On the Optimal Timing of Implicit Social Security Taxes Over the Life Cycle

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Received 25 April 2004; in revised form 26 July 2005; accepted 16 November 2005

Are there still opportunities for welfare-improving reforms in unfunded pension systems? To answer this question, we analyze the intertemporal structure of implicit taxes in pay-as-you-go pension schemes. We demonstrate that these tax rates are declining over the life cycle. This timing is optimal if periodic wage elasticities of labor supply are inversely related to the tax structure. Using German micro data for men and married women, we estimate periodic wage elasticities of labor supply. We observe that an efficient taxation would require implementing a steeper tax profile for male workers and a U-shaped (or mildly N-shaped) tax profile for female workers in addition to a general reduction of the level of implicit tax rates for the latter.

Keywords: public pensions, labor supply, optimal taxation

JEL classification: D 91, H 21, H 55, J 22

1. Introduction

The Pareto efficiency of pay-as-you-go public pension schemes versus potential welfare gains from converting them into fully funded systems have been investigated in much detail during the last decade.[1] The essence of this debate can be summarized as follows: In comparison with fully funded systems, pay-as-you-go pension schemes involve an implicit or, sometimes, explicit tax – usually a wage tax – which is due to the absence of actuarial fairness. This is true for flat-rate benefit schemes as well as for social-insurance-type systems where benefits are closely linked to prior contributions, establishing some degree of intragenerational fairness at least.[2] In the latter case, how-

* Generous support provided by the Economic and Social Research Institute (ESRI) of the Japanese Government is gratefully acknowledged. We would like to thank Wolfgang Meister for providing tax information, and Sascha Becker, Viktor Steiner and two anonymous referees for very helpful comments. All remaining errors are ours.

1 See Breyer (1989), Homburg (1990), Brunner (1994, 1996), Fenge (1995), or Fenge and Schwager (1995).

2 Here, the term “intragenerational fairness” (Homburg and Richter, 1990) is meant to say that the taxlike portion of annual contributions is the same for all members of a given age cohort. For instance, this is a distinctive feature of the German public pension sys-

  – ISSN 0015-2218

ever, distortions of individual labor–leisure decisions that are induced by this wage tax cannot be exploited to nourish a Pareto-improving transition path towards a fully funded system. As long as lump-sum payments are ruled out as a means to ensure an efficient reform, an equivalent tax will be needed in order to redeem the (implicit) public debt that is inherited from the incumbent pay-as-you-go scheme. As a consequence, the labor–leisure distortion cannot be reduced by a transition to a fully funded pension system (Fenge, 1995).[3]

In a recent contribution, Wrede (1999) has spelt out conditions under which Fenge's (1995) result carries over to the case with two or more active periods of life. His analysis is based on a simple, but straightforward, extension of the Fenge's model. Instead of dividing the relevant life span of an individual into two periods – a period of economic activity and a period of retirement – he considers a three-period setting with separate labor–leisure choices for the first two subperiods. Given the different horizons for discounting future pension claims in order to relate them to current contributions, it is obvious that, *ceteris paribus*, the implicit tax rate that individuals face differs between these two subperiods. Quite generally, it will be higher for young workers than for older workers. Forced saving at a lower rate of return than the market rate of interest is more costly earlier in life, as contributions are then locked longer at this low rate of return (Lindbeck and Persson, 2003).

From an analytical point of view, the stylized model employed by Wrede (1999) suffices to conclude that the original result of Fenge (1995) can be generalized to a multiperiod setting only if the internal rate of return to the contributions made by young and by middle-aged workers differs only by the interest factor – so that, from an *ex ante* perspective, the implicit tax rates imposed on their periodic wages are the same. In any other case, the question of whether or not there are opportunities for welfare-improving reforms of existing pay-as-you-go pension systems appears to be open again. But in fact, applying uniform tax rates across the life cycle of a typical individual may in itself not be optimal. It turns out that the main question is whether, for a given age cohort, the time path of implicit tax rates is optimally adjusted to the life-cycle profile of labor-supply elasticities. If this is not the case, individual decisions with respect to periodic labor supply are distorted and a new kind of potential inefficiencies involved in unfunded pensions enters the picture.

In what follows, we will discuss the problem both theoretically, applying optimal-taxation results to an overlapping-generation model, and empiri-

tem, where, abstracting from some minor elements entailing interpersonal redistribution, individual pension claims are proportional to the lifetime profile of annual earnings, discounted by the growth rate of average wages.

3 See Sinn (2000) for a broader review of the literature and an extended discussion.

cally, using micro data from Germany for an econometric analysis of individual labor-supply decisions of men and married women. The reason why we consider only married women is that unmarried women present a very heterogeneous group, which includes women who live with a partner as well as single women – both with and without children. Controlling adequately for these differences would require creating many subsamples. By focusing on (the majority of) married women alone, we evade this problem.

The paper is organized as follows. In section 2, we introduce the notion of implicit tax rates in unfunded pension systems and look at their potentially distorting effects on periodic labor supply over the life cycle. Also, we derive second-best rules of taxation in this framework. In section 3, we present empirical evidence on the life-cycle profile of implicit taxes involved in the German public pension system. In section 4, periodic labor-supply elasticities are estimated. The database we use is pooled time-series data taken from the German Socio-Economic Panel (GSOEP) for West-German employees from 1991 to 2002.[4] In section 5, we evaluate whether, given our theoretical results, the profiles of implicit taxes and labor-supply elasticities are optimally related to each other. In section 6, we discuss the policy implications, asking how to implement a second-best structure of implicit taxes, and point to some qualifications of our results.

2. Theory

2.1. Implicit Tax Rates: The Basic Model

We use a three-period overlapping-generations model. Individuals born in period t are working in periods t and $t+1$, being young (N_t^Y) and middle-aged (N_{t+1}^M), respectively.[5] Disposable time per period is normalized to unity, the labor supply being l_t^Y and l_{t+1}^M, $0 \leq l_t^Y, l_{t+1}^M \leq 1$. Per unit of labor supplied, they earn gross wages W_t and W_{t+1}, from which contributions to the unfunded pension system are deducted at rate θ. In period $t+2$, when they are old (N_{t+2}^O), they retire and are entitled to receive pension benefits p_{t+2}. Periodic consumption is denoted by c_t^Y, c_{t+1}^M, and c_{t+2}^O. In the first two periods of life, individuals consume part of their wages, while c_{t+2}^O is financed by their old-age pensions and, if appropriate, by pure life-cycle savings – assuming that there are no bequests.

The overall setting for our analysis is that of a small open economy where in each period t the interest rate r_t is exogenously determined. For sim-

4 For a brief description see Burkhauser, Kreyenfeld, and Wagner (1997).

5 Here, subscripts are meant to indicate time periods, while superscripts refer to periods in the life cycle.

plicity, we assume that the interest rate remains constant across periods: $r_{t+1} = r_{t+2} = r$.

To abstract from intragenerational redistribution, we assume that all individuals born in period t are identical. *Ex ante*, each of them faces the following problem:

$$\max_{c,l} U_t\left(c_t^Y, c_{t+1}^M, c_{t+2}^O, 1 - l_t^Y, 1 - l_{t+1}^M\right) \tag{1}$$

subject to the intertemporal budget constraint

$$c_t^Y + \frac{c_{t+1}^M}{1+r} + \frac{c_{t+2}^O}{(1+r)^2} = (1-\theta)\, W_t l_t^Y + \frac{(1-\theta)\, W_{t+1} l_{t+1}^M}{1+r} + \frac{p_{t+2}}{(1+r)^2}\,. \tag{2}$$

Wages may differ due to technological change, i.e., $W_t \neq W_{t+1}$ is possible. In what follows, we write lifetime consumption as

$$c_t^Y + \frac{c_{t+1}^M}{1+r} + \frac{c_{t+2}^O}{(1+r)^2} = c_t\,, \tag{3}$$

thus replacing periodic consumption with a composite consumption good c_t. (Note that the relative price of consumption in each period is determined solely by the interest factor $1 + r$, which will not be affected in the following analysis.)

We now turn to deriving implicit taxes for an individual in a given age cohort, focusing on the intertemporal (i.e., life-cycle) aspect. We assume, for simplicity, that the structure of the periodic labor supply is uniform across subsequent generations, i.e., $l_t^Y(W_t) = l_{t+1}^Y(W_{t+1})$ and $l_t^M(W_t) = l_{t+1}^M(W_{t+1})$, etc. In order to derive implicit tax rates, it is important to know how much of the pension benefit can be attributed to contributions made in each working period.

In unfunded pension systems with an imperfectly actuarial link between contributions and benefits, the periodic internal rates of return ι to earlier contributions can be written as a function of the rate of population growth and the rate of productivity or wage growth, i.e.,

$$\iota_{t+1} = \iota(g_{t+1}, g_{t+2}, n_{t+1}, n_{t+2}),$$
$$\iota_{t+2} = \iota(g_{t+2}, n_{t+1}, n_{t+2}).$$

Here g_{t+1} is the growth rate of wages from period t to $t + 1$, and n_{t+1} is the growth rate of the active population from period t to $t + 1$. Thus, ι is determined by the ingredients of the well-known Aaron (1966) condition, viz., the factors constituting the growth rate of the payroll.

Pension benefits can then be written in terms of a generic benefit formula,

$$p_{t+2} = (1 + \iota_{t+1})(1 + \iota_{t+2})\, \theta\, W_t l_t^Y + (1 + \iota_{t+2})\, \theta\, W_{t+1} l_{t+1}^M\,. \tag{4}$$

Plugging in equations (3) and (4), equation (2) reduces to

$$c_t = W_t l_t^Y (1-\tau_t) + \frac{W_{t+1} l_{t+1}^M (1-\tau_{t+1})}{1+r}, \tag{5}$$

where

$$\tau_t = \theta \frac{(1+r)^2 - (1+\iota_{t+1})(1+\iota_{t+2})}{(1+r)^2} \quad \text{and} \quad \tau_{t+1} = \theta \frac{(1+r)-(1+\iota_{t+2})}{1+r} \tag{6}$$

are what we call the implicit tax rates. It is easy to see that both τ_t and τ_{t+1} are positive, and that $\tau_t > \tau_{t+1}$, if internal rates of return ι are smaller than the interest rate r.[6] In calculating τ, we effectively distinguish between a tax-like fraction and an element of mandatory saving involved in total contributions, assuming that only the former is likely to affect individual decisions on periodic labor supply.[7] We also show that, with constant θ, the fraction of wages that is lost to the pension system decreases over a typical life cycle, while the saving element becomes more and more important.

Depending on the precise benefit formula applied, things can be slightly more complicated with real-world pension schemes. Results regarding the actual size and timing of implicit tax rates are clearly sensitive to data and assumptions regarding r, g, and n.[8] Moreover, in reality the contribution rates θ can be increased over time, which directly affects internal return rates for current pensioners. Nevertheless, our result holds true in a large variety of more realistic cases. In section 3, we will present estimates for the full lifetime profile of implicit tax rates imposed on individuals in different age cohorts who participate in the German public pension scheme. These estimates confirm that tax profiles are basically declining over the life cycle unless major changes in contribution rates offset, or even reverse, this trend temporarily.

Proposition 1 (Wrede, 1999) If, for each period t, $\iota_t < r$ is assumed, then implicit tax rates relating to each period are positive and $\tau_t > \tau_{t+1}$.

6 For an in-depth discussion, see Beckmann (2000), who spells out implicit tax rates on an annual level for the case of the current benefit formula of the German public pension scheme.

7 For cross-country evidence related to this point, but neglecting the life-cycle structure of implicit tax rates, see Disney (2004). Of course, if the forced-saving element of the pension scheme exceeds what individuals would have saved voluntarily in order to optimize the time profile of their consumption, and if there is no way of offsetting this through lower private saving, behavior could be distorted in essentially the same way as through the taxlike element. Yet, in the data used for our empirical work, we have no indication that the average individual working subject to the German public pension scheme is faced with a binding constraint of this kind.

8 With higher interest rates (lower growth rates of wages or the active population), implicit tax rates increase at any given point in time, and their time profile gets steeper. See section 3 for further discussions.

The intuition behind this result is the following (Beckmann, 2000). Let the pension entitlement of a person who has paid contributions in one period be called a *pension unit*. If the acquisition of the pension unit is postponed by one period – for instance, through appropriate variations in the timing of labor supply – the contributions necessary to acquire this pension unit will rise by $1 + \iota_{t+1}$. At the same time, one euro of contributions paid tomorrow is only worth $1/(1 + r)$ euro today. The ratio $\rho_{t+1} = (1 + \iota_{t+1})/(1 + r)$ is thus the relative price of a pension unit acquired in the next period. If ι is smaller than r, then a pension unit obviously gets cheaper over time ($\rho_{t+1} < 1$). In other words, the loss against an investment at the market rate r that is involved in buying these units must fall over the individual life cycle.

Building on this result, the above maximization problem can be solved to determine the marginal effect of the implicit tax rates on individual utility. The indirect utility function reads

$$V((1 - \tau_t)\,W_t,\,(1 - \tau_{t+1})(1 + r)^{-1}W_{t+1},\,1 + r,\,I)\,, \tag{7}$$

where the net wages, $(1 - \tau_j)(1 + r)^{t-j}W_j$, $j = t, t + 1$, and the interest factor, $1 + r$, are the relevant prices, and $I \equiv (1 - \tau_t)W_t + (1 - \tau_{t+1})(1 + r)^{-1}W_{t+1}$ is the full income for $l_t = l_{t+1} = 1$.

For our purposes, the most important property of V is that

$$\frac{\partial V}{\partial \tau_k} = -\frac{\partial V}{\partial(1 - \tau_k)} = -\lambda(1 + r)^{t-k}W_k l_k < 0 \qquad \text{for } k = t, t + 1 \tag{8}$$

by Roy's identity, $\lambda > 0$ being the marginal utility of leisure, goods consumption, or – more generally – of income. Irrespective of their precise timing, taxes τ_k on wages (or subsidies for leisure) decrease the welfare of all individuals as they distort the first-best allocation. If the excess burden involved in these tax payments cannot be avoided, one should at least attempt to minimize it. In our model, the main instrument for doing so is given by the time structure of τ.

2.2. A Gender Tax Gap

The basic model is mainly relevant for individuals who pursue a full-time working career over their entire working life. If, instead, we focus on individuals with more fragmented employment records (such as many women), we also have to take into account how spells of unemployment, disablement, or maternity leaves are treated when individual pension benefits are calculated. In addition, for individuals with many years of low contributions – possibly due to long part-time careers – regulations with regard to minimum pensions become important.

Whatever the precise set of rules applied in these areas, there is a potential *gender tax gap* in many existing public pension systems, implying that there may be systematic differences between men and women with respect to their implicit lifetime tax rates τ and their set of implicit annual tax rates τ_t (see also Lindbeck and Persson, 2003).

One reason why both τ and τ_t might be lower for females is that in industrialized countries average life expectancy is considerably higher for women than for men. Almost nowhere in current pension systems is this reflected in gender-specific benefit formulae that would follow from actuarial principles. However, for married women who are not working on a full-time basis during their active life span, this effect can be more than offset by three effects (Feldstein, 1996). First, in some countries (for example, the U.S. and Japan) there are noncontributory benefits for spouses of retirees if the former do not have an employment record of their own. If a married woman takes up work – temporary or part-time, and usually at a lower wage rate than average men – she will forgo (part of) the benefits that are linked to her marital status. Second, a married woman who stays out of the labor market most of her life will be at least entitled to receive survivor benefits once her husband is deceased. Again, (part of) these benefits will be reduced if she holds pension claims of her own, so that part of her contributions is lost on (noncontributory) benefits forgone. Third, from the perspective of a married woman, living longer implies that the expected value of survivor benefits that her husband will receive is very low – in fact, it will usually be zero.

In any case, as long as the earnings of women do not exceed a certain threshold, their implicit tax rates can be much higher than those for men. In many cases, τ can be up to 100%. The point is that in many countries working women still are subjected to rules that were designed for the case of nonworking housewives and mothers. Today, these rules may no longer be appropriate for the majority of married women, as they create strong disincentives for women with (less than) average earning capacities to extend their labor-force attachment even if they want to.[9]

If we want to state the problem more formally, our simple three-period model meets certain limitations. In its basic form, the model neither allows for variations in life expectancy, nor can easily be extended to cover an additional period of time for surviving spouses. For the case of married women with earnings that fall in the range where reductions of their individual pension entitlements matter, we therefore consider the following scenario: We abstract from differences in life expectancy and focus on the existence of dependents' allowances and survivors' benefits.

9 It should be stressed that here we are primarily concerned with noncontributory benefits that are linked to just being married, not to being a mother. In the context of pay-as-you-go pension systems, benefits of the latter type may serve a specific function in rewarding investment in human capital, i.e., in future workers and contributors (see Sinn and Werding, 2000, and Werding, 2001).

Building on a simple "male-chauvinist" model of household labor supply, we include pension benefits that are granted to dependents and survivors and are linked to the employment record of the *first earner* in the household in the husband's budget set.[10] For his wife, these benefits will then be exogenously given as a benefit component $\overline{p}_t$, while earnings-related benefits are subject to a special (say, linear) discount rate δ, with $0 < \delta \leq 1$, such that

$$p_t^f = \overline{p}_t + (1-\delta)p_t\left(\theta W_{t-2}^f l_{t-2}^{Y,f}, \theta W_{t-1}^f l_{t-1}^{M,f}\right). \tag{9}$$

Here, superscript f denotes variables relevant for the woman's own pension benefits – most importantly, her labor supply and her wage earned in both working periods.

Substituting $p_t^f - \overline{p}_t$ in the woman's lifetime budget constraint – the subtraction of $\overline{p}_t$ is needed to avoid double counting at the household level – we obtain

$$c_t^f = [1-(\tau_t+\delta)]\, W_t^f l_t^{Y,f} + \frac{[1-(\tau_{t+1}+\delta)]\, W_{t+1}^f l_{t+1}^{M,f}}{1+r}, \tag{10}$$

where $\tau_t + \delta$ and $\tau_{t+1} + \delta$ are the adjusted implicit tax rates. It is easy to see that, in this version, implicit taxes for married women are higher than those for married ("first-earner") men throughout their life cycle if $\delta > 0$. Given this particular tax structure, married women then make their decision whether or not to participate in the labor market, either on a full-time or on a part-time basis.[11]

True, differences in life expectancies are ignored here, while we try to focus on another, potentially important effect that is due to several types of reductions in noncontributory pension benefits of married women that are relevant in many existing pension schemes. Ultimately, the existence and size of what we call a gender tax gap is again an empirical issue, to which we will turn in section 3 for the case of the German pension system.[12]

2.3. Second-Best Optimal Taxes

In our basic model for full-time earners, goods consumption c is taxed indirectly, using wage earnings in period t – i.e., l_1 and l_2 – as the endogenously variable tax base.[13] We have seen that the implicit taxes imposed on periodic wages differ across periods. This relates our analysis to a series of standard

10 In other words, they will be included in the husband's pension benefits $p_t^m = p_t(\theta\, W_{t-2}^m l_{t-2}^{Y,m}, \theta\, W_{t-1}^m l_{t-1}^{M,m})$, etc.

11 Here, we abstract from more complex models of household time allocation incorporating other decision rules, like those related to joint optimization or mutual altruism, or introducing household production as a third option for using time. Qualitatively, these models would lead to the same result.

12 For cross-country evidence on this point see, again, Disney (2004).

13 In addition, c may be taxed directly at a fixed rate, which is entirely outside our focus.

results from the theory of optimal taxation (Sandmo, 1974, and Atkinson and Sandmo, 1980).

In the tradition of optimal-taxation theory, public authorities are assumed to maximize utility V [equation (7)] subject to the additional constraint that tax revenues have to meet a given amount

$$\Gamma_t = \tau_t \theta W_t l_t^Y + \frac{\tau_{t+1}}{1+r} \theta W_{t+1} l_{t+1}^M . \tag{11}$$

Here, Γ_t is the effective tax to be levied on individuals in a given generation across their life cycle – discounted at period-t values – in order to keep the public debt implied in the pay-as-you-go pension system on an equilibrium path. In other words, Γ_t is an implicit tax on actuarial returns to earlier contributions. This tax is required to make the periodic budget of the pension system including the implicit debt just grow by the growth rate of the wage sum – making sure that θ can be held constant over time.

It is straightforward to show[14] that optimal taxation requires implicit tax rates on period-t wages to be inversely related to the compensated price elasticities of labor supply in period t, modified by compensated price elasticities with respect to period $s \neq t$, so that

$$\frac{\tau_t}{1-\tau_t} = \frac{\sigma_{t+1,t+1} - \sigma_{t,t+1}}{\sigma_{t,t} - \sigma_{t+1,t}} \frac{\tau_{t+1}}{1-\tau_{t+1}} , \tag{12}$$

where σ_{ts} are the compensated price elasticities. This result is closely related to the well-known Ramsey rule for the case of one good and two periods (see Sandmo, 1987, and Atkinson and Stiglitz, 1980). In order to minimize distortions, the set of taxes should essentially be chosen so as to make the substitution effects as small as possible. We may thus state

Proposition 2 (Ramsey rule) Wages should be taxed more heavily in those periods of an individual's working life where

(a) the compensated elasticity of labor supplied with respect to the same period's net wage (i.e., the own-price effect) is low compared to that in other periods of life, and
(b) the compensated elasticity of labor supplied with respect to all other periods' net wages (i.e., the cross-price effect) is low.

An important special case captured by equation (12) is obtained if cross-price effects are assumed to be absent. If $\sigma_{ts} = 0$ with $s \neq t$, then σ_{tt} can be abbreviated to read σ_t and equation (12) reduces to

$$\frac{\tau_t}{1-\tau_t} = \frac{\sigma_{t+1}}{\sigma_t} \frac{\tau_{t+1}}{1-\tau_{t+1}} . \tag{13}$$

In this case, we can state

14 For a formal treatment see, e.g., Atkinson and Stiglitz (1980, chapter 12).

Proposition 3 (Inverse compensated-elasticity rule) In the absence of cross-price effects, the optimal tax rate in each period is inversely proportional to the (compensated) labor-supply elasticity of the same period with respect to net wages.

Building on these basic rules for the intertemporal structure of implicit tax rates to be optimal, we will follow Sandmo's (1974, p. 705) advice that "[e]mpirical explorations of optimal tax structures will be valuable contributions to further study of this problem" in applying his original results to our particular problem. In other words, we will now evaluate whether the optimality conditions hold for the German public pension scheme by comparing the effective time paths of implicit taxes with empirical estimates for the intertemporal structure of labor-supply elasticities. As the cross-price effects that are included in proposition 2 are very hard to handle in an empirical context, we focus on a test of the optimality rule stated in proposition 3, assuming that $\sigma_{ts} = 0$. For a further discussion of cross-price effects see the concluding section.

3. Actual Implicit Tax Profiles in the Case of Germany

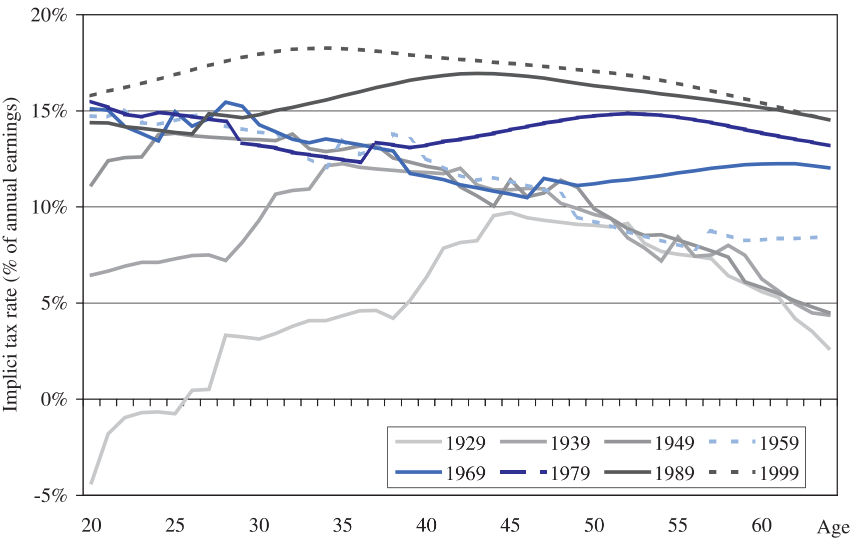
In proposition 1, we have stated that implicit tax rates in unfunded pension systems will constantly decrease over the life cycle provided that (i) contribution rates are constant over time and (ii) the benefit formula (or, rather, the contribution–benefit link) remains unchanged. Obviously, we cannot expect these conditions to be fulfilled when looking at real-world pension systems. In Germany, for instance, contribution rates have increased from 10% in 1950 to 19.5% in 2004. Given the current legal framework, they are expected to reach 23% by 2030 and 25% by 2050, with a notable fraction of the pension budget being covered from general government revenues. Over the same period, the replacement ratio relative to net wages has first increased from some 60% to 70%; it has then been roughly constant at this level until very recently and is now expected to decrease again, to about 54% by the year 2050. All these projections are derived from the CESifo Pension Model, building on the current (i.e., year-2004) legal framework.[15]

Given these nonstationarities, the timing of implicit taxes for each age cohort, evaluated at an annual level, may be rather different from the simple profile predicted in our three-period setup. Using the CESifo Pension Model, we are able to calculate the relevant time profiles over a full working-age period of 45 years for all age cohorts born between 1929 and 1999. Regarding

15 The CESifo Pension Model is a simple simulation tool that is continuously updated to make projections for the main budgetary parameters of the German public pension scheme. For more details see Wissenschaftlicher Beirat (1998), Sinn and Thum (1999), Thum and von Weizsäcker (2000), or Fenge and Werding (2004).

past and present developments of all the relevant parameters, we can use historical data. For the future development of productivity and wages, we assume real annual increases by 1.75%. Another important variable for our calculations is the real interest rate, which is set to be 4% p.a. in our simulations.[16] Both these numbers are based on long-term average rates for West Germany. Using life-expectancy data for male individuals in order to determine the length of the retirement period and including survivor benefits for the remaining life span of their widows, our results can be taken to represent the lifetime profiles of implicit taxes for representative (married) men in each age cohort. In figure 1, we confine our attention to the eight cohorts born in 1929, 1939, ... to illustrate the basic trends.

Figure 1
Implicit Taxes in Germany Over the Life Cycle – Males



Source: CESifo Pension Model.

It is easy to see that older age cohorts, i.e., those born between 1929 and 1949, have benefited from the expansion of the German pension system that took place in the postwar period. The negative implicit tax rates observed for the first years of employment of these individuals clearly reflect the

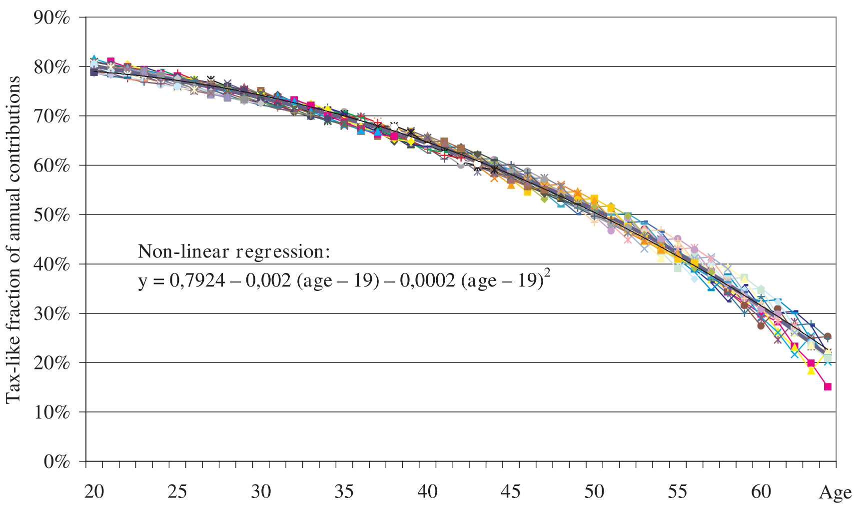
16 For the assumptions made with respect to a standardized work biography, see section 7.1. The sensitivity of the implicit tax profiles to interest rate, wage growth, and the shape of standardized work biographies is discussed at the end of this section.

introductory gift that always arises if an unfunded pension system is initiated or expanded. For the age cohort born in 1959, we have a very simple pattern of implicit annual tax rates that are slowly, but constantly, declining over time. All age cohorts born in 1969 and after are negatively affected by the impact of the demographic transition – though each at a different stage of their life cycle. The upswing of contribution rates and the downturn of benefit levels that are projected to take place in the coming decades peak at around 2035, when the demographic crisis will reach its climax. In each case, however, we also observe the fundamental downward trend that was predicted in our basic model, once the parametric changes have been made and the system settles to a new "equilibrium." All in all, our theoretical predictions are thus confirmed by the empirical example.

If we concentrate on the period from 1991 to 2002 and a set of cohorts born between 1932 and 1982, which are the years and cohorts that effectively enter our following empirical analysis, things turn out to be even more clear-cut. This is demonstrated in figure 2, which illustrates the path of annual implicit tax rates, now measured as a percentage of annual contribution rates for German men in terms of a pooled cross section. With a bold line, the figure also shows the result of a nonlinear regression that is fitted to the 12-year profiles of implicit tax rates that are related to each of the birth cohorts

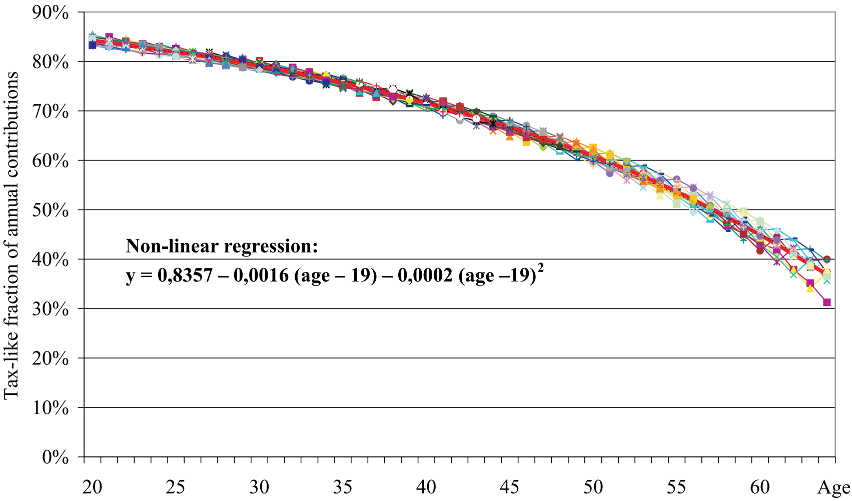
Figure 2

Implicit Taxes in Germany for the Period 1991–2002 – Males



Source: CESifo Pension Model.

Figure 3
Implicit Taxes in Germany for the Period 1991–2002 – Married Females



Source: CESifo Pension Model.

covered. In this artificial life cycle spanning 45 years, implicit taxes decrease from about 79% of contributions in the first year of employment to about 22% in the year before retirement. This clearly conforms to our theoretical results derived from the simple three-period model.

If we turn to similar calculations for women, we now have to take into account that women have a higher life expectancy than men. At the same time, their pension claims rarely extend to benefits for surviving spouses and are reduced if they coincide with survivor and/or spouse benefits that originate from their husbands' pensions. The net effect of these diverging trends is an empirical matter. For the case of the German pension system, figure 3 illustrates the life-cycle profile of implicit tax rates for married women at different ages. The implicit taxes are at about 84% of current contributions in the first year of employment and fall to about 37% in the year before retirement. This also conforms to our theoretical results within a three-period model. The results displayed in figures 2 and 3 also confirm that, at each point in time during their active period of life, implicit tax rates imposed on female workers (who are married) are higher than for their male counterparts.[17] Again, this is mainly what we expected based on our theoretical considerations.

17 For women who stay single over their entire lifetime, the effects of higher life expectancy and the absence of survivor benefits their spouses would be entitled to receive nearly cancel out. Thus, their lifetime profile of implicit tax rates is rather similar to that of males.

Having summarized our observations for the scenarios just defined, some remarks on the sensitivity of our findings the underlying assumptions may be appropriate. If we take as given the current population forecasts and the current legal framework of the German public pension scheme, the level and timing of implicit tax rates is mainly influenced by our assumptions regarding future interest rates and future wage growth. *Ceteris paribus*, higher real interest rates increase implicit tax rates at age 64 only slightly (as they imply heavier discounting of benefits over future years spent in retirement), an effect that is relevant for all age cohorts covered in our calculations; but they have a strong impact on implicit tax rates at younger ages (where the period of heavier discounting may extend to as long as six decades), thus creating steeper tax profiles for those age cohorts who are still relatively young when we start using projected values instead of historical data. Things are basically the same if we assume productivity growth to slow down in the future (as this reduces the internal rate of return of the pension system, and hence future benefits).[18] The reverse holds, in both cases, for opposite changes in assumptions.

By and large, changes in our standardized work biography are only relevant if they affect the timing of retirement. We note in passing that, because in the German public pension scheme pension benefits are assessed based on a linear tax–benefit link, the tax profiles shown in figures 2 and 3 are largely the same for individuals with different levels of earnings. However, earlier retirement implies a parallel downward shift of the tax profile and vice versa. These effects would be stronger if they were induced by a change in the statutory retirement age, but would also occur in the case of a voluntary adjustment (because changes in benefits associated with early, or postponed, retirement are not actuarially fair under current rules). Career breaks that are typical for women only have a minor effect on the profile of annual tax rates (inasmuch as lower lifetime earnings imply that a larger share of a woman's pension is effectively exempted from reductions against noncontributory benefits such as survivor pensions, spells of nonparticipation shift the tax profile downwards). Only women with very low levels of labor-force participation and longer than average life expectancy would be faced with tax rates that are lower than those of their husbands.

Finally, note that, starting from our basic theoretical setup (section 2), we concentrate on implicit tax rates involved in the German public pension scheme in our analysis, largely ignoring additional effects related to explicit

Since we will not deal with this very heterogeneous subgroup in the following, we refrain from discussing the results in more detail.

18 Note that changes in productivity growth have next to no impact on the time profile of contribution rates, because, in spite of recent reforms, benefits are still basically indexed to wages.

wage taxation.[19] In other words, we actually do take explicit taxes into account in calculating net wages and net household income in the empirical estimates that follow. But for the sake of clarity, we neglect their effect on the relevant tax ratios when assessing the optimality of the current tax structure and assume that it is only implicit tax rates that vary by age in a systematic fashion. We will return to these issues in our concluding remarks.

In the next section, we will evaluate whether the timing of annual implicit tax rates in the German public pension scheme conforms to the inverse elasticity rule. In order to do so, we have to estimate the elasticity of labor supply in different periods of a typical life cycle with respect to taxes imposed on net wages.

4. Periodic Labor-Supply Elasticities

4.1. Methodology

Empirical investigations into the time structure of wage elasticities of individual labor supply are largely lacking. Existing econometric studies usually show that, based on static models of labor supply, labor-force attachment declines with age, controlling for a number of other socioeconomic variables.[20] Where age-related regressors are also included in a quadratic form (or as a polynomial of higher order), estimated time patterns of individual labor supply are a little bit more complicated, but, as a rule, labor-force participation and/or the amount of labor supplied are monotonically decreasing starting from some year of age – usually around the late 20s or early 30s.

Certainly, the most elegant approach to calculating compensated wage elasticities of labor supply, σ_i, would be to rely on a fully developed dynamic (i.e., life-cycle) model of individual decisions and to derive a consistent set of periodic labor-supply functions, allowing for some variation in labor-supply elasticities over time.[21] However, exploiting the time-series nature of the panel data we are going to use is difficult. The data span only a period of 12 years of individual life cycles, as some limitations in comparability apply to

19 For an extended theoretical treatment including both implicit and explicit tax rates, see the recent paper by Kifmann (2004).

20 For studies for Germany, see Franz (1985), Strøm and Wagenhals (1991), Untiedt (1992), Buslei and Steiner (1999), or Kaltenborn (2000). Note that the first three studies concentrate on the labor supply of women. International surveys can be found in Pencavel (1986), Killingsworth and Heckman (1986), and Blundell and MaCurdy (1999).

21 The results for wage elasticities obtained in such models do not differ significantly from our results in section 4.5. For example, Ziliak and Kniesner (1999) estimate compensated wage elasticities of 0.12 and an income elasticity of –0.05 for men aged 22–51. Blundell et al. (1993) find compensated wage elasticities in the range of 0.40 to 0.78 for married women aged 18–60.

observations taken from early survey years. In the empirical implementation, we thus content ourselves with a set of static labor-supply estimates for workers in different age groups. The standard procedures developed for this purpose will be sufficient to investigate whether the theoretical problem sketched in section 2 is empirically relevant.

In our estimate, we focus on labor supply in terms of hours of work supplied in response to net wages and, hence, to (implicit) taxes imposed on gross wages. Thus, we use observed labor supply as a proxy for desired labor supply.[22] Furthermore, we abstract from the participation decision[23] and proceed as follows: We apply Heckman's (1979) two-stage model to estimate (hourly) gross wages as a function of several individual and household-level characteristics. We then use estimated gross wages in order to simulate net household income and (marginal) net wages for all individuals. At this stage, we rely on a simplified model of the German tax-transfer system provided by Schwarze (1995). This simulation tool covers the main types of taxes and social security contributions as well as the most important transfer programs that are in operation in Germany.[24] Here, of course, we only include the implicit-tax part of pension contributions in the relevant deductions, considering the remaining part as a form of (forced) saving that does not affect labor-supply decisions.

Next, we use the simulated net household income and net wages to estimate the labor-supply function based on a Tobit model (Tobin, 1958). Finally, we decompose the uncompensated wage elasticities into income and substi-

22 The observed labor supply is potentially influenced by labor-market regulations and labor-market frictions. It is reasonable to assume that, for small changes in relevant parameters, the observed labor supply is less flexible in adjustment to changes of the net wage than is the desired labor supply. On the other hand, with larger changes there might be seemingly erratic adjustments in observed labor supply, with jumps from full-time to part-time work or even to zero working hours.

23 Participation decisions are influenced by a number of institutional details, other than implicit tax rates, arising from the specific benefit formula of a given pension system. For instance, if the focus were on participation versus nonparticipation, special rules applying to early retirement would be very important. At the same time, other regulations that may influence the choice between an extended period of training and labor-market entry would have to be taken into account. Here, we also try to circumvent these peculiarities by concentrating on individuals in those age groups (20–59) where these aspects can be expected to be of minor importance.

24 For an overview, see Haisken-de New (1997). The Schwarze (1995) simulation model includes taxes levied on income (Einkommensteuer, Solidaritätszuschlag) and contributions related to public pensions (gesetzliche Rentenversicherung), public health-care insurance (gesetzliche Krankenversicherung), long-term care insurance (Pflegeversicherung), and unemployment insurance (Arbeitslosenversicherung). We included in addition the transfers provided in the form of social assistance benefits (Sozialhilfe) and housing benefits (Wohngeld), and we updated the simulation model to cover all years until 2002.

tution effects, where the latter give us the compensated wage elasticities we are ultimately interested in.

Two problems arise in the course of these procedures. In the presence of progressive taxation and transfers that are both determined at the household level, increments in net household income that result from an increase in the labor supply are influenced by public transfers (or transfer reductions) and the progressive nature of taxes imposed on wages including wages earned by the partner. We therefore use the information on hourly gross wages obtained from our wage estimation in order to calculate the net household income as well as marginal increases in the net household income (net marginal wages) for the hypothetical case that the individual is working one additional hour per year.

The second problem follows immediately from this approach. If, due to progressive (household-level) taxes and transfer reductions, net wages are given by nonlinear increases in the household income, they are no longer exogenous with respect to the number of hours actually worked. In order to take care of this potential endogeneity problem, we use mean values of the number of hours worked when simulating net household income and any of its (marginal) changes given the individual's gross wage. The mean values are cell averages taken from appropriate subgroups of individuals formed by sex, age, qualification, and work experience and the number of children living in the household, thus reestablishing exogeneity to the extent needed.[25]

4.2. Data and Variables

Our econometric analysis is based on micro data taken from the German Socio-Economic Panel (GSOEP) for the years 1991–2002.[26] For the purpose of our study, we pool the series of annual data provided by the GSOEP to form a number of appropriate subsamples, taking into account the weights attached to each observation.[27] Effectively, we confine our attention to West German households of German nationality. Since our focus is on labor-force participation, we select individuals aged 20–59, looking at males and married females in turn. Finally, we exclude the self-employed and civil

25 Using mean values of the numbers of hours worked provides a more flexible way to circumvent the endogeneity problem than exogenously fixing the numbers of hours worked to no-participation, part-time, and full-time levels (see, e.g., Kaltenborn, 2000; Staat and Wagenhals, 1994; Laisney et al., 1999).

26 For a brief description see Burkhauser, Kreyenfeld, and Wagner (1997).

27 Also, potential correlations in the error terms that are due to the fact that the sample includes repeated answers from identical individuals in subsequent years are taken into account. For this purpose, repeated observations are clustered and the assumption of independence of observations within each cluster is relaxed, while it is still required for observations across clusters.

Table 1
Descriptive Statistics by Age Groups[29]

Characteristics		Males				Married females			
		20–39		40–59		20–39		40–59	
		Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.
Age		29.74	5.43	49.40	5.91	32.47	4.40	48.37	5.58
No. of children		0.55	0.89	0.53	0.92	1.41	1.04	0.51	0.85
Children aged 0–3	*D*	0.14	0.35	0.03	0.18	0.35	0.48	0.02	0.13
Children aged 4–6	*D*	0.08	0.27	0.04	0.20	0.22	0.41	0.03	0.17
Living with a partner	*D*	0.65	0.48	0.84	0.37	1.00	0.00	1.00	0.00
Secondary degree	*D*	0.92	0.46	0.95	0.24	0.94	0.24	0.94	0.23
University degree	*D*	0.13	0.37	0.15	0.39	0.08	0.32	0.06	0.30
Vocational training	*D*	0.66	0.47	0.78	0.42	0.77	0.42	0.72	0.45
Net household income		6,341	5,793	8,870	9,049	27,285	15,084	25,362	15,782
Interest + rent income		492	6,972	730	3,482	441	2,605	842	3,986
No. of observations		14,498		10,317		7,263		7,144	
Employed as of total sample		81.2%		84.5 %		51.8 %		60.6 %	
Job experience (years)		8.31	6.32	25.41	8.65	7.00	5.01	12.37	9.41
Hours worked per week		38.10	7.37	38.95	6.20	26.55	11.68	25.88	10.87
Gross hourly wages		16.46	8.14	20.03	10.19	12.11	6.31	12.25	5.98
Net household income		6,333	5,848	8,741	9,506	25,274	14,521	25,222	15,891
Interest + rent income		430	3,601	818	3,513	414	2,629	775	3,813
Marginal net hourly wages		9.00	6.59	12.38	8.15	6.95	5.18	6.85	4.42

Notes: Year-of-survey variables are not reported.
D denotes dummy variables with $D = 1$ if the characteristic is present.
Income and wages are in year-1995 euros.

servants, because in Germany these individuals are subject to very different treatment with respect to old-age provision. We also exclude those who are already in retirement.

In our estimates, there are two endogenous variables: first, hourly gross wages, which are needed for imputing gross wages for persons who are not employed as the point of departure for simulating net household income and net (marginal) wages (Heckman procedure); second, the actual number of hours worked, which is used as a proxy for the desired amount of labor supply and is accounted for on a weekly basis (Tobit model).[28]

Table 1 displays the descriptive statistics for the exogenous variables. First of all, we note that the variance of hours worked per week is quite substantial. The high standard deviation of this variable indicates that German workers

28 To allow for the fact that the Tobit equation includes generated wage and income variables as independent variables, we provide standard errors obtained by bootstrapping (with 200 resamplings) for our two main variables E and w along with the standard errors based on the assumption of approximate normality of the sampling distribution.

29 The observations are weighted with the respective weights as provided by GSOEP.

have some scope to choose the amount of hours they like to work. With regard to the individual budget constraint, two other variables are clearly important: (other) net household income, i.e., total income available to the household (including income derived from wages earned by the spouse, capital income, public transfers, etc.) if the individual's labor income is ignored, and the change in (total) net household income (i.e., the marginal net wage) if the individual's labor supply is extended by one hour per year from the level actually observed.

The values obtained for the marginal net wage correspond to reasonable assumptions. In Germany, marginal tax rates can easily exceed 40%. They turn out to be lower for older individuals than for the young – among other things because the implicit tax rates involved in the pension system decline substantially over the life cycle. At the same time, marginal tax rates are higher for married women than for men. This mainly reflects the effects of progressive taxation at the household level as well as the higher implicit tax rates.

4.3. The Subsample Design

In order to separate life-cycle effects from cohort effects at least in a rough way, we exploit the long period of time spanned by our data.[30] For a first impression, we divide the pooled sample of individuals (aged 20–59) into two broad subgroups defined by the age groups 20–39 and 40–59. The older subgroup is made up of the cohorts born between 1929 and 1957; the younger subgroup, of those born between 1949 and 1977. Thus, the samples overlap, nine cohorts being contained in both age-related subsamples.

For more detailed results, we then split the sample into two subsamples I and II and consider a larger number of age groups, consisting of five birth cohorts each. Given these operations, all birth cohorts belong to different age groups in the two subsamples: In sample I, they are aged 20–24, 25–29, etc., while in sample II the same individuals are aged 25–29, 30–34, etc. At the same time, all age groups are represented by two different groups of birth cohorts, one from sample I and another one from sample II. This overlapping structure of our data can be exploited to trace back cohort effects in some more detail – even though the overlap is too small to be used for controlling potential cohort effects in a systematic fashion.

4.4. Labor Supply: Tobit Estimates

The focus of our investigation is on typical life-cycle patterns of the labor-supply elasticity, i.e., on differences between younger and older workers. The

30 For an empirical treatment of cohort effects, see Boockmann and Steiner (2000).

Table 2
Results of the Tobit Model

Variables	Males				Married females			
	20–39		40–59		20–39		40–59	
	Coefficient	**Std. Err.**	**Coefficient**	**Std. Err.**	**Coefficient**	**Std. Err.**	**Coefficient**	**Std. Err.**
Living with a partner	**221.43**	44.39	**256.79**	112.63				
Children aged 0–3	**27.59**	40.55	**−355.33**	130.74	**−1051.96**	68.51	−241.83	272.25
Children aged 4–6	38.27	30.80	−177.79	111.58	−127.23	82.72	**−386.63**	147.93
No. of children	14.50	22.09	**118.78**	28.37	**−351.34**	39.81	**−107.74**	45.91
Secondary degree	−19.22	36.51	**182.33**	87.57	**−302.66**	89.32	−74.74	106.02
University degree	**361.14**	51.44	**172.54**	80.33	34.05	71.96	−102.11	77.70
Occupational training	**354.00**	48.56	200.37	109.90	54.91	71.19	−20.37	105.81
Job experience (yr)	**218.43**	18.64	43.92	35.04	**63.54**	29.74	−34.43	24.81
(Job experience)^2 (yr)	**−16.01**	1.63	−2.48	1.66	−3.84	3.14	**4.47**	1.65
(Job experience)^3 (yr)	**0.37**	0.04	0.04	0.02	0.13	0.95	**−0.08**	0.03
Unemployment rate	13.87	15.83	**−70.18**	18.06	−1.01	28.01	20.36	19.93
Net yearly household income *E*	−2.2e-3	2.8e-3 (2.5e-3)	−4.6e-3	2.6e-3 (2.9e-3)	**−0.02**	2.2e-3 (2.2e-3)	**−0.01**	2.9e-3 (2.9e-3)
Marginal net hourly wages *w*	−2.07	2.43 (2.51)	**24.51**	4.85 (5.26)	**78.26**	7.57 (7.49)	**99.79**	8.66 (8.59)
No. of observations	14,498		10,317		7,263		7,144	
Censored observations	2,721		1,595		3,500		2,817	
Prob($\chi > 0$)	0.00		0.00		0.00		0.00	
Pseudo R^2	1.95%		0.71%		5.41%		2.38%	

Notes: Results for constant and year-of-survey dummies are not reported.
Bold numbers denote statistical significance at the 5% level for standard errors based on the assumption of approximate normality of the sampling distribution. For comparison, standard errors obtained by bootstrapping are given in parentheses for *E* and *w*. The (in)significance of *E* and *w* at the 5% level is identical for both approaches.
Income and wages are in year-1995 euros.

results obtained from estimating gross wages based on the Heckman (1979) model are summarized in section 7.2. Table 2 gives the results for the Tobit model, addressing the number of hours worked on a regular basis and including simulated marginal net wages and net household incomes as additional regressors.[31] For ease of exposition, we limit the presentation to the estimates obtained for the larger subgroups of cohorts aged 20–39 and 40–59.[32]

31 We include years of job experience as an independent variable that captures the professional history and allows drawing conclusions with respect to the age of the individual. To avoid multicollinearity, age is not added as a separate variable.

32 The results obtained for the smaller subgroups are available from the authors upon request.

From an economist's perspective, two major determinants of individual labor supply are the wage and household income. The coefficients estimated for the marginal net hourly wage w are both highly significant and positive in all subsamples except for young men, which is precisely what one would expect. Taxing wages should reduce the labor supply, at least with regard to the uncompensated effect – although theoretically the effect can go either way.

The coefficient of household income E is highly significant and negative in the female subsamples, implying a negative income effect, but insignificant in the male subsamples. This is in line with the assumption of optimizing behavior for given wages and household income.[33]

4.5. Wage Elasticities of Labor Supply

Building on our estimates for the Tobit model, we can determine the elasticities of labor supply with respect to net wages. In order to see whether the periodic implicit tax rates, τ_t and τ_{t+1}, are related to the wage elasticities observed for young versus old individuals as required by the inverse elasticity rule, it is the compensated wage elasticities σ that we have to look at. Compensated elasticities of labor supply can be derived by splitting the observable, uncompensated elasticities η into an income effect and a substitution effect according to

$$\eta = \frac{\partial h}{\partial w}\frac{w}{h} = \underbrace{\left(\frac{\partial h}{\partial E}\frac{E}{h}\right)\frac{w \cdot h}{E}}_{\substack{\text{Income}\\ \text{effect}}} + \underbrace{\left(\frac{\partial h}{\partial w}\frac{w}{h}\right)_S}_{\substack{\text{Substitution}\\ \text{effect}}} = \varepsilon^E \frac{w \cdot h}{E} + \sigma \qquad (14)$$

by the Slutsky decomposition.[34] In theory, the substitution effect should be positive, while the income effect should be negative – as is the case in our context, as seen above. The direction of the combined effect and therefore the sign of η is undetermined. In order to see what happens within our econometric model, we calculate the uncompensated effect η from the coefficient for w and the income effect $\varepsilon^E \cdot wh/E$ from the coefficient of E. The substitution effect σ can then be determined as a residual. The final results of these operations for both males and married females are displayed in table 3.

33 For broader surveys, see the references cited in footnote 20.

34 In line with the definition of the relevant variables and our approach to dealing with the potential endogeneity of hourly net wages in the context of a progressive tax system, we use group-specific averages to measure the number of hours worked, h, and to assess net wage rates, w, and net amounts of other household income, E. Note that individuals with zero labor supply have to be excluded, given the way the elasticity is calculated.

Table 3
Wage Elasticities of Labor Supply: Younger versus Older Individuals

	Males aged 20–39	**Males aged 40–59**
Compensated wage elasticity σ	0.010	**0.215**
Income effect	–0.020	–0.057
Uncompensated elasticity η	–0.010	**0.157**
	Married females aged 20–39	**Married females aged 40–59**
Compensated wage elasticity σ	**0.527**	**0.565**
Income effect	**–0.106**	**–0.069**
Uncompensated elasticity η	**0.420**	**0.495**

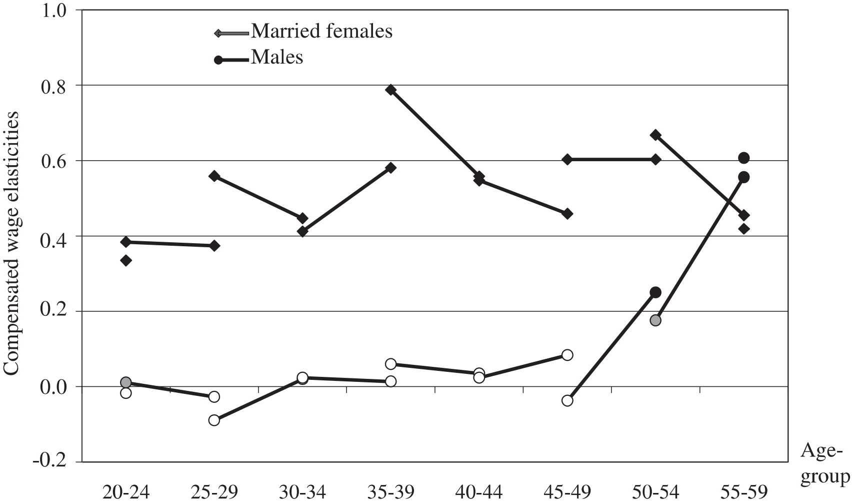
Notes: Bold numbers denote statistical significance at the 5% level for both approaches (see notes to table 2).[35]

Table 3 shows that (compensated) wage elasticities obtained for older men and married women are higher than for those in the younger age group. In fact, this is the result expected beforehand, based on the casual observation that labor-force attachment gets weaker near the end of the working-age period for a number of reasons. By its size, the (within-gender) difference in elasticities appears to be substantial in the male subsamples and somewhat less important in the female subsamples. Also, the difference is statistically significant in the case of males, while it is borderline significant, at best, in the case of females. At the same time, we observe remarkable differences in wage elasticities across the two gender groups for both age categories. We will return to the latter observation in the discussion of our results, concentrating first on a closer examination of the relevant life-cycle effects.

Note that, so far, our estimates largely conform to standard results in the literature. Income effects close to zero are a common result for men (see, e.g., Blomquist and Hansson-Brusewitz, 1990: 0.002; Bourguignon and Magnac, 1990: –0.008; van Soest et al., 1990: –0.01), while married women usually show negative income effects (Triest, 1990: –0.17; Kaiser et al., 1992: –0.18; Blomquist and Hansson-Brusewitz, 1990: –0.05; Strøm and Wagenhals, 1991: –0.06). Uncompensated wage elasticities for men are usually found to be

35 Using the decomposition explained above, the statistical significance of the compensated wage elasticity σ depends on the t-statistics obtained for the w and E coefficients. In cases where both variables are insignificant, we conclude that σ is also insignificantly different from zero. In cases where both variables or at least one is significant, however, we mark σ as significant in table 3 and the following tables where applicable.

Figure 4
Compensated Wage Elasticities of Labor Supply Over the Life Cycle



Source: GSOEP (waves 1991–2002); own estimates.
Notes: Black circles and rhombi indicate significance at the 5% level; gray circles and rhombi denote significance at the 5% level only for the bootstrapping technique (table 8).

low (Blundell and Walker, 1986: 0.024; Bourguignon and Magnac, 1990: 0.1; Blomquist and Hansson-Brusewitz, 1990: 0.13; Flood and MaCurdy, 1992: 0.25), while for married women they are significantly higher (Blomquist and Hansson-Brusewitz, 1990: 0.58; Bourguignon and Magnac, 1990: 1.0; van Soest et al., 1990: 0.79; Kaiser et al., 1992: 1.04; Triest, 1990: 0.97; Strom and Wagenhals, 1991: 0.96). As was already mentioned, empirical results that differentiate between wage elasticities at different stages of the life cycle are largely absent.

Still, the two age categories distinguished here are highly aggregated and heterogeneous. To work out potential differences in labor supply related to age in more detail, we also look at a larger number of smaller age groups. At the same time, we attempt to disentangle pure life-cycle effects and potential cohort effects. Figure 4 displays the values estimated for the compensated wage elasticity σ when the full sample is split into two subsamples I and II, considering a larger number of age groups consisting of five birth cohorts each.[36]

36 The numerical results for wage elasticities of these age groups can be found in table 10.

Effectively, there are now two estimates for the compensated wage elasticity of labor supply for each age group of both men and married women – one taken from subsample I and the other from subsample II. Results for two successive age groups that are derived from the same set of birth cohorts are connected by a line in figure 4. Building on our earlier considerations, estimated values linked by a line should be taken to represent the life-cycle effects for one subsample of birth cohorts, and jumps in the vertical direction would then reflect cohort effects.[37]

We find that, for males aged 20–24, the compensated elasticity of labor supply with respect to net wages is rather small but significantly positive (on the basis of bootstrapped standard errors), while it fluctuates around zero and is insignificant for men aged 25–49. These results are not too surprising: These are the age groups of men who are characterized by participation rates which, in many industrialized countries, are very close to 100%. In other words, they are very likely to work anyway, irrespective of the economic incentives to do so. For men aged 50 and over, elasticities of labor supply go up. These latter results are clearly significant for all the four groups that fall in this category. Also, adjoining elasticities estimated for the same birth cohorts (i.e., those connected by a line) appear to be statistically different from each other for these age groups.[38] Men who are approaching retirement are thus more likely to respond to (current) economic incentives than younger men. As a consequence, implicitly taxing the wages of these individuals must be expected to have a stronger effect on the amount of labor supplied than taxing the wages of younger individuals.

For married females, labor-supply elasticities that are derived from our estimates are highly significant across all age groups. At the same time, they show a lot more variation over the life cycle than those for males, and the significance of differences between adjoining estimates is often weak. Still, consecutive observations for given age cohorts appear to indicate that the elasticities are declining for women aged 20–34, that is, over the early stages of their active period. They are increasing for women aged 35–39, i.e., those who are most likely to have small children. For women aged 40 and over, the elasticities start declining again, in sharp contrast to what we observe in the case of males. Taking into account parallel results for different age cohorts as well, the general impression is that labor-supply elasticities of married females are inversely U-shaped over their entire active period. Probably the strongest result is that, across all age groups from 20 to 54, the elasticity of

37 It should be noted that movements between the two estimates obtained for each group of birth cohorts can also be affected by period effects, which may be imperfectly controlled by our year-of-survey dummies and by aggregate unemployment rates for each year.

38 Note that the same is true for the youngest age cohort for which we have a full set of results.

labor supply with respect to wages is much higher for married women than for men. This observation reflects a common result, found in many econometric studies, indicating that female labor supply reacts more strongly to changes in net wages than male labor supply.

5. Is the Time Profile of Implicit Taxation Optimal?

The final question we have to answer is whether the actual pattern of implicit tax rates involved in the German public pension scheme is optimal if evaluated against the background of both our theoretical and our empirical results.[39] More precisely, we have to ask whether the intertemporal structure of τ_t for males and married females corresponds to the inverse elasticity rule as stated in proposition 3. According to this rule, the ratio of implicit tax rates for young versus old individuals should be inversely related to the ratio of (compensated) wage elasticities. The same condition should also hold for the ratio of implicit tax rates for males versus married females. We will look at each of these issues in turn.

Concentrating first on the intertemporal structure of τ for the two broad age groups, the results are summarized in table 4. Once again, the relevant tax rates τ_t are calculated using the CESifo Pension Model, while σ_t is known from table 3. Let us first look at the results for males. For the inverse elasticity rule to hold, the ratio of the implicit tax rates should equal the inverse ratio of the labor-supply elasticities. This is clearly not the case, as the former is 1.57 and the latter is 21.50. In order to increase the ratio of implicit tax rates, taxes on younger individuals should be higher and/or taxes on older individuals should be lower. In other words, although the path of implicit tax rates in the German public pension system is already falling over the two periods, the implicit tax rates for young individuals should be increased even much more *vis-à-vis* the rates for older individuals.[40]

Turning to married females, we can see from table 4 that almost the opposite is true with respect to the structure of implicit tax rates across their life cycle. While the ratio of implicit tax rates is 1.51 and thus only slightly smaller than that of males, the inverse ratio of the labor-supply elasticities is 1.07, indicating that optimal tax rates would have to be next to constant over the life cycle – at most, they would have to fall just a bit. In other words, the observation that the life-cycle profiles of implicit tax rates are declining – in a similar fashion – for males as well as for married females does not appear

39 Further down, we will comment on how the results would change qualitatively if we took total (marginal) taxes into account, and not only the implicit taxes involved in pension contributions.

40 For a discussion of how this differentiation of implicit tax rates across age groups could be achieved, see section 6.

Table 4

Time Structure of Implicit Taxes and Wage Elasticities: Younger versus Older Individuals

Males	$\frac{\tau_{20-39}}{1-\tau_{20-39}} \frac{1-\tau_{40-59}}{\tau_{40-59}} = 1.57$	$\frac{\sigma_{40-59}}{\sigma_{20-39}} = 21.50$
Married females	$\frac{\tau_{20-39}}{1-\tau_{20-39}} \frac{1-\tau_{40-59}}{\tau_{40-59}} = 1.51$	$\frac{\sigma_{40-59}}{\sigma_{20-39}} = 1.07$

Table 5

Time Structure of Implicit Taxes and Wage Elasticities: Five-year Age Groups

Males		**Married females**	
Implicit taxes	**Wage elasticities**	**Implicit taxes**	**Wage elasticities**
$\tau^{net}_{20-24}/\tau^{net}_{25-29} = 1.05$	$\sigma_{25-29}/\sigma^{(**)}_{20-24} = -2.46$	$\tau^{net}_{20-24}/\tau^{net}_{25-29} = 1.05$	$\sigma^{***}_{25-29}/\sigma^{***}_{20-24} = 0.97$
$\tau^{net}_{25-29}/\tau^{net}_{30-34} = 1.06$	$\sigma_{30-34}/\sigma_{25-29} = -0.23$	$\tau^{net}_{25-29}/\tau^{net}_{30-34} = 1.06$	$\sigma^{***}_{30-34}/\sigma^{***}_{25-29} = 0.80$
$\tau^{net}_{30-34}/\tau^{net}_{35-39} = 1.08$	$\sigma_{35-39}/\sigma_{30-34} = 0.58$	$\tau^{net}_{30-34}/\tau^{net}_{35-39} = 1.08$	$\sigma^{***}_{35-39}/\sigma^{***}_{30-34} = 1.41$
$\tau^{net}_{35-39}/\tau^{net}_{40-44} = 1.11$	$\sigma_{40-44}/\sigma_{35-39} = 0.58$	$\tau^{net}_{35-39}/\tau^{net}_{40-44} = 1.10$	$\sigma^{***}_{40-44}/\sigma^{***}_{35-39} = 0.71$
$\tau^{net}_{40-44}/\tau^{net}_{45-49} = 1.14$	$\sigma_{45-49}/\sigma_{40-44} = 3.50$	$\tau^{net}_{40-44}/\tau^{net}_{45-49} = 1.13$	$\sigma^{***}_{45-49}/\sigma^{***}_{40-44} = 0.84$
$\tau^{net}_{45-49}/\tau^{net}_{50-54} = 1.20$	$\sigma^{***}_{50-54}/\sigma_{45-49} = -6.76$	$\tau^{net}_{45-49}/\tau^{net}_{50-54} = 1.18$	$\sigma^{***}_{50-54}/\sigma^{***}_{45-49} = 1.00$
$\tau^{net}_{50-54}/\tau^{net}_{55-59} = 1.32$	$\sigma^{***}_{55-59}/\sigma^{(**)}_{50-54} = 3.16$	$\tau^{net}_{50-54}/\tau^{net}_{55-59} = 1.25$	$\sigma^{***}_{55-59}/\sigma^{***}_{50-54} = 0.68$

Notes: Here, $\tau^{net}_t/\tau^{net}_{t+1} \equiv \tau_t/(1-\tau_t) \cdot (1-\tau_{t+1})/\tau_{t+1}$.
***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively, for both approaches; asterisks with parentheses indicate statistical significance on the basis of the bootstrapping technique only (table 8).

to be entirely misguided in either case. But an optimal tax profile would have to be much steeper in the case of men, and less steep in the case of married women.

Again, the picture becomes richer if we evaluate the inverse elasticity rule for the larger number of age groups defined over five-year intervals. Table 5 shows the relevant results for males and married females (evaluated for identical sets of age cohorts traced over the two subsample periods, to concentrate on true life-cycle effects). Since the estimates of labor-supply elasticities for males are mostly insignificant for the young and middle-aged groups,[41] the strongest result here appears to be that taxes should, in particu-

41 In addition, the fact that these elasticities fluctuate around zero leads to strange movements in their ratios. For instance, the result of an inverse elasticity ratio of –6.76 for males aged 45–49 and 50–54 is simply due to the fact that the estimated denominator is

lar, fall more strongly for the 55–59 year-olds relative to the 50–54 year-olds than they actually do. Fortunately, detailed results for married females are much more well-defined.

For married women, as for men, implicit tax rates are constantly declining over the life cycle, which gives a tax ratio for adjacent age groups that is slightly larger than unity throughout. On the other hand, the inverse ratio of wage elasticities is often smaller than unity, indicating that for an optimal tax schedule, implicit taxes should increase for some age groups. For example, implicit tax rates should be lower for married women aged 20–24 and 25–29 than for women aged 25–29 and 30–34, respectively. A potential explanation is that young women who are about to enter the labor market respond more strongly to economic incentives, given the outside options of staying in the education system[42] or bearing and raising children instead. Similarly, for women aged 34–39, optimal implicit taxes should decrease more than they really do, a possible reason being that they now face a choice between staying at home and returning from a parental leave to different levels of part-time work. For females in subsequent age groups the optimal profile of implicit tax rates should again start increasing, in sharp contrast to the results for males, where labor-supply elasticities increase significantly for the oldest age groups.

From these observations, it is thus evident that some modifications of the actual timing of implicit taxes could decrease distortions of labor supply. For individuals who are at the early stages of their working life – those aged 20–24 or those aged 25–29 – the implicit tax rates might have to be slightly lower than those for individuals who have settled in their jobs. The level of implicit tax rates imposed on males aged 25–49 does not matter much from an optimal-taxation perspective. Here, the elasticity of labor supply with respect to wages is close to zero, so that the excess burdens of taxation are very small. Things are different with respect to the implicit tax rates placed on males aged 50–59. Our results imply that the relatively low implicit tax rates for these individuals are still way too high, given their high labor-supply elasticities. Otherwise, besides choosing one of the various routes into early retirement,[43] older workers are likely to avoid working overtime hours and try to reduce their workload through part-time work. For married females,

negative and close to zero but statistically insignificant. We are therefore inclined not to attach much weight to it.

42 The same point could be made regarding men aged 20–24 *vis-à-vis* those aged 25–29 if we took the wage elasticity of labor supply of the former to be (small but) significantly positive, and that of the latter not to be significantly different from zero; this would be weakly supported by the graphical impression from figure 4.

43 This option is not considered in our empirical model, where we concentrate on labor supply in terms of hours worked. Studying participation decisions taken by older workers in the presence of early retirement programs, which imply an increase in implicit tax rates to more than 100% if the alternative is to retire now or later without a corresponding

an optimal life-cycle profile of implicit tax rates would have to fundamentally differ from that for males. It should certainly decline less sharply than the existing one. Ideally, it might effectively have to be U-shaped (or mildly N-shaped), mainly reflecting the higher potential for distortions of labor-supply decisions of women aged 30–39 than of women aged under 30 or over 40.

So far, we have focused on the optimal timing of the implicit tax rates over the life cycle, largely treating males and married females in isolation. Finally, we can also spell out our results regarding the (non)optimality of the gender tax gap that exists in many public pension systems. In order to do so, we have to look at cross-gender differences between implicit tax rates and labor-supply elasticities, restricting our attention to the structure of τ_t and σ_t for males and married females based on the two broad age groups considered in table 4. The results are shown in table 6.

Table 6
Implicit Taxes and Wage Elasticities Across Genders

Young individuals	$\frac{\tau_{20-39}^{women}}{1-\tau_{20-39}^{women}} \frac{1-\tau_{20-39}^{men}}{\tau_{20-39}^{men}} = 1.02$	$\frac{\sigma_{20-39}^{men}}{\sigma_{20-39}^{women}} = 0.02$
Older individuals	$\frac{\tau_{40-59}^{women}}{1-\tau_{40-59}^{women}} \frac{1-\tau_{40-59}^{men}}{\tau_{40-59}^{men}} = 1.06$	$\frac{\sigma_{40-59}^{men}}{\sigma_{40-59}^{women}} = 0.38$

The clear-cut results summarized here are already revealed in figure 4. Since, on average, married women in both age groups are much more responsive to taxes, implicit tax rates imposed on them should be substantially lower than for men. However, given the usual second-earner status of many women and the widely used reductions in their own pension benefits if the latter coincide with dependents' or survivors' benefits, actual implicit tax rates for females are even higher than for males. In this case, the inverse elasticity rule of optimal taxation is obviously violated.

6. Conclusions

What have we learned from our investigation into the structure of implicit taxes that are involved in virtually all unfunded pension systems? And what are the policy implications of our findings? If we restrict our attention to

adjustment in the level of annual pension benefits, is clearly important in itself (see, for instance, Börsch-Supan, 2000, or Brinch, Hernæs, and Strøm, 2001).

the scenario that corresponds to the simple three-period model employed in the theoretical analysis, our preliminary conclusion could be as follows: Since in real-world pension systems implicit tax rates must be expected to decrease over the life cycle, support for the basic optimality of this structure can be derived from the observation that the labor-supply elasticity increases over the same period for men and married women alike, though at widely differing speeds in each of these cases.

At the same time, our results point to three potential sources of inefficiencies entailed in many existing unfunded pension systems. First, when investigating the time structure of implicit taxes in more detail, one problem is that relatively high levels of implicit tax rates are falling on male individuals near their retirement age.[44] Second, tax rates for married females are continuously declining, despite the higher responsiveness of women in the period of (potential) motherhood in terms of their labor supply. A third problem arises from the higher level of implicit taxation that applies to a typical second earner and thus mainly to married women.[45]

The last problem falls in the same class as a number of other well-known distortions that are created through explicit, progressive household-level taxation or child-related benefits that are inversely related to household income. Therefore, it may not rank highest on the agenda for strengthening the general incentives for women to participate in the labor market. As far as the pension system is concerned, the key to solving these problems will lie in increasing the degree of actuarial fairness. For example, mandatory contributions could be paid for spouses who are not working, and survivor benefits (as well as pure spouse benefits, which are absent in the German pension system) could be reduced or even abolished (Werding, 2005). It could then be expected that for single-earner couples the burden involved in public pension systems would go up. For all other individuals – two-earner couples as well as single males and females – it might go down because, *ceteris paribus*, the link between contributions and pension benefits would become more actuarial.

The first two potential inefficiencies mentioned above call for more differentiated approaches to pension reform. The first problem refers to implicit tax rates that may be too high for males who are about to enter retirement. Up to a point, it is interesting that this problem shows up in our estimates at all, because we limit attention to individuals aged less than 60, excluding

44 Here, the problem is not that this level of taxation is lower than for younger individuals, but that it may still be too high, given the increase in labor-supply elasticities.

45 A fourth problem that could be added here is that the highest level of implicit tax rates usually falls on very young individuals, females as well as males. But empirical support for the conclusion that this really creates a problem, especially in the case of males, is weak in our estimates.

those who are formally entitled to take up pension benefits early. In Germany, there are many routes for older workers who want to exit from the labor market. For instance, there are programs in which part-time work of older individuals is subsidized through unemployment insurance benefits (or, starting from age 60, even out of the pension budget). Börsch-Supan (2000) has demonstrated that early-retirement rules have an important influence on older workers' decisions to leave the labor force. If we were able to fully take into account the incentive effects of all kinds of early-retirement programs, our results would even be reinforced, because the effect of the relevant rules is to increase implicit taxes for older workers even further, and these taxes are already too high if we disregard those rules.

To a large extent, the second problem may be related to women who are, or could be, mothers, indicating that their hours-of-work decisions are more strongly influenced by financial considerations than in other periods of life. But part of it may also be a pure life-cycle phenomenon related to women in their middle age who see other tasks for themselves than working in the labor market, especially when they are financially secure through the presence of a first-earner husband. In any case, the problem would again be aggravated by progressive, household-level taxation and by child benefits that are inversely related to household income, as these contribute to high effective tax rates on wages earned by women in the relevant age group.

Throughout, our analysis has neglected the effects of cross-period wage elasticities of labor supply. Some remarks concerning these effects may be required here. It seems plausible to assume that cross-period elasticities are mainly relevant for adjacent time periods, especially at the stages of a typical working life affected by the above problems. During these periods, individuals do not necessarily plan to work full time, but have outside options like taking care of children, working at home, or retiring early at the end of their professional life. *A priori*, it is unclear whether high implicit taxes on wages in one period reduce the labor supply in other periods or enhance it. But the direction of this effect is not important. What matters is that the higher the cross-period elasticities are, the stronger will be the distortion of labor–leisure decisions in other periods due to implicit taxation. Hence, our result that a reduction in implicit taxes for middle-aged females and older males could be welfare-increasing would hold *a fortiori* if cross-period elasticities turned out to be significant.

If we take these problems seriously, they should therefore be solved by shifting the burden of implicit taxes over the individual life cycle (and across genders) so as to minimize existing distortions. For instance, Lindbeck and Persson (2003) conclude that, in an optimal-taxation framework, a decreasing path of implicit taxes over the life cycle might require "the contribution rate... [to] increase with age in a quasi-actuarial system, in order to bring about tax smoothing" (p. 85). The analysis in this paper, however, has shown that this argument ignores the relation between implicit taxes and periodic labor-supply elasticity. According to our findings, the inverse elasticity rule implies that in order to minimize distortions, taxes should be highest where the labor supply is least elastic and vice versa. Given the increasing profile of labor-supply elasticities of males and the inversely U-shaped profile of females, smoothing the life-cycle profile of implicit taxes as proposed by Lindbeck and Persson cannot be optimal. In contrast, we have seen that the declining pattern of implicit tax rates of unfunded pensions may even not be steep enough for men, while an optimal profile should be roughly U-shaped for women.[46]

Certainly, some our results would have to be slightly modified on including explicit taxes in the analysis. In contrast to implicit taxes, explicit taxes are *a priori* age-neutral. Including them in our calculations regarding optimal tax profiles would therefore decrease the relevant tax ratios, while the qualitative results should be unaffected. However, given the progressive character of explicit taxes, marginal tax rates usually rise with wages. Therefore, if wages rise with age, reflecting productivity changes or seniority rules of pay, explicit tax rates can be basically expected to increase over the life cycle. Putting together the different life-cycle profiles of explicit and implicit tax rates, some of our conclusions would thus be weakened, while others would become even stronger. In particular, high implicit tax rates for young individuals may, to some extent, be offset by relatively low explicit tax rates that are imposed on this group, so that potential distortions become smaller here. On the other hand, our findings that, considering the relevant age profiles of labor-supply elasticities, implicit tax rates could be too high for older individuals, for married women in their middle ages, or for second earners in general is likely to hold *a fortiori* if explicit taxes are also taken into account.

In theory, manipulating the life-cycle profile of implicit tax rates can be achieved by differentiating either of the two instruments that are most relevant for the level of τ_t: annual contribution rates or annual rates of return. The annual contribution rates needed to acquire a given amount of pension entitlements could be differentiated across age groups, for example, by increasing the contribution rate for those age groups with a rather inelastic

46 If we suppose the fourth problem to exist as well (see footnote 45) for both young women and young men who prefer to stay in the educational system for a longer period of time than is necessary to invest in future productivity (or to complete a degree for signaling purposes), then the optimal tax profiles need to be adjusted even further. In the case of males, tax rates should initially increase a bit; in the case of females, tax rates would have to be mildly N-shaped.

labor supply and decreasing it for those who react more strongly to changes in net wages. This would result in higher implicit tax rates falling on (young and) middle-aged males than on older ones, and lower implicit tax rates falling on middle-aged females than on (younger and) older ones. Alternatively, annual rates of return could be set differently for different age groups. Keeping the contribution rate constant across age groups, men could then make larger additions to their pension benefits by paying the same amount of contributions while they were (young or) close to retirement than while being middle-aged; the same holds for women at an intermediate stage of their working life.

In both cases, contribution rates and rates of return would have to be determined such that the annual budget constraint of the pension system holds and the total implicit debt carried by a given individual would not change. Thus, income and expenditure of the unfunded pension system must be balanced in each period, and the present value of individual contributions and benefits over the full life cycle must not be altered. Still, these two constraints leave some freedom for manipulating the level of annual implicit tax rates.

In practice, differentiating contribution rates by age may be harder to accomplish than varying rates of return. The reason for this is that administrative costs for employers, who would then have to take into account the age structure of their employees to determine the contributions, matter much more than similar effects resulting from changes in the benefit formula, which could easily be handled by the social security administration.[47] At the same time, changes in future benefits may be less perceptible, and hence less of an incentive, for many individuals than changes in current contribution rates. The pros and cons of the two strategies suggested here may thus have to be balanced against each other in some more detail.

There is another difficulty involved in defining, and keeping fixed, the optimum profiles of implicit tax rates for all the individuals affected. Figure 1 illustrates that any changes in the system, expected or not, can create a disturbance that hits many cohorts at a time, each being in a different stage of the life cycle. In order to install an optimal structure of implicit tax rates,

47 In fact, Austria has already made a step in this direction by attributing higher pension entitlements to contributions made at the age of 31–45. A differentiation across age groups is thus feasible. On the other hand, at least for males, pension entitlements should have been decreased, not increased, for these age groups, given their relatively inelastic labor supply, in order to establish an optimal life-cycle profile of implicit tax rates. Another instrument that to some extent fits in here was introduced, as a minor detail, in the German 2001 pension reform. Since then, there have been special top-ups on benefit entitlements accrued by women through contributions paid during the first years after a child is born. So far, however, the effects on total entitlements are small and explicitly limited to women with rather low earnings.

this has to be avoided. In fact, the structure of optimally differentiated contribution rates or rates of return must not only hold within a given period of time. Instead, it must be designed to hold over the full period of labor-force participation plus retirement of any given age cohort. It is obvious that optimality conditions of this kind are not easily implemented in real-world pension systems.[48]

Finally, we should take into account that our empirical results are based on a rather short period of observations made in the past. Are they really relevant for designing public pension schemes for the future, with an eye on the challenge that is created through demographic change? After all, the financial viability of existing pension systems may necessitate major reforms that follow other priorities: increases in the statutory retirement age or direct reductions in annual benefit levels. With reforms of this kind becoming effective in future years, there may thus be older workers who, through lack of foresight or low lifetime earnings, then have to work anyway as long as they are able to in order to support themselves in old age. On the other hand, if observable (uncompensated) elasticities of labor supply are low under these circumstances, this by no means implies that compensated elasticities have moved in the same direction. Whenever the pension system reaches a new steady state, the declining pattern of implicit tax rates that we have shown to exist will be reestablished, and the problems we have unearthed are again relevant.

All in all, our results do not make a very strong case against the efficiency of existing pay-as-you-go pension systems with their declining tax patterns. Yet, they highlight some details where improvements might be necessary, in particular with respect to the high-level implicit taxation of older males and middle-aged females and high implicit tax rates for married females in general. While married women should be subjected to special treatment, and not just to rules regarding spouse benefits or survivor benefits applying on a household level, all individuals should be taxed conditional on their age, for instance by applying lower annual contribution rates or higher rates of return to those who must be expected to respond more elastically to implicit tax rates. In any case, our results contradict a standard proposal that suggests smoothing the profile of implicit tax rates across the individual life cycle and highlight the need for a tax structure that takes variations in labor-supply elasticities into account.

48 It is also apparent that adapting public pension systems to optimal taxation rules may involve a huge loss in flexibility regarding short-term adjustments, which is often cited as being one of the main advantages of unfunded pension systems in contrast with the rigidities involved in funded systems. On the other hand, inasmuch as short-term flexibility effectively means susceptibility to (myopic) political manipulations, this need not be a serious drawback.

7. Appendix

7.1. Standardized Work Biographies

As a representative agent in each age cohort, we construct an individual with a stylized biography and working career (see table 7), which we do not alter across generations. We consider a male (blue- or white-collar) worker who enters his active period of life at the age of 20 and earns the average wage throughout his career. He is fully active until the age of 53, when he is assumed to become disabled with some positive probability. With what is left of his working capacity, he continues work until the age of 65. Upon retirement, he is entitled to receive pension benefits, paid to him and to his spouse. When he dies, his widow will receive a widows' pension for some more years.[49] As a result, the three main types of pension benefits – disability pensions, old-age pensions, and survivor benefits – are included in our model.

Table 7
Basic Assumptions on the Representative Agent

Age 20–52	Full-time employment with average earnings → contributions paid on full-time earnings	33 years
Age 53–64	Reduced probability of full-time employment → 83.4%: contributions paid on full-time earnings → 16.6%: (full) disability benefits received	12 years
Age 65–74	Period of retirement → old-age pension benefits based on prior earnings	10 years
Age 75(–86)	Death at age 75 → Survivor benefits payable to the surviving spouse	11 years

7.2. Estimates for the Wage Equation

In our data set, information on gross wages is only available for individuals who are actually employed. Restricting attention to these individuals in order to estimate the wage elasticity with respect to hours of work supplied involves a potential sample selection bias and may therefore lead to distorted results.

49 Mortality assumptions for the individual and his wife are based on conditional life expectancy for men and women at relevant ages. For more details, see Thum and Weizsäcker (2000), who did earlier calculations of this kind.

Building on the Heckman (1979) procedure, we therefore impute gross wages in two stages.

At the first stage (selection equation), we estimate participation probabilities for all individuals (both employed and nonemployed). This gives us a probability for the observation of a wage which can be used to correct for the sample selection bias when estimating a wage function based on all individuals in employment (table 8). At the second stage (wage equation), the wage function is estimated and used to impute wage rates for the nonemployed, exploiting the fact that they share characteristics with the employed (table 9).

The selection bias is captured in the selection variable λ and enters the wage equation. For reasons of identification, we exclude variables from the wage equation that can be supposed to influence the participation decision but not the wage rate, viz. family situation (partner, number and age of children), other household income (interest and rent income), and the unemployment rate.

Table 8

First Stage – Selection Equation (Heckman)

Variable	Males		Married females	
	Coefficient	Std. Err.	Coefficient	Std. Err.
Living with a partner	**0.18**	0.06	−0.21	0.17
Children aged 0–3	0.12	0.07	**−0.52**	0.07
Children aged 4–6	−0.02	0.08	−0.07	0.04
No. of children	**0.14**	0.03	−0.02	0.02
Secondary degree	0.02	0.04	−0.02	0.08
University degree	**0.52**	0.08	**0.16**	0.06
Occupational training	**0.32**	0.06	0.08	0.08
Job experience (yr)	**0.17**	0.01	**0.05**	0.02
(Job experience)^2 (yr)	**−0.01**	9.1e-4	−1.3e-3	1.3e-3
(Job experience)^3 (yr)	**1.4e-4**	0.2e-4	0.2e-4	0.3e-4
Unemployment rate	0.01	0.03	**−0.06**	0.02
Interest and rent income	0.1e-4	0.0e-4	**−0.1e-4**	4.7e-6
λ	2.16	0.05	2.11	0.06
No. of observations	24,815		14,407	
Censored observations	4,316		6,317	
Prob($\chi > 0$)	0.00		0.00	
Pseudo R^2	9.42%		8.72%	

Notes: Results for constants and year-of-survey dummies are not reported. Bold numbers denote statistical significance at the 5% level, at least. Interest and rent income is divided by 10,000.

Table 9
Second-Stage Wage Equation (Heckman)

Variable	Males		Married females	
	Coefficient	**Std. Err.**	**Coefficient**	**Std. Err.**
Secondary degree	1.21	0.742	**1.79**	0.70
University degree	**9.57**	0.74	**2.85**	0.57
Occupational training	0.97	0.52	**1.59**	0.75
Job experience (yr)	**0.62**	0.09	**0.42**	0.15
(Job experience)^2 (yr)	**−0.02**	0.01	−4.1e-3	0.01
(Job experience)^3 (yr)	1.5e-4	0.9e-4	−0.3e-4	1.9e-4
λ (sample selection)	−1.67	0.35	7.71	0.60
No. of observations	24,815		14,407	
Censored observations	4,316		6,317	
Prob($\chi > 0$)	0.00		0.00	

Notes: Results for constants and year-of-survey dummies are not reported. Bold numbers denote statistical significance at the 5% level, at least.

7.3. Compensated Wage Elasticities

Table 10
Compensated Wage Elasticities

Birth Cohorts	Age groups (Males)							
	20–24	25–29	30–34	35–39	40–44	45–49	50–54	55–59
1972–81	−0.017							
1967–76	0.011(**)	−0.027						
1962–71		−0.089	0.020					
1957–66			0.024	0.014				
1952–61				0.060	0.035			
1947–56					0.024	0.084		
1942–51						−0.037	0.250**	
1937–46							0.176(**)	0.556***
1932–41								0.607***

Table 10
Continued

Birth Cohorts	Age groups (Married females)							
	20–24	25–29	30–34	35–39	40–44	45–49	50–54	55–59
1972–81	0.335**							
1967–76	0.384***	0.374***						
1962–71		0.559***	0.447***					
1957–66			0.412***	0.581***				
1952–61				0.786***	0.558***			
1947–56					0.547***	0.459***		
1942–51						0.603***	0.603***	
1937–46							0.668***	0.455***
1932–41								0.419***

Source: GSOEP (1991–2002).

Notes: ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively, for both approaches; asterisks with parentheses indicate statistical significance on the basis of the bootstrapping technique only.

References

Aaron, H. (1966), The Social Insurance Paradox, Canadian Journal of Economics and Political Science 32, 371–374.

Atkinson, A. B., and Sandmo, A. (1980), Welfare Implications of the Taxation of Savings, Economic Journal 90, 529–549.

Atkinson, A. B., and Stiglitz, J. E. (1980), Lectures on Public Economics, McGraw-Hill: London.

Beckmann, K. (2000), A Note on the Tax Rate Implicit in Contributions to Pay-as-you-go Public Pension Systems, FinanzArchiv 57, 63–76.

Blomquist, S., and Hansson-Brusewitz, U. (1990), The Effect of Taxes on Male and Female Labor Supply in Sweden, Journal of Human Resources 25, 317–357.

Blundell, R., and McCurdy, T. (1999), Labor Supply: A Review of Alternative Approaches, in: Ashenfelter, O. C., and Card, D. (Eds.), Handbook of Labor Economics, Vol. 3A, Amsterdam, New York, Oxford, Tokyo, 1559–1695.

Blundell, R., Meghir, C., and Neves, P. (1993), Labor Supply and Intertemporal Substitution, Journal of Econometrics 59, 137–160.

Blundell, R., and Walker, I. (1986), A Life Cycle Consistent Empirical Model of Labor Supply Using Cross Section Data, Review of Economic Studies 53, 539–558.

Börsch-Supan, A. (2000), Incentive Effects of Social Security on Labor Force Participation: Evidence in Germany and Across Europe, Journal of Public Economics 78, 25–49.

Boockmann, B., and Steiner, V. (2000), Cohort Effects and the Returns to Education in West Germany, ZEW Discussion Paper 00–05, Mannheim.

Bourguignon, F., and Magnac, T. (1990), Labor Supply and Taxation in France, Journal of Human Resources 25, 358–389.

Breyer, F. (1989), On the Intergenerational Pareto Efficiency of Pay-as-you-go Financed Pension Systems, Journal of Institutional and Theoretical Economics 145, 643–658.

Brinch, C., Hernæs, E., and Strøm, S. (2001), Labor Supply Effects of an Early Retirement Programme, CESifo Working Paper 463, Munich.

Brunner, J. K. (1994), Redistribution and the Efficiency of the Pay-as-you-go Pension System, Journal of Institutional and Theoretical Economics 150, 511–523.

Brunner, J. K. (1996), Transition from a Pay-as-you-go to a Fully Funded Pension System: The Case of Differing Individuals and Intragenerational Fairness, Journal of Public Economics 6, 131–146.

Burkhauser, R. V., Kreyenfeld, M., and Wagner, G. G. (1997), The German Socio-Economic Panel: A Representative Sample of Reunited Germany and its Parts, Vierteljahreshefte zur Wirtschaftsforschung 66, 7–16.

Buslei, H., and Steiner, V. (1999), Beschäftigungseffekte von Lohnsubventionen im Niedriglohnbereich, Nomos: Baden-Baden.

Disney, R. (2004), Are Contributions to Public Pension Programmes a Tax on Employment?, Economic Policy 39, 267–311.

Feldstein, M. S. (1996), The Missing Piece in Policy Analysis: Social Security Reform, American Economic Review 86, 1–14.

Fenge, R. (1995), Pareto-efficiency of the Pay-as-you-go Pension System with Intragenerational Fairness, FinanzArchiv 52, 357–363.

Fenge, R., and Schwager, R. (1995), Pareto-improving Transition from a Pay-as-you-go to a Fully Funded Pension System in a Model with Differing Earning Abilities, Zeitschrift für Wirtschafts- und Sozialwissenschaften 115, 367–376.

Fenge, R., and Werding, M. (2004), Ageing and the Tax Implied in Public Pension Schemes: Simulations for Selected OECD Countries, Fiscal Studies 25, 159–200.

Flood, L. R., and McCurdy, T. (1992), Work Disincentive Effects of Taxes: An Empirical Analysis of Swedish Men, Carnegie-Rochester Conference Series on Public Policy 37, 239–278.

Franz, W. (1985), An Econometric Analysis of Female Work Participation, Education, and Fertility: Theory and Empirical Evidence for the Federal Republic of Germany, Journal of Labour Economics 3, 218–234.

Haisken-de New, J. P. (1997), A Primer on the German Institutional Background for GSOEP Users, http://panel.gsoep.de/soepinfo2001 (Basic information – institutional background).

Heckman, J. J. (1979), Sample Selection Bias as a Specification Error, Econometrica 47, 153–161.

Homburg, S. (1990), The Efficiency of Unfunded Pension Schemes, Journal of Institutional and Theoretical Economics 146, 640–647.

Homburg, S., and Richter, W. (1990), Eine effizienzorientierte Reform der GRV, in: Felderer, B. (Ed.), Bevölkerung und Wirtschaft, Duncker & Humblot: Berlin, 183–191.

Kaiser, H., van Essen, U., and Spahn, P. B. (1992), Income Taxation and the Supply of Labor in West Germany, Jahrbücher für Nationalökonomie und Statistik 209, 87–105.

Kaltenborn, B. (2000), Reformkonzepte für die Sozialhilfe: Finanzbedarf und Arbeitsmarkteffekte, Nomos: Baden-Baden.

Kifmann, M. (2004), Age-dependent Taxation and the Optimal Retirement Benefit Formula, University of Konstanz, Diskussionspapier 04/20 der DFG Forschergruppe Heterogene Arbeit.

Killingsworth, M. R., and Heckman, J. (1986), Female Labor Supply: A Survey, in: Ashenfelter, O. C., and Layard, R. (Eds.), Handbook of Labour Economics, Vol. 1, Amsterdam, New York, Oxford, Tokyo, 103–204.

Laisney, F., et al. (1999), Labour Force and Welfare Participation of Lone Mothers in West Germany, Économie Publique, Études et Recherches 3–4, 111–144.

Lindbeck, A., and Persson, M. (2003), The Gains from Pension Reform, Journal of Economic Literature 41, 74–112.

Pencavel, J. (1986), Labor Supply of Men: A Survey, in: Ashenfelter, O. C., and Layard, R. (Eds.), Handbook of Labour Economics, Vol. 1, North-Holland: Amsterdam, New York, Oxford, Tokyo, 3–102.

Sandmo, A. (1974), A Note on the Structure of Optimal Taxation, American Economic Review 64, 701–706.

Sandmo, A. (1987), A Reinterpretation of Elasticity Formulae in Optimum Tax Theory, Economica 54, 89–96.

Schwarze, J. (1995), Simulating German Income and Social Security Tax Payments Using the GSOEP, Cross-National Studies in Aging, Program Project Paper 19, Syracuse.

Sinn, H.-W. (2000), Pension Reform and Demographic Crisis. Why a Funded System Is Needed and Why It Is not Needed, International Tax and Public Finance 7, 389–410.

Sinn, H.-W., and Thum, M. (1999), Gesetzliche Rentenversicherung: Prognosen im Vergleich, FinanzArchiv 56, 104–135.

Sinn, H.-W., and Werding, M. (2000), Rentenniveausenkung und Teilkapitaldeckung: ifo Empfehlungen zur Konsolidierung des Umlageverfahrens, ifo Schnelldienst 53, 12–25.

Staat, M., and Wagenhals, G. (1994), The Labour Supply of German Single Mothers: A Bivariate Probit Model, Vierteljahreshefte zur Wirtschaftsforschung 63, 113–118.

Strøm, S., and Wagenhals, G. (1991), Female Labour Supply in the Federal Republic, Jahrbücher für Nationalökonomie und Statistik 208, 575–595.

Thum, M., and von Weizsäcker, J. (2000), Implizite Einkommensteuer als Messlatte für die aktuellen Rentenreformvorschläge, Perspektiven der Wirtschaftspolitik 1, 453–468.

Tobin, J. (1958), Estimation of Relationship for Limited Dependent Variables, Econometrica 26, 24–36.

Triest, R. K. (1990), The Effect of Income Taxation on Labor Supply in the US, Journal of Human Resources 25, 491–516.

Untiedt, G. (1992), Das Erwerbsverhalten verheirateter Frauen in der Bundesrepublik Deutschland, Physica: Heidelberg.

Van Soest, A., Woittiez, I., and Kapteyn, A. (1990), Labour Supply, Income Taxes, and Hours Restrictions in the Netherlands, Journal of Human Resources 25, 517–558.

Werding, M. (2001), Child Expenditure and Public Pensions, International Studies on Social Security 8, 141–165.

Werding, M. (2005), Survivor Benefits and the Gender Tax Gap in Public Pension Schemes: Observations from Germany, CESifo Working Paper 1596, Munich.

Wissenschaftlicher Beirat beim Bundesministerium für Wirtschaft (1998), Grundlegende Reform der gesetzlichen Rentenversicherung, Bundesministerium für Wirtschaft, Bonn.

Wrede, M. (1999), Pareto Efficient Pay-as-you-go Pension Systems with Multiperiod Lives, Jahrbücher für Nationalökonomie und Statistik 219, 494–503.

Ziliak, J. P., and Kniesner, T. J. (1999), Estimating Life Cycle Labor Supply Tax Effects, Journal of Political Economy 107, 326–359.

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