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Accounting of pay-as-you-go pension schemes using accrued-to-date liabilities – An example for Switzerland

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Due to demographic change, the fiscal sustainability of pension schemes financed on a pay-as-you-go (PAYGO) basis is of more interest for policy makers than ever. Unsustainable financing brings along a future burden to pensioners through pension cuts and/or to the working population through increasing contribution rates.

With comparable data about the unfunded accrued-to-date pension liabilities of social security pension schemes soon being available due to a recent update of the international System of National Accounts (2008 SNA), we present a simple framework for accounting of paygo pension schemes using these estimates of accrued-to-date liabilities. Additionally we incorporate another definition of liabilities, the current workers' and pensioners' net liabilities (CWL).

Applying this accounting framework using both definitions of liabilities to the Swiss pension scheme (AHV), we show that financing of the AHV is unsustainable. In order to restore fiscal sustainability either an increase in the contribution rate to 12 percent or a cut in average pension levels of about 38 percent would be necessary.

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1. Introduction

Unfunded pension entitlements of private households from social security schemes, especially from pension schemes, contribute significantly to the income of elderly households during retirement. However, they have not been subject to much attention until lately.[1] While private financial savings are annually estimated in the core accounts within the system of national accounts, unfunded entitlements from government employer or social security pension schemes have so far been neglected. With the recent update of the international System of National Accounts (2008 SNA), which has been adopted to the European System of National Accounts (ESA 2010), it has become mandatory to publish unfunded pension liabilities for government employer as well as social security pension schemes in a supplementary table for all European countries from 2017 on. Therefore, each single European country has to develop a model in order to estimate these accrued-to-date liabilities (ADL)[2] and will publish the results on a yearly basis. While the publishing of ADL itself is undoubtedly helpful in giving an overview on overall unfunded pension wealth for private households or the implicit liabilities of pension schemes and their evolution over time, they nevertheless only capture one side of a pension scheme's balance sheet.

The question whether a pension scheme is sustainable or not, what could be of essential interest for policy makers or administrative issues, can of course not be answered by looking solely at the amount of accrued-to-date liabilities. Thus, we present a simple framework for the accounting mechanisms of pension schemes on a pay-as-you-go (PAYGO) basis. Thereby the calculations build on the accounting mechanisms of the Swedish notional-defined contribution (NDC) pension scheme and the analytics of Settergren and Mikula (2005), and use the opportunities given by the new figures on accrued-to-date liabilities. The accounting framework is applied to the Swiss old-age pension scheme, the "Alters- und Hinterlassenenversicherung" (AHV).[3] This extension allows us to assess the sustainability of the pension scheme based on data currently available and to calculate figures similar to those reported by private funded pension schemes as e.g. the funding ratio or the amount of uncovered liabilities.

The remainder of this paper is structured as follows. After outlining the methodology for calculating the liabilities (section 2.1.) and assets (section 2.2.) of the Swiss pension scheme, the empirical results for the balance sheet of the year 2010 are presented in section 3.1., followed by some additional policy measures to ensure the fiscal sustainability of the AHV. The article finishes with an outlook on the implications of this approach.

[1] See e.g. OECD (2013), p.71.

[2] Accrued-to-date liabilites (ADL) refer to the pension liabilities legally accrued until a specific date, which would have to be settled if the pension scheme was to be closed by that date. A more detailed description of the definition and calculation of ADLs is given in section 2.1.

[3] Similar work has already been done by Boado-Penas et al. (2008) for the Spanish pension scheme.

2. Methodology

Accounting of a pension scheme requires consideration of all types of both liabilities and assets. In the following sections first the concept of balancing a PAYGO pension scheme is developed in general. Afterwards the detailed calculation procedure of the balancing positions is outlined with a special focus on the institutional details of the Swiss old-age pension scheme (AHV).

2.1. Budget balance

Generally, balancing a PAYGO pension system follows the same basic accounting principles as balancing a funded pension scheme. The appropriate budget constraint states that total assets have to be equal to total liabilities:

Eq. 1 $$\boldsymbol{Liabilities - Assets = 0}$$

The liabilities of a pension system, to start with the more intuitive part, consist of the pension liabilities to all individuals currently entitled to a pension in the future. In the further context the term pension liabilities ($\boldsymbol{PL_t}$) is used in line with Settergren and Mikula (2005) and describes net pension liabilities (net of contributions). With respect to assets, several types of assets can be distinguished. Every pension scheme has at least some financial reserves or a small buffer fund ($\boldsymbol{BF_t}$) in order to cope with short-period deficits. However, for a PAYGO pension system the most relevant source for financing existing pension liabilities are the contributions of current and future generations. Relying on future contributions, or the "contribution asset" ($\boldsymbol{CA_t}$) as called by Settergren and Mikula (2005), is therefore an inherent feature of all pension schemes based on pay-as-you-go financing. We extend the more general framework of Settergren and Mikula (2005) by the inclusion of public subsidies, hereafter called public contribution asset ($\boldsymbol{PCA_t}$). Many public pension schemes rely to some extent on public financing via taxes either as a general subsidy or as targeted contributions in order to finance specific subsidies or benefits e.g. with respect to child or elderly caring.

However, if the overall budget constraint does not add up to zero the remaining unfunded (overfunded) part of the liabilities can also be interpreted as unintended intergenerational redistribution ($\boldsymbol{UIR_t}$) at the expense of future (current) generations.[4] Combining these balance positions leads to Equation 2.

Eq. 2 $$\boldsymbol{PL_t = BF_t + CA_t + PCA_t + UIR_t}$$

2.2.Liabilities

The total liabilities of a pension scheme financed on a pay-as-you-go basis are based on the promise to pay pensions at some time in the future. The total stock of liabilities of a pension

[4] Thereby, unintended intergenerational redistribution corresponds to the definition of "accumulated deficit" used by Boado-Penas et al. (2008). Actually, both definitions measure the same amount, namely the uncovered liabilities. The term "accumulated deficit" emphasizes the fact that these deficits have implicitly already been accumulated whereas our focus is on the burden imposed on future generations through unsustainable financing of the pension system.

system is therefore equal to the sum of pension entitlements of all participants of this scheme. To put it differently, every pension entitlement or individual pension wealth simultaneously represents a liability of the pension scheme. In order to reflect the different timing of these pension payments, liabilities or entitlements need to be discounted and reported in present value terms.[5]

For the purpose of balancing a pension scheme, only the consideration of net liabilities is appropriate. The relevant amount of net liabilities can be estimated using two slightly different but essentially connected calculation procedures. First, one can estimate accrued-to-date liabilities (ADL). This concept includes the present value of all pension entitlements accrued up to the respective base year; no future accrual of pension entitlements is taken into account.

The second approach expands ADL in the way that also further accruals of pension entitlements by current workers are considered in present value terms, leading to the concept of Current workers and pensioners' liabilities (CWL).[6] As in our context the CWL represent net liabilities one has to subtract the present value of the future contributions of current workers. If the present value of these future contributions corresponds to the hereby accrued present value of pension entitlements, as it is the case in notional-defined-contribution schemes (NDC) as e.g. in Sweden, net liabilities under both calculation approaches are equal. If the present value of the additionally accrued pension entitlements exceeds the present value of the corresponding future contributions then CWL are larger than ADL and vice versa. In the following sections we will additionally report the concept of CWL although only the concept of ADL is applied in the supplementary table in the System of National Accounts,[7] as CWL can be obtained by a simple extension of the ADL model and they incorporate additional information as we will see in section 3.2.

For the estimation of pension liabilities it is important to distinguish between pension entitlements accrued by present retirees and pension entitlements accrued by current contributors. The former group has their working and contribution period already completed and is therefore entitled to a full pension benefit. For the estimation of accrued-to-date liabilities it is important to take into account that current contributors have not yet accrued 100 per cent of their future (expected) full pension benefits upon retirement. They still have an (expected) contribution period ahead of them. Pension entitlements reflect the present value of all future pension benefits which have been accrued-to-date. Contrary to other figures of national accounts, accrued-to-date liabilities are calculated not solely on the basis of historic data. In fact, a projection of future pension payments is required. For a more detailed discussion of the methodology and arising issues see Eurostat (2011).

[5] A crucial question hereby is the choice of the appropriate discount rate, which will be discussed in more detail in section 3.1.

[6] For a more detailed description of the different distinctions of liabilities see Eurostat (2011), pp.15-18.

[7] See Eurostat (2011).

2.2.1. Pension liabilities of current pensioners

Our estimation of pension rights of current retirees is based on Eq. 3. As it is shown, pension entitlements of a current retiree depend on two factors. The first factor represents the annual pension benefit paid out in the base year $\boldsymbol{B_{x,g,b}^{accrued}}$, as this pension is already fully accrued.

Eq. 3 $$\boldsymbol{E_{x,g,b} = B_{x,g,b}^{accrued} * CAF_{x,g,b}}$$

The second factor for the entitlement calculations is called cumulated annuity factor $\mathbf{CAF_{x,g,b}}$. The $\mathbf{CAF_{x,g,b}}$ represents the sum of remaining retirement periods each weighted with cumulated discount rates, survival probabilities and pension indexation effects. The potential retirement periods of an x year old retiree in the base year b extends from the base year $b + 1$ until the year $b + (D - x)$, i.e. the year in which the retiree will reach the maximum considered age of D.

Eq. 4 $$\boldsymbol{CAF_{x,g,b} = \sum_{f=b+1}^{b+(D-x)} \left(\prod_{s=b+1}^{f} (1 + a_s) * \prod_{s=b+1}^{f} p_{x+(s-b),g,s} * \prod_{s=b+1}^{f} \frac{1}{(1 + d_s)} \right)}$$

The value of the $\mathbf{CAF_{x,g,b}}$ depends on 1) the annual increase $\boldsymbol{a}$ of pension benefits in a future year f, i.e. on the indexation regime, 2) the gender-specific survival probabilities $\boldsymbol{p}$ in future years f at age $x + (f - b)$ and 3) the discount rate $\boldsymbol{d}$ applied.

The estimation of entitlements of current receivers of child, orphan, and disability pensions follows the same procedure as for old age pensions with one exception. The future time horizon for these pensioners is usually shorter. Child and orphan pensions in Switzerland are only paid out until the child reaches the age of 18 or until it finishes education with a maximum age of 25.

Additionally, married pensioners have accrued an entitlement to survivors' pensions if the spouse dies. These survivors' pension entitlements are also included in the estimates of accrued-to-date liabilities.[8]

2.2.2. Pension liabilities of current contributors

The estimation of pension entitlements of current contributors follows closely the approach described in the previous section. However, two further aspects need to be considered when calculating accrued pension rights of this group. On the one hand, it has to be taken into account that present contributors are not entitled to a full pension one receives after a full contribution career. On the other hand, current contributors are not yet retired. Hence, their future pension payment needs to be newly estimated.

[8] Due to the complex institutional details regarding the amount of survivor's pensions, the detailed calculation of the survivor's pension for current pensioners as well as for current contributors can be made available upon request.

Current contributors are, generally, expected to accrue further pension rights in the future. This aspect differentiates them from present retirees. To indicate to which extent a future full pension B^{full} has been accrued-to-date the so called accrual factor AF is introduced (see Equation 5).

Eq. 5
$$\boldsymbol{E_{x,g,b} = \sum_{s=x+1}^{D} \underbrace{B_{s,g,f}^{full} * \mathrm{AF}_{x,g,b}}_{B_{x,g,b}^{accrued}} * p_{s,g,f}^{accum} * (1+d)^{x-s}}$$

Equation 5 illustrates nicely the link between the estimation of accrued-to-date pension entitlements (ADL) to current workers and pensioners' liabilities (CWL). While for the latter concept, generally, only pensions after a full contribution career (B^{full}) are taken into account, the ADL approach considers only a certain proportion (represented by the accrual factor AF) of these "full" pensions (in case of current contributors). Taking into account the full pension after the completed contribution career we end up with the gross current workers' and pensioners' liabilities. Further subtracting the present value of the future contributions necessary to receive this full pension, we get the net liabilities of current workers after a full contribution career (CWL).

The value of AF $(0 \leq AF \leq 1)$ may differ by age and gender. For present pensioners the accrual factors are by definition equal to unity, i.e. they are fully entitled to their pensions paid in future years. For current contributors who are still expected to earn further pension rights in the future the accrual factor, generally, amounts to a level below unity.

The **accrual factor** AF^r at the age of retirement r depends on the number of contribution years $CY^{\,b}$ accrued by the end of the base year b relative to the contribution years accrued at the age of retirement r, $CY^{\,r}$, as shown in Equation 6:[9]

Eq. 6
$$\boldsymbol{AF_{x,g,f}^{r} = \frac{CY_{x,g,b}^{b}}{CY_{x,g,b}^{r}}}$$

For present pensioners the level of pension benefits can be directly obtained from the institutions responsible for the respective pension scheme. For current contributors, on the contrary, this future retiree income has to be newly estimated. Thanks to the provision of detailed micro data on non-retired current and former contributors we are able to estimate individual pension entitlements based on individual heterogeneous contribution careers.

[9] In order to estimate the entitlement of an individual, full consideration has to be given to the fact that retirement is possible at different ages and pension entitlements at different retirement ages must not be equal due to non-actuarial neutral pension decrements. Therefore, pension entitlements are estimated at each possible retirement age, summed up, and weighted by the retirement probabilities at each age.

2.3. Assets

Having outlined the concept and calculation of the liabilities entering the balance sheet, the following section will present and discuss the calculation of the assets usually present in a pay-as-you-go pension scheme.

2.3.1. Buffer fund

First of all, financial reserves, e.g. buffer funds, are obviously assets of the pension scheme, with data on their amount being usually available through official statistics. The size of the buffer fund of a pension scheme can vary widely from only about two times the monthly expenditures in Germany[10] to over four times the yearly pension disbursements in Sweden[11]. In the case of Switzerland the buffer fund of the old-age pension system (AHV-Fonds) is operating financial reserves of about 1.20 times the yearly expenditure.[12]

From an accounting perspective the buffer fund should enter the balancing sheet in nominal terms, as the rate of return of it equals the appropriate discount rate, the rate of return on financial assets.

2.3.2. Implicit intergenerational redistribution or contribution asset

Although it is obvious that some kind of an implicit liability to future generations is existent in every pension scheme financed on a PAYGO basis, it is nevertheless difficult to estimate the exact amount of this "intended" intergenerational redistribution or contribution asset (*CA*). While some authors have proposed to use the sum of implicit taxes or the so-called "hidden asset" as a measure of the implicit intergenerational redistribution,[13] we will stick to the concept of a "contribution asset" as outlined by Settergren and Mikula (2005) for several reasons. The first reason is that the existence and the size of implicit taxes depend on the difference between the internal rate of return of the pension system relative to the return of an alternative investment, the interest rate of the financial market.[14] As we are interested in the sustainability of the pension scheme itself, the more appropriate measure of the implicit intergenerational redistribution seems to be the system-inherent contribution asset as it abstracts from any investment comparisons and therefore from other factors determining the financial market interest rate. The second reason is the progressivity of the Swiss pension formula with a fixed minimum and maximum pension (twice the minimum pension), which induces the implicit tax to vary extensively with income and probably more within than between generations.

The concept of the contribution asset is based on the idea of the contributions it takes until all liabilities within the pension system are turned over once given stable population, as well as income and pension replacement rate patterns. As a starting point one has to ask, how long does a euro of contributions take on average until it is paid out as a pension benefit? This equals the duration until all liabilities are on average turned over once. In order to obtain this turnover

[10] See Deutsche Rentenversicherung (2015), p.26.
[11] See Swedish Pension Agency (2014).
[12] This figure includes a loan of 5 bn. CHF to the disability pension system, see BSV (2015), p.1.
[13] See for example Sinn (2000), Fenge and Werding (2003) and Vidal-Melia and Boado-Penas (2013).
[14] See Vidal-Melia and Boado-Penas (2013).

duration $\boldsymbol{TD_t}$ the money weighted average age of contributors $\boldsymbol{A_c}$ is deducted from the money weighted average age of retirees $\boldsymbol{A_r}$.

Eq. 7 $$\boldsymbol{TD_t = A_r - A_c}$$

The contribution asset itself measures the sum of contributions paid until all liabilities are on average turned over and equals therefore the turnover duration times the sum of contributions of the base year ($\boldsymbol{C_t}$).[15]

Eq. 8 $$\boldsymbol{CA_t = TD_t * C_t}$$

The calculation of the contribution asset is generally based on cross-sectional population and pension data. It therefore relies on the actually observed situation and doesn't take into account possible but uncertain developments in the future. However, if calculated on a yearly basis it is a repeated measure of the expected inherent redistribution and therefore an important indicator for the evolution of the long-term contribution base of the pension system.

2.3.3. Public contribution asset

In most countries additional subsidies from general tax revenue also play a significant role in financing the pension system. These public subsidies may be connected to the total amount of pensions paid or may be nominally fixed and perhaps also indexed. While calculating the present value of public subsidies connected to pension expenses is fairly simple, the consideration of other public subsidies is not that intuitive. In Switzerland the largest part of public subsidies to the old-age pension system is proportional to pension expenses and amounts to 19.55 percent of these expenses. The present value of these public subsidies can be derived easily by taking the same proportion of the pension liability in present value terms. This procedure implicitly assumes the same discount factor used for the calculation of the pension liabilities, which is appropriate if the sum of these public subsidies in present value terms is considered to be transferred to the pension system immediately in order to finance these future obligations.

However, the correct specification of unconditional transfers or subsidies from tax revenue is more difficult. For example, in Switzerland 0.83 percentage points of the value added tax is used for financing the old-age pension system. Additionally, a fraction of the revenues from the state owned casinos is transferred directly to the buffer fund. The difficulty with these pension unrelated subsidies is to consider only the fraction relevant for financing the existing pension liabilities of the base year. As these liabilities are on average completely turned over within the length of the turnover duration, we use the calculation methodology of the contribution asset in order to estimate the asset stemming from these public subsidies unrelated to pension expenses. With $\boldsymbol{\theta}$ denoting the fraction of pension payments to be subsidized, the resulting public contribution asset ($\boldsymbol{PCA_t}$) consists of $\boldsymbol{\theta}$ times the pension liabilities, plus the pension unrelated subsidies ($\boldsymbol{S_t}$) times the turnover duration.

Eq. 9 $$\boldsymbol{PCA_t = \theta * PL_t + TD_t * S_t}$$

[15] For a more detailed derivation and discussion of the contribution asset see Settergren and Mikula (2005) and Vidal-Melia and Boado-Penas (2013).

3. Empirical results

Having outlined the calculation methodology for all balancing items, the following section presents the remaining assumptions needed and subsequently the empirical estimates for the balance sheet of the Swiss old-age pension system (AHV) at the end of 2010 and further deduced implications. The empirical estimates of the net pension liabilities are based on two detailed micro-datasets, the first covering the complete contribution record for non-retirees until the end of the base year 2010 and the second one containing detailed pension relevant information about current pensioners at the end of 2010. The figures on total contributions and public subsidies independent of the pension expenses are taken from the official statistics of the AHV.[16]

3.1. Assumptions

As outlined in section 2.2., the estimation of the pension liabilities of the Swiss old-age pension system (AHV) needs some basic assumptions about the long-term indexation of pension benefits, the growth rate of wages and the future evolution of survival probabilities. With the pension benefits being indexed according to a mixture of inflation and nominal wage growth, we need both assumptions about future inflation as well as real wage growth. For both assumptions we stick to the assumptions taken in Bundesrat (2013), namely an annual inflation rate of 1.5 percent and real wage growth being equal to annual productivity growth which in turn is assumed to amount to 1 percent. For the future evolution of gender-specific survival probabilities we stick to the assumptions of the European Population Projections 2013 (EUROPOP2013) for Switzerland.

A crucial question within the calculation of pension liabilities in present value terms regards the choice of the appropriate discount rate. As already Aaron (1966) has pointed out, the implicit rate of return of a PAYGO pension system equals the growth of the wage bill or the sum of wage and working population growth. If future changes in the working population are neglected given the base year balancing perspective, which is also applied in the estimation of the contribution asset, the appropriate internal rate of return of the pension system equals wage growth. Following this approach, we use the assumed nominal wage growth of 2.5 percent as discount factor.[17] Furthermore, we only consider the old-age pension system whereas the absolute values of ADL estimated by the Nation Statistical Office and published in the Supplementary Table also include the liabilities of the disability pension scheme.

3.2. Balance sheet

Based on these assumptions, the following section presents the empirical estimates for the balance sheet of the Swiss old-age pension scheme for the year 2010. We estimate the balance sheet first applying a pure actuarial approach using accrued-to-date liabilities (ADL) and second incorporating a projection of future contributions and further accrual of pension rights for

[16] See BSV (2015), p.1.

[17] While in our context we choose the rate of wage growth as the appropriate discount rate for the calculation of the accrued-to-date pension liabilities, a real discount rate of 3 percent reflecting the European average ten-year government bond yields is recommended by Eurostat (2011) for the estimation of the supplementary table.

current workers, as shown in Table 1. In order to derive these CWL, we first estimate total pension entitlements after a full contribution career and subtract future contributions of current workers. Every model calculating accrued-to-date liabilities as proposed by Eurostat (2011) implicitly projects pension benefits after a full contribution career[18] and can therefore be extended easily to additionally estimating current workers' and pensioners' liabilities (CWL). Both approaches render equal figures for present value pension liabilities of current pensioners due to their already accrued full pension. However, gross pension liabilities of current active contributors rise from 1,290 to 2,360 bn. CHF if the future accrual of pension rights is additionally taken into account. At the same time, further contributions amount to 754 bn. CHF in present value terms, which is less than the rise of the pension liabilities of current active contributors. Hence, net liabilities increase from 1,882 to 2,198 bn. CHF if the concept of CWL is used instead of ADL. With the larger part of public subsidies being connected to pension expenses and therefore to gross liabilities, the present value of this part of public subsidies simultaneously increases significantly from 368 to 577 bn. CHF. The remaining assets are not subject to any changes between both approaches. The largest asset position are the future contributions of current and future working generations used to finance today's liabilities, measured by the contribution asset. The unintended intergenerational redistribution (UIR) or the uncovered liabilities amount to about 30 percent of the net liabilities in both approaches, stating that the pension system is actuarially already running deficits to be covered by future contributors. Or to turn it around, assets cover only about 70 percent of the liabilities. Although both measures of liabilities are built upon a slightly differing time horizon, they yield nearly identical measures of the fiscal sustainability of the pension system.

With the underlying fiction of a stable population one could now ask what sufficient policy measures would have to look like in order to ensure the fiscal sustainability of this pension system given the base year population. One possibility is to cut back the pension levels or to increase the contribution rate until it is sufficiently high in order to finance the current pension level. From inserting Equation 9 and Equation 8 in Equation 2 and solving for the net pension liabilities we get the following equation:

Eq. 10
$$\boldsymbol{PL_t = \frac{TD_t * (C_t + S_t) + BF_t + UIR_t}{(1 - \theta)}}$$

Fiscal sustainability requires $\boldsymbol{UIR}$ being equal to zero and therefore the fiscal sustainable net pension liabilities $\boldsymbol{PL_t^*}$ can be expressed as in Equation 11. The fiscal sustainable net pension liabilities are equal to the pension unrelated assets divided by the fraction of pension expenses financed by contributions.

Eq. 11
$$\boldsymbol{PL_t^* = \frac{TD_t * (C_t + S_t) + BF_t}{(1 - \theta)}}$$

Combining Equation 10 and Equation 11, the necessary change in average pension levels therefore amounts to:

[18] Eurostat (2011) recommends the use of the projected benefit obligations approach (PBO). Within this approach the projection of the future contribution career of current workers takes into account future wage increases either by general wage growth or by individual promotions (compare Eurostat (2011), p. 20).

Eq. 12
$$\Delta PL_t = \frac{PL_t^* - PL_t}{PL_t} = -\frac{UIR_t}{(1-\theta) * PL_t}$$

The higher the share of pension expenses financed by public subsidies, the higher is the necessary pension cut due to the simultaneously decreasing public contribution asset. In this case, the necessary cut in pension levels amounts to between 37.9 percent with the ADL approach and 38.5 percent with the CWL approach. The difference between both approaches stems from the non-actuarially neutral contributions, given the assumed discount rate.

On the contrary, the applied approach of net pension liabilities plays a crucial role in determining the fiscally sustainable contribution rate to the pension scheme. This becomes clear by deriving the formula for this sustainable contribution rate. Starting with Equation 2, writing the net pension liabilities as gross pension liabilities GPL_t minus the present value of future contributions of current contributors PVC_t and setting the uncovered liabilities or the unintended intergenerational redistribution UIR_t to zero we end up with Equation 13.

Eq. 13
$$GPL_t - PVC_t = BF_t + CA_t + PCA_t$$

Writing the present value of future contributions PVC_t as the sum of future income in present value terms FY_t times the contribution rate τ_t and the contribution asset CA_t as the sum of contributable income in the base year Y_t times the contribution rate τ_t times the turnover duration TD_t, we only need to solve for the contribution rate in order to maintain the following condition stating that the fiscally sustainable contribution rate equals the gross pension liabilities not covered either by the buffer fund or the public subsidies divided by the sum of current workers' future contributable income and the sum of income subject to contributions until the pension scheme has technically rolled over all net liabilities once.

Eq. 14
$$\tau_t^* = \frac{GPL_t - BF_t - PCA_t}{Y_t * TD_t + FY_t}$$

While under the ADL approach the contribution rate has to be raised from the current level of 8.4 percent to 14.3 percent, this necessary increase of the contribution rate turns out to be smaller in the case of the CWL approach with a sustainable contribution rate of 12.0 percent. This difference can be explained by the different time horizon of both approaches. The CWL approach considers current workers' future contributions and therefore the financing basis reacts more pronounced to an increase in the contribution rate. In order to estimate the necessary steady state contribution rate of a pension system, using the concept of CWL yields the more appropriate results than using ADL.

Table 1: Balance sheet of the AHV in bn. CHF at the end of 2010

Balance position	details	ADL PBO	CWL Full pension-contributions
(net) liabilities	(= PV pensions - PV contributions)	**1,882**	**2,198**
Present value pensions	(current pensioners)	592	592
Present value pensions	(current active)	1,290	2,360
Present value contributions	(current active)	0	754
Assets		**1,308**	**1,518**
Funds	(end of year)	**49**	**49**
public contribution asset	(present value of federal contributions, 19.55 % of AHV-expenses)	**368**	**577**
public contribution asset	(present value of federal contributions, independent of AHV-expenses)	**78**	**78**
contribution asset	(future actives, = Turnover duration x contributions)	**814**	**814**
Unintended intergenerational redistribution/ Uncovered liabilites	(= (net-)liabilities - assets)	**573**	**680**
Necessary pension cut in %		**37.9**	**38.5**
Necessary contribution rate in %		**14.3**	**12.0**
Funding ratio (= Assets /(net-) liabilities)		**0.695**	**0.690**

Source: Own calculations based on micro data from the Swiss pension system and BSV (2015).

4. Implications, limitations and outlook

In this article we propose a framework based on Settergren and Mikula (2005) for accounting of PAYGO pension schemes. Using the estimates of accrued-to-date liabilities, which will soon be available worldwide via the supplementary table in the System of National Accounts, we assess the fiscal sustainability of the Swiss old-age pension system. Thereby, we estimate that about 30 percent of total liabilities are turned over to future generations additionally to the inherent intergenerational redistribution of a PAYGO financed pension system. Furthermore, we show how an ADL estimation model can be extended easily to additionally incorporating the current workers' and pensioners' net liabilities and therefore cover a medium-term time horizon. Having shown the underfinancing of the Swiss old-age pension system, we show two policy measures in order to restore the fiscal sustainability, namely an increase in the contribution rate to 12.0 percent or a general cut in pension levels of about 38 percent, and discuss the validity within both liability approaches.

Generally, one could view the steady-state assumption as a limitation of this balancing framework. In our opinion this is not a substantial limitation as the approach allows the assessment of the sustainability of the pension system itself as it does only rely on some long-term assumptions regarding the wage growth, inflation and the future evolution of survival probabilities and not on assumptions on volatile migration and long-term fertility rates. The effect of the business cycle on the results of one particular year might be a problem, but as the figures on ADL will be available on a yearly basis, comparing outcomes for several years should overcome this limitation. With information on ADL soon being provided on a comparable basis, this framework offers a valuable opportunity for policy makers and administrative divisions to assess the sustainability of pension schemes early and to react to imbalances timely. Given the yearly availability of the estimates of pension liabilities, changes in variables relevant for fiscal sustainability are incorporated timely in the contribution base, e.g. life expectancy being higher than assumed or migration flows, and can be used to minimize generational imbalances within the pension scheme.

Although our estimates are only based on the old-age pension system, the methodology can be extended easily. For example, disability pension schemes usually also incorporated in the estimates of the pension liabilities in the supplementary table can be considered or the concept can even be applied to other social security schemes financed on a pay-as-you-go basis as e.g. unemployment insurance or even social health or long-term care insurance.

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