DISCUSSION PAPER SERIES

No. 8425

THE TAX BENEFIT OF INCOME SMOOTHING

Kristian Rydqvist, Steven Schwartz and Joshua Spizman

FINANCIAL ECONOMICS

Centre for Economic Policy Research

www.cepr.org

Available online at: www.cepr.org/pubs/dps/DP8425.asp

ISSN 0265-8003

THE TAX BENEFIT OF INCOME SMOOTHING

Kristian Rydqvist, Binghamton University and CEPR
Steven Schwartz, Binghamton University
Joshua Spizman, Binghamton University and University of Central Florida

Discussion Paper No. 8425
June 2011

Centre for Economic Policy Research
77 Bastwick Street, London EC1V 3PZ, UK
Tel: (44 20) 7183 8801, Fax: (44 20) 7183 8820
Email: cepr@cepr.org, Website: www.cepr.org

CEPR Discussion Paper No. 8425

June 2011

ABSTRACT

The Tax Benefit of Income Smoothing*

A worker can contribute pre-tax dollars to a private pension plan. Under a progressive tax, this feature reduces income taxes. Ippolito (1986} argues that an individual in 1979 can reduce lifetime taxes by 20%. We re-examine his analysis using the complete time-series of US income tax history and find that the tax benefit of income smoothing is much smaller.

JEL Classification: D91, G11, G18, G23 and H24
Keywords: income tax history, private pensions and tax progressivity

Kristian Rydqvist
School of Management
Binghamton University
P.O. Box 6015
Binghamton,
New York 13902-6015
USA
Email: rydqvist@binghamton.edu

For further Discussion Papers by this author see:
www.cepr.org/pubs/new-dps/dplist.asp?authorid=109536

Steven Schwartz
School of Management
Binghamton University
Binghamton, New York 13902-6015
USA

Email: sschwart@binghamton.edu

For further Discussion Papers by this author see:
www.cepr.org/pubs/new-dps/dplist.asp?authorid=173649

Joshua Spizman
Binghamton University
School of Management
Binghamton, New York 13902
USA

Email: jspizma1@binghamton.edu

For further Discussion Papers by this author see:
www.cepr.org/pubs/new-dps/dplist.asp?authorid=170699

* We thank participants at the Southern Finance Association for comments.

Submitted 31 May 2011

1 Introduction

One of the most persistent beliefs regarding retirement planning under a progressive tax system is that there is a benefit to postponing income tax liability until retirement.[1] This belief rests on the simple observation that marginal tax rates decrease in the absence of employment income. As a consequence, lifetime tax liability can be lowered by shifting taxable income from work years to retirement until marginal tax rates are equalized.[2] We refer to this process as income smoothing. Our objective is to quantify the smoothing benefit. Assigning a numerical value to the smoothing benefit is interesting to investment advisers, union leader, and scholars engaged in financial retirement planning.

Surprisingly little analytical work has been done to quantify the benefit of income smoothing using actual income data and tax rates. Ippolito (1986), in his extensive analysis of the United States private pension system, estimates the potential smoothing benefit as 20% of life-time taxes or, expressed in terms of tax rates, a reduction of the effective tax rate by five to six percentage points. His calculations are based on a life-cycle consumption model and actual taxes paid from Statistics of Income. Some other attempts such as those by Ozanne and Lindeman (1987) and Horan (2005) are only suggestive because the tax rates at contribution and withdrawal are treated as exogenous. For example, Ozanne and Lindeman (1987) assume that the contribution rate is 28% and the withdrawal rate 15%, thus implying that tax liability is almost cut in half. Gokhale, Kotlikoff, and Neumann (2008) use a life-cycle financial planner program (Economic Security Planner) to numerically evaluate the tax benefits of saving before tax. In their analysis, the smoothing benefit is mixed in with other effects.

In this paper, we follow and extensively develop the modeling approach of Ippolito (1986). Relative to the attention paid to the smoothing benefit in textbooks, articles, and by investment advisers, our estimate of the smoothing benefit is surprisingly small. Under extreme behavioral

[1] E.g., Ippolito (1986), Feenberg and Skinner (1989), Lankford (2008), Horan (2009), and Nishiyama (2010). See also the tax treatment of pensions in the *Encyclopedia of Taxation and Tax Policy*.

[2] For example, Stiglitz (1988a) writes: "On the other hand, many individuals have a lower income when they retire than when they worked and thus are subject to lower tax rates at retirement. The current system allows income that is used in retirement to be taxed at the lower marginal rates prevalent then." See also Ippolito (1986), Ragan (1994), and Turner (2005).

assumptions that entail lifetime planning from the time the worker enters the job market until death, the average worker cannot reduce the effective tax rate by more than 2.5 percentage points. There are two main restrictions on the smoothing benefit: the United States income tax system is not sufficiently progressive to motivate income shifting between work years and retirement, and Social Security income reduces the need to save privately for retirement. With Social Security, the average tax rate reduction resulting from lifetime income smoothing decreases to 1.4 percentage points. We believe that such a small magnitude is unlikely to motivate the type of disciplined savings necessary to obtain the smoothing benefit.

Our findings on the magnitude of the smoothing benefit are robust to a variety of parameter choices. We perform comparative statics on real interest, income growth, life expectancy, the savings rate, and the years spent saving for retirement. Real interest fills up lower marginal tax brackets in retirement with capital income and, thus, prevents the worker using them for smoothing. Real interest and Social Security influence the smoothing benefit in a similar way. Income growth and increased life expectancy raise the smoothing benefit; income growth because it represents income variability, which can be beneficially smoothed, and increased life expectancy because it increases the number of years available for smoothing. However, the effects of both income growth and increased life expectancy as well as variations in the savings rate and the start of retirement savings are all relatively small because of the lack of progressivity in the United States personal income tax code.

Historical smoothing benefit calculations from 1950 conclude our analysis. The historical time-series sheds light on Ippolito's hypothesis that a smoothing benefit is one of the reasons for the growth of the private pension system in the United States. As the smoothing benefit is quite small throughout most of the post-war period, the tax benefit of income smoothing does not appear to be a significant factor in the growth of union led retirement plans. In defense of Ippolito (1986), who studies the growth of the private pension system right before the Tax Reform Act of 1986 (TRA 1986), the smoothing benefit is briefly higher than at any other point in time and may have attracted the attention of union leaders and other retirement planners.

The income smoothing problem in our paper adds to the literature on tax shifting within a progressive system. There are papers studying the tax implications of shifting income across spouses, unmarried couples, from parents to children, and across households.[3] Also, the tax code itself permits income smoothing. There are carry back and carry forward provisions for corporations (operating losses) and households (capital losses), and farmers and fishermen can pay tax on income averaged over the current year and the three past years, so called income averaging.

The rest of the paper is organized as follows: Section 2 provides the reader with a short summary of the main features of the private and public pension systems in the United States. In the next Section 3, we set out the life-cycle model and derive the tax implications of income smoothing within a stylized tax table with only three income brackets and large tax rate jumps. In Section 4, we apply the model to personal income taxation in the United States 2010, and examine the robustness to parameters choices. The analysis ends with the analysis of the historical United States time-series. Section 5 concludes the paper.

2 Institutional Background

In the United States, there is an array of retirement savings options. We describe the most relevant options to our study. We classify options according to the tax provisions that attach to them. Other important attributes include the sponsor, the party who bears the risk of investment performance, and the option of not participating.

A large class of retirement savings options allows for pre-tax contributions to savings, tax-free accruals, and taxed withdrawals. Options in this class include 401(k), 403(b), 414(h), and 457(g) employer-sponsored retirement savings plans. Qualifying contributions to traditional IRAs are also included. The difference between IRAs and the other options is that IRAs are self-initiated, while 401(k) products must be provided by employers. Also, the statutory limits on IRA contributions are relatively small. Defined benefit pension plans also belong to this class. Although workers may not have to contribute explicitly to their pension plan it is often the case that pension benefits are granted in lieu of wage increases (Lowenstein (2008)). Hence defined benefit pension plans offer

[3] Stephens and Ward-Batts (2004) analyze spouses, Eissa and Hoynes (2000) study unmarried couples, and Stiglitz (1988b) discuss shifting income from parents to children. Green and Rydqvist (1999) and Rydqvist (2011) examine interpersonal netting of stock market gains and losses through trading in lottery bonds.

implicit pre-tax retirement savings. The important distinction between defined contribution plans such as 401(k)s and defined benefit plans is the party that bears the risk of investment performance. In the former it is the worker, in the latter it is the employer.

A second option for retirement savings is an after-tax contribution that offers tax free accrual and withdrawal of earnings. Options in this class are employer-sponsored Roth 401(k)s and self-initiated Roth IRAs. As in the pre-tax case, the Roth 401(k) allows for significantly higher statutory limits on contributions than the Roth IRA. It is also possible to convert traditional IRAs and 401(k)s to Roth plans. The Roth plans essentially trade the smoothing benefits of pre-tax contributions for the ability to withdraw funds tax-free.

A third option, that is generally not of great importance, are after tax contributions that offer tax free accrual of earnings but not tax free withdrawal. Most notable in this class are contributions to traditional IRAs that do not qualify for pre-tax treatment. For individuals covered by a retirement plan by their employers, the income limit excludes many individuals who would have the financial resources for savings from qualifying for pre-tax treatment of contributions. For individuals without an employer-sponsored plan there is no income limit, however there are significant limits on the size of contributions relative to 401(k) plans. United States Savings Bonds have similar provisions in that they are after tax savings vehicles that accrue earnings tax free but are taxed upon withdrawal. One difference between savings bonds and IRAs is that savings bond income is not taxable at the state and local level.

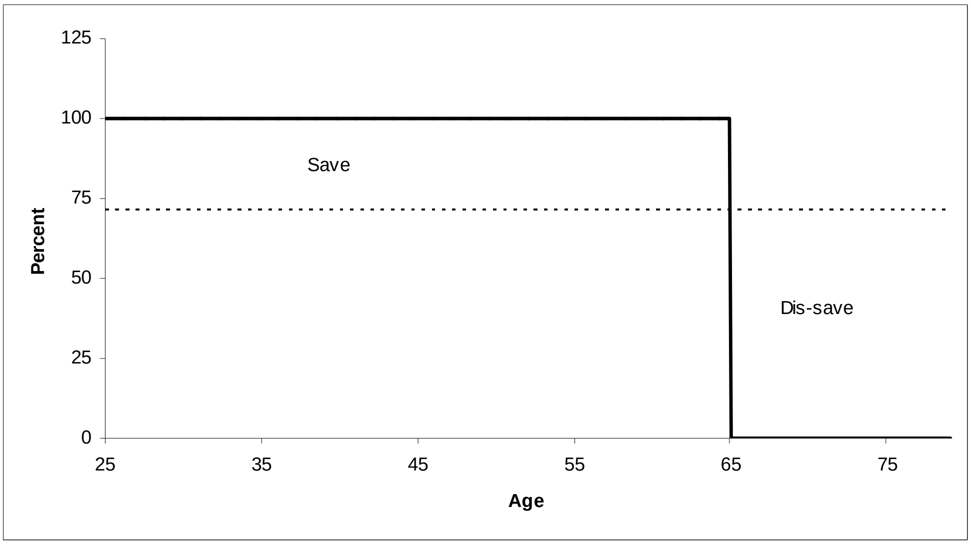
By far the most important source of retirement income in the United States is Social Security. Unlike all of the options described above, Social Security is mandatory for most workers in the United States. Overall Social Security accounts for about 40% of retirees' income and virtually 100% of income for the bottom third of retirees (Reno and Lavery (2007)). Social Security shares some tax attributes with all three retirement savings options described above. Contributions from workers are made after tax, there are no taxes paid during accumulation of benefits and, for many retirees, benefits are not taxed upon withdrawal. In this sense, Social Security acts like a Roth IRA or Roth 401(k). Beginning in 1984, individuals who have significant income in retirement other than Social Security may have some of their Social Security benefits taxed as regular income. For these individuals Social Security acts, in part, like non-qualified contributions to traditional IRAs. Of particular note is that withdrawals from 401(k) plans and similar products are considered other income while withdrawals from Roth products are not. Therefore, savings for retirement pre-tax may come at a cost of increased taxes on Social Security benefits. Finally, half of Social Security premiums are paid by employers. To the extent that these premiums substitute for taxable wages, Social Security resembles a 401(k) and, hence, provides some smoothing benefits (Vroman (1974) and Ippolito (1986)).

3 Income Smoothing

3.1 Zero Interest and No Income Growth

We analyze the consumption and savings decision of a worker who can save before income tax in a retirement account that is offered to the worker through his employment contract. The retirement

Figure 1: Life-Cycle Model

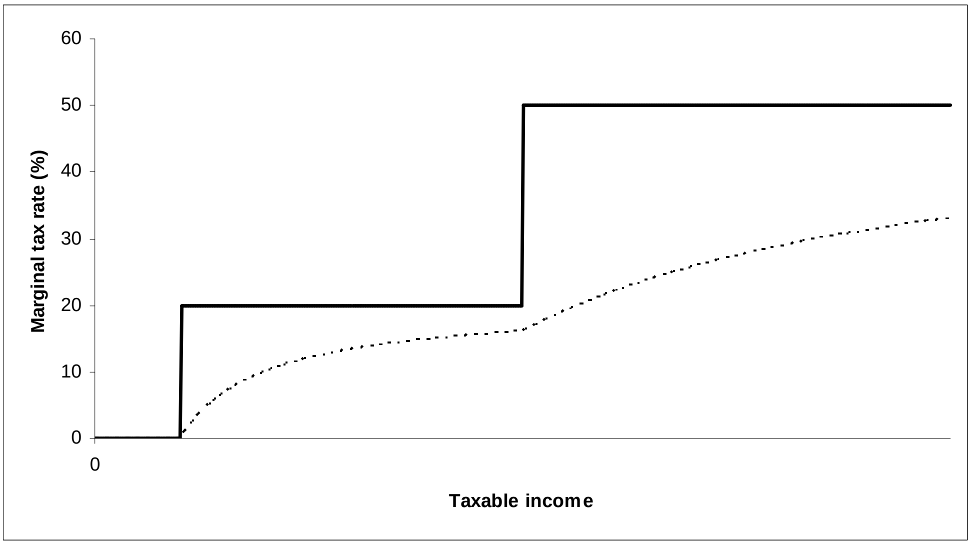


The figure shows the annual before-tax income during work years (solid line) and annual income smoothed over adult life time (dotted line). We assume 40 work years and 16 retirement years.

account is either a company pension or a 401(k)-type account. The worker contributes to the retirement account over n work years to support consumption over $m - n$ retirement years. A numerical example is provided in Figure 1 assuming certainty, zero interest, and no income growth. The worker has an annual income of 100 during work years and zero income during retirement years, he begins working at age 25, he retires at age 65, and he dies at age 81. In this example that entails perfect income smoothing over the life cycle the before-tax savings rate is 28.6%.

Our strategy is to analyze the tax benefit of income smoothing using a stylized tax table. Later, in Section 4 below, we quantify the smoothing benefit using United States 2010 tax tables. The stylized tax table in Figure 2 is a step function with three income brackets and marginal tax rates at 0%, 20%, and 50%. The breakpoints between income brackets are $10,000 and $50,000, respectively. Within each income bracket the marginal tax rate is constant. The average tax rate curve plotted below (dotted line) is an increasing function with jumps at the break points between income brackets. The stylized tax table has few income brackets as is typical after The Tax Reform Act of 1986 (TRA 1986), but the tax rate increments between income brackets have been exaggerated to bring out the model properties.[4]

Figure 2: Stylized Tax Table



This figure plots marginal and average tax rates for a stylized tax table with three income brackets and marginal tax rates at 0%, 20%, and 50%. The break points between income brackets are $10,000 and $50,000, respectively.

[4]Tax tables before TRA 1986 often have more than 30 income brackets. Such tax tables would be better approximated by a continuous function between the first and the third income bracket. Continuous tax tables exist. In Germany, the marginal tax rate is determined by a polynomial.

We make the following assumptions: First, we consider certainty only. This is a simplification that abstracts away from uncertain labor income, life expectancy, and future income tax. Uncertain life expectancy is handled by company pensions (defined benefit plans) or the private market for life annuities, but uncertain labor income is difficult to contract away. Analyzing the many possible responses to uncertain labor income and the effects on the tax benefit of income smoothing is beyond the scope of our paper. Second, in our model, the only purpose to save is to support consumption during retirement. Other motivations such as precautionary saving (under uncertainty) or saving for housing, college, and bequest are not considered. We believe that such other motivations reduce the tax benefit of income smoothing. Third, we assume that the worker prefers more to less, but we do not restrict ourselves to concave utility functions. The first-order effect of shifting income from work years to retirement is to reduce tax liability. Smoothing consumption over the life cycle has a second-order effect on welfare that we are less interested in quantifying. Nevertheless, since perfect income smoothing implies simple analytical solutions, we frequently refer to this special case, which is supported by an increasing and concave utility function. Fourth, the utility function is time separable with a time preference set at zero. When we evaluate the numerical results in Section 4, we discuss the tradeoff between impatience and the tax benefit of income smoothing, but we do not see any reason to explicitly add time preferences to the model. Fifth and finally, the worker can save as many pre-tax dollars for retirement as he wants (no contribution limit), and he can borrow any amount he wishes against future income. This assumption allows us to focus on the tax problem, knowing that the worker can reach any desired life-cycle consumption path by borrowing and lending after tax.[5] Lending and borrowing constraints may matter in practice, but they make little difference to the analysis of the tax benefit of income smoothing and can, therefore, be safely ignored.

The worker's objective is to choose the before-tax income rate ϕ that minimizes lifetime tax liability:

$$\min_{\phi} \quad \mathcal{T} = nT(\phi Y) + (m-n)T\left(\frac{n(1-\phi)Y}{m-n}\right), \tag{1}$$

[5] The corresponding assumption that allows the researcher to separate the tax problem from the investment problem is used by Constantinides (1983), Huang (2008), and others. With zero interest, any after-tax savings account will do. What we have in mind is a Roth type account where positive interest can accrue without tax liability.

where Y is annual income, $T(\cdot)$ is the tax liability function, n is the number of work years, and $m - n$ is the number of retirement years. The first term on the right hand side is the annual tax liability on work income, and the second term is the annual tax liability on retirement income. The first-order condition for a minimum requires that the marginal tax rate during work years and retirement years are equal:

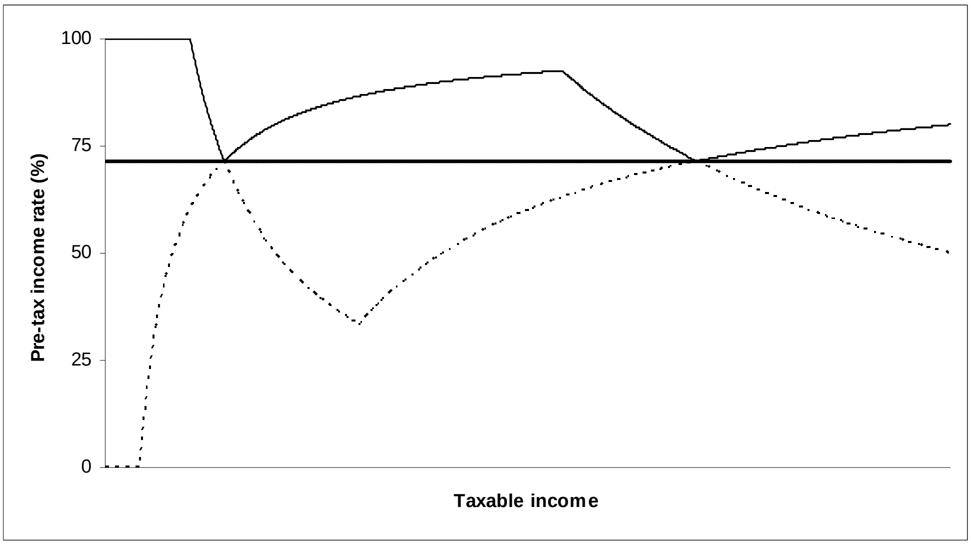
$$T'(\phi Y) = T'\left(\frac{n(1-\phi)Y}{m-n}\right). \tag{2}$$

One specific solution that we refer to as perfect income smoothing is when work year income equals retirement year income:

$$\phi = \frac{n}{m}. \tag{3}$$

Generally, the tax-minimization problem has multiple solutions because the tax liability function is piecewise linear. As long as marginal tax rates are different during work years and retirement years, tax liability can be reduced by shifting income, but when marginal tax rates are equal, shifting income between work years and retirement years does not change tax liability.

Figure 3: Tax-Minimizing Income Rate



The figure shows the income rate with perfect smoothing $\phi = n/m$ (solid middle line), the maximum ϕ_{max} (solid line above), and the minimum ϕ_{min} (dotted line below) tax-minimizing income rate using the stylized tax table, 40 work years, and 16 retirement years.

The range of solutions within the stylized tax table can be seen in Figure 3. The solid line above displays the maximum solution ϕ_{max} and the dotted line below the minimum solution ϕ_{min}. The horizontal line in the middle represents the special case when income is perfectly smoothed over the life cycle. Perfect smoothing is the unique solution to the tax-minimization problem where the ϕ_{max} and ϕ_{min} functions intersect near each breakpoint Y_b:

$$Y = Y_b \times \left(\frac{m}{n}\right), \tag{4}$$

At this income level, tax liability is minimized by shifting all income out of the higher income bracket into the lower brackets. At income levels below \$625, any $\phi \in [0\%, 100\%]$ is a tax-minimizing solution as the worker can shift his entire income in or out of the retirement account without ever being liable for income tax.

3.1.1 Smoothing Benefit Measure

The average tax rate conveniently summarizes the worker's tax liability. The average tax rate is defined as the worker's tax liability divided by his pre-tax income:

$$\tau(Y) = \frac{T(Y)}{Y}. \tag{5}$$

For any before-tax income rate ϕ, we measure the tax benefit of income smoothing as the reduction in the average tax rate:

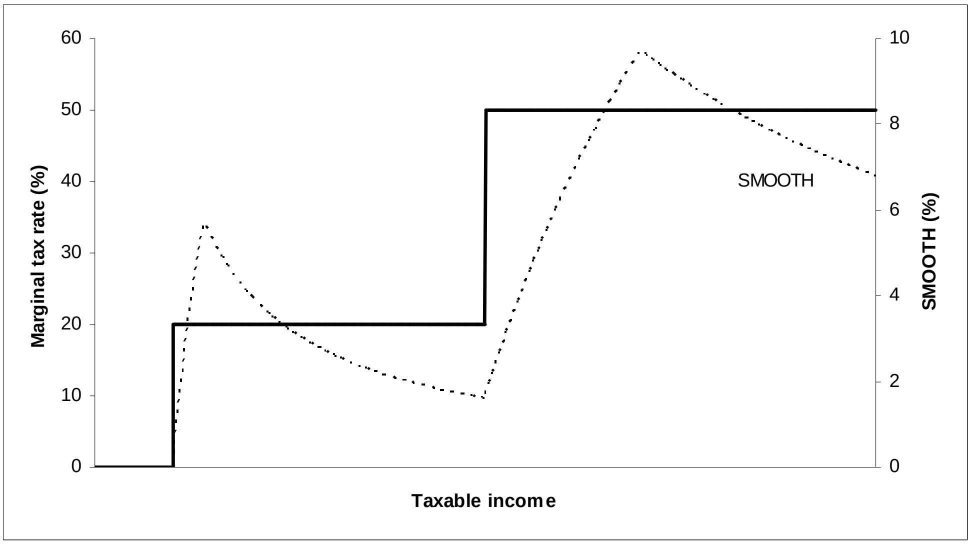
$$\text{SMOOTH} = \tau(Y) - \left(\frac{nT(\phi Y) + (m-n)T\left(\frac{n(1-\phi)Y}{m-n}\right)}{nY}\right), \tag{6}$$

In the special case of perfect income smoothing, we have $\phi = n/m$, and the expression simplifies to:

$$\text{SMOOTH} = \tau(Y) - \tau(\phi Y). \tag{7}$$

The smoothing benefit measure increases with the slope of the average tax rate curve, which depends on tax progressivity.[6] The average tax rate curve is upward-sloping when the tax is progressive (as in the stylized tax table), it is flat when the tax is proportional, and it is downward-sloping when the tax is regressive. Accordingly, the worker benefits from income smoothing if the tax is progressive, income smoothing has no effect on tax liability if the tax is proportional, and income smoothing hurts the worker if the tax is regressive.[7] The smoothing benefit measure is also a function of the number of work years n relative to the number of retirement years $m-n$. An increase in the number of work years relative to time in retirement reduces relative smoothing space, while an increase in retirement years relative to work years increases it.

Figure 4: Tax Benefit of Income Smoothing



This figure plots the marginal tax rate function (solid line; left axis) along with the tax benefit of income smoothing (dotted line; right axis) using the stylized tax table, 40 work years, and 16 retirement years.

Figure 4 plots SMOOTH as a function of pre-tax income (dotted line; right scale) along with the marginal tax rate function (solid line; left scale). The SMOOTH function has a local minimum at the breakpoint between income brackets, and it has a local maximum to the right of each breakpoint,

[6]Slitor (1948) proposes to measure tax progressivity as the instantaneous slope of the average tax rate curve. Other common measures of tax progressivity are based on the difference between the marginal tax rate and the average tax rate (see Røed and Strøm (2002)).

[7]Income tax tables are generally progressive. One interesting exception is the taxation of Social Security income (see Section 4.2.3). Another interesting case is related to the current debate over the budget deficit whether future tax liability must increase (during retirement years) to cover the budget deficit (during work years).

where the tax-minimization problem has a unique solution given by Equation (4). Not surprisingly, the tax benefit of income smoothing is most pronounced near the breakpoints between income brackets where the worker can shift income out of the higher bracket.[8] For the same reason, the smoothing benefit is particularly small right below each breakpoint where large amounts of pre-tax income must be shifted into retirement to reach the lower income bracket.

The worker benefits from income smoothing also when the marginal tax rate remains the same before and after income smoothing. We illustrate this point in Table 1. In the example in the

Table 1: Inframarginal Income Tax

Before smoothing			After smoothing			
Income (Y)	First bracket (%)	Third bracket (%)	Income (ϕY)	First bracket (%)	Third bracket (%)	SMOOTH (%)
14,000	71	0	10,000	100	0	7.5
50,000	20	0	35,714	28	0	1.6
70,000	14	29	50,000	20	0	9.7
120,000	8	58	85,714	12	42	5.7

The table illustrates how income smoothing shifts income into lower tax brackets under perfect income smoothing. The left column in each section is taxable income, and the right column is the percent of this income that is taxed in the higher bracket. The calculations are based on the stylized tax table, 40 work years, and 16 retirement years.

top row, income smoothing moves the worker entirely into the tax-free region. In this case, excess income from the second bracket over 40 work years exactly fills up the space for income smoothing in the first bracket:

$$\begin{aligned} &\text{Demand:} \quad 40 \times (14,000 - 10,000) &= 160,000. \\ &\text{Space:} \quad 16 \times 10,000 &= 160,000. \end{aligned}$$

Since the worker escapes income taxation, the average tax rate decreases by a relatively large amount, here, 7.5 percentage points. This example also illustrates why the spikes in the SMOOTH function occur inside the income brackets and not at the breakpoint between two income brackets. Smoothing peaks at the point where income can be completely shifted out of the higher income bracket.

[8] See Milligan (2003) for a related discussion (page 260, footnote 11).

The other three examples illustrate the tax benefit of income smoothing when the worker cannot escape income tax. In all three cases, the proportion of income in the first bracket increases and, as a result, the average tax rate is reduced. The tax benefit of income smoothing is relatively small at the pre-smooth income level $50,000, which is right at the top income bracket (second row). The reason is that excess income from the second bracket far exceeds the space for income smoothing in the first bracket:

$$\begin{array}{lll} \text{Demand:} & 40 \times (50,000 - 10,000) & = 1,600,000. \\ \text{Space:} & 16 \times 10,000 & = \quad 160,000. \end{array}$$

Consequently, the proportion of income that can be shifted from the second to the first bracket is only 28-20=8%, and the average tax rate reduction is modest 1.3%. However, the worker benefits from income smoothing despite that the marginal tax rate equals 20% with or without smoothing.

Proceeding to the example in the third row, we see that excess income from the top bracket exactly fills up the space for income smoothing in the two lower brackets:

$$\begin{array}{lll} \text{Demand:} & 40 \times (70,000 - 50,000) & = 800,000. \\ \text{Space:} & 16 \times (10,000 + 40,000) & = 800,000. \end{array}$$

The tax benefit is particularly large in this example, SMOOTH=9.7%, because income smoothing allows the worker to avoid the high marginal tax rate of the top income bracket. The example in the fourth row resembles that in the second row. The marginal tax rate equals 50% both before and after smoothing, but the average tax rate decreases because the proportion of income that is taxed in the third bracket decreases.

3.1.2 Invariance Property

The multiplicity of solutions to the tax-minimization problem (1) means that the worker can vary the savings rate or the point of time when he begins saving for retirement without reducing the smoothing benefit. This property is important in the post-TRA 1986 environment, since it gives the worker flexibility with respect to saving for retirement without giving up the smoothing benefit.

The invariance property is numerically illustrated in Figure 5. The upper plot shows the effect of varying the beginning age.[9] The number of work years is n, but the worker postpones saving for retirement x years. We compute the smoothing benefit with postponement as:

$$\text{SMOOTH} = \tau(Y) - \left(\frac{xT(Y) + (n-x)T(\phi Y) + (m-n)T\left(\frac{(n-x)(1-\phi)Y}{m-n}\right)}{nY} \right). \tag{8}$$

The smoothing benefit is maximized at the beginning age of 25 years but, the two functions associated with \$50,000 and \$120,000 have long flat stretches where the smoothing benefit is invariant to the beginning age. When pre-tax income is \$120,000, the worker can postpone saving until age 55 without reducing the smoothing benefit and, for pre-tax income \$50,000, the worker can wait until three years before retirement. Of course, the required savings rate associated with such late starts may be both economically painful and statutorily infeasible. The \$70,000 function that occurs at a local SMOOTH maximum is single-peaked. Every year of postponement means a loss of smoothing benefits as perfect income smoothing is required to reach the maximum benefit of 9.7%.

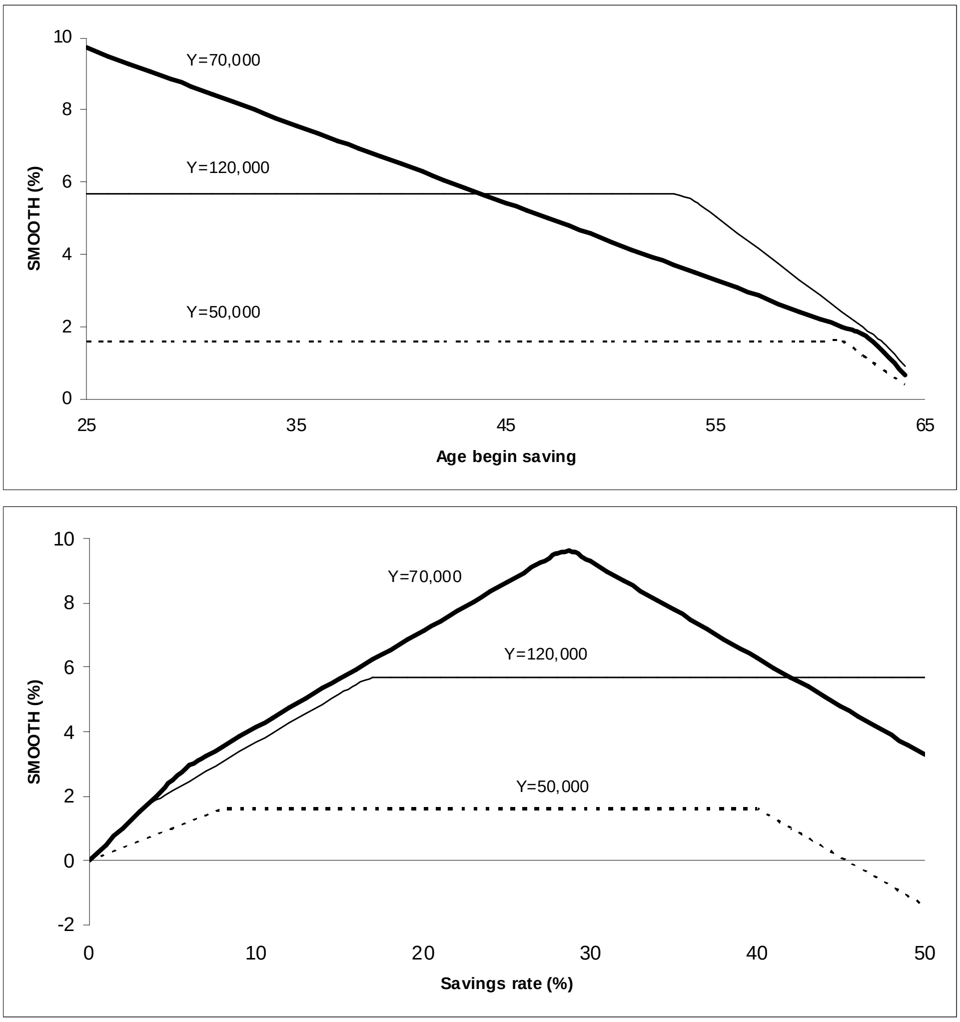
The lower plot shows SMOOTH as a function of the savings rate. As in the upper plot, the two functions associated with income levels \$50,000 and \$120,000 display long flat stretches where the smoothing benefit does not depend on the savings rate, while the \$70,000 function is single-peaked. At \$50,000, where smoothing space is small relative to smoothing demand, any savings rate from 8% to 40% yields the maximum smoothing benefit of 1.6%. The income level \$120,000 represents an intermediate case with the flat stretch is shifted towards higher savings rates. A low savings rate implies a low replacement ratio, and vice versa. The replacement ratio of retirement year income to work year income is defined by:

$$\rho = \frac{(n(1-\phi)Y)/(m-n)}{\phi Y} = \frac{n}{m-n} \cdot \frac{1-\phi}{\phi}. \tag{9}$$

For an annual income of \$50,000, we have $\phi_{min} = 60\%$ and $\phi_{max} = 92\%$. The replacement ratios

[9] Since we analyze a constant income stream over time, we can think of this model experiment as one with time-varying marginal utility of consumption. When the worker is young and the marginal utility of consumption is relatively high the worker does not save, and when he is old and marginal utility is low the worker behaves as in the life-cycle model See discussions in Bernheim, Skinner, and Weinberg (2001) and Browning and Crossley (2001) related to empirical validation of the life-cycle model.

Figure 5: Invariance Property



The figure plots the smoothing benefit against the savings rate and the beginning age for three different income levels. The calculations are based on the stylized tax table, 40 work years, and 16 retirement years.

associated with these numbers are 167% and 22%, respectively. Hence, the replacement ratio can vary within this range without reducing the smoothing benefit.

3.2 Interest and Income Growth

We conclude the analysis of the model and the stylized tax table by investigating how real interest and income growth influence the tax benefit of income smoothing. We analyze real as opposed to nominal interest and income growth because we are interested in long-term retirement planning. In accordance with current practice, we assume that tax tables are indexed to inflation.[10] Interest and income growth move the smoothing benefit in opposite directions. Interest reduces the smoothing benefit, and income growth raises it. The two effects approximately cancel out. Therefore, in the subsequent analysis of income smoothing in the United States in Section 4 below, we ignore interest and income growth.

3.2.1 Interest

Interest generates capital income that reduces the need to save for retirement. Consequently, the tax benefit of smoothing labor income decreases as capital income fills up smoothing space in lower income brackets. In the limit, as the interest rate approaches infinity, the savings rate and the smoothing benefit go to zero.

Consider the interest rate $r > 0$. Each year, the worker pays tax and consumes the net proceeds from ϕY, and he saves the residual $Y(1-\phi)$ for retirement. The future value of the retirement account after n work years equals:

$$FV_n = F_n Y(1-\phi), \tag{10}$$

where $F_n = \left[(1+r)^n - 1\right]/r$ is the future-value annuity factor. The tax-minimization problem with interest becomes:

$$\min_{\phi} \quad \mathcal{T} = nT(\phi Y) + (m-n)T\left(\frac{F_n(1-\phi)Y}{m-n}\right). \tag{11}$$

[10] At times, nominal bracket creep can be important (Rydqvist, Spizman, and Strebulaev (2010)). Income tax tables are nominally fixed over extended time periods between World War II and TRA 1986, but discrete adjustments take place, and formal cost-of-living indexation is introduced with TRA 1986.

Interest enters through the future-value annuity factor inside the second term on the right hand side of the equation. The income effect of earning real interest can be large. A one percent real interest rate raises the future-value annuity factor from $F_n = 40$ to $F_n = 48.9$, which means that one percent real interest compounded over 40 years is equivalent to adding 8.9 years of work income.

A simple analytical solution obtains when income is perfectly smoothed over the life cycle. At the time of retirement, the worker exchanges the balance from the retirement account for a life-annuity to be paid over $m - n$ retirement years. The procedure of saving a constant amount over working years and exchanging the account balance for a life-annuity at retirement is analytically equivalent to exchanging a work-year annuity for a lifetime annuity at the beginning of the working career. Let A_n be the annuity factor over n work years and A_m the corresponding annuity over m life years. Perfect income smoothing over the life cycle means that the work-year annuity with present value $A_n Y$ equals the life annuity worth $A_m \phi Y$. The resulting before-tax income rate is, accordingly:

$$\phi = \frac{A_n}{A_m}. \tag{12}$$

This expressions implies that the savings rate decreases with the interest rate. Using the base-case parameters above, a real interest rate of $r = 1\%$ reduces the savings rate from 28.6% to 23.1%, and a real interest rate of $r = 4\%$ reduces it to 10.9%. Since the worker saves less, the smoothing benefit decreases.

3.2.2 Income Growth

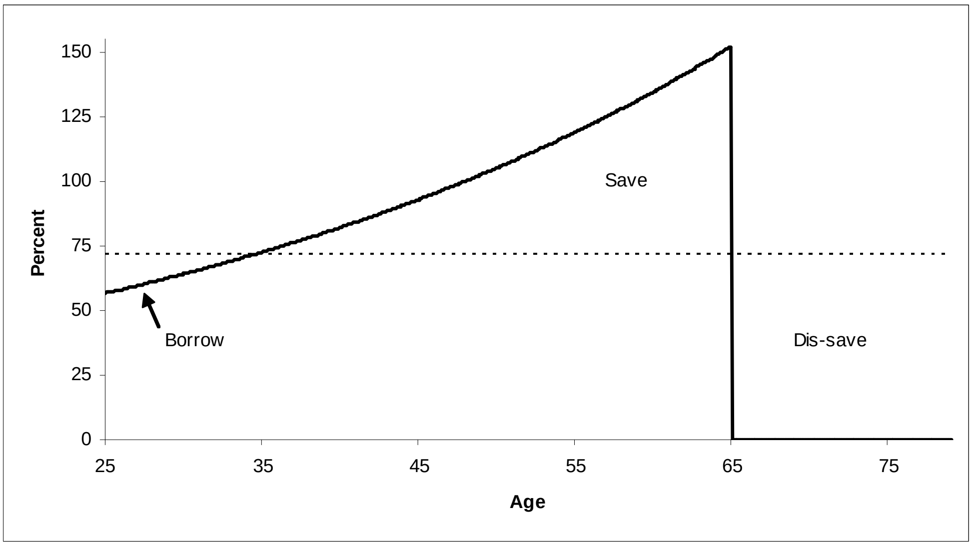
Since the tax liability function is convex, a variable income stream is taxed more than a smooth income stream. Income growth means that income varies over time such that more income is exposed to the marginal tax rates of the higher income brackets towards the end of the working career. Income smoothing reduces the exposure near retirement.

The analysis parallels that of interest. Consider the constant growth rate $g > 0$, and define the future-value annuity factor of income growth as $G_n = \left[(1+g)^n - 1\right]/g$. To make the numbers comparable with the no-growth case, we choose the starting income level Y_0 at age 25 such that the present value of a growth annuity over n working years equals the present value of a no-growth annuity, $G_n Y_0 = nY$, where Y is the no-growth annual income. Each year, labor income equals $Y_t = (1+g)^t Y_0$, and the worker saves $(1-\phi_t)Y_t$ for retirement. To reduce the dimensionality of the problem, we impose the perfect smoothing solution. The worker chooses a unique before-tax income rate ϕ that minimizes lifetime taxes:

$$\min_{\phi} \quad \mathcal{T} = nT\left(\frac{G_n \phi Y_0}{n}\right) + (m-n)T\left(\frac{G_n(1-\phi)Y_0}{m-n}\right). \tag{13}$$

The first term on the right hand side is the annual income during work years, and the second term is the annual income during retirement years. The worker accumulates a balance inside the retirement account and, at retirement, exchanges the account balance for a life annuity. In the beginning, the account balance may be negative as the worker must borrow to smooth income. Towards the end, the worker saves enough to retire and to pay off the loans. The perfect smoothing

Figure 6: Interest and Income Growth



The figure shows the annual income during work years (solid line) and annual income smoothed over adult life time (dotted line). The real growth rate is 2.5%.

solution is equivalent to exchanging a work-year growth annuity for a lifetime no-growth annuity at age 25. Perfect income smoothing means that two annuities are equal so that the before-tax income rate becomes:

$$\phi = \frac{G_n Y_0}{mY} = \frac{n}{m}. \tag{14}$$

Hence, the choice of the initial income level Y_0 preserves the parameter ϕ, and we refer to $1-\phi$ as the implicit savings rate under the life annuity contract. A numerical example can be seen in Figure 6. The worker borrows from age 25 to 34, he saves from age 35 to 64, and he dis-saves from age 65 to 81. In practice, the worker may not be able to borrow during early work years, and contribution limits may restrict how much he can save during late years. Borrowing and lending constraints reduce the smoothing benefit, although the invariance property of the smoothing benefit function suggests that borrowing and lending constraints are not binding over wide parameter ranges.

3.2.3 Smoothing with Interest and Income Growth

Interest and income growth move the smoothing benefit in opposite directions. The net effect depends on parameters and income level. We compute the smoothing benefit with interest as:

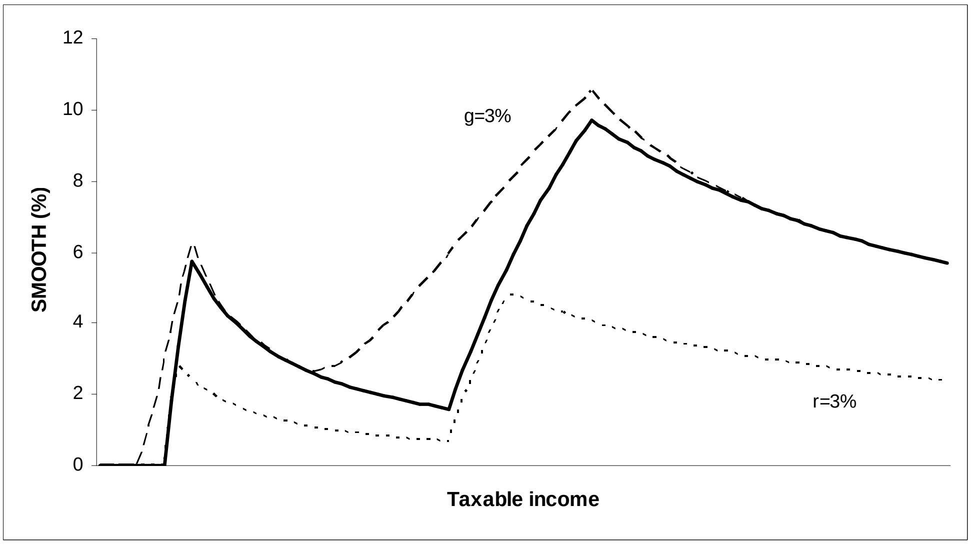
$$\text{SMOOTH} = \tau(Y) - \tau\left(\frac{A_n Y}{A_m}\right), \tag{15}$$

and the smoothing benefit with income growth as:

$$\text{SMOOTH} = \frac{\sum_{t=1}^{n} T(Y_t)}{nY} - \tau(\phi Y). \tag{16}$$

In Figure 7, we plot the smoothing benefit against taxable income assuming zero interest and no income growth (solid line), real interest rate $r = 3\%$ (dashed line below), and real growth rate $g = 3\%$ (dashed line above). The smoothing benefit decreases with interest, and it increases with income growth. The effect of interest is most pronounced at each local SMOOTH maximum. The effect is also large at high income levels because high income earners save more and interest on larger savings fill up fixed smoothing space in lower income brackets, thus preventing the worker from smoothing labor income. The effect of income growth is the largest at the local SMOOTH minima. Elsewhere, at very low income levels, income growth does not push the worker into the higher bracket and, at very high income levels, labor income quickly outgrows the fixed smoothing space.

Figure 7: Smoothing with Interest and Income Growth



The figure plots the smoothing benefit as a function of taxable income conditional assuming zero interest and no growth rate (solid thick line), 3% interest (dashed line below), and 3% income growth (dashed line above). The calculations are based on the stylized tax table, 40 work years, and 16 retirement years.

4 Income Smoothing in the United States

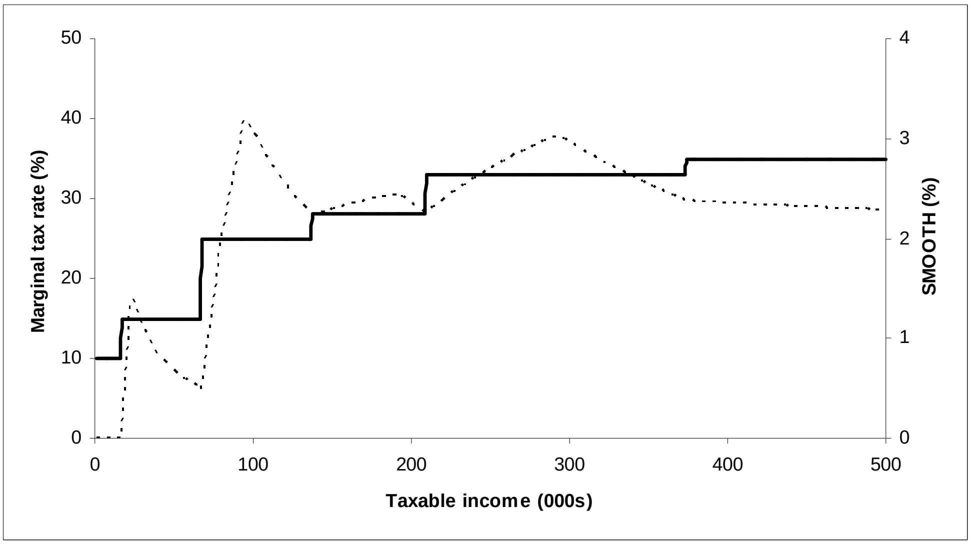
4.1 United States 2010

In this section, we quantify the tax benefit of income smoothing in the United States 2010 using the federal income tax table. The smoothing benefit is evaluated for a married couple filing jointly. We make no attempt to account for the effects of progressive state and local taxes as they vary widely across the United States.[11]

The federal tax rate schedule up to $500,000 (left axis) along with the smoothing benefit (right axis) can be seen in Figure 8. The smoothing benefit is about one percent at low income levels, and it fluctuates between two and three percentage points from $100,000 to $500,000. The average smoothing benefit in this income range is 2.5%. The smoothing benefit is smaller than in the stylized tax table in Figure 4 above, which we purposely made extra progressive. The smoothing benefit is sensitive to the income level around the breakpoint between the 15% and 25% income

[11] By ignoring state and local taxes, we implicitly ignore the option to move from a high-tax state during work years to a zero-tax state in retirement.

Figure 8: Income Smoothing in the United States 2010



This figure plots the federal tax rate schedule (solid line; left axis) and the tax benefit of income smoothing assuming 40 work years, 16 retirement years, no interest, and no income growth.

brackets. Otherwise, it is approximately constant. Maximum SMOOTH occurs at annual income $95,200, where the worker can shift all his income from the 25% bracket into the two lower brackets.

This is how the model works in 2010: A worker earns $100,000 before tax. Tax liability before income smoothing is $17,362 and after perfect income smoothing $10,220. Saving for retirement before tax results in an immediate tax reduction of $7,142 per work year. However, withdrawals from the retirement account are taxed at $10,220 per year. The worker benefits from income smoothing because 40 times the tax liability reduction during work years exceeds 16 times the tax liability increase during retirement years. The difference is $3,054 per year in the work force, or SMOOTH=3.054%. Hence, smoothing before-tax income over the life cycle reduces the average tax rate by approximately three percentage points from 17.362% to 14.308%.

Given the decision to save for retirement, the smoothing benefit is free money that the worker can collect without sacrifice. If we open up the model and assign a cost to saving for retirement, then the worker must trade off the smoothing benefit for the cost of setting aside money for retirement. Table 2 has been constructed under the assumption that there is a tradeoff between the tax benefit of income smoothing and setting aside money for retirement. There are many

Table 2: Smoothing Benefit-Savings Rate Tradeoff

		Smoothing benefit target		
	Perfect smoothing	Max	2%	1%
Minimum savings rate (%)	28.6	22.8	13.7	5.2

The first row reports the minimum percentage savings rate to reach a smoothing benefit target. The savings rate and the number of years have been evaluated in increments of $1000 between $100,000 and $500,000 using the Federal tax table 2010 for a married couple filing jointly. The table shows the arithmetic average. The demographic parameters are 40 work years and 16 retirement years.

examples. The worker may be impatient, or he may be reluctant to save inside a retirement account, where funds cannot be withdrawn as needed.[12] The table reports the minimum savings rate that yields a targeted smoothing benefit. We evaluate the smoothing benefit for each increment of $1000 between $100,000 and $500,000 and compute the arithmetic average. The calculations are limited to the income range where the smoothing benefit is approximately independent of income level. The chosen range is also where we think saving privately inside a retirement matters. Perfect income smoothing requires that the worker saves 28.6% of his before-tax income. If saving is costly, the worker can reduce the savings rate to 22.8% without lowering the smoothing benefit. A savings rate of 22.8% may still be too high. In this case, the worker can generate smoothing benefits in the amount of two percent and one percent by reducing the savings rate to 13.7% and 5.2%, respectively. These numbers are in line with the contribution rates of standard 401(k) contracts that, accordingly, generate smoothing benefits of one to two percent.

4.2 Extensions

We proceed by examining the sensitivity of the smoothing benefit calculations to life expectancy and the number of work years. In the last subsection, we introduce Social Security and examine how retirement income from the Social Security Administration changes our calculations.

[12] Money inside a retirement account can only be used for retirement. Early withdrawal or borrowing from a retirement account are highly restricted, if possible at all.

4.2.1 Life Expectancy

Smoothing space depends on life expectancy. We have chosen to work with $m = 81$, but the National Center for Health Statistics provides us with numerous alternative life expectancy numbers. In Table 3, we report life expectancy statistics and associated smoothing benefits conditional on statistical method, male or female, and whether the individual has reached age 25 or age 65. For a married couple, we also report the joint and last survivor life expectancy conditional on both spouses reaching 65 years old. The period method is based on realized life expectancy, while the cohort method is based on life expectancy forecasts that take life expectancy growth into account. The tabulated life expectancy statistics vary widely from 76.9 to 92.1, and the associated smoothing

Table 3: Life Expectancy

	Conditional on age 30		Conditional on age 65		
	Period	Cohort	Period	Cohort	Joint
A. Male					
Life expectancy (years)	76.9	82.4	81.8	85.9	92.1
Smoothing benefit (%)	1.9	2.7	2.6	3.2	3.9
B. Female					
Life expectancy (years)	80.9	85.9	84.2	88.4	92.1
Smoothing benefit (%)	2.5	3.1	2.9	3.5	3.9

The table shows select life expectancy statistics from the National Center for Health Statistics. The period method is based on realizations, while the cohort method forecasts life expectancy growth. The smoothing benefit has been evaluated for annual income in increments of $1000 between $100,000 and $500,000 using the Federal tax table 2010 for a married couple filing jointly. The table reports the arithmetic average.

benefits from 1.9% to 3.9%. Our choice of $m = 81$ puts us somewhere in the middle. Adding eleven years of life expectancy raises the average smoothing benefit from 2.5% to 3.9%, and subtracting four years reduces it to 1.9%. While longevity raises the smoothing benefit, we conclude that the order of magnitude does not depend on which life expectancy number we pick.

4.2.2 Catch-Up Provision

Smoothing space also depends on when the worker starts saving for retirement. Starting late unambiguously reduces the lifetime tax benefit of income smoothing (see Section 3.1.2 above) but, regarding the lost years as sunk, the tax incentive to smooth income increases with age because relative smoothing space increases. Consider a worker who did not save for retirement as young and, suddenly, becomes aware of the retirement problem at age 50. The catch-up provision in the tax code is designed for this scenario. In 2010, the 401(k) limit is $49,000 per year. This limit applies to employer-sponsored programs.[13] In addition, a worker can contribute on his own an additional $16,500 plus the catch-up contribution amount of $5,500 from age 50. How large is the smoothing benefit for someone who misses out the first 25 years? The fifty-year old worker has 15 remaining work years to support 16 retirement years. With no other income during retirement, there is plenty of smoothing space relative to demand. In fact, smoothing space may be so abundant that the worker cannot take full advantage of the smoothing benefit within statutory contribution limits.

Table 4: Catch-Up Provision

			Smoothing benefit target					
Income	Statutory limit	Perfect smoothing	Max	5%	4%	3%	2%	1%
$100,000	67.0	51.6	32.0	n/a	31.0	21.0	13.3	6.6
$200,000	33.5	*51.6*	*36.3*	*36.0*	27.3	19.6	11.9	5.5
$300,000	22.3	*51.6*	*48.8*	*28.4*	20.5	15.0	9.4	4.3
$400,000	16.8	*51.6*	*47.7*	*35.3*	*22.8*	14.6	9.1	4.0
$500,000	4.4	*51.6*	*44.6*	*39.5*	*23.6*	*14.1*	*9.1*	4.1

The table reports percentage minimum savings rates at various targeted smoothing benefits for a worker who begins saving at age 50 to support consumption during 16 retirement years. Italicized savings rates are infeasible under statutory contribution limits. The savings rates have been evaluated in increments of $1000 between $100,000 and $500,000 using the Federal tax table 2010 for a married couple filing jointly. The table reports the arithmetic average.

Smoothing benefit calculations for a fifty-year old late starter can be found in Table 4. The percentage contribution limit and the minimum savings rate to reach a smoothing benefit target are

[13] There are also limitations on how much can be contributed to and paid out from a defined benefit plan, but these limits are difficult to translate into a savings rate.

reported at five income levels. We obtain a percentage contribution limit by adding the 401(k) and the elective dollar limits and dividing by annual income.[14] Italicized savings rates are statutorily infeasible. The smoothing benefit peaks between five and six percent, but such high smoothing benefits are not statutorily feasible. A four-percent smoothing benefit is feasible from $100,000–$300,000. For this category of late starters, the tax incentive to smooth income is higher than for those who start at age 25. Otherwise, as the smoothing benefit target decreases, savings rates become statutorily feasible, but the smoothing benefit does not exceed that of early retirement savers in Figure 8.

4.2.3 Social Security

Social Security is a government-sponsored program in the United States that provides support for individuals in times of hardship such as death of a spouse, disability, and old age (retirement). The program is supported by a 6.2% payroll tax paid by the employee and a 6.2% payroll tax paid by employers, both capped at wages of $106,800 in 2010. In our analysis, we ignore the contribution component and treat the income received from the Social Security system as exogenous. This assumption means that Social Security income fills up smoothing space with non-labor income and, therefore, reduces the tax benefit of income smoothing. The effect on the smoothing benefit is essentially the same as that of earning real interest (see Section 3.2 above).

The taxation of Social Security income is different from the taxation of other income. The tax rate schedule is the same, but the tax liability function is different, i.e., one dollar of retirement income is taxed differently from one dollar of work year income. The income-tax basis with Social Security is defined as:

$$Y' = \frac{n(1-\phi)Y}{m-n} + 0.5Y_s, \tag{17}$$

where the first term is the amount of private retirement income given by our model and the second term is half the Social Security income. A portion of Social Security income is tax exempt. The

[14]The 401(k) contribution limit is an upper boundary. Standard pension contracts specify a percentage contribution rate that is equal to all workers with certain characteristics. A typical worker has no bargaining power over the standard contract and must accept the contribution rate whether he reaches the $49,000 contribution limit or not. The 50-year-old worker has full discretion over the elective $22,000 amount, however.

taxed portion of Social Security income is determined by the following function:

$$Y_s^{\tau}(Y) = \begin{cases} 0, & \text{if } Y' \leq \$32,000, \\ \min[0.50(Y' - \$32,000), \ \ 0.50Y_s], & \text{if } \$32,000 < Y' \leq \$44,000, \\ \min[0.85(Y' - \$44,000) + \$6,000, \ \ 0.85Y_s], & \text{if } Y' > \$44,000. \end{cases} \quad (18)$$

Social Security income is tax free at low income levels (first row), and it is 85% taxed at high income levels (third row). Between the floor and the cap, the taxed portion of Social Security income increases linearly at the rate of 50 cents per dollar between \$32,000 and \$44,000, and at the rate of 85 cents per dollar above \$44,000. The taxed portion of Social Security income is a function of private retirement income, $Y_s^{\tau}(Y)$, which depends on the worker's decision variable ϕ, so the worker controls the taxed portion of Social Security income through the amount he sets aside for private retirement.

The worker solves the following tax-minimization problem with income from Social Security:

$$\min_{\phi} \quad \mathcal{T} = nT(\phi Y) + (m-n)T\left(\frac{n(1-\phi)Y}{m-n} + Y_s^{\tau}(Y)\right). \quad (19)$$

The worker picks a tax-minimizing solution ϕ that determines the tax benefit of income smoothing as:

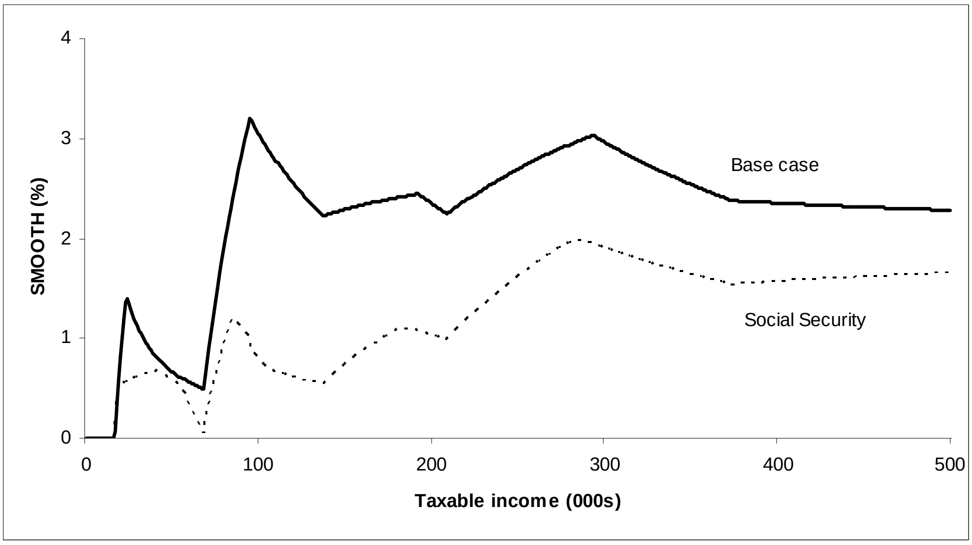
$$\text{SMOOTH} = \left[\frac{nT(Y)}{nY + (m-n)Y_s}\right] - \left[\frac{nT(\phi Y) + (m-n)T\left(\frac{n(1-\phi)Y}{m-n} + Y_s^{\tau}(Y)\right)}{nY + (m-n)Y_s}\right]. \quad (20)$$

As previously, there are multiple tax-minimizing solutions. However, with Social Security income, there is a middle-income zone, where the worker chooses ϕ such that the taxed portion of Social Security income stays at exactly zero or 50%. In this range, the marginal tax rate function in retirement has a hump that prevents the marginal tax rate between work years and retirement years to equalize. In this range, the solution to the tax-minimization problem occurs at a kink in the tax liability function, which implies a unique solution.[15]

In Figure 9, we report the smoothing benefit with and without Social Security using the 2010 tax rate schedule. As noted by the Social Security Administration, "The benefit computation is

[15] A detailed analysis of Social Security income is available from the authors on request.

Figure 9: Social Security



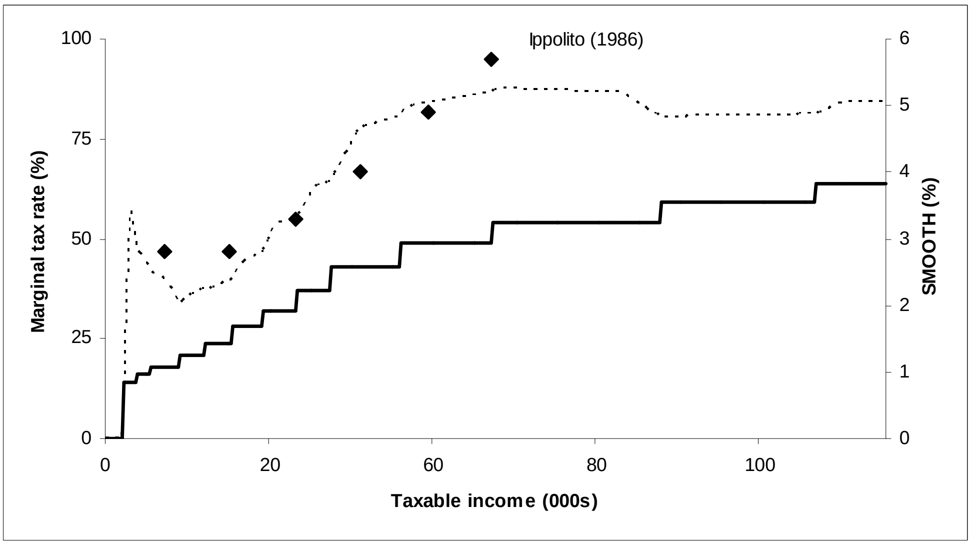
The figure compares the tax benefit of income smoothing without Social Security (base case) with Social Security when the worker can borrow and lend after tax.

complex and there is no simple method or table to tell you how much you may receive". For our numerical calculations, we use the benefits estimator found on the Social Security web site. We retrieve the benefit amount for wages in increments of $5,000 and interpolate the values between. We see that Social Security reduces the tax benefit of income smoothing relative to the base case by approximately one to two percentage points. The main reason is smoothing space reduction. Social Security income fills up the lower infra-marginal brackets that otherwise would have been available for private retirement income. At lower income levels, a large portion of Social Security income is tax exempt and, therefore, does not fill up smoothing space. Untaxed Social Security income affects the smoothing benefit only through its impact on the need to save for retirement.

4.3 United States 1950–2010

We end our examination by reporting smoothing benefit numbers from the United States history after 1950. This year, General Motors signs its first private pension contract with the United Automobile Workers, which marks the beginning of the growth of the private pension system in the United States. The historical time-series allow us to compare our estimates with those of Ippolito (1986). The historical numbers can also shed light on the argument that the smoothing benefit is one of the driving forces behind the growth of the private pension system in the United States (Ippolito (1986)).

Figure 10: Income Smoothing in the United States 1979



This figure plots the federal tax rate schedule (solid line; left axis) and the tax benefit of income smoothing assuming 40 work years, 13 retirement years, no interest, and no income growth (dashed line; right axis). Ippolito (1986) bases his calculations on the Statistics of Income (filled diamonds).

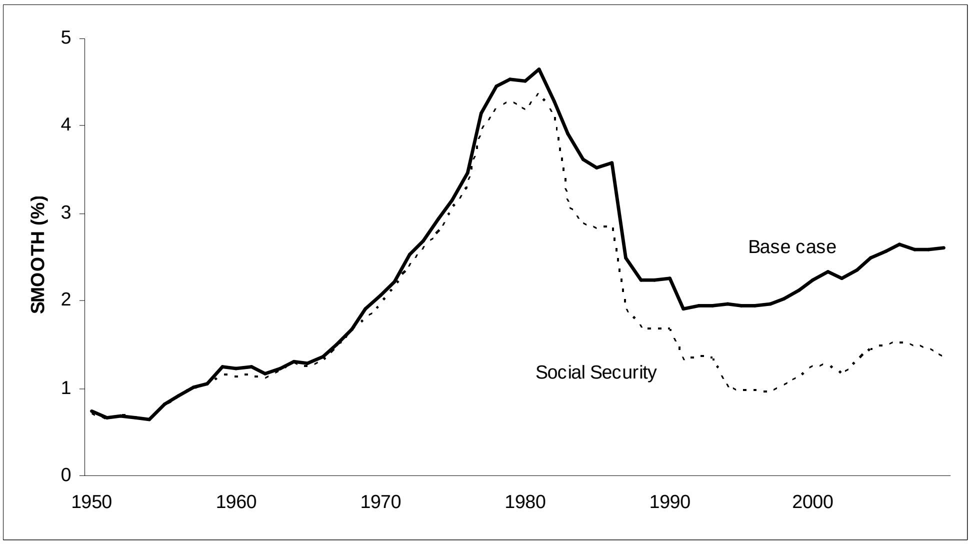
Ippolito (1986) bases his calculations on actual taxes paid according to Statistics of Income rather than the Federal tax rate schedule. He assumes that work begins at age 25 and that the worker retires at age 65 but, since life expectancy is shorter in 1979, the worker dies at age 78. His smoothing benefit calculations are marked as diamonds in Figure 10, where we also plot the Federal marginal tax rate schedule up to $120,000 and our smoothing benefit function using his demographic parameters. The chosen income range corresponds in real terms approximately to the income range in 2010. We see that our smoothing benefit numbers are approximately equal to those of Ippolito (1986), so our choice of the Federal tax rate schedule rather than Statistics of Income makes little difference.[16] The smoothing benefit is generally higher in 1979 than in 2010 because the 1979 tax table is more progressive. The smoothing benefit averaged over the income range $20,000 to $120,000 is 4.7%.

Our historical smoothing benefit calculations are based on life expectancy statistics from the

[16]We infer these estimates from the information provided by Ippolito (1986) in Table 2-1.

Human Mortality Database, the average of male and female conditional on age 25.[17] Tax liability is evaluated assuming an annual income of five times GDP per capita, which is approximately $60,000 in 1979 and $230,000 in 2008 (the most recently available). This income level is relatively high so that saving privately for retirement matters, but it is not so high that standard pension plans become marginal. It is at the margin of the 401(k) contribution limit and statutorily feasible.[18] GDP-per-capita time-series are taken from the International Financial Statistics Browser provided by the International Monetary Fund. We compute the smoothing benefit with and without Social Security. A worker with income equal to five times GDP per capita receives the maximum Social Security benefit.

Figure 11: Smoothing Benefit History



The solid line above is the base case smoothing benefit assuming 40 work years and retirement years equal to life expectancy minus 65. Tax liability is evaluated at an income of five times GDP per capita. The dashed line below adjust for Social Security income.

The post-war time-series of smoothing benefits is displayed in Figure 11. The solid line above represents our base case, and the dashed line below the smoothing benefit with Social Security. The time-series path is hump shaped with a positive time trend. Increasing life expectancy drives the time trend. The peak occurs shortly before the tax reform when Ippolito (1986) analyzes the

[17]University of California, Berkeley (USA) available at www.mortality.org.

[18]Contribution limits are introduced with the 401(k) plan. With the exception of the Keogh plan (1962) and the IRA (1975), there is freedom to contract (see Gokhale, Kotlikoff, and Warshawsky (2004)).

tax benefit of income smoothing. The hump is the result of bracket creep and the regulatory response to combat it. Income tax tables are essentially unchanged from 1950 to 1980. While personal income taxes are nominally fixed during this long thirty-year period, nominal income per capita increases approximately six times. As a result of income growth, five times GDP per capita grows from $10,000 in 1950 to $60,000 in 1980. The effect on the smoothing benefit can be seen in Figure 10 above. The smoothing benefit associated with $10,000 income is about 3% (1950), while the smoothing benefit of $60,000 is above 5% (1980). Together with increased life expectancy, bracket creep raises the smoothing benefit from 1% in 1950 to 5% in 1980 as seen in Figure 11. The tax reform (TRA 1986) reduces progressivity, and inflation indexing prevents further bracket creep.

Social Security reduces the smoothing benefit, but the effect of Social Security changes over time. Before 1983, when Social Security income is tax exempt and Social Security impacts the smoothing benefit only through the reduced need to save for retirement, the effect is minimal. From 1983, a portion of Social security income is taxed. In 1983, the second row of Equation (18) is added and, in 1994, the third row. The gap between the base case without Social Security and the one with Social Security widens each time the taxed portion increases and Social Security income fills up the smoothing space.

5 Conclusion

Households can defer income taxes until withdrawal by saving before tax inside a traditional retirement account. Under a progressive tax system, deferral of income tax to retirement provides a tax benefit. The tax benefit of income smoothing is perceived as large. However, our estimates for the United States in 2010 in the amount of 2.5% without Social Security and 1.4% adjusted for Social Security are surprisingly small relative to the perceived benefit. Our calculations are derived from a stylized life-cycle model of economic behavior. We have not studied what economic agents actually do. Especially, we have not discussed the effects of smoothing on individuals' savings behavior or the rationale for tax policies related to pension and retirement savings. However, our calculations suggest that the tax benefit of income smoothing is too small to explain the growth of the US private pension system, as claimed by Ippolito (1986). At best, the smoothing benefit can have inspired retirement planners and labor unions bargaining for pensions over wages during a short time period in the 1970s, when the smoothing benefit was substantially larger than today.

References

Bernheim, B. Douglas, Jonathan Skinner, and Steven Weinberg, 2001, What Accounts for the Variation in Retirement Wealth among U.S. Households?, *American Economic Review* 91, 832–857.

Browning, Martin, and Thomas F. Crossley, 2001, What Accounts for the Variation in Retirement Wealth among U.S. Households?, *Journal of Economic Perspective* 15, 3–22.

Constantinides, George M., 1983, Capital Market Equilibrium with Personal Tax, *Econometrica* 51, 611–636.

Eissa, and Hoynes, 2000, Tax and Transfer Policy, and Family Formation: Marriage and Cohabitation, working paper, UC Berkeley.

Feenberg, Daniel, and Jonathan Skinner, 1989, Sources of IRA Saving, *Tax Policy and the Economy* 3, 25–46.

Gokhale, Jagadeesh, Laurence J. Kotlikoff, and Todd Neumann, 2008, Does Participation in 401(k) Raise Lifetime Taxes?, working paper, Federal Reserve Bank of Cleveland.

Gokhale, Jagadeesh, Laurence J. Kotlikoff, and Mark J. Warshawsky, 2004, Life-Cycle Saving, Limits on Contributions to DC Pension Plans, and Lifetime Tax Benefits, in William G. Gale, John. B. Shoven, and Mark J. Warshawsky, *Private Pensions and Public Policies* (Brookings Institutions Press, Washington D.C.).

Green, Richard C., and Kristian Rydqvist, 1999, Ex-Day Behavior with Dividend Preference and Limitations to Short-Term Arbitrage: The Case of Swedish Lottery Bonds, *Journal of Financial Economics* 53, 145–187.

Horan, Stephen M., 2005, *Tax-Advantaged Savings Accounts and Tax-Efficient Wealth Accumulation.* (Research Foundation of the CFA Institute).

Horan, Stephen M., 2009, *Private Wealth: Wealth Management in Practice.* (John Wiley & Sons, Hoboken, New Jersey).

Huang, Jennifer, 2008, Taxable and Tax-Deferred Investing: A Tax-Arbitrage Approach, *Review of Financial Studies* 21, 2173–2207.

Ippolito, Richard A., 1986, *Pensions, Economics, and Public Policy.* (Dow Jones-Irwin Homewood Illinois).

Lankford, Kimberly, 2008, Taxes on 401(k) and IRA Withdrawals, available at http://www.kiplinger.com/columns/ask/archive/2008/q0508.htm.

Lowenstein, Roger, 2008, *While America Aged: How Pension Debts Ruined General Motors, Stopped the NYC Subways, Bankrupted San Diego, and Loom as the Next Financial Crisis.* (Penguin Press, New York).

Milligan, Kevin, 2003, How Do Contribution Limits Affect Contributions to Tax-Preferred Savings Accounts?, *Journal of Public Economics* 87, 253–281.

Nishiyama, Shinichi, 2010, The Budgetary and Welfare Effects of Tax-Deferred Retirement Savings Accounts, working paper, Georgia State University.

Ozanne, Larry, and David Lindeman, 1987, Tax Policy for Pensions and other Retirement Savings, Congressional Budget Office Study, Congress of the United States.

Ragan, Christopher, 1994, Progressive Income Taxes ad the Substitution Effect of RRSPs, *Canadian Journal of Economics* 27, 43–57.

Reno, Virginia P., and Joni Lavery, 2007, Social Security and Retirement Income Adequacy, Social Security Brief 25, pp. 1-12, National Academy of Social Insurance.

Røed, Knut, and Steinar Strøm, 2002, Progressive Taxes and the Labour Market: Is the Trade-Off between Equality and Efficiency Inevitable?, *Journal of Economic Surveys* 16, 77–110.

Rydqvist, Kristian, 2011, Tax Arbitrage with Risk and Effort Aversion: Swedish Lottery Bonds 1970–1990, working paper, SSRN.

Rydqvist, Kristian, Joshua D. Spizman, and Ilya Strebulaev, 2010, The Evolution of Aggregate Stock Ownership, working paper, SSRN.

Slitor, Richard E., 1948, The Measurement of Progressivity and Built-In Flexibility, *Quarterly Journal of Economics* 62, 309–313.

Stephens, Melvin, and Jennifer Ward-Batts, 2004, The Impact of Separate Taxation on the Intra-Household Allocation of Assets: Evidence from the UK, *Journal of Public Economics* 88, 1989–2007.

Stiglitz, Joseph E., 1988a, *Economics of the Public Sector.* (W.W. Norton & Company).

Stiglitz, Joseph E., 1988b, The general theory of tax avoidance, NBER working paper.

Turner, John A., 2005, Pensions, tax treatment of, in J. Cordes, R. Ebel, and J. Gravelle, eds.: *NTA Encyclopedia of Taxation and Tax Policy* (Urban Institute Press, Washington D.C.).

Vroman, Wayne, 1974, Employer Payroll Taxes and Money Wage Behavior, *Applied Economics* 6, 189–204.