CESifo Working Papers

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CESifo Working Paper No. 706 (1)

April 2002

Category 1: Public Finance

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ISSN 1617-9595

CESifo *Working Paper No. 706*
April 2002

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Abstract

We derive an ex post neutral comprehensive income tax on pension schemes equivalent to a Johansson-Samuelson tax that guarantees non-discriminatory treatment of lifetime-dependent and other investments. By separately taxing contributions and benefits, our concept does not require any assumptions on the return of a pension scheme and, therefore, is of special interest for taxing public PAYGO schemes. Assuming constant tax and interest rates, the system is characterized by constant fractions of deductible contributions and taxable pensions. The tax base from neutral pension taxation considerably exceeds the one under existing legislation, e.g. in Germany or in the U.S.

JEL Classification: H21, H24, H55.

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1 Introduction

European pension systems are under growing pressure from an aging population, rising life expectancy and a shrinking contributing workforce. Together with the reform of public and private pension schemes different forms of tax rules for pension income are being introduced. The most recent example is the introduction of a voluntary, funded pension plan to supplement the obligatory pay-as-you-go (PAYGO) pension scheme in Germany[1]. The new, so-called Riester[2] scheme is taxed on a cash basis: received pensions will be taxed as personal income of the recipient whereas contributions are fully deductible.

This seems to be in line with other ways of preferential tax treatment for old-age savings as pensions for retired civil servants, company and individual schemes are all taxed differently with some cash flow element as the common denominator. In contrast, the official model of the income tax system is taxation of comprehensive income. Interest income is taxed as regular income. Business income of corporations and non-corporate firms alike is calculated as modified accounting profit, the capital invested is written off following linear or declining balance depreciation schedules. There is no ACE[3] element or immediate write-off of the capital base[4].

Overall, the tax burden on capital income depends on the legal category of an investment. There is a dualism of income concepts in German income tax legislation with some investments, including the Riester scheme, being taxed on a consumption or cash flow base, and others being taxed on an accounting profit base. As a consequence, income taxation distorts investment and savings decisions of individuals. Even career decisions and labor supply may be affected, as individuals opt into or out of a specific pension scheme when choosing a job.

This is not merely a German problem: France, the Netherlands, Switzerland, the UK, and the US all have income tax systems which, in general, tax interest income and the marginal return on investment. At the same time, all of them provide special rules for some forms of long-term savings or pension schemes, which resemble a cash flow tax rather than a comprehensive income tax: either contributions or pension payments can be deducted from the tax-base, and accrued dividends or interest payments during the holding period

[1] § 10a EStG (Einkommensteuergesetz, German income tax code).

[2] Named after the German Federal Secretary of Labor and Social affairs, Walter Riester.

[3] ACE = allowance for the cost of equity; a frequently used term for a neutral income tax equivalent to a cash flow tax in PV terms and first described by Boadway and Bruce (1984) and Wenger (1983).

[4] There are exceptions for some types of assets which can be neglected for the purpose of this paper.

are partly or fully tax-exempt[5]. Clearly, by the standards of an income tax, some of the most important long-term savings vehicles are being subsidized by tax legislation in the major economies, and there may be good reasons for doing so. On the other hand, to quantify these incentives the question must be raised what a non-distorting, i.e., neutral income tax on pension schemes would look like.

This paper aims at designing feasible taxation rules for pension schemes which are neutral in the context of a comprehensive income tax system; the yardstick being the Johansson-Samuelson tax that taxes true economic income from all investments and savings (Preinreich 1951, Samuelson 1964, Johansson 1969). As the economic income from a pension typically changes every year and, therefore, is complicated to administer, we pay special attention to an alternative method which allows to deduct a share of contributions and to tax a share of pensions that are constant over time. Our approach guarantees tax neutrality especially when future pension benefits – and herewith the pension's rate of return – are unknown during the contribution period. Therefore, it is of special interest for the taxation of PAYGO schemes, where expected pensions not only depend on an individual's expected contribution but also on macroeconomic factors or policy changes.

From an individual's point of view a pension scheme is an investment competing with other savings forms. It is taxed neutrally if its attractiveness compared to alternative investments is the same before and after tax. Taxation that is neutral in a broad sense will not discriminate between investments whose return depends on an individual's survival and other investments whose return is not lifetime-dependent. Neutrality, as we understand it, is not restricted to *ex ante* or expected return[6], but also requires *ex post* neutral taxation of the realized return from the pension scheme.

Our view of public pension schemes as investments is not undisputed. While Börsch-Supan (2000), Homburg (2000), Schnabel (1998) and Wagener (2001) have the same perspective, other authors like Sinn (2000) tend to regard contributions as taxes and benefits as personal subsidies. It could be argued that an individual's labor supply decision determines the participation in a particular pension scheme. In this case, there would be no separate pension decision. Therefore, pensions would have to be taxed like labor income, which in the case of Germany would mean on a cash basis. This would definitely be the case if participation were compulsory for any type of labor – employed, self-employed or civil ser-

[5]For an overview see PricewaterhouseCoopers (1999a, 1999b).

[6]This is the concept presented by Richter (1987) who uses actuarily based present values.

vant. But even then, participation could be avoided by disguising labor income as capital income – a problem widely observed in the Scandinavian system of dual income taxation where tax rates on labor income are higher than those on capital income (Sørensen 1994, Cnossen 1999). From the empirical evidence that individuals try to escape the compulsory pension scheme (Börsch-Supan and Schnabel 1998) follows that the decisions on labor supply und pension participation can be separated. Therefore, interpreting pension schemes as investments seems appropriate.

The paper is organized as follows: In section 2, we refer to the Johansson-Samuelson tax which serves as a yardstick for a neutral comprehensive income tax. The neutral tax base is derived for a deterministic lifetime of the recipient. Section 3 relaxes this restrictive assumption. It deals with tax corrections when either contribution or pension period differ from their expected values. Section 4 shows how tax neutrality can be reached after distorting tax treatment of contributions or pensions. Part 5 summarizes and concludes.

2 Two forms of neutral taxation

2.1 Net present value before tax

The economic attractiveness of a pension scheme is described by its net present value (NPV) which we define as follows:

$$NPV_0 = -NPV_0^C + NPV_0^P = -\sum_{t=1}^{\widehat{T}_C} C_t \,(1+i)^{-t} + \sum_{t=\widehat{T}_C+1}^{\widehat{T}_C+\widehat{T}_P} P_t \,(1+i)^{-t} \tag{1}$$

with
- C_t: contribution in period t
- i: discount rate (before tax)
- NPV_0: NPV of the total cash flow
- NPV_0^C: PV of contributions (before tax)
- NPV_0^P: PV of pensions (before tax)
- P_t: pension in period t
- t: time index
- $\widehat{T}_P$: expected length of pension period
- $\widehat{T}_C$: expected length of contribution period.

Contributions are being paid during $1 \leq t \leq \widehat{T}_C$, after that, in $\widehat{T}_C + 1 \leq t \leq \widehat{T}_C + \widehat{T}_P$, the individual receives the pension benefits, the pension period thus having $\widehat{T}_P$ periods. For reasons of convenience we restrict our analysis to contributions and benefits growing at the constant rates g_C and g_P, respectively:

$$C_t = \begin{cases} (1+g_C)^{t-1}\ C_1 & \text{for } 1 \le t \le \widehat{T}_C \\ 0 & \text{otherwise} \end{cases} \tag{2}$$

$$P_t = \begin{cases} (1+g_P)^{t-\left(\widehat{T}_C+1\right)}\ P_{\widehat{T}_C+1} & \text{for } \widehat{T}_C+1 \le t \le \widehat{T}_C+\widehat{T}_P \\ 0 & \text{otherwise} \end{cases}. \tag{3}$$

Using the annuity factors $a(\cdot)$ equation (1) can be rewritten as:

$$\begin{aligned} NPV_0 &= -C_1 \frac{1-\left(\frac{1+g_C}{1+i}\right)^{\widehat{T}_C}}{i-g_C} + P_{\widehat{T}_C+1} \frac{1-\left(\frac{1+g_P}{1+i}\right)^{\widehat{T}_P}}{i-g_P} (1+i)^{-\widehat{T}_C} \\ &= -C_1 \cdot a\left(i, g_C, \widehat{T}_C\right) + P_{\widehat{T}_C+1} \cdot a\left(i, g_P, \widehat{T}_P\right)(1+i)^{-\widehat{T}_C} \end{aligned} \tag{4}$$

with $a(\cdot)$: annuity factor as a function of discount rate, growth rate and time.

We further assume a constant and proportional income tax rate τ, an immediate and complete loss-offset and a uniform and time-invariant capital market rate i which is used as the discount rate. Contribution period and benefit period are known with certainty. Only later, in section 3, we analyze contribution and benefit periods of length $T_C \neq \widehat{T}_C$ and $T_P \neq \widehat{T}_P$, respectively.

2.2 Neutrality condition when future benefits are unknown

The Johansson-Samuelson tax – which is the ideal form of a neutral comprehensive income tax – ensures neutrality by economic depreciation of all investments. As a consequence, PVs, the decision criterion for investment alternatives, are invariant with respect to tax rates, which implies that PVs before tax ($\tau = 0$) and after tax ($\tau > 0$) are equal:

$$NPV_0^\tau = NPV_0. \tag{5}$$

A sufficient condition for equation (5) is the identity of the tax base and economic income in each period. Economic income is defined as the return i on the PV_{t-1} of an investment at the beginning of the period: $\pi_t = i \cdot PV_{t-1}$. Obviously, the PV is a function of *all* future cash flows, i.e., contributions and benefits. As future benefits of a PAYGO scheme are typically unknown during the contribution period, the neutral tax base in the contribution period cannot be calculated. Therefore, we use the fact that invariance of the PV for the constant discount rate i and the tax rate τ is also given if the PV of all tax bases equals the PV of economic income over the total investment period. We split up the total cash flow into two components: contributions and benefits, and compute PVs for both periods separately. This does not require any assumption about the relative weight of contributions vs. benefits or – in other words – about the return on contributions. Thus, our modified sufficient condition for neutrality is:

$$NPV_0^C = NPV_0^{C,\tau} \ \wedge \ NPV_0^P = NPV_0^{P,\tau} \ \Rightarrow \ NPV_0 = NPV_0^{\tau}. \tag{6}$$

In detailed form, the after-tax NPV of contributions and benefits is:

$$NPV_0^{\tau} = -NPV_0^{C,\tau} + NPV_0^{P,\tau} \tag{7}$$

$$= -C_1^{\tau}\, a\left(i_\tau, g_C, \widehat{T}_C\right) + \frac{P^{\tau}_{\widehat{T}_C+1}\, a\left(i_\tau, g_P, \widehat{T}_P\right)}{(1+i_\tau)^{\widehat{T}_C}} \tag{8}$$

with
C_t^{τ}: contribution after tax in period t
$i_\tau = i(1-\tau)$: discount rate after tax
NPV_0^{τ}: total NPV after tax
$NPV_0^{C,\tau}$: PV after tax of contributions
$NPV_0^{P,\tau}$: PV after tax of benefits
P_t^{τ}: pension benefit after tax in period t.

In the following sections we describe two different forms of a neutral tax on the pension scheme, which are both based on the idea of separating PVs of contributions and benefits.

2.3 Taxing economic income

If taxing economic income π_t delivers a tax rate-invariant PV of the total investment, the same must hold true when applied to the contributions only. The PV at time $t \in \left[0, \widehat{T}_C\right]$ of the *remaining* pre-tax contribution cash flow $\left\{-C_{t+1}, -C_{t+2}, \dots, -C_{\widehat{T}_C}\right\}$ is:

$$PV_t^C = -C_1 \sum_{\tau=t+1}^{\widehat{T}_C} \frac{(1+g_C)^{\tau-1}}{(1+i)^{\tau-t}} = -C_1\,(1+i)^t\, \frac{\left(\frac{1+g_C}{1+i}\right)^t - \left(\frac{1+g_C}{1+i}\right)^{\widehat{T}_C}}{i-g_C}$$

$$= -C_1 \frac{(1+g_C)^t \left[1 - \left(\frac{1+g_C}{1+i}\right)^{\widehat{T}_C - t}\right]}{i-g_C}, \tag{9}$$

and the PV at time $t-1$ is:

$$PV_{t-1}^C = -C_1 \frac{(1+g_C)^{t-1} \left[1 - \left(\frac{1+g_C}{1+i}\right)^{\widehat{T}_C-(t-1)}\right]}{i-g_C}. \tag{10}$$

Inserting PV_{t-1}^C yields the expression for the economic income from contributions π_t^C, i.e., the neutral tax base at date t of the contribution period:

$$\pi_t^C = i\, PV_{t-1}^C = -i\, C_1\,(1+g_C)^{t-1}\, a\left(i, g_C, \widehat{T}_C - (t-1)\right). \tag{11}$$

Economic income from contributions is negative at any date $0 < t \leq \widehat{T}_C$ given the fact that all contributions and their PV are negative. Calculating the PV of all (negative) tax payments from contributions on the tax base (11) results in[7]:

$$TaxPV\left(\pi^C\right) = -C_1\left[a\left(i_\tau, g_C, \widehat{T}_C\right) - a\left(i, g_C, \widehat{T}_C\right)\right]. \tag{12}$$

Equation (12) has an obvious interpretation: the PV of the neutral tax burden is the difference between pre-tax contributions discounted at the after-tax rate and the pre-tax rate, respectively. Since $i_\tau < i$ implies $a\left(i_\tau, g_C, \widehat{T}_C\right) > a\left(i, g_C, \widehat{T}_C\right)$, the PV of taxes for the contribution period is negative. Thus, in sum, the PV of contributions after tax equals the one before tax, and we have proven that condition (6) holds for the contribution part of the pension scheme.

Analogously, economic income from the cash flow of *benefits* π_t^P can be derived through the expressions for the pre-tax PV of the pension benefits discounted to date t and $t-1$, respectively:

$$\begin{aligned}\pi_t^P &= i\,PV_{t-1}^P \\ &= \begin{cases} i\,P_{\widehat{T}_C+1}\left(1+g_P\right)^{t-1-\widehat{T}_C} a\left(i, g_P, \left(\widehat{T}_P + \widehat{T}_C\right) - (t-1)\right) & \text{for } \widehat{T}_C + 1 \leq t \leq \widehat{T}_C + \widehat{T}_P \\ i\,P_{\widehat{T}_C+1}\left(1+i\right)^{t-1-\widehat{T}_C} a\left(i, g_P, \widehat{T}_P\right) & \text{for } 1 \leq t \leq \widehat{T}_C. \end{cases}\end{aligned} \tag{13}$$

This term is always positive. There is a positive tax base already in the contribution phase $1 \leq t \leq \widehat{T}_C$ as the PV of the benefit stream is compounding by $(1+i)$. This positive imputed income at each date of the contribution phase has to be added to the (negative) tax base from contributions (11). Obviously, this can only be done if the level of future pension benefits is known at any date $1 \leq t \leq \widehat{T}_C$ of the contribution phase. If this is not the case, there are at least two ways to ensure neutrality: wait until the PV of pensions is certain and recover taxes then, or make preliminary assumptions about $P_{\widehat{T}_C+1}, g_P$, and $\widehat{T}_P$ and correct them as soon as actual figures are known. The advantage of taxation based on estimated parameters would be to level tax payments over time as the positive tax base could be offset against the negative tax base from contributions at every date of the contribution phase. In contrast, waiting until pensions are paid is more in line with traditional tax legislation and tax payers' intuition as tax payments are not triggered by the accrual of unfunded and somewhat shaky claims. Such a technique of postponed taxation is developed in the following section.

[7]The derivation is given in the appendix.

The NPV at date $t = 0$ of all taxes paid on the economic income from pension benefits during the contribution and benefit phase is[8]:

$$TaxPV\left(\pi^P\right) = \sum_{t=1}^{\widehat{T}_P+\widehat{T}_C} \frac{\tau\, \pi_t^P}{\left(1+i_\tau\right)^t} = P_{\widehat{T}_C+1}\left[\frac{a\left(i_\tau, g_P, \widehat{T}_P\right)}{\left(1+i_\tau\right)^{\widehat{T}_C}} - \frac{a\left(i, g_P, \widehat{T}_P\right)}{\left(1+i\right)^{\widehat{T}_C}}\right]. \tag{14}$$

Again, taxes are the difference between the PVs of the cash flow discounted at the rates after and before tax, respectively. This is equivalent to (12) for contributions, the only difference being an additional discount from date $t = \widehat{T}_C$, the beginning of the benefit phase, to $t = 0$, the point of reference.

2.4 Taxing a constant share of contributions and pensions

As economic income does not directly depend on the cash income or payment of the period but rather on the PV of the remaining cash flow after the current tax date, the concept is rather complicated to administer and difficult to understand for taxpayers. Obviously, it would be much more convenient to have a tax base that is directly linked to the payments – contribution or benefit – of the same period as a constant share of it. Actually, this type of tax rule can be observed in some countries' legislation: Under US law, the employer's share of contributions to a pension scheme is tax deductible while the employee's contributions are deductible only for particular pension schemes and up to legally specified limits (Sec. 401 ff. IRC). By comparison, under German tax law, pension benefits and other annuities received are taxable to a percentage that depends on the expected length of the annuity phase (§ 22 EStG). In our context of neutral pension taxation two issues arise, a theoretical and a practical one: first, we explore what neutral constant-share taxation would look like, second, we use our findings to evaluate whether actual taxation of the obligatory German pension scheme complies with the neutrality conditions and thus can be regarded as systematically correct.

As we have argued before, it is only sufficient, but not necessary for neutral income taxation that the tax base in each period is equal to economic income. A less restrictive condition is the identity of PVs of economic income with the tax bases to be defined, or – which is equivalent for a constant tax rate – identity of the PV of taxes paid under both rules. We assume a constant share $\alpha_{\widehat{T}_C}$ of contributions to be tax-deductible and a constant share of pension benefits $\beta_{\widehat{T}_C,\widehat{T}_P}$ to be taxable income. After-tax contributions

[8]This can be derived in analogy to (12) with an additional discounting to the point of reference $t = 0$.

and benefits thus can be written as:

$$C_t^\tau = \left(1 - \tau\, \alpha_{\widehat{T}_C}\right) C_t \tag{15}$$

$$P_t^\tau = \left(1 - \tau\, \beta_{\widehat{T}_C,\widehat{T}_P}\right) P_t. \tag{16}$$

Using these expressions the after-tax PV of the tax scheme can be reformulated as:

$$\begin{aligned} NPV_0^\tau &= NPV_0^{C,\tau} + NPV_0^{P,\tau} \\ &= -\left(1 - \tau\, \alpha_{\widehat{T}_C}\right) C_1\, a\left(i_\tau, g_C, \widehat{T}_C\right) + \left(1 - \tau\, \beta_{\widehat{T}_C,\widehat{T}_P}\right) P_{\widehat{T}_C+1} \frac{a\left(i_\tau, g_P, \widehat{T}_P\right)}{\left(1+i_\tau\right)^{\widehat{T}_C}} \end{aligned} \tag{17}$$

with $\alpha_{\widehat{T}_C}$: constant share of contributions for (expected) contribution phase $\widehat{T}_C$
$\beta_{\widehat{T}_C,\widehat{T}_P}$: constant share of pension benefits for (expected) benefit phase $\widehat{T}_P$.

Again, we have to look at the two phases separately since we still assume the level of benefits to be unknown during the contribution phase. If benefits are known at date $t = 0$ there exists more than one solution for $NPV_0^\tau \overset{!}{=} NPV_0$. Tax authorities would thus be free to set one of the two parameters $\beta_{\widehat{T}_C,\widehat{T}_P}$ and $\alpha_{\widehat{T}_C}$. An increased share of deductible contributions could then be offset through a higher taxable share of pensions. We start with contributions and equate PVs before and after taxes

$$-C_1\, a\left(i, g_C, \widehat{T}_C\right) = -\left(1 - \tau\, \alpha_{\widehat{T}_C}\right) C_1\, a\left(i_\tau, g_C, \widehat{T}_C\right) \tag{18}$$

to arrive at the deductible share of contributions:

$$\alpha_{\widehat{T}_C} = \frac{1}{\tau}\left[1 - \frac{a\left(i, g_C, \widehat{T}_C\right)}{a\left(i_\tau, g_C, \widehat{T}_C\right)}\right], \tag{19}$$

with $\alpha_{\widehat{T}_C} > 0$ for all tax rates $0 < \tau < 1$ as $a\left(i, g_C, \widehat{T}_C\right) < a\left(i_\tau, g_C, \widehat{T}_C\right)$. A positive share of contribution payments results in a negative tax payment or tax reimbursement. $\alpha_{\widehat{T}_C}$ has to be set once, at the beginning of the contribution phase, and can then be applied to calculate the deductible share of all future contributions. The second element of the sum on the right hand side of equation (18) is the PV of the tax payments:

$$TaxPV\left(\alpha_{\widehat{T}_C}\right) = -C_1\left[a\left(i_\tau, g_C, \widehat{T}_C\right) - a\left(i, g_C, \widehat{T}_C\right)\right]. \tag{20}$$

As expected, it is equal to the PV of taxes on the economic income from contributions, given in equation (12). Another way of deriving $\alpha_{\widehat{T}_C}$ is equating the PVs of taxes on $\alpha_{\widehat{T}_C}$ and on economic income[9].

[9] For the complete calculus hereof see Kiesewetter and Niemann (2001).

Figure 1 illustrates equation (19) for contribution periods of one through fifty years and for contributions constant over time (solid line) and growing by $g_C = 4\%$ annually (dotted line), respectively. We assume a tax rate of $\tau = 30\%$. For $g_C = 4\%$ the neutral deductible contribution share $\alpha_{\widehat{T}_C}$ is in the range of 63% to 80% for contribution phases between 30 and 40 years. This is approximately the deductible fraction of total contributions paid by employers and employees under German tax law[10].

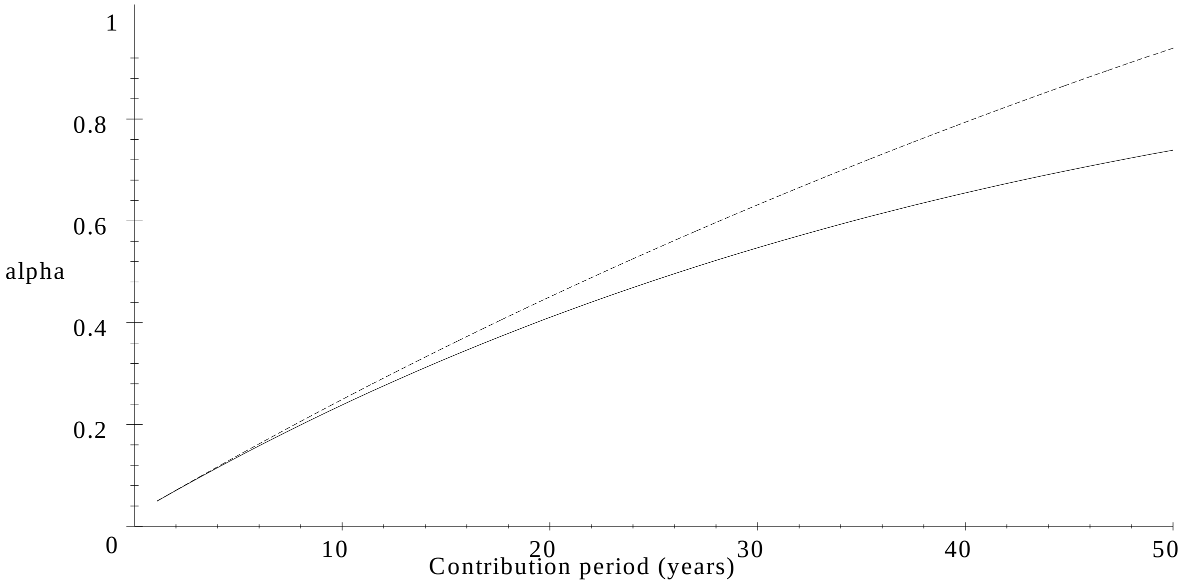

Figure 1: Neutral deductible share $\alpha_{\widehat{T}_C}$ as a function of the contribution period $\widehat{T}_C$

———————: decuctible share of contributions $\alpha_{\widehat{T}_C}$ for $\tau = 30\%$, $i = 5\%$ and $g_C = 0$

– – – – – – – –: decuctible share of contributions $\alpha_{\widehat{T}_C}$ for $\tau = 30\%, i = 5\%$ and $g_C = 4\%$

The taxable share of pension benefits $\beta_{\widehat{T}_C,\widehat{T}_P}$ can be derived in the same way as $\alpha_{\widehat{T}_C}$, equating PVs of pensions before and after tax[11]:

$$P_{\widehat{T}_C+1} \frac{a\left(i, g_P, \widehat{T}_P\right)}{(1+i)^{\widehat{T}_C}} = \left(1 - \tau\, \beta_{\widehat{T}_C,\widehat{T}_P}\right)\, P_{\widehat{T}_C+1} \frac{a\left(i_\tau, g_P, \widehat{T}_P\right)}{(1+i_\tau)^{\widehat{T}_C}}. \tag{21}$$

[10]Most authors estimate that about 70 percent of total contributions are deductible on average; Wellisch (2001), p. 287 and Wiegard (2000), p. 9. By German tax law, employers' contributions are fully deductible, and employees' contributions can be deducted up to a limit which depends on individual circumstances, § 10 (3) EStG. For an overview see PricewaterhouseCoopers (1999b), p. 148.

[11]Again, the equivalent but more complicated way of equating present values of taxes on the share $\beta_{\widehat{T}_C,\widehat{T}_P}$ of benefits and on the economic income from benefits is presented in Kiesewetter and Niemann (2001).

Solving for $\beta_{\widehat{T}_C,\widehat{T}_P}$ yields the following expression for the taxable share of pension benefits:

$$\beta_{\widehat{T}_C,\widehat{T}_P} = \frac{1}{\tau}\left[1 - \left(\frac{1+i_\tau}{1+i}\right)^{\widehat{T}_C} \frac{a\left(i, g_P, \widehat{T}_P\right)}{a\left(i_\tau, g_P, \widehat{T}_P\right)}\right]. \tag{22}$$

As $\beta_{\widehat{T}_C,\widehat{T}_P}$ is positive for all tax rates $0 < \tau < 1$ every positive pension payment results in a positive tax base and tax payment. The taxable share of pensions is an increasing function of the *contribution* period $\widehat{T}_C$:

$$\frac{\partial \beta_{\widehat{T}_C,\widehat{T}_P}}{\partial \widehat{T}_C} = -\frac{1}{\tau}\frac{a\left(i, g_P, \widehat{T}_P\right)}{a\left(i_\tau, g_P, \widehat{T}_P\right)}\left(\frac{1+i_\tau}{1+i}\right)^{\widehat{T}_C} \ln\left(\frac{1+i_\tau}{1+i}\right) > 0. \tag{23}$$

The economic explanation for (23) is easy: because we don't tax the economic income from (future) pensions during the contribution phase we have to compensate for these taxes later, when taxing the share $\beta_{\widehat{T}_C,\widehat{T}_P}$ of pension payments. The longer the contribution period the bigger the accumulated, hitherto untaxed appreciations of the PV of pensions we have to make up for.

Figure 2 denotes the neutral taxable share of pensions according to equation (22) for pension periods of 1 to 30 years. Pensions are constant (solid line) and growing by $g_P =$ 1.5% p.a. (dotted line), respectively. As in the previous example, the other parameters are $\tau = 30\%$ and $i = 5\%$. We assume pension payments after a contribution period of $T_C = 35$. Unlike the deductions for contributions these neutral tax bases are much higher than the taxable pension income under German income tax law. For an expected pension period of 14 years[12], e.g., the neutral tax base is approximately 150% of pension benefits instead of the actual taxable share of pension benefits of 27%. This high fraction is due to the fact that $\beta_{T_C,\widehat{T}_P}$ is an increasing function of the contribution period T_C preceeding pension payments. In contrast, the legal definition of the tax base does not depend on the contribution period in any way.

[12] According to the mortality statistics for Germany 1986/88 underlying the German tax code, this corresponds to a pension age of 65 years of a male recipient. See § 14 and appendix 9 BewG (Bewertungsgesetz, German law on the assessment of assets and liabilities).

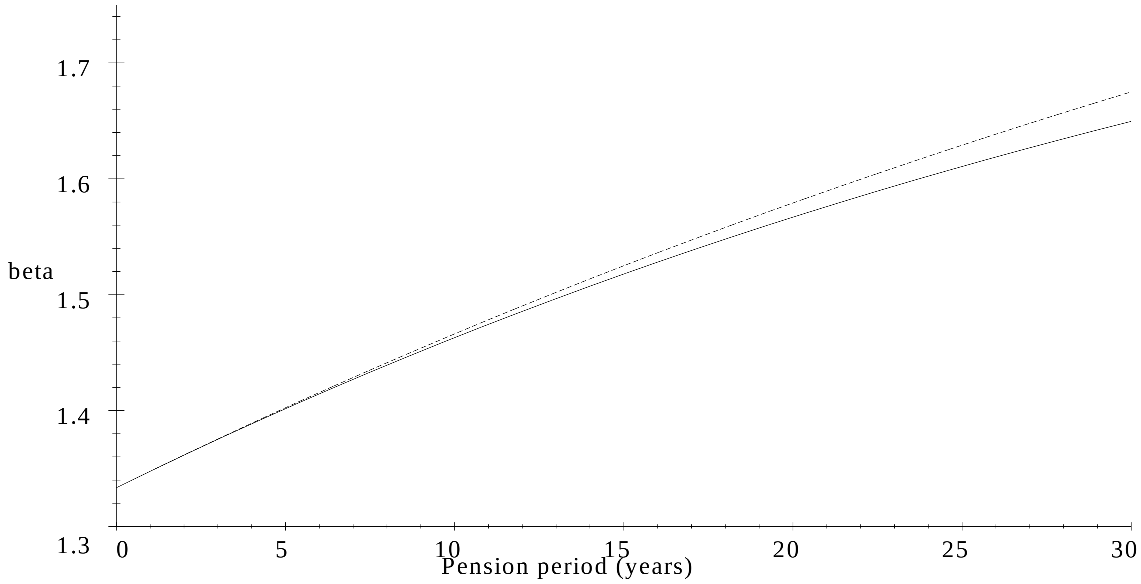

Figure 2: Neutral taxable share $\beta_{T_C,\widehat{T}_P}$ as a function of the pension period $\widehat{T}_P$

——————: taxable share of pensions $\beta_{T_C,\widehat{T}_P}$ for $T_C = 35$, $\tau = 30\%$, $i = 5\%$ and $g_P = 0$

– – – – – – – –: taxable share of pensions $\beta_{T_C,\widehat{T}_P}$ for $T_C = 35$, $\tau = 30\%, i = 5\%$ and $g_P = 1.5\%$

3 Ex post neutral taxation when contribution or pension periods are uncertain

Both methods of taxing pension contributions and benefits derived in the previous section are neutral if and only if the duration of the contribution and benefit phases are known with certainty. This is rather unlikely for public pension schemes and, in part, for privately contracted annuity plans. Depending on the specifics of a public pension scheme, there may be contribution-free times during a participant's active phase and future benefits not only depend on the contribution history but also on macroeconomic factors or the actual policy when a participant enters the benefit phase. But undoubtedly, the most important reason for deviations of actual from expected pension durations is the fact that an individual's lifetime may be longer or shorter than the average life expectancy of his/her cohort.

Given these uncertainties, taxation of pension schemes based on average assumptions on the contribution phase $\widehat{T}_C$ and the pension phase $\widehat{T}_P$ will not be neutral in many cases. Individuals who have different assumptions or knowledge about their retirement age and life expectancy will thus not be indifferent between a pension scheme and a pre-tax equally profitable long-term investment which is not lifetime-dependent even if the tax parameters are actuarily correct on average. An individual who expects to outlive the average would favor a pension plan because of non-neutral taxation. Neglecting this restricts the neutrality concept considerably to a mere ex ante decision neutrality for "average" individuals. Theoretically, neutrality could be reached be applying subjective instead of statistical life expectancies. Individual ex ante assessment of taxpayers, though, is not feasible for three reasons: administrative efficiency, legal certainty, and non-revelation of individual beliefs. Instead, ex post corrections are practicable and can be anticipated by taxpayers when deciding on their investments.

Furthermore, ex ante neutrality does not guarantee equal taxation of equal cash flows. A participant who was expected to receive pension benefits during 14 years but dies after 10 years would have to pay higher taxes than a participant receiving the same pension payment and whose actual and expected pension phase is 10 years. Another taxpayer receiving benefits for 10 years who was expected to live for only 6 years would pay still less. Contrary to this, ex post tax correction for deviating contribution or benefit phases can ensure invariance of the NPV in all cases thus ensuring neutrality *and* equity. This concept guarantees tax neutrality for individuals with biased as well as unbiased expectations of their own lifetime irrespective of whether these expectations prove right or wrong.

3.1 Correcting for a differing contribution phase

We assume that a share of contribution payments $\alpha_{\widehat{T}_C}$ has been deducted. If the actual contribution phase lasts $T_C \neq \widehat{T}_C$ periods a corrective additional tax payment must be calculated such that the PV of tax payments is neutral with respect to T_C periods[13]. Tax correction can be done through a one-off payment or through periodical additional payments.

3.1.1 One-off correction

The PV of neutral taxation of a contribution phase of $T_C \neq \widehat{T}_C$ periods is:

$$TaxPV_{T_C}^{neutral} = -C_1 \left[a\left(i_\tau, g_C, T_C\right) - a\left(i, g_C, T_C\right)\right]. \tag{24}$$

[13]The correction technique presented here ca be regarded as a special case for taxing annuities of a more general approach developed by König (1997).

Effectively paid (here: received) taxes based on the deductible share $\alpha_{\widehat{T}_C}$ during T_C periods have a PV of:

$$\begin{aligned} TaxPV^{actual}_{T_C} &= -C_1\,\tau\,\alpha_{\widehat{T}_C}\,a\left(i_\tau, g_C, T_C\right) \\ &= -C_1\left[a\left(i_\tau, g_C, T_C\right) - a\left(i, g_C, \widehat{T}_C\right)\frac{a\left(i_\tau, g_C, T_C\right)}{a\left(i_\tau, g_C, \widehat{T}_C\right)}\right]. \end{aligned} \tag{25}$$

The PV of the corrective tax payment in $t = T_C$ is the difference between these terms compounded by $(1+i_\tau)^{T_C}$ to:

$$\Delta_\alpha^{T_C/\widehat{T}_C} = (1+i_\tau)^{T_C}\; C_1\left[a\left(i, g_C, T_C\right) - a\left(i, g_C, \widehat{T}_C\right)\frac{a\left(i_\tau, g_C, T_C\right)}{a\left(i_\tau, g_C, \widehat{T}_C\right)}\right] \tag{26}$$

with $\Delta_\alpha^{T_C/\widehat{T}_C}$: Corrective tax payment to ensure ex post neutrality.

$\Delta_\alpha^{T_C/\widehat{T}_C}$ is positive for a shorter contribution phase $T_C < \widehat{T}_C$. For a longer contribution phase $T_C > \widehat{T}_C$, the deductible share leading to neutrality α_{T_C} is greater than $\alpha_{\widehat{T}_C}$ which had been applied for the taxation of contributions, and the participant receives a one-off reimbursement of overpaid taxes.

3.1.2 Periodic correction

When the actual contribution phase is longer than expected, i.e., $T_C > \widehat{T}_C$, a periodic tax correction could be made instead of the one-off reimbursement $\Delta_\alpha^{T_C/\widehat{T}_C}$. We derive the periodic corrective payment assuming that the contribution phase is extended by one period to $\widehat{T}_C + 1$ instead of $\widehat{T}_C$ periods. The neutral PV of tax deductions for $T_C = \widehat{T}_C + 1$ is:

$$TaxPV^{neutral}_{\widehat{T}_C+1} = -C_1\left[a\left(i_\tau, g_C, \widehat{T}_C+1\right) - a\left(i, g_C, \widehat{T}_C+1\right)\right]. \tag{27}$$

The neutral deductions for a $\widehat{T}_C$-period phase, which have been granted hitherto, have a PV of:

$$TaxPV^{neutral}_{\widehat{T}_C} = -C_1\left[a\left(i_\tau, g_C, \widehat{T}_C\right) - a\left(i, g_C, \widehat{T}_C\right)\right]. \tag{28}$$

The difference gives the PV of the neutral tax deduction in $\widehat{T}_C + 1$[14]:

$$\begin{aligned} & TaxPV^{neutral}_{\widehat{T}_C+1} - TaxPV^{neutral}_{\widehat{T}_C} \\ = \; & -C_1\left(1+g_C\right)^{\widehat{T}_C}\left[\left(1+i_\tau\right)^{-\left(\widehat{T}_C+1\right)} - \left(1+i\right)^{-\left(\widehat{T}_C+1\right)}\right]. \end{aligned} \tag{29}$$

[14]See appendix B for the derivation.

Compounding it to the date of payment results in the tax reimbursement in period $\widehat{T}_C+1$:

$$-C_1\ (1+g_C)^{\widehat{T}_C}\ \left[1-\left(\frac{1+i_\tau}{1+i}\right)^{\widehat{T}_C+1}\right]. \tag{30}$$

The additional reimbursement must be calculated if at date $\widehat{T}_C+1$ a tax deduction based on $\alpha_{\widehat{T}_C}$ has already been granted. This is the difference between the neutral tax in $\widehat{T}_C+1$ and the amount already granted. The latter is:

$$-\tau\, C_1\ (1+g_C)^{\widehat{T}_C}\ \alpha_{\widehat{T}_C} = -C_1\ (1+g_C)^{\widehat{T}_C}\ \left[1-\frac{a\left(i,g_C,\widehat{T}_C\right)}{a\left(i_\tau,g_C,\widehat{T}_C\right)}\right]. \tag{31}$$

The remaining reimbursement after subtracting this is:

$$\Delta_\alpha^{\widehat{T}_C+1/\widehat{T}_C} = -C_1\ (1+g_C)^{\widehat{T}_C}\ \left[\frac{a\left(i,g_C,\widehat{T}_C\right)}{a\left(i_\tau,g_C,\widehat{T}_C\right)}-\left(\frac{1+i_\tau}{1+i}\right)^{\widehat{T}_C+1}\right]. \tag{32}$$

3.2 Correcting for a differing benefit phase

At the beginning of the benefit phase following a contribution phase of T_C periods the taxable share will be set as:

$$\beta_{T_C,\widehat{T}_P} = \frac{1}{\tau}\left[1-\left(\frac{1+i_\tau}{1+i}\right)^{T_C}\ \frac{a\left(i,g_P,\widehat{T}_P\right)}{a\left(i_\tau,g_P,\widehat{T}_P\right)}\right]. \tag{33}$$

For $T_C \neq \widehat{T}_C$ this expression differs from $\beta_{\widehat{T}_C,\widehat{T}_P}$ under certainty, which was given in equation (22), because it is a function of the length of the preceeding contribution period. The realized duration T_C now replaces $\widehat{T}_C$[15]. Note that (33) is an increasing function of T_C but does not depend on the amount of the contributions paid. In most cases, the actual benefit period T_P will differ from the assumed $\widehat{T}_P$. Thus, having taxed a share $\beta_{T_C,\widehat{T}_P}$ of pension payments requires an ex post correction for neutrality.

3.2.1 One-off correction

The PV of the neutral tax on pension benefits paid from $t=T_C+1$ through $t=T_C+T_P$ is:

$$TaxPV_{T_C,T_P}^{neutral} = P_{T_C+1}\left[\frac{a\left(i_\tau,g_P,T_P\right)}{(1+i_\tau)^{T_C}}-\frac{a\left(i,g_P,T_P\right)}{(1+i)^{T_C}}\right], \tag{34}$$

[15]In the basic case we assume the remaining life expectancy of a tax payer to be $\widehat{T}_P$ when entering the benefit phase after a $\widehat{T}_C$-period contribution. For a contribution phase of $T_C \neq \widehat{T}_C$ the remaining life expectancy thus will be $\widehat{T}_P-\widehat{T}_C+T_C$ rather than $\widehat{T}_P$. Therefore, it could be argued that the taxable share of pensions should be fixed as $\beta_{T_C,(\widehat{T}_P-\widehat{T}_C+T_C)}$ instead of $\beta_{T_C,\widehat{T}_P}$. Whatever the value for $\widehat{T}_P$, tax corrections will be necessary in most cases as almost nobody exactly realizes the expected lifetime.

and the PV of the taxes actually levied is:

$$\begin{aligned} TaxPV^{actual}_{T_C,\widehat{T}_P} &= \tau\,\beta_{T_C,\widehat{T}_P}\,P_{T_C+1}\frac{a\left(i_\tau,g_P,T_P\right)}{\left(1+i_\tau\right)^{T_C}} \\ &= P_{T_C+1}\left[\frac{a\left(i_\tau,g_P,T_P\right)}{\left(1+i_\tau\right)^{T_C}}-\frac{a\left(i,g_P,\widehat{T}_P\right)}{\left(1+i\right)^{T_C}}\,\frac{a\left(i_\tau,g_P,T_P\right)}{a\left(i_\tau,g_P,\widehat{T}_P\right)}\right]. \end{aligned} \tag{35}$$

Hence, we get the corrective tax payment by compounding the difference of (34) and (35) to date $t = T_C + T_P$, when the payment is made:

$$\Delta_\beta^{T_P/\widehat{T}_P} = \frac{\left(1+i_\tau\right)^{T_P+T_C}}{\left(1+i\right)^{T_C}}\,P_{T_C+1}\left[a\left(i,g_P,\widehat{T}_P\right)\,\frac{a\left(i_\tau,g_P,T_P\right)}{a\left(i_\tau,g_P,\widehat{T}_P\right)}-a\left(i,g_P,T_P\right)\right]. \tag{36}$$

$\Delta_\beta^{\widehat{T}_P+1/\widehat{T}_P} > 0$ results in an additional tax payment for longer pension phases $T_P > \widehat{T}_P$. If pension payments end earlier than assumed, then $\Delta_\beta^{\widehat{T}_P+1/\widehat{T}_P} < 0$ and taxes have to be paid back. As this reimbursement takes place at the death of the taxpayer we must assume that payments to heirs yield the same utility as payments to the taxpayer.

3.2.2 Periodic correction

During the benefit phase regular tax payments are always positive. The taxable income from pension payments is an increasing function of the length of the pension phase. In other words: the longer pensions are paid, the higher the neutral taxable share $\beta_{T_C,\widehat{T}_P}$. Thus, there will be an additional tax payment if the pension phase proves to be longer than assumed. If the actual period T_P is much longer than $\widehat{T}_P$ the one-off corrective tax payment may easily exceed the last pension payment itself. Therefore, a periodic tax correction for longer than expected pension periods is of practical interest. This can be derived in complete analogy to the periodic correction of taxation of contributions. The neutral tax payment in period $t = T_C + \widehat{T}_P + 1$ is:

$$P_{T_C+1}\,\left(1+g_P\right)^{\widehat{T}_P}\,\left[1-\left(\frac{1+i_\tau}{1+i}\right)^{T_C+\widehat{T}_P+1}\right]. \tag{37}$$

If at date $t = T_C + \widehat{T}_P + 1$ taxes have already been levied on the basis of $\beta_{T_C,\widehat{T}_P}$ as it has been fixed ex ante, only the difference between this and (37) must be paid on top:

$$\Delta_\beta^{\widehat{T}_P+1/\widehat{T}_P} = P_{T_C+1}\,\left(1+g_P\right)^{\widehat{T}_P}\,\left(\frac{1+i_\tau}{1+i}\right)^{T_C}\left[\frac{a\left(i,g_P,\widehat{T}_P\right)}{a\left(i_\tau,g_P,\widehat{T}_P\right)}-\left(\frac{1+i_\tau}{1+i}\right)^{\widehat{T}_P+1}\right]. \tag{38}$$

4 Ex post neutrality after arbitrary treatment of contributions

In the previous section we have presented a tax correction technique in order to ensure ex post neutrality when the contribution or benefit phases differ from the assumed underlying tax parameters. Obviously, the same technique works not only for differing durations but also for any other deviation from neutral taxation. There is one case of practical importance: taxation of pension schemes according to existing, non-neutral legislation can ex post be converted into a neutral tax.

We assume a non-neutral share α_G of contributions to be deductible and a non-neutral share β_G of benefits to be taxable. As they will typically differ from the neutral shares α_{T_C} and β_{T_C,T_P} tax corrections will be necessary for every participant.

The PV of neutral taxes on contributions is defined as before:

$$TaxPV_{T_C}^{neutral} = -C_1 \left[a\left(i_\tau, g_C, T_C\right) - a\left(i, g_C, T_C\right) \right], \tag{39}$$

the PV of actual taxes during T_C periods is:

$$TaxPV_{T_C}^{actual} = -\tau\, \alpha_G\, C_1\, a\left(i_\tau, g_C, T_C\right). \tag{40}$$

Compounding the difference to the date of payment $t = T_C$ yields:

$$\begin{aligned} \Delta_{\alpha_G/\alpha}^{T_C} &= (1+i_\tau)^{T_C} \left(TaxPV_{T_C}^{neutral} - TaxPV_{T_C}^{actual} \right) \\ &= -C_1\, (1+i_\tau)^{T_C} \left[(1-\tau\, \alpha_G)\, a\left(i_\tau, g_C, T_C\right) - a\left(i, g_C, T_C\right) \right]. \end{aligned} \tag{41}$$

Correcting taxation on benefits will take place at date $t = T_C + T_P$, when the last pension payment is made. We have derived the PV of the neutral tax as:

$$TaxPV_{T_C,T_P}^{neutral} = P_{T_C+1} \left[\frac{a\left(i_\tau, g_P, T_P\right)}{(1+i_\tau)^{T_C}} - \frac{a\left(i, g_P, T_P\right)}{(1+i)^{T_C}} \right], \tag{42}$$

whereas the PV of taxes actually paid is:

$$TaxPV_{T_C,T_P}^{actual} = \tau\, \beta_G\, P_{T_C+1} \frac{a\left(i_\tau, g_P, T_P\right)}{(1+i_\tau)^{T_C}}. \tag{43}$$

Subtracting and compounding yields the corrective tax payment at $t = T_C + T_P$:

$$\Delta_{\beta_G/\beta}^{T_P/\widehat{T}_P} = (1+i_\tau)^{T_C+T_P}\; P_{T_C+1} \left[\frac{(1-\tau\, \beta_G)\; a\left(i_\tau, g_P, T_P\right)}{(1+i_\tau)^{T_C}} - \frac{a\left(i, g_P, T_P\right)}{(1+i)^{T_C}} \right]. \tag{44}$$

5 Conclusions

In this paper, we have shown two different ways of levying an ex post neutral income tax on pension schemes, which are equivalent under certainty about future pension benefits and the duration of the contribution and the benefit phases. However, it is a general problem of public PAYGO pension schemes that future benefits are uncertain throughout the entire contribution phase. Demographic and other macroeconomic trends as well as possible policy shifts make benefits hard to predict. Furthermore, the return of a pension scheme typically depends on various individual factors like the cohort the participant belongs to, gender, possible survivor benefits, etc.

To arrive at a tax that is equivalent to a Johansson-Samuelson tax in PV terms, we suggest to tax a constant share of benefits which is a function of the amount and future growth of the annuity, its expected duration, the capital market rate and the individual's marginal tax rate. By doing so, the same tax burden is realized as would result from taxing economic income from the pension benefits, starting in period one of the *contribution* phase. In contrast to this, taxation of a constant share of benefits starts only at the beginning of the pension phase, when the amount to be received is known.

In addition, economic income from the cash flow of contributions has to be taxed in the same way. As these payments are negative, so is economic income, i.e., the tax base from contributions, leading to a tax reimbursement in each period of the contribution phase. Two methods are applicable: taxing economic income or a constant deductible share of contributions. Since economic income has to be calculated for each period, it is the more complex concept.

A common problem of our solutions is the necessity to make assumptions about the length of contribution and benefit phases. If these are uncertain, it is necessary to adjust taxation ex post in order to reach neutrality defined in a broad sense. In reality, some more determinants of the neutral tax are uncertain and must be assumed, among them the market rate of interest or the individual's tax rate. Therefore, a feasible tax base can only approximate economic income, although, theoretically, a tax correction could be made for any deviation from neutral taxation, not only those caused by the time aspect we have focussed on.

Comparing our findings to actual tax legislation on pensions in Germany shows that the latter cannot even serve as a rough approximation of a Johansson-Samuelson tax.

Rather, it resembles some kind of modified cash flow tax. This is the declared aim of the newly introduced chapter on the taxation of the new, funded Riester pension scheme. However, taxation of the PAYGO scheme which has been practiced for more than forty years has unintentionally had a similar effect for an average participant: about two thirds of contributions of an average participant are deductible and about one third of pension benefits are treated as taxable income. This means that most of the return on probably the biggest part of long-term savings of German taxpayers has never been subject to tax, whereas most other capital income is fully taxable under German tax law.

Our paper shows a way to reform pension taxation in order to bring it in line with a comprehensive income tax. As a consequence, the tax burden on pension income would rise dramatically given current income tax rates. For an average retiree the taxable income from benefits would have to be approximately five times higher than the actual tax base. That this was politically inacceptable even in the better days of the German PAYGO scheme may very well be the explanation for the persistence of an element of consumption taxation in a tax code whose official paradigm during half a century has been and still seems to be to tax marginal return on capital as regular income.

Given the enormous tax rise and its hardly predictable effects on people's savings decisions, the question arises whether taxing economic income can be a model for tax reform at all. If the answer is no, the conclusion must be to tax consumption instead of income through some type of cash flow or ACE tax. This, of course, would concern any source of income, not only pensions.

Appendix

A Present value of neutral taxes on contributions

The PV of neutral taxes on economic income from contributions (12) is given by:

$$
\begin{aligned}
TaxPV\left(\pi^C\right) &= \sum_{t=1}^{\widehat{T}_C} \frac{\tau\,\pi_t^C}{\left(1+i_\tau\right)^t} \\
&= -\frac{\tau\, i\, C_1}{i-g_C} \sum_{t=1}^{\widehat{T}_C} \frac{\left(1+g_C\right)^{t-1}\left[1-\left(\frac{1+g_C}{1+i}\right)^{\widehat{T}_C-(t-1)}\right]}{\left(1+i_\tau\right)^t} \\
&= -\frac{\tau\, i\, C_1}{i-g_C}\left[\sum_{t=1}^{\widehat{T}_C} \frac{\left(1+g_C\right)^{t-1}}{\left(1+i_\tau\right)^t} - \sum_{t=1}^{\widehat{T}_C} \frac{\left(\frac{1+g_C}{1+i}\right)^{\widehat{T}_C}\left(1+i\right)^{t-1}}{\left(1+i_\tau\right)^t}\right] \\
&= -\frac{\tau\, i\, C_1}{i-g_C}\left[\frac{1-\left(\frac{1+g_C}{1+i_\tau}\right)^{\widehat{T}_C}}{i_\tau-g_C} - \left(\frac{1+g_C}{1+i}\right)^{\widehat{T}_C} \frac{1-\left(\frac{1+i}{1+i_\tau}\right)^{\widehat{T}_C}}{i_\tau-i}\right] \\
&= -\frac{\tau\, i\, C_1}{i-g_C}\left[\frac{1-\left(\frac{1+g_C}{1+i_\tau}\right)^{\widehat{T}_C}}{i_\tau-g_C} + \frac{\left(\frac{1+g_C}{1+i}\right)^{\widehat{T}_C}-\left(\frac{1+g_C}{1+i_\tau}\right)^{\widehat{T}_C}}{\tau\, i}\right] \\
&= -C_1\left[\frac{\tau\, i}{i-g_C}\,\frac{1-\left(\frac{1+g_C}{1+i_\tau}\right)^{\widehat{T}_C}}{i_\tau-g_C} + \frac{\left(\frac{1+g_C}{1+i}\right)^{\widehat{T}_C}-\left(\frac{1+g_C}{1+i_\tau}\right)^{\widehat{T}_C}}{i-g_C}\right] \\
&= -C_1\left[\frac{\tau\, i}{i-g_C}\,\frac{1-\left(\frac{1+g_C}{1+i_\tau}\right)^{\widehat{T}_C}}{i_\tau-g_C} + \frac{\left(\frac{1+g_C}{1+i}\right)^{\widehat{T}_C}-1}{i-g_C} - \frac{\left(\frac{1+g_C}{1+i_\tau}\right)^{\widehat{T}_C}-1}{i-g_C}\right] \\
&= -C_1\left[\left(\frac{\tau\, i}{i_\tau-g_C}+1\right)\frac{1-\left(\frac{1+g_C}{1+i_\tau}\right)^{\widehat{T}_C}}{i-g_C} - \frac{1-\left(\frac{1+g_C}{1+i}\right)^{\widehat{T}_C}}{i-g_C}\right] \\
&= -C_1\left[\frac{i-g_C}{i_\tau-g_C}\cdot\frac{1-\left(\frac{1+g_C}{1+i_\tau}\right)^{\widehat{T}_C}}{i-g_C} - \frac{1-\left(\frac{1+g_C}{1+i}\right)^{\widehat{T}_C}}{i-g_C}\right] \\
&= -C_1\left[\frac{1-\left(\frac{1+g_C}{1+i_\tau}\right)^{\widehat{T}_C}}{i_\tau-g_C} - \frac{1-\left(\frac{1+g_C}{1+i}\right)^{\widehat{T}_C}}{i-g_C}\right]
\end{aligned}
$$

$$= \quad -C_1 \left[a\left(i_\tau, g_C, \widehat{T}_C\right) - a\left(i, g_C, \widehat{T}_C\right)\right].$$

The present value of neutral taxes on the economic income from pension benefits (14) can be derived analogously taking into account an additional discounting of $\widehat{T}_C$ periods to the point of reference $t = 0$.

B Periodic correction of contributions

Equation (29) is derived as follows:

$$\begin{aligned}
&= \quad -C_1 \left[\frac{1-\left(\frac{1+g_C}{1+i_\tau}\right)^{\widehat{T}_C+1}}{i_\tau - g_C} - \frac{1-\left(\frac{1+g_C}{1+i_\tau}\right)^{\widehat{T}_C}}{i_\tau - g_C} + \frac{1-\left(\frac{1+g_C}{1+i}\right)^{\widehat{T}_C+1}}{i - g_C} - \frac{1-\left(\frac{1+g_C}{1+i}\right)^{\widehat{T}_C}}{i - g_C} \right] \\
&= \quad -C_1 \left[\frac{\left(\frac{1+g_C}{1+i_\tau}\right)^{\widehat{T}_C}\left(1-\frac{1+g_C}{1+i_\tau}\right)}{i_\tau - g_C} - \frac{\left(\frac{1+g_C}{1+i}\right)^{\widehat{T}_C}\left(1-\frac{1+g_C}{1+i}\right)}{i - g_C} \right] \\
&= \quad -C_1 \left[\frac{\left(\frac{1+g_C}{1+i_\tau}\right)^{\widehat{T}_C}\ \frac{i_\tau - g_C}{1+i_\tau}}{i_\tau - g_C} - \frac{\left(\frac{1+g_C}{1+i}\right)^{\widehat{T}_C}\ \frac{i-g_C}{1+i}}{i - g_C} \right] \\
&= \quad -C_1\ (1+g_C)^{\widehat{T}_C} \left[(1+i_\tau)^{-\left(\widehat{T}_C+1\right)} - (1+i)^{-\left(\widehat{T}_C+1\right)} \right].
\end{aligned}$$

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