**Appendix: Methodology**

The twelve country teams have set up social security benefit calculators (Section A1) which compute the after tax benefit stream from each salient social security program and pathway as a function of a common synthetic earnings history (Section A4), common taxation assumptions (Section A5) and common synthetic mortality rates (Section A6). This benefit stream starts after “retirement” which may take several “pathways”. This is defined more precisely in Section A2. We compute the benefit stream for individuals with several stylized socio-economic characteristics such as sex, marital status and education. They are defined in Section A3.

**A1: Computation of *ITAX***

Section 3 has described the construction of *ITAX*, our key indicator of retirement incentives. More formally, social security benefit calculators convert an earnings history *y* up to age *R*-1 into a benefit *B* from age *R* onwards:

(1) *Bk,t,a(R,i) = fk,t,a(y(R-1,i))*

where *Bk,t,a(R,i)* is the after tax benefit from social security program and/or pathway *k* for an individual of type *i* and at age *a*≥*R*, where *R* is the first year of benefit receipt occurring at calendar time *t*. Note that potential cohort differences are fully captured in this notation. This benefit has changed over time (index *t*) due to policy changes, as we know, and it may change as individuals age (index *a*). The benefit is dependent on the entire earnings history as expressed by *y(R-1,i)* which is the vector of earnings from age 15 to *R*-1 for an individual with a specific set of socio-economic characteristics (index *i*). In most countries, benefit computations start at *a*=55 and end at *a*=69; in some countries, however, it is possible to claim pensions even earlier. In eligibility for a pathway is modeled by setting *Bk,t,a(R,i)* = 0.

Summarizing and properly discounting the expected stream of social security benefits for the remaining life span yields the social security wealth, denoted by *SSW*. For an individual of type *i* starting to claim benefits from program/pathway *k* at age *R* in time *t*, social security wealth is the present discounted value of all future social security benefits:

(3) *SSWk,t(R,i)* = Σ*a=R,T Bk,t,a(R,i) σt,a* β*a-R*.

Discounting has two components: σt,a is the survival probability at age a in time t and β is the usual discount factor for a discount rate of 3%.

Postponing claiming by one year has two effects on social security wealth. On the one hand, annual benefits *Bk,t,a(R,i)* increase with later claiming in most countries due to additional contributions and actuarial adjustments. On the other hand, however, benefits are received one year less. The accrual of social security wealth

(4) *ACCk,t(R,i) = SSWk,t+1(R+1,i) - SSWk,t(R,i)*

can thus be positive, zero, or negative. If the accrual is negative, the social security system imposes an implicit tax on claiming later. This implicit tax rate is the (negative) accrual of social security wealth divided by the after tax earnings during the additional year of work:

(5) *ITAXk,t(R,i) = - ACCk,t(R,i)/Yt+1,i*

Since most countries feature earnings tests at least at ages before the statutory retirement age, this implicit tax on claiming later is also an implicit tax on working longer. *ITAX* is the key incentive variable which we model in this volume and associate with the change in labor force participation. A positive value of *ITAX* means that there is a tax on working longer, a negative value represents a subsidy for working longer. It collapses all the various dimensions of social security policy into a single dimension; this is as much an advantage as it is a disadvantage. The advantage is that the single dimension of *ITAX* permits to easily display associations between policy and potential outcomes such as old-age employment or labor force participation. The obvious disadvantage is that social security policies may be more complex and may even have inconsistencies that are masked by a one-dimensional measure.

The main work in this volume is for each country to compute a time series 1980-2016 of the implicit tax rate that governs the decision to claim social security benefits at age *R* where *R* ranges in most countries from 55 to 69:

**Figure A1: Time series of incentive variables**

55 56 … 68 69

1980 x(55,1980,i,k) x(56,1980,i,k) … x(68,1980,i,k) x(69,1980,i,k)

… … … … … …

2015 x(55,2015,i,k) x(56,2015,i,k) … x(68,2015,i,k) x(69,2015,i,k)

In this matrix, the entry *x*(55,1980,*i*,*k*) represents the implicit tax of claiming benefits from program/pathway *k* one year later expressed as a percentage of the earnings in that additional year for a 55-old worker of type *i* under the pension rules that have been legislated in 1980.

**A2. Definition of retirement and pathways**

In many languages, there is only one word “retirement” for two distinct economic decisions: exiting the labor force and claiming a pension or social security benefits. For the benefit calculator, *R* is the combination of the age of claiming and leaving the labor force. The matrix in Figure A1 represents the *implicit tax of working longer* only in the case when social security or other rules enforce the equality of the age of retirement from the labor force (*RL*) and the age of claiming benefits (*RC*). Most often, this equality is enforced by earnings tests which disallow earning more than *Ytest* and/or by clawback rules in the benefit calculation which tax earnings while receiving benefits at a high rate *τ* in addition to earnings taxation.

In most European countries and Japan, earnings tests are still strict such that claiming benefits forces the individual to give up work for pay. In these countries, the two decisions are equivalent and working a year longer implies postponing claiming benefits by a year. In the US and the UK, however, earnings tests have been abolished. Hence, retiring from work and claiming benefits are separate decisions in principle, although we still observe a strong habitual link between retiring from the labor force and claiming benefits.

More recently, “flexible retirement” models have been introduced by some countries which permit part-time work and partial retirement. Where relevant, we model them as a separate pathway, using the following procedure:

* As a general rule, the yardstick of comparison (i.e., the denominator in equation 5) is the income that a non-retiring individual is projected to earn in the additional year (Yt+1,i).
* We first compute the above matrix of the implicit tax of claiming later. This is an interesting concept per se even in the absence of earnings tests.
* In countries with a strict earnings test (Ytest =0 and τ=100%), this is also the implicit tax of working longer.
* In countries and time periods without earnings tests, the implicit tax on working longer is zero even if the implicit tax of claiming later is not. We will therefore see a jump in the former variable when a country abolished a strict earnings test.
* In the general case (Ytest > 0 and τ < 100%) we introduce a new concept of the relative financial loss due to working one year longer and delaying claiming by one year. This financial loss has two components, namely potential earnings lost due to the earnings test and/or partial retirement rules and the reduction of SSW. If Ymax is the maximum allowable net labor income while receiving benefits, i.e. after respecting the earnings test, clawback rules and wage taxation, then this financial loss due to working one year longer and delaying claiming by one year is

(6) LOSSk,t(R,i) = - ACCk,t(R,i) - [Ymax - Yt+1,i]

Set relative to potential earnings, the resulting incentive variable is

(7) RFLk,t(R,i) = LOSSk,t(R,i)/Yt+1,i.

If there is no earnings test, Ymax = Yt+1,i and a loss occurs only through a negative accrual. If there is a strict earnings test, Ymax = 0 and the loss is the negative accrual plus the entire wage that an individual could have earned in this year. In all other cases, 0 < Ymax < Yt+1,i.

For countries in which pathways to retirement via disability or unemployment insurance are important (e.g., Germany and Italy), we construct separate matrices for each pathway. We then compute a weighted mean over these pathways where the weights are the actual proportions in which these pathways have been selected. The country chapters show graphs how the weights have evolved over time.

**A3. Definition of synthetic “types”: socio-economic characteristics**

We compute separate matrices for a low skill/education worker (in countries without skill data: 50% of median income), a medium skill/education and a high skill/education worker (alternatively: 200% of median income), separately for single women, single men, married women, and married men (index *i*), for a total of 12 matrices. For countries with split social security systems (e.g., France), we have different matrices for private and public sector workers (index *k*).

The index *i* distinguishes:

* Male single, female single, male married, female married
* low, medium and high skill level or education; if not available, use 50% of median income, median income, and 200% of median income

The case of couples retiring at different ages can become very complex. To keep matters simply, we focus on a male (female) who is married to a partner 3 years younger (older) of the same skill/education type. We assume that the spouse’s retirement behavior is fixed, i.e., will not react to the own retirement decision. In many countries, the case for couples is therefore identical to the unmarried case. One example for an exception is the US with their spouse benefits; other examples include survivor benefits.

**A4. Construction of common earnings histories**

This volume focuses on typical workers with standardized earnings profiles over their life courses. We base the calculation on three different assumptions:

1. *common synthetic earnings profiles* in which the slopes are the same across all countries. We have calculated earnings profiles for the three skill/education groups from the US Current Population Survey (CPS), the German Socio-Economic Panel (GSOEP) and administrative data from the Italian pension system (INPS). They are scaled such that earnings at age 50 are one. The profiles are fairly similar across the three countries, so we use the simple average of these profiles. They are smoothened to prevent artificial spikes in the implicit taxes and kept flat at higher ages when selection effects dominate the data. They are therefore synthetic profiles for the purpose of standardization. They are then scaled at age 50 to each country’s median income at age 50 for the respective sex/education group. Figure 12 depicts the average across all skill/education groups:

**Figure 12: Common earnings profiles**

Men Women

|  |  |
| --- | --- |
|  |  |

1. *country-specific earnings profiles* that are constant over time (based on 2016 or the most recent available data).
2. *country and time-specific earnings profiles*

Assumption (a) will isolate the effect of social security incentives from international differences in earnings profiles. Assumption (b) will honor the fact that earnings profiles are different across countries and exert their own incentives, but isolate them from differences in earnings profiles across cohorts.

The country-specific earnings profiles are derived from aggregate labor force statistics available in each participating country; to account for cohort effects, theses profiles are based on cohort-specific longitudinal data wherever available. With sufficient data, they are aggregated from models of the earnings process which exploits all available information on individuals’ earnings histories, based on regressions of the form:

(8) ΔlnYt = α + Xtδ + β1AGE + β2AGESQ+ β3ΔlnYt-1 + β4ΔlnYt-2 + β5ΔlnYt-1\*AGE +

β6ΔlnYt-1\*AGESQ + β7ΔlnYt-2\*AGE + β8ΔlnYt-2\*AGESQ +TIMEtλ + ε

where Yt is earnings of individual i in period t  
X is a set of human capital control variables for individual i: education, marital status, race, tenure in the labor market, tenure at the firm, region of residence, etc.

AGE is age, AGESQ is its square  
TIME is a set of dummy variables for each year of the sample

Earnings are deflated by a consumer price index or equivalent. The data is then differenced such that the dependent variable is the percentage change in earnings for the individual. After having run the regression on an individual basis, we aggregate the projected earnings profiles over the lower, middle and upper tercile of the income distribution, separately for men and women.

Some countries condition the eligibility for a certain pathway (e.g. Germany) or pension benefits in general (e.g. France) to the number of years of contribution. These may include drop-out years for parents during child raising, sometimes also unemployment, further education, care for parents etc. In this case, we use a suitable average number of such years derived from national labor statistics.

Regarding the age of entry into the labor force, we also use common assumptions of ages 16, 20, and 25, respectively, for low, medium and high education/skill level. In addition, some country teams added analyses based on country-specific profiles, e.g., used median age of labor force entry in their national data for that type of worker.

**A5. Common taxation**

Social security benefits are computed net of applicable income taxes. The earnings in the denominator of *ITAX* are net of payroll taxes, i.e., income taxes, mandatory social contributions etc.

Common approach: We usedconstant and flat tax rates provided by the OECD. They are the average tax rates on gross labor income incl. social security contributions from the OECD ("total tax wedge"), averaged over the years 2000, 2005, 2010 and 2015.

National approach: Some country teams used an income tax calculator (stratified by single vs. couple household) which included the preferred tax treatment of pension benefits. Other country teams used simpler alternatives, e.g., applied statutory tax rates stratified by household type and income bracket.

**A6. Common survival probabilities**

Similar to the earnings profiles, this phase focuses on typical workers with standardized survival curves in order to isolate the effect of social security incentives from international differences in mortality (case a), plus national specifications (cases b and c):

1. identical age and gender-specific survival rates across all countries. We use the average survival rates provided Eurostat which refers to the EU28 countries. The underlying life expectancy at age 15 is 67.8 years for women and 64.7 years for men. In addition, these rates are adjusted to generate a life expectancy which is 3 years higher (lower) to reflect the difference in life expectancy across the three income categories. This adjustment is a mixture of a proportional increase (decrease, resp.) of the survival rates and a shift of the survival curve to the right. These values are used to calculate the conditional probability that a 55-year-old will alive at every future age (56-100) when he/she might receive benefits, and so on for workers of different ages represented in the matrix.

Alternative assumptions are analogous to the respective assumptions on earnings histories:

1. country-specific survival rates that are constant over time
2. country and time-specific survival rates

Assumption (b) will honor the fact that mortality rates are different across countries and exert their own incentives, but isolate them from the reduction in mortality over time.

**A7. Occupational and private pensions**

In some countries, occupational pensions play a minor role and are simply ignored (e.g. in Italy). In other countries they are an essential part of the old-age income provision system (e.g. in The Netherlands). If occupational pensions are included, they are treated as an “add on” to public pensions; hence public and occupational pensions are considered as a package. DC pensions are only included when they affect the eligibility for means-tested benefits (e.g., in Canada). Private pensions (e.g., IRAs in the US and Riester pensions in Germany) are not included.

**Glossary**

This glossary comprises the typical technical terms which are important for consistency between the country papers. Table G1 lists common terms. Where it is impossible to harmonize the terms, there are country-specific technical terms displayed in Table G2 further below.

Terms in *italics* refer to other terms which are defined in the Glossary.

**Table G1: Common terms**

|  |  |
| --- | --- |
| **Term** | **Definition** |
|  |  |
| Claiming age | The claiming age denotes the age at which an individual decides to initiate receipt of benefits from a *social security program*. |
| Earliest eligibility age | The earliest eligibility age is defined as the age at which *early retirement* through a *social security program* is possible, mostly with reduced benefits. |
| Early retirement | Early retirement is the practice of claiming benefits from a *social security program* before an individual reaches the *statutory eligibility age*. Early retirement is possible after attaining the *earliest eligibility age* and is usually dependent on fulfilling a certain number of insurance years or a specific contribution history (in some cases, more years of contributions are required than at the *statutory eligibility age*). Early retirement benefits are typically reduced relative to the benefits available at the *statutory eligibility age*. |
| Earnings tests | Earnings tests limit the amount of earnings that can be received by an individual who receives benefits from a *social security program*. Earning tests often apply only before the *statutory eligibility age* or are stricter before than after this age. |
| Implicit tax rate | The implicit tax rate is the negative of the change in *social security wealth* arising from an additional year of work (or the negative of the accrual) divided by the after tax earnings. A positive value means that there is a tax on working longer, a negative value represents a subsidy for working longer. |
| Labor force exit age | The labor force exit age is the age at which an individual decides to stop working. |
| Means test | A means test is the practice of determining whether an individual qualifies for benefits from the basic social safety net, usually by comparing the individual’s income and/or assets to a threshold value. |
| Old age pension  Partial (“flexible”) retirement | Government benefit where the primary eligibility requirement is attaining a certain (old) age, though a contribution history may also be required. An old age pension is one example of a *social security program*, a broader term that encompasses other public transfer programs.  Partial (“flexible”) retirement schemes are models which permit individuals to access benefits from a *social security program* and continue working part-time in order to make a gradual transition from full-time work to full retirement possible. |
| Retirement age | To be avoided because it is ambiguous whether claiming age or labor force exit age is meant. |
| Social security program | Social security programs encompass *old-age pension* (OA), disability insurance (DI), unemployment insurance (UI) and other public transfer programs available at older ages. |
| Social security wealth | The social security wealth for an individual who claims benefits at a specific age and in a specific year from a *social security program* is the present discounted value of all future benefits from this *social security program.* |
| Statutory eligibility age | The statutory eligibility age is the age at which an individual is eligible for full public old-age pension benefits, without reduction for early claiming. There may be a (relatively short) contribution history required, which is sometimes less than the number of years of contributions required in order to claim *early retirement* benefits. |

**Table G2: Country-specific deviations**

|  |  |  |
| --- | --- | --- |
| **Term (country specific)** | **Definition** | **Country** |
|  |  |  |
| Full rate age | The full rate age is defined as the age at which an individual is eligible for a full public old-age pension before the *statutory eligibility age* after fulfilling both a minimum contribution history and the *earliest eligibility age*. | France, Germany |
|  |  |  |
| Social Security | This is a specific US terminology. While the term social security in Europe (in lower case spelling) refers to many branches of the welfare system, including also health and unemployment insurance, the term in the US (now capitalized) refers to old age and disability benefits only. | US |
|  |  |  |
| State pension age | This is a specific UK terminology. The state pension age is the earliest age at which an individual can start receiving the UK State Pension – and the age at which the vast majority start receiving it. It varies by several eligibility criteria. | UK |