific pension regulations – namely the pension increments and decrements – as well as the country-specific life expectancies.

wages have been earned – in other words periods of employment. Therefore, it would be consistent to include also employment rates – which can greatly differ over the life cycle and between countries – in the calculation of ABO pension liabilities.[50] We assume that this extension would slightly lower the (ABO) results of the Freiburg model. Two aspects play a role for this assumption: First of all, employment rates of the age groups 55 to 60 years old are relatively low in comparison to other cohorts. Secondly, pension benefits of these older age groups are relatively large since they are less discounted – being paid in the nearer future – than coming pension benefits of younger cohorts. In case of an extension of the model with respect to employment rates, the necessary input data could be taken from Eurostat.

In various countries the entitlement of a pension is dependent on a minimum period of membership or contribution in the pension system (MPC). For example, in Italy 20 years (for people insured before the year 1996) of contribution are necessary to receive a pension entitlement while in Belgium no minimum period of membership in the pension system is required.[51] Looking at these country-specific differences the question arises whether dissimilar MPC should be taken into account when calculating ADL. An argument in favour could be the following thought experiment: Imagine the pension system will be terminated and provisions will have to be made for all pension entitlements accrued-to-date. What does this imply for the calculation of ADL? Would Italy have to make fewer provisions since it has implemented a longer MPC than Belgium, given the ceteris paribus condition? Intuition would say yes. But since we cannot be certain about such a political outcome we do not consider regulations regarding MPC in our model. It is nevertheless worth debating to extent the model by such MPC. But it also has to be noted that this would alter the results significantly – as shown in Table 3. In the case of Italy the ADL would be lowered by roughly eleven per cent when considering MPC, while in Belgium on the contrary such an extension of the model would have no impact on the results.

[50] See Eurostat (2009). Of course employment rates can also differ between cohorts. Since the data basis for an implementation of cohort specific employment rates is rather limited we would only recommend the consideration of country- and age-specific employment rates in the model.

[51] For an overview about the country-specific legal frameworks see MISSOC (2009).

Table 3: Impact of a consideration of minimum contribution periods on ADL[52]

Country (MPC)	Amount of ADL (relative deviation to standard scenario)
Italy (20 years)	-11 %
Lithuania (15 years)	-7 %
Germany (5 years)	-1 %
Belgium (0 years)	0 %

Source: Own calculations

Summarizing, the Freiburg model – like every model – clearly simplifies reality by using a limited set of input factors and assumptions. This feature leads to a number of limitations of the model discussed above. But it can also be considered as its strength since pension liabilities being a complex value can be estimated in a straightforward way. Therefore, the model fits very well when only a limited amount of data can be provided, as it is mostly the case in extensive country comparisons. Nevertheless, various extensions of the model – such as a consideration of employment rates, ageing specific growth rates or minimum contribution periods – are worth to be discussed and could be implemented in the Freiburg model without too many difficulties.

[52] Since we do not have information about the age-sex-specific contribution history we had to approximate the below given numbers. This estimation is based on the assumption that contributors which are younger than a certain threshold (= number of MPC in years + 1 + average age to enter the workforce in the respective country) have not accrued any entitlements. It is evident that the ADL turn out increasingly lower the higher the number of MPC considered. This is caused by the fact that with an increasing MPC not only more contributors fall under the above defined threshold but also are these contributors on average older and therefore increasingly higher entitlements remain out of consideration.

5 Summary and outlook

With the demographic challenges ahead, the calculation of ADL offers a valuable tool to evaluate pension systems under various perspectives. First of all, this approach helps to assess the costs of terminating unfunded public pension schemes. The concept of ADL also represents a useful tool to examine various pension reforms – such as changes in pension indexations or minimum retirement ages – and their impact on pension entitlements. Moreover, measuring ADL can give a further insight when looking on the impact of PAYG pension schemes on national savings. In this context, ADL quantifies the social security wealth which represents a significant determinant on saving rates – as has been pointed out first by Feldstein (1974). With the current revision of the 1993 SNA and the resulting implementation of ADL in national accounts a further impetus has been given to pay attention to the concept of ADL.

This paper introduces the approach of the Freiburg model to quantify ADL. The presented model has been applied to carry out benchmark calculations of 19 EU member states on behalf of the Eurostat/ECB Contact Group on Pensions. After a short introduction, in section 2 we outlined the calculation procedure of the Freiburg model step by step. Section 3 gave an overview of the general assumptions and the data supply necessary for the application of the model. The following section 4 revealed that the Freiburg model entails a large degree of simplification using a limited set of input factors. This leads to a major strength of the model: It fits very well when only a limited amount of data can be provided – as it is mostly the case for undertaking large country comparisons. Furthermore, section 4 presented possible extensions of the Freiburg model such as a consideration of ageing specific growth rates or minimum contribution periods which are worth to be discussed.

Besides these possible extensions of the Freiburg model, several interesting issues could be raised for future research. One concerns the field of application. So far the concept of ADL has only been carried out for calculating entitlements of pension systems. But one may argue that entitlements exist also in other fields of unfunded social security systems as for example long term care insurance. Therefore, future research could extend the concept of ADL also to other social security systems which are based on a PAYG principle.

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