Chapter 18

TAXATION AND SAVING*

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Abstract

In this survey, I summarize and evaluate the extant literature concerning taxation and personal saving. I describe the theoretical models that economists have used to depict saving decisions, and I explore the positive and normative implications of these models. The central positive question is whether and to what extent specific public policies raise or lower the rate of saving. The central normative question is whether and to what extent it is desirable to tax the economic returns to saving. I also examine empirical evidence on the saving effects of various tax policies. This evidence includes econometric studies of the generic relation between saving and the after-tax rate of return, as well as analyses of responses to the economic incentives that are imbedded in tax-deferred retirement accounts. Finally, I also discuss several indirect channels through which tax policy may affect household saving by altering the behavior of third parties, such as employers.

Keywords

taxation, saving, personal saving, corporate saving, tax-deferred retirement accounts, pensions, interest elasticity of saving, optimal taxation, welfare costs of taxation

JEL classification: H20

1. Introduction

Recognizing the importance of saving as a determinant of both personal economic security and national economic performance, policymakers worldwide have become increasingly interested in developing effective strategies for stimulating (or in some cases discouraging) thrift. This interest has become particularly acute in the United States, where rates of saving are currently very low both by historical standards and in comparison to other developed countries. Concerns over low saving have led to a variety of policy proposals designed to stimulate thrift through the tax system, ranging from narrowly focused tax-deferred savings accounts to broad-based consumption taxation. Economic research has played an important role in the resulting public policy debates, and economists have weighed in on virtually all sides of the pertinent issues.

In this survey, I summarize and evaluate the extant literature concerning taxation and personal saving[1]. I describe the theoretical models that economists have used to depict saving decisions, and I explore the positive and normative implications of these models. The central positive question is whether and to what extent specific public policies raise or lower the rate of saving. The central normative question is whether and to what extent it is desirable to tax the economic returns to saving. I also examine empirical evidence on the saving effects of various tax policies. This evidence includes econometric studies of the generic relation between saving and the after-tax rate of return, as well as analyses of responses to the economic incentives that are imbedded in tax-deferred retirement accounts. Finally, I also discuss several indirect channels through which tax policy may affect household saving by altering the behavior of third parties, such as employers.

The remainder of the chapter is divided into five sections. Section 2 discusses theories of taxation and saving. It investigates the positive and normative implications of taxing the returns to saving under several variants of the life-cycle hypothesis, as well as under behavioral alternatives. Section 3 describes the available evidence on the generic relation between saving and the after-tax rate of return. It identifies two distinct approaches to measurement (estimation of consumption or saving equations, and estimation of consumption Euler equations), and it discusses the limitations of each. In Section 4, I examine evidence on the effects of opportunities to save through tax-deferred retirement accounts. This section focuses primarily on US tax policies, and includes detailed discussions of Individual Retirement Accounts (IRAs) and 401(k)s. Both IRAs and 401(k)s have accounted for large flows of saving, but there is heated controversy over the extent to which these flows represent new saving. In Section 5,

[1] National saving consists of two components: private saving and public saving. Private saving takes place among households (personal saving) and corporations (corporate saving). Public saving is the sum of budget surpluses (or deficits) for federal, state, and local governments. For the most part, this chapter concerns the impact of tax policy on the personal component of national saving. However, collateral effects on other components of national saving (e.g., changes in government revenue and shifts between corporate saving and private saving) are considered where relevant.

I shift attention to indirect links between taxation and household saving. I discuss the implications for household saving resulting from tax-induced changes in other aspects of the economic environment, including the size and scope of the pension system, the characteristics of employment-based pensions, the level of corporate saving, the availability of employment-based investment and retirement education, and the intensity with which financial institutions market and promote specific financial products. Section 6 concludes.

2. Theories of taxation and saving

For more than fifty years, the framework of intertemporal utility maximization has dominated economists' thinking about the tax treatment of saving. This framework traces its roots to Irving Fisher (1930), and lies at the heart of the Life Cycle Hypothesis (LCH) articulated by Modigliani and Brumberg (1954). Empirical tests of the LCH have yielded mixed results, leading some to modify the framework and others to reject it outright in favor of alternative approaches. In this section, I examine the positive and normative implications of the LCH, variants of the LCH, and alternative behavioral theories of tax policy and saving.

2.1. The life-cycle hypothesis

In the following discussion, I illustrate some pertinent implications of the LCH through a simple model. Imagine an individual who lives for a total of $T+1$ years, earning wages of w_τ in each year τ. This individual derives utility from consumption, c_τ, according to an intertemporally separable utility function of the form

$$\sum_{\tau=0}^{T} u_\tau(c_\tau)\rho^\tau, \tag{1}$$

where $\rho < 1$ represents a pure rate of time preference. The individual can alter the intertemporal allocation of resources by borrowing or lending. Let A_τ denote net asset holdings at the outset of period τ; for convenience, assume for the moment that $A_0 = 0$.[2] After receiving the wage w_τ and consuming c_τ, the individual is left with $A_\tau + w_\tau - c_\tau$. Prior to the start of period $\tau+1$, these investments earn pre-tax returns at the rate i. Capital-income taxes are applied symmetrically, so that interest received is taxed and

[2] This assumption is actually without loss of generality, since one can simply take the period-0 wage, w_0, to include the value of any initial assets.

interest paid is subsidized at the rate m [3]. Thus, for any given consumption path, asset holdings evolve as follows:

$$A_{\tau+1} = [A_\tau + w_\tau - c_\tau]\beta, \tag{2}$$

where

$$\beta \equiv 1 + i(1-m). \tag{3}$$

A consumption path is feasible as long as the individual dies with non-negative asset holdings [4]:

$$A_{T+1} \geqslant 0. \tag{4}$$

This restriction is equivalent to the requirement that

$$\sum_{\tau=0}^{T} c_\tau \beta^{-\tau} \leqslant W(\beta), \tag{5}$$

where

$$W(\beta) \equiv \sum_{\tau=0}^{T} w_\tau \beta^{-\tau} \tag{6}$$

represents the present discounted value of lifetime resources.

Behavior is governed by maximization of utility function (1) subject to restriction (5). It is useful for our current purposes to write optimal consumption as a function, $c_\tau(W,\beta)$, of the present discounted value of lifetime resources, W, and the discount factor, β. Using Equation (2), one can derive functions describing asset holdings, $A_\tau(W,\beta)$, along the optimal path. The associated level of saving, s_τ, is then given by the difference between total income (including investment returns) and consumption:

$$s_\tau(W(\beta),\beta) = \left(\frac{\beta-1}{\beta}\right) A_\tau(W(\beta),\beta) + w_\tau - c_\tau(W(\beta),\beta). \tag{7}$$

2.1.1. Positive analysis of taxation and saving

As is clear from Equations (3) and (7), conventional life-cycle models imply that changes in the capital-income tax rate, m, and in the pre-tax rate of return, i, both

[3] In practice, the tax system subsidizes interest payments to other parties by permitting individuals to deduct these payments from other income, subject to some limitations, prior to calculating taxes.

[4] In the special case where T is infinite, this inequality is replaced by the transversality condition.

influence saving by altering the after-tax rate of return, $i(1-m)$. The direction and magnitude of these effects are governed by the *interest elasticity of saving*.

In theory, the uncompensated interest elasticity of saving can be positive or negative, so saving can either rise or fall in response to an increase in the after-tax rate of return. This point is usually made in the context of a simple two-period model, where earnings are fixed and received entirely in the first period. In this setting, saving is equivalent to expenditure on second-period consumption. An increase in the after-tax rate of return amounts to an uncompensated reduction in the price of second-period consumption. The associated substitution effect shifts consumption towards the future (thereby increasing saving), while the associated income effect is usually assumed to increase consumption in both periods (thereby reducing saving). There is no theoretical presumption that either effect dominates. Indeed, with Cobb–Douglas utility (which implies fixed expenditure shares), a reduction in the rate of capital-income taxation has no effect on the level of saving, since the income and substitution effects offset exactly.

Further consideration of the two-period model suggests that the uncompensated interest elasticity of saving should depend on the distribution of earnings through time. In the standard Slutsky decomposition for the derivative of first-period consumption with respect to the price of second-period consumption, the income derivative is multiplied by the excess of second-period consumption over second-period earnings. Consequently, if second-period consumption exceeds second-period earnings, then the income effect associated with an increase in the interest rate results in greater first-period consumption. However, as one shifts earnings from the first period into the second period (holding the present discounted value of earnings constant so as not to alter consumption), the income effect shrinks, thereby enhancing the tendency for saving to rise in response to higher rates of return. When second-period earnings exceed second-period consumption, the household borrows in the first period; the income effect changes sign and reinforces the substitution effect.

These points remain valid even in more elaborate, multi-period life-cycle models, such as the one outlined above. Consider the effect on saving (equivalently, current consumption) of an unanticipated, permanent increase in the capital-income tax rate (m) at time $t=0$ [5]. Manipulation of the Slutsky equation allows us to decompose this into a substitution effect and an income effect:

$$\varepsilon^{u}_{0\beta} = \varepsilon^{c}_{0\beta} + \varepsilon_{0W}\left(\sum_{\tau=1}^{T}\tau\left(\frac{\beta^{-\tau}(c_\tau - w_\tau)}{W}\right)\right), \tag{8}$$

where $\varepsilon^{u}_{0\beta}$ is the uncompensated elasticity of period-0 consumption with respect to β, $\varepsilon^{c}_{0\beta}$ is the compensated elasticity of period-0 consumption with respect

[5] By focusing on period 0 and in assuming that the individual has no initial wealth (other than human capital), I am abstracting from possible wealth effects arising from asset revaluations.

to β, and ε_{0W} is the elasticity of first-period consumption with respect to lifetime resources (W)[6]. We know that $\varepsilon^c_{0\beta} < 0$, and normally $\varepsilon_{0W} > 0$. Focusing exclusively on the substitution effect, an increase in the after-tax rate of return (β) leads to a decline in consumption and an increase in saving. For earnings trajectories that give rise to no saving in any period ($c_\tau = w_\tau$ for all τ), the uncompensated interest elasticity of saving is governed entirely by the substitution effect; higher rates of return call forth more saving. As one shifts more resources towards the first period, initial saving becomes positive and subsequent saving becomes negative ($c_\tau > w_\tau$). The income effect counteracts the substitution effect, giving rise to smaller (potentially negative) interest elasticities of saving. As one shifts more resources away from the first period, initial saving becomes negative and subsequent saving becomes positive ($c_\tau < w_\tau$). In that case, the income effect reinforces the substitution effect, which suggests that households may reduce borrowing (increase net saving) sharply in response to an increase in the after-tax rate of interest.

To elucidate the relationship between the interest elasticity of saving and the structural parameters of the model, I will specialize to the class of utility functions that exhibit constant elasticity of intertemporal substitution:

$$u(c) = \frac{c^{1-\gamma}}{1-\gamma}. \tag{9}$$

Standard arguments imply that the optimal consumption profile satisfies the following Euler equation:

$$c_{\tau+1} = c_\tau(\beta\rho)^{1/\gamma}. \tag{10}$$

Equation (10) tells us that a change in the after-tax rate of return affects saving by altering the *slope* of the consumption trajectory. Moreover, the sensitivity of this response depends critically on $1/\gamma$, the intertemporal elasticity of substitution in consumption. In the extreme case of Leontief preferences ($1/\gamma = 0$), the slope of the consumption trajectory is entirely independent of β. Of course, this does not mean that the *level* of consumption is also independent of β. On the contrary, an increase in β reduces the present discounted value of any given consumption stream. If $W(\beta)$ is independent of β (which occurs if all earnings are received in period 0), a higher after-tax rate of return permits the individual to increase consumption in every period. With income fixed, this means that saving actually *declines* in response to a reduction in the rate of capital-income taxation. Thus, when $W = w_0$, a reduction in m can stimulate

[6] To derive this expression, note that $\partial c_0/\partial\beta = \sum_{\tau=1}^{T}(\partial C_0/\partial p_\tau)(\mathrm{d}p_\tau/\mathrm{d}\beta)$, where $C_0(p_1, \ldots, p_T, w_0, \ldots, w_T)$ describes optimal period-0 consumption as a function of the household's earnings stream and the implicit prices of consumption in later periods ($p_\tau \equiv \beta^{-\tau}$). Similarly, $\partial c_0/\partial\beta|_u = \sum_{\tau=1}^{T}\left(\partial C_0/\partial p_\tau|_u\right)(\mathrm{d}p_\tau/\mathrm{d}\beta)$. Note that the "substitution effect" is actually composed of many distinct substitution effects.

saving only if the slope of the consumption trajectory is sufficiently sensitive to β. This can only occur for higher values of $1/\gamma$.

Using Equations (5) and (10), one can obtain the following closed-form solution for initial consumption:

$$c_0(W,\beta) = \left(\frac{1-\lambda(\beta)}{1-\lambda(\beta)^{T+1}}\right) W, \tag{11}$$

where

$$\lambda(\beta) = \beta^{\frac{1-\gamma}{\gamma}} \rho^{\frac{1}{\gamma}}. \tag{12}$$

From Equation (11) it follows that, abstracting from the effect of β on the present discounted value of earnings (i.e. assuming that all earnings are received in period 0), $ds_0/d\beta$ has the same sign as $\lambda'(\beta)$. In the special case of Cobb–Douglas preferences (unitary elasticity of intertemporal substitution), $\gamma = 1$, so λ is independent of β, and saving is insensitive to the after-tax rate of return. For smaller elasticities of intertemporal substitution ($0 \leqslant 1/\gamma < 1$), $\lambda'(\beta) < 0$, so saving *falls* in response to an increase in the after-tax rate of return. Obviously, this includes the special case of Leontief preferences, discussed above. When the elasticity of intertemporal substitution exceeds unity ($1/\gamma > 1$), $\lambda'(\beta) > 0$, and saving *rises* in response to an increase in the after-tax rate of return. Thus, the sign of the pure price effect is indeterminate; there is no theoretical presumption that the interest elasticity of saving is positive. Moreover, with $W = w_0$, Cobb–Douglas preferences define the boundary between positive and negative elasticities.

When the household has positive future earnings ($W(\beta) > w_0$), Equation (11) implies that a change in β will also affect savings by altering the present discounted value of earnings. To study this effect in isolation, assume that $\gamma = 1$ (the Cobb–Douglas case), so that $\lambda'(\beta) = 0$ (the effect discussed in the previous paragraph vanishes). Provided that consumption is a normal good ($\partial c_0/\partial W > 0$), $dc_0/d\beta$ and $W'(\beta)$ have identical signs. Furthermore,

$$W'(\beta) = -\frac{W}{\beta} \sum_{\tau=1}^{T} \tau \left(\frac{w_\tau \beta^{-\tau}}{W}\right) \leqslant 0. \tag{13}$$

As long as the individual has some future earnings ($W > w_0$), the inequality in (13) is strict, which means that the interest elasticity of saving is necessarily *positive* in the Cobb–Douglas case. The intuition for this result is straightforward: an increase in the after-tax rate of return reduces the present discounted value of lifetime resources, thereby causing current consumption to fall, and current saving to rise.

As is clear from Equation (13), the size of $W'(\beta)$ depends on the timing of earnings. More specifically, the summation term is recognizable formally as the *duration* of the earnings stream $(w_0, w_1, \ldots, w_T)$. In words, duration is defined as a weighted average

of the times (τ) at which earnings are received, where the weights correspond to the fraction of total earnings (in present value) received at each point in time. When more earnings are received further in the future, duration is greater; the present discounted value of lifetime resources falls more in response to an increase in the after-tax rate of return, and so the associated increase in saving is larger.

If the duration of an individual's earnings stream is sufficiently large, then the interest elasticity of saving may be positive, even with Leontief preferences. Summers (1981) argues that $W'(\beta)$ is in fact quite substantial in realistically parameterized life-cycle models, and he suggests that this re-establishes a presumption in favor of the view that the interest elasticity of saving is positive and sizable. A number of authors have challenged this view. Evans (1983) demonstrates that the elasticities implied by these models are sensitive to the values of key parameters, including the assumed rate of time preference. Starrett (1988) exhibits sensitivity with respect to assumptions concerning the functional specification of utility[7]. As will be discussed in subsequent sections, it is also possible to overturn Summers' result by introducing liquidity constraints, uncertainty, and/or certain types of bequest motives.

Thus far, I have confined my remarks to tax policies that alter both the marginal and inframarginal returns to saving. It is also important to consider policies that do not have this feature. As will be discussed in Section 4, the US government has in the past attempted to stimulate saving through tax-deferred retirement accounts, which reduce the rate of taxation applicable to saving below some threshold level (the contribution limit). For the simple life-cycle model outlined in this section, saving within a tax-deferred account is a perfect substitute for other saving, and it also generates a higher return. Consequently, the model predicts that the contribution limit always binds. Even if desired saving is less than allowable contributions, individuals should reach the limit by borrowing or by shifting other assets. As a result, tax-deferred accounts do not alter the returns to saving on the margin. The reduction in the tax rate applicable to the returns from inframarginal saving amounts to a lump-sum windfall; the individual responds by increasing consumption and reducing saving.

2.1.2. Normative analysis of taxation and saving

Normative analyses of taxation and saving focus on two distinct but obviously interrelated sets of questions. First, should the government meet its revenue requirements in part by taxing the returns to saving? If so, how should it structure the tax, and what rates should it apply? Second, taking any particular tax system as a starting point, how

[7] In particular, one can reverse Summers' results by assuming that individuals have Stone–Geary utility functions of the form $u(c) = (c - \theta)^{1-\gamma}/(1-\gamma)$. Intuitively, some portion of saving is then motivated by the need to achieve a fixed target (the minimum consumption level θ) in every period. When the after-tax rate of return rises, the individual does not need to save as much to achieve this target. Consequently, when θ is large, the interest elasticity of saving tends to be small or negative.

large are the social gains or losses resulting from reforms that alter the tax burden on the returns to saving?

2.1.2.1. Optimal taxation of the returns to saving. The first set of questions concerns the role of capital-income taxation in an optimally designed tax system. The literature on optimal taxation contains a variety of pertinent results. For general background, see the related chapter 21 by Auerbach and Hines (2002) in this Handbook, or, for further discussion, the chapter by Chari and Kehoe (1999) in the Handbook of Macroeconomics.

There appears to be a presumption among many economists that capital-income taxes raise revenue less efficiently than taxes on consumption or wages. To understand the basis for this view, it is useful to start with the following simple model. Imagine an individual who lives for a total of $T+1$ years, and who derives utility from consumption, c_τ, according to the utility function $U(c_0,\ldots,c_T)$. For the moment, assume that the individual earns no wage income, but is endowed with initial assets A_0. Investments in period τ earn pre-tax returns at the rate i_τ between periods τ and $\tau+1$, and are taxed at the rate m_τ[8]. In addition, consumption is taxed at the time-invariant rate t[9]. The individual's budget constraint is then given by

$$\sum_{\tau=0}^{T}\left(\prod_{k=0}^{\tau-1}\frac{1}{1+i_k(1-m_k)}\right)c_\tau(1+t)\leqslant A_0. \tag{14}$$

If one sets m_τ equal to zero for all τ, Equation (14) simplifies to

$$\sum_{\tau=0}^{T}\left(\prod_{k=0}^{\tau-1}\frac{1}{1+i_k}\right)c_\tau\leqslant\frac{A_0}{1+t}. \tag{15}$$

It follows that, in this simple framework, a flat time-invariant consumption tax is equivalent to a non-distortionary lump-sum tax on endowments. In contrast, capital-income taxation is inefficient because it changes the relative prices of consumption in different periods, thereby rotating the budget constraint.

In the context of this same model, it is instructive to ask the following question. Suppose that consumption taxes are unavailable, so that the government must rely on distortionary capital-income taxes to raise revenue. How should it structure these taxes? While this question is somewhat artificial, it allows us to develop useful insights

[8] For simplicity, assume throughout that i_τ is fixed, so that the underlying production technology is linear.

[9] When time-varying consumption taxes and capital-income taxes are both available, there is some redundancy in the tax system. For example, one can replicate the effects of a time-invariant consumption tax with a system that taxes capital income at a constant rate, while taxing consumption at a decreasing rate over time.

concerning the optimal structure of capital-income taxes in more elaborate economic environments.

Setting $t = 0$ to reflect the absence of a consumption tax, we can rewrite the budget constraint as

$$c_0 + \sum_{\tau=1}^{T} q_\tau c_\tau (1 + \mu_\tau) \leqslant A_0, \tag{16}$$

where, in effect,

$$q_\tau \equiv \prod_{k=0}^{\tau-1} \frac{1}{1 + i_k} \tag{17}$$

is the producer price of consumption in period τ, and

$$\mu_\tau \equiv \prod_{k=0}^{\tau-1} \left(\frac{1 + i_k}{1 + i_k(1 - m_k)} \right) - 1 \tag{18}$$

is the effective tax rate on consumption in period τ.

When the model is reformulated in this way, it is immediately recognizable as a standard Ramsey optimal commodity-tax problem, where c_0 is the untaxed numeraire. One need only reinterpret standard results to characterize the optimal system of capital-income taxation. Under familiar (and commonly assumed) conditions, the government uses capital-income taxes temporarily, but then abandons them after some initial transition. More generally, it is possible to show that capital-income tax rates converge to zero with time (provided that T is sufficiently large)[10].

To understand these results, note that

$$\mu_\tau = (1 + \mu_{\tau-1}) \left(\frac{1 + i_{\tau-1}}{1 + i_{\tau-1}(1 - m_{\tau-1})} \right) - 1 \tag{19}$$

(where $\mu_0 \equiv 0$). Thus, a uniform commodity tax system ($\mu_\tau = \mu$, a constant, for all τ) is equivalent to a system in which capital income is taxed in period 0, but never thereafter ($m_0 > 0$, and $m_\tau = 0$ for all $\tau > 0$). A sufficient condition for the optimality of uniform

[10] The desirability of a zero long-run capital income tax rate emerges as a result in a variety of settings; see Diamond (1973), Auerbach (1979), Atkinson and Sandmo (1980), Judd (1985, 1999), Chamley (1986), Zhu (1992), Bull (1993), Jones, Manuelli and Rossi (1993, 1997) and Chari, Christiano and Kehoe (1994). Some of these papers analyze models with overlapping generations of (typically homogeneous) finite-lived agents, while others consider models with (sometimes heterogeneous) infinite-lived agents. The discussion in this section focuses on a simple case in which there is a representative agent whose horizon coincides with that of the economy, but it also includes some brief comments on the role of capital-income taxation in OLG models.

commodity taxation is that the utility function takes the form $U(x_0, \phi(x))$, where x_0 is the untaxed numeraire, x is the vector of taxed commodities, and ϕ: $\mathbb{R}^K \rightarrow \mathbb{R}$ (K being the number of taxed goods) is homothetic [Auerbach (1979)]. Note that these conditions are satisfied for the familiar (and commonly assumed) case of an intertemporally separable, isoelastic utility function [as in Equations (1) and (9)]. Consequently, with this formulation of utility, it is optimal to tax capital income once in the first period, but never again[11].

When preferences are *not* of the form described in the preceding paragraph, in general it will not be optimal to tax c_1 through c_T at a uniform rate. If the optimal commodity tax rate, μ_τ^*, rises with τ, then by Equation (19), it is optimal to tax capital income. Conversely, if the optimal commodity-tax rate falls with τ, then it is optimal to subsidize capital income.

Consider the infinite-horizon case where $T = \infty$. Imagine for the moment that the optimal capital-income tax rate is strictly positive and bounded away from zero in the long run. Then, by Equation (19), μ_τ^* converges to infinity for large τ. This implies that the distortion of future consumption rises without bound over time, which seems contrary to the usual principles of optimal taxation[12]. Recall in particular that the optimal commodity-tax rates are determined by compensated price elasticities. Provided that these elasticities converge to well-defined limits for large τ, one would expect μ_τ^* to converge to some finite limiting value, μ^*. This intuition is in fact correct.

[11] Technically, this solution is only valid when the present discounted value of the government's revenue requirement is not too large. When revenue requirements are substantial, the optimal value of μ may exceed i_0. According to Equation (19), this corresponds to an initial capital-income tax in excess of 100% ($m_0 > 1$). As long as individuals can invest in non-interest-bearing assets such as money, the *effective* tax rate on capital income can never exceed 100%, even if the statutory rate is greater. (If non-interest-bearing assets are nominal, then one can achieve an effective tax rate in excess of 100 percent, but there is still a maximum, and the analysis is qualitatively unchanged.) Thus, as we raise μ beyond i_0, a distortionary tax wedge appears between c_1 and other goods. Provided that preferences take the form $U(c_0, c_1, \phi(c_2, \ldots, c_T))$, where ϕ is homothetic, the new tax wedge will not disturb the conditions for optimality between c_2 through c_T, so uniform taxation of these goods will still be optimal. Thus, the solution would involve 100% capital-income taxation in the first period, positive capital-income taxation in the second, and no capital-income taxation thereafter. Of course, since $m_\tau \leqslant 1$ for all τ, Equation (19) also implies that there is a maximum effective commodity tax rate on consumption in every period τ: $(1+i_0)(1+i_1)\cdots(1+i_{\tau-1})-1$. If the revenue requirement is large enough, some of these other constraints will bind as well. However, the same logic applies: provided that preferences take the form $U(c_0, \ldots, c_\tau, \phi(c_{\tau+1}, \ldots, c_T))$ for all τ (where ϕ is always homothetic), constraints on effective tax rates for c_0 through c_τ will not disturb the optimality conditions that call for uniform taxation between $c_{\tau+1}$ through c_T. Notably, this condition is satisfied for the intertemporally separable, isoelastic case [Equations (1) and (9)]. Thus, the constrained solution always involves 100% capital-income taxation in periods 0 through some period $\tau-2$, positive capital-income taxation in period $\tau-1$, and no capital-income taxation thereafter. The use of capital-income taxation is therefore always transitory, and the period of transition is longer when revenue requirements are greater.

[12] Similarly, if the optimal capital-income tax rate is strictly negative and bounded away from zero in the long run, μ_τ^* converges to -1 for large τ, which also implies that the distortion of future consumption rises without bound.

It follows that the optimal rate of capital-income taxation may be positive or negative in the short run, but it converges to zero for the long run. Even if μ_τ^* converges to *several* limiting values, the associated capital-income taxes must still *average* zero in the long run [see Judd (1999) for further discussion].

The optimal tax problem described above is artificial in at least two respects: first, it assumes that tax instruments other than capital-income taxes are unavailable, and second, it assumes that taxes only distort decisions on the intertemporal margin. In practice, there are other taxes and other pertinent behavioral margins. Nevertheless, both the qualitative results and the associated intuition from the simple model are reasonably general.

To illustrate, modify the preceding model to incorporate a first-period labor–leisure choice, as well as a labor-income tax and a time-invariant consumption tax. Let L denote hours of leisure, $\bar{L}$ denote the individual's total endowment of time, w denote the hourly wage rate, and z denote the tax rate on labor income. For the moment, simplify by assuming that the individual has no initial assets ($A_0 = 0$). Then the budget constraint becomes

$$\sum_{\tau=0}^{T}\left(\prod_{k=0}^{\tau-1}\frac{1}{1+i_k(1-m_k)}\right)c_\tau(1+t) \leqslant (1-z)\,w(\bar{L}-L), \tag{20}$$

from which it is readily apparent that the consumption tax and the labor-income tax are equivalent. We can rewrite Equation (20) as

$$wL+\sum_{\tau=0}^{T} q_\tau c_\tau(1+\mu_\tau) \leqslant w\bar{L}, \tag{21}$$

where q_τ is, again, the producer price of consumption in period τ [see Equation (17)], and

$$\mu_\tau \equiv \left(\frac{1+t}{1-z}\right)\prod_{k=0}^{\tau-1}\left(\frac{1+i_k}{1+i_k(1-m_k)}\right)-1 \tag{22}$$

is the effective tax rate on consumption in period τ. This is again recognizable as a standard Ramsey optimal commodity-tax problem, where in this case L is the untaxed numeraire good and c_0 through c_T are the taxable goods. Provided that the utility function is of the form $U(L, \phi(c_0,\ldots,c_T))$ with ϕ homothetic, the optimal commodity-tax rates, μ_τ^*, are uniform, which requires a positive tax on either consumption or labor income ($z>0$ or $t>0$) and no taxes on capital income ($m_\tau = 0$ for all τ, including period 0). For models in which the individual potentially supplies labor in every period, a similar conclusion follows under an analogous condition[13]. Even if preferences do

[13] Assuming that the government can tax labor income at different rates in different years, capital income should not be taxed if utility function is of the form $U(L_0,\ldots,L_T,\phi(c_0,\ldots,c_T))$, where ϕ is homothetic.

not satisfy this condition, optimal capital-income taxes will still be zero in the long run (for $T=\infty$) provided that the μ_τ^* converge with τ to some limiting value, μ^* – a condition that holds with considerable generality.

The analysis becomes somewhat more complicated when the individual has initial assets ($A_0>0$). In that case, the budget constraint is

$$\sum_{\tau=0}^{T}\left(\prod_{k=0}^{\tau-1}\frac{1}{1+i_k(1-m_k)}\right)c_\tau(1+t)\leqslant(1-z)\,w(\bar{L}-L)+A_0. \tag{23}$$

Note that consumption taxation and labor-income taxation are no long equivalent. Indeed, by setting $t>0$ (*taxing* consumption), $z=-t$ (*subsidizing* labor), and $m_\tau=0$ for all τ, one can, in effect, create a non-distortionary tax on the initial endowment, A_0. This is usually regarded as an impractical solution since it ignores the incentive problems that arise if the government is unable to make a credible commitment *not* to expropriate accumulated capital. As a modeling strategy, it is therefore natural to assume that either the consumption tax or the wage tax is unavailable.

If the wage tax is unavailable, one can rewrite the budget constraint as

$$wL+\sum_{\tau=0}^{T}q_\tau c_\tau(1+\mu_\tau)\leqslant w\bar{L}+A_0, \tag{24}$$

where q_τ and μ_τ are defined as above [with $z=0$ in Equation (22)]. This is completely equivalent to the last case considered (with $A_0=0$). With the usual separability and homotheticity condition, taxation of capital income is undesirable. For $T=\infty$, optimal rates of capital-income taxation converge to zero in the long run provided that the optimal commodity-tax rate, μ_τ^*, converges to some limit.

It is natural to conjecture that the same results would hold when a labor-income tax is available and a consumption tax is not, but this is not quite correct. From Equation (23) it is evident that the labor-income tax combines a non-distortionary tax on a portion of the individual's endowment ($w\bar{L}$) with a distortionary leisure subsidy. Unlike a consumption tax, the labor-income tax does not extract revenue from the individual's financial endowment (A_0). In contrast, capital-income taxation provides the government with a mechanism for getting at the financial endowment, albeit at the cost of distorting decision-making on both the intertemporal margin and the labor–leisure margin. Clearly, capital-income taxation is unavoidable when $w\bar{L}$ is small relative to the government's revenue requirement and A_0. More generally, it is desirable to rely on both labor-income taxation and capital-income taxation, at least in the short run (even with the usual separability and homotheticity conditions), trading off the costs of the associated distortions against the benefits of tapping into different portions of the individual's endowment for the purpose of raising revenue.

We have already seen, however, that the government should not ordinarily rely on capital-income taxation in the long run even when its use is unavoidable in the

short run. Capital-income taxation necessarily entails distortions between current and future consumption, but one can avoid distorting consumption between different future periods by taxing investment returns only in transition. Similar principles apply in the case where a labor-income tax is available and a consumption tax is not. Provided that utility takes the form $U(L, c_0, \phi(c_1, \ldots, c_T))$ with ϕ homothetic, the government should use capital-income taxation to mimic a commodity tax that is uniform over $c_1, \ldots, c_T$ [14]. This is accomplished by taxing capital income in the initial period, and never thereafter [15]. Under relatively weak conditions, one can also guarantee more generally that, for economies with sufficiently long horizons, the optimal commodity-tax rates on c_T converge to a constant for large τ, which implies that the government should avoid capital-income taxation in the long run [Judd (1999)].

As is clear from this discussion, the avoidance of capital-income taxation in the long run has emerged as a major theme of the pertinent literature. It holds with considerable generality within a broad class of models. However, three qualifications are in order.

First, justifications for taxing or subsidizing capital income – even in the long run – may exist in more elaborate economic models. For example, Judd (1997) demonstrates that capital-income subsidies are optimal when firms exercise some degree of market power over intermediate capital goods (in effect, the subsidy offsets the private "tax"); conversely, capital-income taxes may be optimal in the long run when there is an untaxable source of pure profits that is related to the level of investment [Jones, Manuelli and Rossi (1993, 1997)]. As will be noted in Section 2.2.2, the existence of liquidity constraints may affect the desirability of capital-income taxation. Presumably, capital-income taxes or subsidies could also be optimal in the long run if the social benefits of investment activities (such as research and development) exceed the private benefits accruing to the investor.

Second, the optimal tax policy may not be time-consistent. Imagine, for example, that the government has access to taxes on labor income and capital income. Under appropriate conditions (see above), we know that the solution involves no capital-income taxation beyond the first period. Suppose, however, that the government re-optimizes each period. Provided that the individual holds positive assets, the re-optimized solution typically involves positive capital-income taxation in the short run. Consequently, the government is unwilling to follow through on its plan not to tax capital income after the initial period. In such situations, one can describe the government's choice as the equilibrium of a dynamic game. Under some conditions, it is still possible to construct equilibrium strategies that implement an efficient

[14] These restrictions are satisfied when, for example, one can write the utility function as $v(L) + u(c_0, \ldots, c_T)$, where $u(\cdot)$ takes the form described in Equations (1) and (9).

[15] Once again, depending on the magnitude of the revenue requirement, this may require an initial capital-income tax rate in excess of 100 percent, which is infeasible. In that case, there might be several transitional periods during which the government would tax capital income. See footnote 11 for further discussion.

tax scheme, but in other circumstances the rate of capital-income taxation may be either positive or negative, even in the long run [Benhabib and Rustichini (1997)].

Third, I have implicitly assumed throughout the preceding discussion that the representative household's planning horizon coincides with the horizon for the economy. Atkinson and Sandmo (1980), Auerbach (1979) and Diamond (1973) have studied the features of optimal tax systems in simple infinite-horizon models with overlapping generations of finite-lived individuals[16]. In these models, more restrictive conditions are required to guarantee that the optimal long-run tax on capital income is zero. Specific results depend on assumptions about the government's use of other policy instruments. When the government has sufficient control over the generational distribution of resources, the task of designing an optimal tax system is, in steady state, equivalent to the standard Ramsey tax problem for a representative finite-lived individual[17]. Though the limiting arguments mentioned in the preceding discussion no longer apply, the optimal capital-income tax rate is still zero in the long run if preferences are weakly separable into leisure and consumption, and homothetic in consumption.

When the government *cannot* optimize its use of debt, capital-income taxes play an important role in determining capital intensity. The steady-state welfare effects of capital-income taxation then depend on the divergence of initial steady-state capital intensity from the golden rule, and on the sensitivity of steady-state capital intensity to the after-tax rate of return. When capital accumulation is too low ($f'(k) > n$, where $f'(k)$ is the marginal product of capital and n is the population growth rate), the optimal tax structure reflects the benefits of setting capital-income taxes so as to encourage greater saving. Notably, in contrast to the standard Ramsey tax problem, the sign and magnitude of these benefits are governed by the *uncompensated* interest elasticity of saving, rather than the compensated elasticity. Since it is impossible to sign the uncompensated interest elasticity of saving as a matter of theory, the optimal

[16] Atkinson and Sandmo solve a problem wherein the government maximizes the discounted sum of individual lifetime welfares, and they examine the steady state of the solution. Auerbach solves a problem wherein the government maximizes steady-state welfare. The latter approach implies that the planner's social welfare function places no weight on the welfare of transitional generations. This favors policies that redistribute resources from transitional generations to steady-state generations, e.g., by moving the economy towards the golden-rule growth path. Such policies are not necessarily attractive when judged purely on the grounds of efficiency.

[17] For the most part, the literature considers models in which households live for two periods. In that setting, the equivalence result described in the text holds as long as the government can use public debt to achieve the desired steady-state capital stock. More generally, when households have T-period lifespans, the government needs $T-1$ redistributional instruments. The equivalence result also assumes that the government can implement age-specific taxes, for example by applying different tax rates to capital income earned by two distinct cohorts at the same point in time. The problem becomes more complicated when the government must apply the same tax rates to all cohorts at each point in time. However, the optimal long-run tax on capital income continues to be zero under the same conditions identified in the text.

tax structure can involve either a tax or a subsidy on capital income, even when there is too little capital accumulation in the initial steady state. In general, it is no longer desirable to refrain from taxing or subsidizing capital income even when the usual sufficient conditions (weak separability of preferences between consumption and leisure coupled with homotheticity in consumption) are satisfied.

2.1.2.2. The welfare costs of taxing the returns to saving. The second set of normative questions mentioned at the outset of Section 2.1.2 concerns the welfare effects of tax reforms. As a general matter, proposals to reform some arbitrary status quo by reducing or eliminating capital-income taxes can either raise or lower social welfare. Clearly, such proposals must inevitably reduce welfare when the status quo coincides with an optimal tax scheme involving positive taxes on capital income. Even when the optimal capital-income tax rate is zero, the welfare losses resulting from the taxation of investment returns can be either large or small, depending on the features of the economic environment.

Under certain conditions, one can approximate the welfare losses associated with the taxation of a consumption good by computing the area of a "Harberger triangle" [Harberger (1964)]. Since this area is proportional to the product of the square of the tax rate and the good's compensated demand elasticity, a small elasticity implies a small welfare loss. In the context of capital-income taxation, the pertinent behavioral margin involves the response of saving to a change in the after-tax rate of return. As will be discussed in Section 3, various studies have placed the uncompensated interest elasticity of saving at or near zero. If we take this evidence at face value and assume that the income effect in Equation (8) is small (e.g., because saving, s_0, is a small fraction of lifetime earnings, W), it is tempting to conclude that the compensated interest elasticity of saving must also be near zero, and to infer that the welfare costs of capital-income taxation are small. This inference is inappropriate: capital-income taxation may be highly inefficient even when compensated changes in the after-tax rate of return have little or no effect on saving [Feldstein (1978)].

To understand this point, imagine an individual who lives for two periods, supplying labor inelastically during the first period, and retiring prior to the second period. The relevant consumption goods are current consumption and future consumption, *not* current consumption and saving. Saving is related to *expenditure* on future consumption. To compute the size of the Harberger triangle, one must use the compensated elasticity of demand for second-period consumption with respect to the interest rate, rather than a compensated interest elasticity of saving[18]. Consequently, the Harberger triangle can be sizable even if the uncompensated interest elasticity of saving is zero and income effects are small.

[18] The notion of a compensated interest elasticity of saving is not even well-defined, since its size differs according to whether compensation is distributed in the first period or in the second period.

Feldstein (1978) uses the Harberger approximation to compute the welfare cost of capital-income taxation in a simple, two-period, representative-agent model. In the first period of life, the individual chooses labor supply and consumption; second-period consumption is determined as a residual. Assuming that the relevant *uncompensated* elasticities (the interest elasticity of saving, the labor supply elasticity, and the associated cross-price elasticities) are all zero, Feldstein finds that capital-income taxation entails substantial welfare losses. Specifically, when the initial tax rates on capital and labor income are both 40 percent, replacement of the capital-income tax with an equal-yield labor-income tax increases welfare by roughly 18 percent of tax revenue[19].

Notably, Feldstein's analysis abstracts from general-equilibrium effects, in that pre-tax factor returns (the wage rate and the interest rate) are taken as fixed. Other authors have explicitly considered the welfare costs of capital-income taxation in general-equilibrium growth models. This literature is divided into two segments: studies that employ models with infinite-lived households, and studies that employ models with overlapping generations of finite-lived households.

Chamley (1981) studies the welfare effects of replacing a capital-income tax with a non-distortionary lump sum tax in a model with a representative, infinite-lived household. He solves for the adjustment path from an initial steady state by linearizing the economy's equations of motion. Noting that the marginal deadweight loss of taxation is zero at the first-best allocation, he uses a quadratic approximation to compute the associated change in welfare. Under plausible parametric assumptions, he finds that, when labor supply is fixed, the welfare cost of capital-income taxation is approximately 11 percent of revenue when the tax rate is 30 percent, and 26 percent of revenue when the tax rate is 50 percent. The quadratic approximation implies that the welfare cost is roughly twice as high for the marginal dollar of revenue. These figures increase by as much as a third when Chamley allows for the possibility that capital-income taxes may also distort labor supply.

Judd (1987) studies a similar model, but improves upon Chamley's analysis in two ways: first, he considers experiments involving revenue-neutral changes in other distortionary taxes; second, he linearizes around steady states with positive taxes to obtain exact expressions for the marginal deadweight loss of taxation given any initial tax system. He finds that, on the margin, replacing capital-income taxation with labor-income taxation raises welfare for a broad range of estimated taste and technology parameters. Since the optimal long-run capital-income tax rate converges to zero for this class of models (see Section 2.1.2.1), this finding is understandable[20]. Judd's preferred calculations suggest that the welfare gain of an immediate and permanent

[19] It does not necessarily follow that the optimal income tax system involves no taxation of capital income under these parametric assumptions; Feldstein does not investigate this issue.

[20] For many of his parametric calculations, Judd also assumes that utility is additively separable in consumption and leisure, and that the consumption and leisure components are both homothetic. Chamley makes a similar assumption when he modifies his model to allow for variable labor supply. When

cut in capital taxation exceeds 25 cents on each dollar of revenue, and exceeds one dollar per dollar of revenue under plausible assumptions.

A somewhat different set of considerations governs the welfare effects of capital-income taxation in models with overlapping generations of finite-lived households. First, relative to models with infinite-lived agents, more restrictive conditions are required to guarantee that the optimal capital-income tax rate converges to zero in the long run (see Section 2.1.2.1). Consequently, there is less reason to believe *a priori* that a reduction in the capital-income tax rate will necessarily raise welfare. Second, unless the government adopts offsetting deficit policies, different tax systems may have different consequences for the intergenerational distribution of resources. It is important not to confuse these distributional effects with efficiency effects.

Taxes affect intergenerational distribution both directly and indirectly. Direct distributional effects result from different patterns of nominal incidence at fixed prices. For example, relative to a wage tax, a consumption tax distributes resources away from generations that are currently retired toward those that are currently working. Indirect distributional effects result from changes in equilibrium prices. For example, all else equal, an increase in capital accumulation during any period raises wages in subsequent periods by increasing the marginal productivity of labor, thereby benefitting later generations[21].

In overlapping-generations (OLG) models, tax policy affects capital accumulation (and hence intergenerational distribution) in two ways. First, saving may be sensitive to the after-tax rate of return. The associated effects of tax policy on capital accumulation and intergenerational distribution are governed by the uncompensated interest elasticity of saving. Second, there are general-equilibrium feedback effects from intergenerational distribution to capital accumulation (and hence back to intergenerational distribution). To illustrate, consider once again the choice between a wage tax and a consumption tax. Relative to a consumption tax, the wage tax leaves greater resources in the hands of current retirees, and less in the hands of current workers. Since retirees have higher marginal propensities to consume out of income, this tends to reduce

wage taxes are available but consumption taxes are not, these conditions imply that the optimal capital-income tax rate is exactly zero after some initial period of transition. Thus, when the government abandons the capital-income tax, it gives up an efficient levy on the initial capital stock, but this effect is swamped by the benefits of eliminating intertemporal distortions (at least for these parametric cases). Judd also considers parametric cases with non-separable utility for which optimal capital-income tax rates presumably converge to zero more gradually, and obtains similar results.

[21] A permanent increase in steady-state capital accumulation makes each steady-state generation better off only if the increase in labor productivity, and hence in after-tax wages, exceeds the required increase in saving. If the economy is on the "wrong" side of the golden-rule growth path (so that capital accumulation is inefficiently high, in the sense that $f'(k) < n$), then greater capital accumulation reduces steady-state welfare. In that case, tax policies that move the economy toward the golden-rule growth path can generate pure efficiency gains. However, it is generally believed that this is not the empirically relevant case. Movements toward the golden-rule growth path from below ($f'(k) > n$) raise issues of intergenerational distribution, rather than efficiency.

capital accumulation, thereby depressing wages in subsequent periods and distributing resources away from workers over a short-term horizon.

Diamond (1970) and Summers (1981) use OLG models to study the steady-state effects of capital-income taxation. Diamond obtains qualitative results for a model in which households live for two periods, while Summers attempts to quantify tax effects for a more realistic, parameterized model in which households live for fifty-five periods. The length of the household's horizon is important in this context because it affects the duration of the household's earnings stream, and hence the magnitude of the uncompensated interest elasticity of saving (see Section 2.1.1), which in turn governs the responsiveness of capital accumulation to changes in the after-tax rate of return. Summers' preferred calculations imply that steady-state welfare (expressed as a percentage of lifetime income) would rise by roughly 12 percent if capital-income taxes were replaced with consumption taxes, and by roughly 5 percent if capital-income taxes were replaced with wage taxes.

In evaluating Summers' results, one must bear several considerations in mind. First, he ignores the economy's transition path following tax reform[22]. The steady-state effects that he calculates are large because (i) the economy is below the golden-rule growth path ($f'(k) > n$), (ii) the model implies a substantial uncompensated interest elasticity of saving, and (iii) the effects of tax reform on capital accumulation are not offset by changes in government deficit policy. As discussed in Section 2.1.1, the implied value of the interest elasticity of saving – and hence the size of the associated steady-state welfare effect – is sensitive to parametric assumptions. More importantly, by focusing only on steady states, Summers' welfare calculations blend distributional effects with efficiency effects. It is important to remember that movements toward the golden-rule growth path benefit steady-state generations at the expense of transitional generations. If redistribution toward steady-state generations is desirable, the government could accomplish this objective in other ways (e.g., by running surpluses), without abandoning capital-income taxation.

Second, Summers assumes that households supply labor inelastically. Since this implies that the optimal capital-income tax rate is zero, reforms that eliminate capital-income taxes are inevitably welfare-improving. Consumption taxation and wage taxation are, in this model, equivalent to non-distortionary lump-sum taxation. Consequently, Summers does not examine policy experiments wherein the capital-income tax is replaced with another distortionary tax.

The equivalence of consumption taxes and wage taxes to lump-sum taxes, and hence to each other, may seem inconsistent with Summers' calculations, which imply that these two alternatives have very different steady-state effects. The explanation is that the switch from one system to the other would alter the timing of tax collection, but Summers does not permit offsetting changes in deficit policy. On average, consumption

[22] Summers (1981) cites an earlier unpublished version of his paper in which he examined the speed of transition, assuming myopic expectations.

occurs later in life than earnings. One can achieve a completely equivalent outcome, including an equivalent steady state, with a consumption tax or a wage tax levied at the same flat rate, provided that the government runs a higher debt with the consumption tax to compensate for the fact that it is collecting revenue later in the life of each individual. If one then eliminates this incremental debt (which Summers implicitly requires), steady-state capital accumulation will rise. Provided that the economy is initially below the golden-rule growth path, this increases steady-state welfare. The effect is, however, somewhat artificial, since the government could achieve the same outcome in the wage-tax setting by running a surplus.

Auerbach, Kotlikoff and Skinner (1983) [henceforth AKS; see also Auerbach and Kotlikoff (1987)] study a similar model, but improve upon Summers' analysis by allowing for variable labor supply, and by using computational methods to solve for the full dynamic path of the economy under rational expectations. Perhaps most importantly, they explicitly separate efficiency effects from distributional effects by examining two distinct types of tax-reform experiments. In the first type of experiment, tax rates are set to balance the government's budget period by period, and no government borrowing or lending takes place. This corresponds to Summers' approach. In the second type of experiment, tax rates are set to cover real exogenous government spending each period, but lump-sum transfers are used in combination with deficits and/or surpluses to alter the distribution of resources across generations. In particular, the authors hold fixed the utility of generations that are alive at the time of the tax reform, while distributing the net benefits or costs of the reform equally (expressed as percentages of lifetime income) across all subsequent generations. For the first type of experiment, results reflect a blend of distributional and efficiency effects, while the second type of experiment isolates efficiency effects.

Simulation results for the AKS model reveal a number of noteworthy patterns[23]. If the government were to replace the income tax with a consumption tax without adjusting deficit policy to fine-tune the intergenerational distribution of resources (a tax-reform experiment of the first type), the utility of the oldest initial cohorts would decline, but steady-state welfare (expressed as a percentage of lifetime income) would rise by roughly 6 percent. For a similar experiment involving the replacement of the income tax with a wage tax, the utility of the oldest initial cohorts would rise, but steady-state welfare would fall by roughly 4 percent. For tax-reform experiments of the second type, the welfare of all generations (other than those alive at the time of the reform) would rise by roughly 2 percent for a consumption tax, and fall by roughly 2 percent for a wage tax.

To understand the AKS results, it is helpful to begin with tax-reform experiments of the first type, for which steady-state results are directly comparable with Summers' analysis. Since labor supply is variable, the alternatives to capital-income taxation are

[23] These results presuppose an initial income tax rate of 30 percent. Auerbach and Kotlikoff (1987) provide results for a lower initial income tax rate (15 percent).

not distortion-free in the AKS setting, and consequently the steady-state outcomes with consumption taxation and wage taxation are considerably less attractive than in Summers' model. The steady-state ranking of consumption taxation and wage taxation continues to be driven by differences in the timing of revenue collection, coupled with the assumption that the government balances its budget period by period.

Differences between the transitional effects of consumption taxation and wage taxation originate from the divergent treatment of individuals who are already alive when the reforms are enacted. Since existing retirees earn no wages, they are plainly better off when the income tax is replaced with a wage tax, and worse off when it is replaced with a consumption tax. This differential treatment of the initial generations has two further effects. First, it implies that a consumption tax is less distortionary than a wage tax. In effect, the consumption tax supplements the wage tax with a non-distortionary capital levy. Since households must fund their consumption either from wages or from initial assets, the consumption tax base is strictly larger (in present-value terms) than the wage tax base, and the government can raise the same revenue with a lower tax rate. Like the wage tax, the consumption tax falls on labor and distorts the labor–leisure choice, but to a lesser extent since the rate is lower. Unlike the wage tax, the consumption tax also falls on initial assets, but this portion is non-distortionary since individuals cannot retroactively alter the labor earnings from which they accumulated their initial assets.

Second, the differential treatment of initial generations implies that consumption taxation promotes saving and capital accumulation in the short run, while wage taxation has the opposite effect. Within the life-cycle model, the marginal propensity to consume resources rises with age. Relative to an income tax, a consumption tax distributes resources away from older generations at the time of the reform, while a wage tax distributes resources towards these generations. The utilities of the oldest cohorts fall with consumption taxation, but younger generations benefit because higher capital accumulation raises wages and expands the tax base (permitting the government to apply even lower rates). In contrast, the utility of the oldest cohorts rises with wage taxation, but younger generations are adversely affected because lower capital accumulation depresses wages and contracts the tax base (requiring the government to impose even higher tax rates).

Now consider tax reform experiments of the second type, in which taxes are set to cover real exogenous government spending each period, but lump-sum transfers are used in combination with deficits and/or surpluses to alter the distribution of resources across generations. Under consumption taxation, transitional generations require compensation, so the steady-state outcome becomes less attractive (a welfare gain of 2 percent, instead of 6 percent). Under wage taxation, the government can extract compensation from the oldest cohorts, so the steady-state outcome becomes more attractive (a welfare loss of 2 percent, instead of 4 percent). The consumption-tax outcome is Pareto superior to the wage-tax outcome solely because the consumption tax incorporates a non-distortionary levy on existing capital, and thereby permits the government to impose a lower implicit tax rate on labor. Relative to

income taxation, consumption taxation has three effects: (i) it eliminates intertemporal distortions, (ii) it alters labor–leisure distortions, and (iii) it adds a non-distortionary levy on initial capital. The net impact of the first two effects is unclear[24], but the third effect is plainly beneficial. Relative to income taxation, wage taxation also has the first two effects, but it adds a lump-sum subsidy to initial capital. This third effect is plainly detrimental, since it requires the government to raise tax rates, aggravating the labor–leisure distortion. It is natural to wonder about the sign and magnitude of pure efficiency effects when one eliminates surprise capital levies and subsidies (the third effect) by considering fully anticipated tax reforms, but AKS do not undertake such experiments.

Subsequent research has refined, elaborated, and extended the work of Summers and AKS [see Auerbach and Kotlikoff (1987), Seidman (1983, 1984), Hubbard and Judd (1986), Starrett (1988), McGee (1989), Gravelle (1991a), Auerbach (1996) and Fullerton and Rogers (1993, 1996)]. Some of these studies are discussed in the next section, which considers variants of the life-cycle hypothesis.

2.2. Variants of the life-cycle hypothesis

Various studies have usefully extended the positive and normative analysis of capital-income taxation within life-cycle models to settings with additional realistic features. Chief among these features are bequest motives, liquidity constraints, and uncertainty. This section briefly summarizes these branches of the literature. For more detailed surveys, see Johnson, Diamond and Zodrow (1997) and Engen and Gale (1996a).

2.2.1. Bequest motives

Though there is widespread agreement that intergenerational transfers account for a significant fraction of household wealth, quantitative estimates vary widely. Kotlikoff and Summers (1981) conclude that roughly 50 to 80 percent of total wealth is due to intergenerational transfers, but subsequent studies tend to place this figure between 25 and 50 percent [see Aaron and Munnell (1992), Barthold and Ito (1992) and Gale and Scholz (1994a)]. To some extent, the dispute is definitional [see Modigliani (1988) and Kotlikoff (1988)].

[24] Although AKS do not solve for the optimal long-run capital-income tax rate when deficit policy is also optimized, there is no particular reason to believe that it is zero, since AKS depart from the assumptions that are known to generate this result. Specifically, AKS use a nested CES representation of preferences, with a parameter governing the substitutability between leisure and consumption within each period, and another parameter governing the substitutability between felicity in different periods. These preferences are not weakly separable in consumption and leisure. A natural conjecture is that the optimal capital-income tax rate is positive when contemporaneous consumption and leisure are substitutes (since this suggests that one should tax consumption more heavily during retirement), and negative when they are complements. However, without further analysis, it is impossible to know whether considerations arising from non-separability are quantitatively significant.

Theories of bequest motives fall into several distinct categories. One school of thought holds that bequests result from uncertainty concerning length of life coupled with restrictions on the availability of annuity insurance contracts [see Davies (1981)]. A second maintains that individuals care directly about the amount of wealth bequeathed to their heirs [see Blinder (1974), or Andreoni (1989)]. A third is predicated on the assumption that individuals have altruistic preferences, in the sense that they care directly about the utility or consumption of their heirs [see Barro (1974), or Becker (1974)]. A fourth depicts bequests as payments associated with transactions within families [see Bernheim, Shleifer and Summers (1985) or Kotlikoff and Spivak (1981)].

A number of studies have examined the empirical validity of these various alternatives. Collectively, the evidence points to a mixture of motives. Several authors have investigated the hypothesis that bequests are intentional, rather than accidental [Bernheim, Shleifer and Summers (1985), Hurd (1987, 1989), Bernheim (1991), Gale and Scholz (1994a)]. A number of studies have tested the altruism hypothesis by attempting to determine whether intergenerational transfers compensate for earnings differentials between generations and across children [Tomes (1981), Kurz (1984), Altonji, Hayashi and Kotlikoff (1992), and Laitner and Juster (1996)]. Bernheim and Bagwell (1988) argue that the altruism model leads inevitably to stronger, empirically untenable conclusions. Specific implications of exchange motives have also been examined [Bernheim, Shleifer and Summers (1985), and Cox (1987)]. All available theories have difficulty accounting for the robust empirical finding that more than two-thirds of US testators divide their estates exactly equally among their heirs [Menchik (1980), Wilhelm (1996)][25].

The implications of bequest motives for tax policy depend critically upon the type of motive that one assumes. For example, the taxation of bequests and inheritances is clearly non-distortionary if intergenerational transfers are accidental, but may have substantial efficiency costs if individuals have other motives. Different assumptions therefore lead to different implications concerning the desirability of including bequests in the consumption tax base, or inheritances in the wage tax base.

The interest elasticity of saving is also sensitive to one's assumptions about the nature of bequest motives. Standard formulations of the altruistic motive imply that the long-run interest elasticity of saving is much higher than in the absence of a bequest motive [Summers (1981), Evans (1983) and Lord and Rangazas (1992)]; indeed, the long-run partial-equilibrium interest elasticity of saving is infinite. In contrast, several studies have found that the interest elasticity of saving declines when one introduces accidental bequests [Engen (1994)] or preferences for bequests that are defined over the amount of wealth bequeathed rather than over heirs' consumption or utility [Evans

[25] Bernheim and Severinov (2000) argue that it is possible to account for the prevalence of equal division in a model with altruistic bequest motives if the division of bequests serves as a signal of the parent's relative affection for each child.

(1983), Starrett (1988), Fullerton and Rogers (1993)]. These are not general results, but depend instead upon the form of the utility function, and on the manner in which one recalibrates other parameters of the model when bequests motives are introduced[26]. In some instances, the interest elasticity of saving can even be negative. This might, for example, occur if an individual seeks to bequeath a fixed level of wealth: with a higher rate of return, less saving is required to reach the target.

Bequest motives also alter the welfare implications of capital-income taxation. If these motives are altruistic, then one can treat a sequence of finite-lived generations as a single, infinite-lived dynasty, and proceed as in Chamley (1981) and Judd (1987). If individuals' preferences are defined over the size of their bequest, the welfare effects of taxing the returns to saving become sensitive to the manner in which the model is calibrated. For such models, bequests are similar to consumption from the point of the testator, but they differ from consumption from the point of view of the economy because they add to capital accumulation. Consequently, when one incorporates bequests, one must recalibrate other parameters to replicate a baseline capital–labor ratio and interest rate. Evans (1983) recalibrates by adjusting the intertemporal elasticity of substitution, and finds that the introduction of a bequest motive significantly increases the impact of capital-income taxation on steady-state consumption. In contrast, Seidman (1984) recalibrates by adjusting the subjective discount rate, and finds that the welfare costs of capital-income taxation are relatively insensitive to the presence or absence of a bequest motive. Seidman also argues that the addition of a bequest motive reduces the transitional losses suffered by the initial generation of elderly individuals following a consumption-tax reform. This occurs for two reasons. First, when the model is recalibrated in the presence of a bequest motive, it implies less life-cycle saving, and hence less taxable consumption during retirement. Second, Seidman finds that, in the presence of a bequest motive, the elderly benefit from a slower rate of convergence to the new steady state.

2.2.2. Liquidity constraints

Up to this point, I have abstracted from liquidity constraints by assuming that individuals can borrow and lend at the same interest rate. The appropriateness of this assumption is debatable. There is a large empirical literature that attempts to assess the importance of liquidity constraints. One important branch examines data on asset holdings and the availability of credit, while another studies the sensitivity of consumption to income. A review of this literature is well beyond the scope of this chapter, but the interested reader can find citations, summaries, and evaluations in a variety of other places [see e.g., Attanasio (1995), Hubbard and Judd (1986), or Hayashi (1985)].

[26] The introduction of a bequest motive raises the steady-state capital–labor ratio and lowers the interest rate. If one adjusts other parameters (such as the intertemporal elasticity of substitution) to replicate baseline data, this will affect the interest elasticity of saving.

Liquidity constraints can in principle play an important role in determining the positive and normative effects of capital-income taxation. However, the nature of this role depends on one's assumptions concerning the characteristics of the market failure that gives rise to limitations on borrowing. The simplest approach is to model these limitations as exogenous non-negativity constraints on net worth (excluding human capital). One can justify this approach by appealing to transactions costs and/or the possibility of personal bankruptcy.

Since liquidity-constrained individuals do not alter their saving in response to small changes in the rate of return, the interest elasticity of aggregate saving tends to fall as binding credit constraints become more common. The introduction of an exogenous limitation on borrowing also implies that tax-deferred savings accounts can increase saving even in the presence of contribution limits. If desired saving is less than the limit and if the individual has no other wealth, then the limit must not bind. The availability of the tax-deferred account can therefore increase the individual's rate of return on the marginal dollar of saving – something that could not occur without liquidity constraints (see Section 2.1). Limitations on borrowing" also imply that saving in tax-deferred accounts may not be a perfect substitute for other saving (in contrast to the simple life-cycle model of Section 2.1). Since the government generally imposes significant penalties for early withdrawal, individuals sacrifice liquidity when they transfer assets into these accounts. If they anticipate a need to access savings prior to retirement (such as educational expenses for a child), they may prefer to save through other instruments[27]. It follows that individuals may choose to contribute less than the limit even when they have positive savings outside of tax-favored accounts, and that tax-favored saving may represent new saving even when contribution limits bind.

According to Hubbard and Judd (1986), the welfare costs of capital-income taxation in simulation models tend to be smaller (relative to the costs of labor-income taxation) in the presence of exogenous liquidity constraints. This reflects two considerations. First, since constrained individuals must deviate from their unconstrained optima, policies that exacerbate the severity and/or duration of the constraints are likely to have substantial, first-order efficiency costs. This effect is particularly pronounced when the intertemporal elasticity of substitution is low. A switch from capital-income taxation towards wage taxation reduces the consumption of constrained consumers, which produces a first-order reduction in welfare. Second, the potential efficiency gains from a reduction in capital-income taxation are smaller in the presence of borrowing limitations because constrained individuals do not alter their current consumption in response to a change in the after-tax rate of return. Due to these factors, the efficiency costs associated with an increase in the rate of labor-income taxation may exceed the efficiency gains resulting from a revenue-neutral reduction in the rate of capital-income taxation, even when the initial rate of capital-income taxation is

[27] If the anticipated needs are sufficiently far in the future, the individual may be better off saving through a tax-deferred account and paying the early withdrawal penalty.

substantial. It follows that the optimal capital-income tax rate may be positive [see also Aiyagari (1995)]. Similar issues arise with respect to consumption taxation. Though consumption tends to occur later in life than earnings, the two tax bases are identical during periods in which an individual encounters the borrowing constraint.

In some instances, it may be inappropriate to model liquidity constraints by introducing exogenous lower bounds on net worth. If credit-market failures result from informational asymmetries, the location of the constraint may be sensitive to other features of the economic environment. Under some conditions, changes in the timing of taxes over the life cycle can produce completely offsetting endogenous movements in borrowing constraints [see Hayashi (1985), as well as the discussions in Yotsuzuka (1987), and Bernheim (1987)]. In that case, a shift to wage taxation would not necessarily reduce current consumption.

2.2.3. Uncertainty and precautionary saving

Throughout the preceding discussion, I have assumed that households face no uncertainty with respect to their future incomes, exogenous expenses (such as medical costs), or any other factor. This is obviously a simplification. In practice, uncertainty plays a potentially important role in the life-cycle planning process, and gives rise to precautionary motives for saving. There is an extensive empirical literature that attempts to evaluate the importance of these motives. Various authors have examined the relationship between saving and measures of uncertainty, such as income variability and mortality risk. Others have relied on self-reported assessments of saving motives. A review of this literature is well beyond the scope of this chapter, but the interested reader is referred to the discussion in Engen and Gale (1996a).

The positive effects of capital-income taxation can change significantly when one introduces uncertainty. Unlike life-cycle saving, precautionary saving tends to be relatively insensitive to the after-tax rate of return. Consequently, when one adds uncertainty to a simulation model and recalibrates the model to replicate the same baseline capital–labor ratio and interest rate, the interest elasticity of saving can fall considerably. Using an overlapping-generations model similar to that of Summers (1981), Engen (1994) finds that, when earnings are stochastic, this elasticity is only one-tenth as large as it is when earnings are certain.

The introduction of uncertainty also has important implications concerning the positive effects of tax-deferred saving accounts. In the presence of credit constraints, uncertainty increases the value of liquidity, and thereby further reduces the degree of substitutability between liquid financial assets and illiquid tax-deferred saving. In the stochastic life-cycle model, the desire for liquidity is stronger among younger individuals, and the substitutability between tax-favored saving and other saving is lower. Consequently, as an individual ages, a shrinking fraction of tax-favored saving represents new saving. By the same token, contributions rise with age as the cost of illiquidity declines. Thus, the bulk of tax-favored saving is undertaken by individuals with a high degree of substitutability between tax-favored saving and other saving,

for whom a relatively small fraction of tax-favored saving represents new saving. Simulations suggest nevertheless that tax-favored saving accounts increase national saving significantly in the long run, but saving may decline in the short run as individuals fund their contributions from existing stores of wealth [Engen and Gale (1993, 1996a), Engen, Gale and Scholz (1994)].

The introduction of uncertainty also alters the normative effects of capital-income taxation. Using the overlapping-generations model mentioned above, Engen (1994) shows that steady-state welfare gains from replacing a capital-income tax with either a wage tax or a consumption tax are much smaller when income is stochastic. This finding reflects several factors. In Engen's model, the steady-state welfare cost of capital-income taxation is lower in the presence of uncertainty because the uncompensated interest elasticity of saving is smaller, and because it is necessary to recalibrate other parameters to compensate for the emergence of precautionary saving. Uncertainty also changes the welfare costs and benefits of labor-income taxation. Wage taxes mimic insurance by reducing the variability of after-tax income[28]. This beneficial effect is particularly pronounced when the labor-income tax is progressive. However, the associated reduction in uncertainty also mutes precautionary saving motives, thereby reducing capital accumulation and steady-state welfare.

Several authors have also explored normative aspects of capital-income taxation in stochastic models with infinite-lived agents. Given a particular realization of the state of nature, there is no reason to believe that it is optimal to tax consumption at an identical rate in any two consecutive periods. Consequently, the implied rate of capital-income taxation need not be zero, even in the long run. However, if the state of nature is not yet known, one might imagine that expectations about the optimal time-dated commodity-tax rates would converge to some limiting distribution over a long horizon. If these expectations are the same for periods t and $t+1$, then the sets of implied positive and negative capital-income tax realizations are mirror images of each other. It is therefore natural to conjecture that the optimal long-run *ex ante* capital-income tax rate is zero. Zhu (1992) shows that this conjecture is valid only under certain conditions, but Chari, Christiano and Kehoe (1994) find that the optimal long-run *ex ante* capital-income tax rate is approximately zero for plausible parameterizations of a stochastic simulation model.

2.3. *Behavioral theories*

In recent years, a number of economists have questioned the suitability of the life-cycle hypothesis for modeling the effects of tax policy on personal saving. Their concerns fall into two categories: issues related to bounded rationality, and issues related to self-control. I consider each of these in turn.

[28] Engen assumes that income variability is not insurable in the private sector, but he does not model the implied market failure explicitly. Depending upon the source of the market failure, the welfare gains from public insurance provision (e.g., through a wage tax) could be illusory.

Issues of bounded rationality arise from the complexity of intertemporal planning. To determine the solution of a standard life-cycle problem, an individual would require a high level of sophistication and extensive information on pertinent economic parameters. Yet much of the population appears ill-equipped to make even the most basic economic calculations [see Bernheim (1994a), or, for a general review of evidence on bounded rationality, Conlisk (1996)].

It is often argued that unsophisticated individuals may nevertheless act *as if* they solve complex mathematical problems. This view is particularly plausible when *either* (i) the activity in question is frequently repeated (so that the individual has the opportunity to experiment and learn), (ii) decisions taken by other individuals, as well as the consequences of these decisions, are both observable and pertinent (i.e. relevant vicarious experience is plentiful), or (iii) individuals recognize the need to obtain advice from qualified professionals, and have no difficulty obtaining this advice and monitoring its quality. Skeptics maintain that none of these conditions are satisfied in the context of the life-cycle planning problem. With respect to the first possibility, individuals usually retire only once – they have no opportunity to practice the life-cycle process. With respect to the second possibility, information on others' decisions is often poor. Moreover, since the consequences of these decisions are not fully known until well after an individual retires, and since 30-year-olds face very different economic conditions than the 90-year-olds whose consequences are fully known, vicarious observation of others tends to be either incomplete or of questionable relevance. Finally, with respect to the third possibility, unsophisticated individuals may be ill-equipped to evaluate the quality of information and advice provided by financial experts, or to evaluate experts' qualifications. In addition, they may not recognize or acknowledge the need for advice in the first place.

Formal models of bounded rationality typically proceed in one of several different directions [see Conlisk (1996) for a literature review]. Some impose structure on beliefs, for example by assuming a bias toward excessive optimism, a penchant for noticing salient or reassuring information, a tendency to forget information in the absence of rehearsal or corroboration, or a proclivity to update beliefs in a simplistic manner (e.g., through adaptive expectations). Others impose restrictions on decisions, limiting behavior to simple rules of thumb, such as saving a fixed fraction of income[29]. These restrictions are often empirically motivated. However, since they are not derived from generally applicable principles, this approach is necessarily somewhat *ad hoc,* and it fails to provide applied economists with a "tool kit" for addressing new problems. Other models envision costs to optimization [e.g., the notion of "satisficing", due to Simon (1955)]. While this approach appears to proceed from

[29] Notably, the advice of professional financial planners is often guided by extremely rough rules of thumb. According to the standard materials used for the curricula required to obtain the designation of Chartered Financial Consultant, "as a rule of thumb financial planners suggest that most families should plan to devote about 20 percent of their gross income to accumulation objectives" (Doyle and Johnson 1991).

general principles, the application of these principles is ultimately somewhat arbitrary. Instead of solving a particular optimization problem, one can certainly formulate and solve an alternative meta-problem that incorporates costs of computation. However, it is no less objectionable to assume that an individual can costlessly solve this meta-problem, than to assume that the individual can costlessly solve the original problem. Any coherent treatment of computational costs would therefore appear to lead to an infinite regress [Lipman (1991)].

The second issue – self-control – refers to the ability to follow through on intertemporal plans that require an individual to forego short-term gratification. While the life-cycle hypothesis implicitly assumes that self-control is perfect, a large body of psychological research suggests that imperfect self-control lies at the heart of many intertemporal decision-making problems [see e.g., Ainslie (1975, 1982, 1984, 1992), Maital (1986), Furnham and Lewis (1986), Schelling (1984), Thaler and Shefrin (1981), Shefrin and Thaler (1988) and Hoch and Lowenstein (1991)].

One can formalize problems of self-control in a number of different ways. Thaler and Shefrin (1981) propose a model in which an individual decision-maker consists of two distinct "selves" – a farsighted, patient "planner" and a shortsighted, impatient "doer". The planner can keep the doer in check only by expending costly effort ("willpower"). Laibson (1994a,b, 1996) analyzes a class of models in which problems with self-control arise directly from time-inconsistent preferences[30]. In contrast to the LCH, Laibson's formulation of the intertemporal planning problem assumes that an individual becomes less willing to defer gratification from period t to some period $s > t$ once period t actually arrives. As a result, the individual is typically unwilling to follow through on an optimal intertemporal plan. One can derive Laibson's model from a multiple-self framework similar to that of Thaler–Shefrin by assuming that the "planner" and the "doer" strike an efficient bargain in every period.

Existing models of self-control have at least one serious drawback: their solutions are significantly more complex than those of standard life-cycle problems. For example, the application of Laibson's framework requires one to solve for the equilibrium of a dynamic game played between an individual's current "self" and all of his or her future incarnations. Thus, in "solving" the problem of self-control, these frameworks accentuate the problems associated with cognitive limitations.

2.3.1. Positive analysis of taxation and saving

One can find a fair number of references to alternative behavioral hypotheses in otherwise conventional analyses of tax policy [see e.g., the discussions of IRA advertising in Venti and Wise (1992), and of "false" contribution limits in Feenberg

[30] Laibson's approach is motivated by psychological research, indicating that rates of time preference are approximately "hyperbolic" [see e.g., Ainslie (1992)]. His analysis of behavior is an outgrowth of earlier work on time-inconsistent preferences by Strotz (1955), Phelps and Pollak (1968) and others.

and Skinner (1989)]. Yet these references are usually haphazard, and mentioned in a rather *ad hoc* way as possible explanations for otherwise puzzling phenomena. With rare exceptions, alternative behavioral hypothesis have not been used as frameworks for organizing lines of inquiry concerning the effects of taxes on saving[31].

Certain behavioral hypotheses have clear implications concerning the effects of tax policy on saving. Consider, for example, the possibility that advice from professional financial advisors has a significant impact on behavior. If this view is correct, then to say something about the interest elasticity of saving, one should examine the nature of advice and determine how this advice changes with a change in the after-tax rate of return. The most common retirement-planning technique involves setting some fixed target for retirement (usually derived from an arbitrary earnings replacement rate) and computing the annual inflation-adjusted contribution to savings sufficient to achieve this target [see Doyle and Johnson (1991)]. The resulting interest elasticity is negative because higher rates of return make it easier to accumulate the resources required to reach the target.

While the implications of other behavioral hypotheses are often less clear, some alternatives lend themselves to formal analysis. Laibson, Repetto and Tobacman (1998) examine the steady-state effects of providing consumers with opportunities to save through accounts that resemble 401(k)s (contributions are deductible, earnings accumulate tax-free, and early withdrawals are penalized). Their model is similar to that of Engen, Gale and Scholz (1994), except that the specification of consumer preferences allows for hyperbolic discounting. According to their simulations, the steady-state rate of national saving rises significantly in the presence of tax-deferred retirement accounts, and the effect is roughly 30 percent larger when consumers have hyperbolic preferences (relative to the baseline case in which consumers have standard exponential preferences).

Though the literature on behavioral alternatives to the LCH contains few sharp predictions concerning the positive effects of tax policy on saving, it does suggest a number of pertinent qualitative principles. Specifically, taxes can change perceptions concerning the costs and benefits of saving, they can affect the feasibility of self-control by influencing the structure of private behavioral rules, and they can have an impact on personal saving indirectly by altering the decisions of third parties. I will elaborate on each of these possibilities in turn.

(i) *Perceptions of the costs and benefits from saving.* When saving incentives are in place, boundedly rational individuals may be more likely to learn that others regard the benefits of saving as important. For example, the availability of a 401(k) may stimulate conversations about contributions and investments, and thereby produce "peer-group"

[31] Exceptions include Thaler (1994), Bernheim (1994a, 1995, 1997a), Laibson (1996, 1998) and Laibson, Repetto and Tobacman (1998).

influences involving both demonstration and competition[32]. Likewise, tax incentives may stimulate promotional and educational activities that underscore the long-term benefits of saving (see the discussion of third-party activities later in this section, as well as Sections 5.4 and 5.5). The very existence of a pro-saving policy may indicate that "authorities" perceive the need for greater thrift. Likewise, individuals may attach significance to contribution limits (expressed either as fixed amounts or as fractions of compensation), on the grounds that these limits reflect the judgement of experts.

By segmenting retirement saving from other forms of saving, certain kinds of tax-favored accounts may make it easier to monitor progress towards long-term objectives. Information on total accumulated balances is usually provided automatically, or is readily available. Thus, individuals have a convenient yardstick for measuring the adequacy or inadequacy of their thrift. For those who save little, this may have the effect of making the costs of short-sightedness more explicit.

Thaler and Shefrin's behavioral life-cycle model assumes that the planner values saving, while the doer does not. In this setting, one imagines that tax incentives might affect saving by altering the *planner's* perceptions of costs and benefits. However, it is also possible that saving incentives might affect behavior by influencing the *doer's* perceptions. Scitovsky (1976) has raised the possibility that some individuals may view saving as a virtuous activity in and of itself, without any explicit contemplation of future consequences (see also Katona 1975). Pro-saving policies may promote this outlook by reinforcing the notion that, as something worthy of encouragement, saving is intrinsically rewarding and immediately gratifying.

Under certain circumstances, contributions to tax-favored accounts may also instill the perception that saving yields more concrete short-run benefits. By making tax-deductible contributions to a tax-favored account (when permitted), an individual can reduce the amount of taxes owed in the current year, or increase the size of his or her refund. Feenberg and Skinner (1989) have argued that the prospect of writing a larger check to the bank and a smaller check to the IRS may be particularly appealing on psychological grounds. Since the basis of this appeal (beating the IRS today) is a form of instant gratification, up-front deductibility may weaken the doer's opposition to thrift. This observation has potentially important implications concerning the choice between "front-loaded" and "back-loaded" plans. In a front-loaded plan, contributions are deductible and withdrawals are fully taxable; in a back-loaded plan, contributions are not deductible and withdrawals of *principal* are not taxable. The preceding discussion suggests that front-loaded plans may be more effective, since they may coopt impatient selves with the immediate reward of a current-year tax deduction. In contrast, under the LCH, individuals should prefer front-loaded plans to back-loaded plans if and only if they expect their marginal tax rates to fall.

[32] There is considerable evidence that economic decisions in general are strongly affected by peer-group effects. See e.g., Whyte (1943), Rainwater (1970), Stack (1974), or Jones (1984). For evidence on peer effects in the context of 401(k) plans, see Duflo and Saez (2000).

(ii) *Private rules.* The literature on self-control emphasizes the use of "private rules". Hoch and Lowenstein (1991) argue that individuals overcome impulsive inclinations by attaching global significance to small transgressions of these rules. For example, individuals may stake some aspect of their personal self-worth on their ability to follow a self-imposed rule; the benefits of breaking the rule in any isolated instance are counterbalanced by the loss of self-esteem. Similarly, an individual may construe transgressions of a rule as evidence that he or she will never be able to follow similar rules; consequently, the short-term gains from deviation are weighed against the losses associated with all related failures of self-discipline, now and in the future. With hyperbolic discounting, behavior of this kind is sustainable as an equilibrium of the intertemporal game played between an individual and his or her future incarnations [Laibson (1994a)].

Saving incentives may facilitate the formation of effective private rules in three ways. First, they may provide a natural context for developing rules concerning the level of saving. Possible rules could include always "maxing out" on tax-favored contributions, or always contributing some smaller amount to tax-deferred plans. Certain plans, such as 401(k)s, actually provide participants with limited ability to commit themselves to these rules for short periods of time.

Second, individuals may also develop private rules regarding the allowable uses of funds that they have previously placed in tax-favored accounts. For example, they might promise themselves that they will not withdraw these funds for any purpose short of a dire emergency. This phenomenon relates to the notion of "mental accounting" discussed by Shefrin and Thaler (1988). The existence of penalties for early withdrawal may help the individual establish and enforce barriers around tax-favored accounts. Somewhat paradoxically, these barriers may be high precisely because impatient selves (doers) have a strong aversion to paying immediate penalties. Anticipating a possible future loss of self-control, an individual may actually be more likely to contribute to a tax-favored account that provides a credible mechanism for precommitment. In contrast, under the life-cycle hypothesis, restrictions on early withdrawals reduce the likelihood that individuals will be willing to make contributions.

Third, as mentioned above, tax-favored savings accounts may make it easier to monitor progress toward long-term objectives. Effective monitoring is essential for the enforcement of private rules. According to Thaler and Shefrin (1981), "simply keeping track seems to act as a tax on any behavior which the planner views as deviant".

(iii) *Third-party activities.* Non-neutralities in the tax system may stimulate activities by "third parties" – that is, parties other than the individuals who benefit directly from the tax provisions, such as employers or vendors of tax-favored investments products. These activities may in turn affect the level of personal saving through either life-cycle or psychological channels.

The most obvious example of this phenomenon is the private pension system. As will be discussed in Section 5.1, the tax benefits accorded pensions probably account, at least in part, for their popularity. When an employer offers a traditional defined-benefit or defined-contribution pension plan, saving automatically increases unless

the individual takes steps to negate this effect. Pure life-cycle decision-makers would pierce the "pension veil" and treat the accrued value of pension benefits as a close substitute for other long-term saving. Even so, mandatory pensions may increase the saving of some households by forcing them to undertake more long-term saving than they would otherwise choose. Contributions to pension plans may also represent incremental private saving under various alternative behavioral hypotheses. Households may pierce the pension veil imperfectly, they may track pension accruals in different "mental accounts" than other long-term saving, or the mere presence of a pension plan may make them more aware of retirement issues.

Selective saving incentives may also have subtle effects on the features of pension plans. For example, 401(k) plans have historically received favorable tax treatment only if they satisfied non-discrimination requirements regarding the relative levels of benefits provided to highly compensated and non-highly-compensated employees. Rather than risk losing tax-favored status, many firms have taken steps to increase the participation and contributions of non-highly-compensated employees, and/or to decrease the contributions of highly compensated employees [Garrett (1995)]. These steps often included provisions whereby firms matched employee contributions, and the adoption of retirement education programs. These kinds of plan features have the potential to affect overall saving by eligible workers. Education may be particularly effective if low saving results from a failure to appreciate financial vulnerabilities.

Selective incentives may also encourage the vendors of tax-favored savings vehicles to advertise and promote their products actively. These promotional efforts may serve an educational function, or simply focus public attention on retirement income security. For example, the expansion of eligibility for IRAs to all taxpayers in 1981 was accompanied by a great deal of advertising and media fanfare.

The distinctive positive implications of the behavioral framework are perhaps most apparent when one considers the choice between broad-based policies for promoting saving, such as consumption taxation, and more limited strategies, such as IRAs. IRAs and other narrowly focused programs raise the *marginal* after-tax rate of return only for particular types of saving, and only if this saving does not exceed contribution limits. In contrast, a shift to broad-based consumption taxation would raise the marginal after-tax rate of return for all households, irrespective of the amount saved or the reason for saving. Provided that the interest elasticity of saving is positive, the LCH therefore leads us to expect that saving would increase more in response to consumption taxation than to narrower programs. Yet some of the behavioral considerations discussed in this section suggest the opposite. Narrow measures can focus attention on a single issue (such as the adequacy of saving for retirement), expose individuals to information concerning the importance of saving, provide a natural context for the development and enforcement of private rules, and promote the growth of pro-saving institutions. Contribution limits in particular may actually stimulate saving if they validate specific targets, provide natural focal points for the formation of private rules, or make it easier to monitor compliance with these rules. Conversely, a broad-based consumption tax could undermine the narrow focus on specific objectives that may be essential for the

exercise of self-control. It would remove one of the primary reasons for compensating workers through pension plans, and it would eliminate the special feature of particular financial instruments (such as IRAs and life-insurance policies) that make them especially marketable. It would also eliminate the quirky aspects of the tax system that subtly promote activities such as employee retirement education.

Before moving to a discussion of the evidence on taxation and saving, it is also important to emphasize that, depending upon whether one adopts the perspective of the LCH or some behavioral alternative, one may be inclined to draw very different positive inferences from the same set of empirical findings. As an example, consider the generalizability of evidence on the interest elasticity of saving. Within the context of the LCH, all saving incentives motivate changes in behavior through the same fundamental mechanism: an increase in the after-tax rate of return alters the intertemporal terms of trade. Measurement of a "generic" interest elasticity of saving therefore emerges as a central research priority. Alternative behavioral hypotheses allow for the possibility that the interest elasticity of saving may vary according to context, and that households may respond (both positively and negatively) to aspects of tax-incentive programs that are not directly related to the after-tax rate of return. In that case, measurement of the interest elasticity of saving in one context may shed little light on the effectiveness of tax policy in another context.

2.3.2. Normative analysis of taxation and saving

Proponents of pro-saving policies frequently argue that the prevailing rate of saving is "too low", and that individuals are providing inadequately for their futures [see e.g., Bernheim (1997b)]. Although it is possible to make sense of these claims within the context of the LCH, further clarification is required. A deliberate, forward-looking life-cycle planner carefully weighs the costs and benefits of saving. While impatient individuals may appear to save too little from the perspective of those with greater patience, this is merely a reflection of preferences. A traditional guiding principle of US economic policy is respect for free choice and diversity of tastes. A devotee of classical music might similarly deplore popular musical genres, but this is hardly an argument for subsidizing recordings of Stravinsky.

Once one steps away from the LCH, it is much easier to make sense of the claim that individuals save too little (e.g., if profligacy results from a failure to understand financial vulnerabilities, or from an unintended break-down of self-control). Moreover, the welfare gains associated with these policies are likely to be much larger than those implied by the LCH. In general, variations in consumption have greater effects on welfare when initial choices are farther removed from an optimum. Thus, under the LCH, the welfare costs of a small tax on capital income are second-order, and the welfare costs of a larger tax are limited by the extent to which that tax induces a departure from the optimum. In contrast, under alternative behavioral hypotheses, an individual may depart substantially from his or her optimum even in the absence of a tax. Thus, the marginal benefits from stimulating saving are potentially much greater.

According to Laibson's (1996) simulations, customers with hyperbolic preferences are willing to sacrifice nine-tenths of a year's worth of income to induce the government to implement optimal revenue-neutral saving incentives.

3. Evidence on responses to changes in the after-tax rate of return

Much of the literature on the relation between taxation and personal saving attempts to measure the interest elasticity of saving without reference to a specific policy. Studies of this kind implicitly assume there is a well-defined *generic* interest elasticity of saving. While this premise is valid under the LCH, some behavioral alternatives suggest that it is impossible to separate behavior meaningfully from institutional context (see Section 2.3).

The magnitude of the interest elasticity of saving is inherently an empirical issue; as discussed in Section 2, even the sign of this elasticity is theoretically ambiguous. The extant literature reflects two distinct approaches to measurement. One approach involves the estimation of functions describing either consumption or saving. The second approach involves the recovery of structural preference parameters through the estimation of consumption Euler equations. I will discuss each of these in turn. The interested reader may also wish to consult Elmendorf's (1996) survey for additional details.

3.1. The consumption/saving function approach

The earliest approach to measuring the interest elasticity of saving involved the estimation of a consumption function or saving function featuring an interest rate among the list of explanatory variables. Since the initial work of Wright (1969), this approach has yielded a variety of elasticity estimates, ranging from essentially zero [Blinder (1975), Howrey and Hymans (1978), Skinner and Feenberg (1989)] to 0.4 [Boskin (1978), Boskin and Lau (1978)]. This range is somewhat misleading, since the estimates tend to cluster near zero. There has been considerable discussion in the literature concerning the sources of the discrepancies between these various estimates [see e.g., Sandmo (1985)], with particular attention being given to the proper measurement of the real after-tax rate of return[33].

This approach has been criticized on the grounds that explanatory variables such as disposable income and the interest rate are potentially endogenous. A more fundamental problem follows from the "Lucas critique" of reduced-form empirical models [Lucas (1976)]. Since the relation between consumption (saving) and interest rates depends on expectations (which in turn result from the broader economic

[33] Given the complexity of the US tax system, some have even questioned whether it is possible to summarize the intertemporal terms of trade with a single number [Balcer and Judd (1987)].

context), there may not exist anything that one could properly regard as a stable saving or consumption function. If changes in the interest rate are correlated with changes in expectations about future resources or economic conditions, this will confound efforts to identify the interest elasticity of saving. In short, the historical relation between saving and the after-tax rate of return may provide a poor basis for forecasting the manner in which saving might respond to future changes in tax policy.

An inspection of historical US data reinforces this concern. Low-elasticity estimates are largely attributable to data from the 1970s, during which saving was relatively high and *ex post* real rates of return were very low. Since the 1970s were unusual in many other respects that might have affected expectations, this limited experience provides a questionable basis for forecasting future changes in saving. Unfortunately, the historical record does not offer a "clean" macroeconomic experiment involving a change in the rate of return and no change (or, at least, a known change) in expectations, from which one might *directly* infer the interest elasticity of saving.

3.2. The Euler-equation approach

As discussed in Section 2, a variety of studies compute interest elasticities of saving, as well as the welfare costs of alternative tax systems, in hypothetical economies populated by optimizing agents. Various authors have used these models to map estimates of structural preference parameters into estimates of elasticities and efficiency effects.

Naturally, the positive and normative effects of capital-income taxation depend upon a large number of economic parameters. As noted in Section 2.1.1, one critical preference parameter is the intertemporal elasticity of substitution in consumption [$1/\gamma$ in Equation (9)]. Equation (10) (the consumption Euler equation) implies that this parameter governs the rate at which the slope of the consumption trajectory responds to changes in the after-tax rate of return.

Note that one can rewrite Equation (10) as follows:

$$\frac{\Delta c_\tau}{c_\tau} \approx \frac{1}{\gamma} r - \frac{1}{\gamma}\delta, \tag{25}$$

where r is the real after-tax rate of return ($i(1-m)$ in the model of Section 2.1.1), and $\rho \equiv 1/(1+\delta)$[34]. Equation (25) suggests that it is possible to estimate the intertemporal elasticity of substitution by regressing the fractional change in consumption on the real after-tax rate of return. As a formal matter, since we derived Equation (25) from a model with no uncertainty, it is a deterministic relation and not a stochastic

[34] To obtain this expression, take logs of both sides of Equation (10) and use $\ln(1+x) \approx x$.

regression equation. Under some conditions [see, e.g., Hall (1988), or Deaton (1992)], Equation (25) generalizes in the presence of uncertainty to the following expression:

$$\frac{\Delta c_\tau}{c_\tau} \approx \frac{1}{\gamma} r - \frac{1}{\gamma}\delta + \mu + \varepsilon, \tag{26}$$

where μ depends on the variance of errors in forecasting consumption growth and ε is a random disturbance.

In principle, it is possible to estimate Equation (26) and recover $1/\gamma$ from the coefficient of the real after-tax rate of return. The contemporaneous value of r may be correlated with the error term, either because it is determined endogenously with the change in consumption or because it is associated with new information that affects the level of consumption. However, theory implies that ε is orthogonal to all information available prior to time τ, including past disturbances. Lagged variables are therefore necessarily exogenous, and make ideal instruments for r.

The procedure described in the preceding paragraph finesses a number of problems that arise with respect to the estimation of functions explaining aggregate consumption and/or saving. It provides a theoretically coherent treatment of endogeneity issues, it identifies structural preference parameters, and it avoids the estimation of reduced-form coefficients that are confounded by expectational and informational effects. Naturally, some problems remain (e.g., difficulties associated with the measurement of an after-tax real rate of return), and a number of new problems emerge (see below).

The interpretation of the coefficient of r in Equation (26) as the intertemporal elasticity of substitution is, of course, model-specific. As Hall (1988) notes, the standard life-cycle model makes an automatic connection between this intertemporal elasticity and the coefficient of risk aversion, whereas no connection appears to exist in practice. Although Hall exhibits one specification of utility that breaks this connection while still generating an Euler equation with an identical interpretation, there is no guarantee that this conclusion follows for other specifications. Other models obscure the structural interpretation of Equation (26), thereby rendering the approach vulnerable to the Lucas critique. For example, in the presence of uncertainty and liquidity constraints, individuals may engage in "buffer stock" saving. The expected desirability of next period's consumption – and hence the slope of the optimal consumption profile – may then depend on all factors affecting the probability that the individual will run out of liquid wealth, including expectations about future income. If one moves to other behavioral hypotheses, estimates of Equation (26) may have no structural underpinnings.

For the United States, there has been relatively little historical correlation between the growth rate of aggregate consumption and measures of the after-tax rate of return. Consequently, estimates of aggregate-consumption Euler equations imply intertemporal elasticities of substitution near zero [Hall (1988), Campbell and Mankiw (1989)]. Unfortunately, the assumptions required for valid aggregation are extremely restrictive [Deaton (1992)], and there is some evidence that aggregation

leads to quantitatively significant biases in practice [Attanasio and Weber (1993)]. Most household-level studies imply that intertemporal elasticities of substitution are significantly greater than zero (Leontief preferences) and less than unity (Cobb–Douglas preferences), but estimates vary considerably within this range [see, e.g., Shapiro (1984), Zeldes (1989), Runkle (1991), Lawrance (1991), Dynan (1993), Attanasio and Weber (1993, 1995) and Attanasio and Browning (1995)]. Though the use of household panel data avoids the aggregation problems mentioned above, it necessitates other compromises. Panels are typically short, and data are often available only for isolated components of consumption (e.g. food)[35]. Microeconomic studies also frequently rely on variation in after-tax rates of return arising from cross-sectional differences in marginal tax rates, even though this variation is plausibly related to other pertinent household characteristics (e.g., factors explaining differences in wealth and income).

In the current context, it is also important to emphasize that one cannot infer the interest elasticity of saving directly from estimates of an Euler equation. Though Equation (26) provides information on the *shape* of the consumption profile, it does not tie down the *level* of consumption. This statement requires some clarification. In the simplest life-cycle models, the present discounted values of consumption and lifetime resources must be identical; consequently, one *can* infer the level of consumption, and thereby deduce the interest elasticity of saving, from the shape of the consumption profile. However, when one adds uncertainty, the intertemporal budget constraint becomes considerably more complex, and when one adds bequests (either intentional or accidental), the present discounted value of consumption need not equal the present discounted value of lifetime resources. In such models, the level of consumption is not recoverable from the shape of the consumption profile, and depends instead on a broader range of factors. Even fixing the parameters of the Euler equation, the implied interest elasticity of saving is sensitive to assumptions concerning bequest motives, the variability of income and expenses, risk aversion, and the prevalence of liquidity constraints (see Section 2)[36]. Similar statements hold for the welfare effects of alternative tax policies.

4. Evidence on responses to tax-deferred savings accounts

The existing literature on tax-deferred savings accounts focuses primarily (though not exclusively) on Individual Retirement Accounts (IRAs) and 401(k)s in the United

[35] Attanasio and Weber (1995) address these problems by constructing a longer, synthetic panel using the Consumer Expenditure Surveys, which contain more comprehensive consumption data.

[36] Many of these parameters are difficult to estimate. For example, though the constant term in the Euler equation depends on the pure rate of time preference (ρ), it also depends on risk aversion and the variability of consumption (through μ). One cannot separately identify ρ and μ without further assumptions.

States. A large branch of this literature attempts to measure a direct effect: all else equal, how much less would contributors have saved had these programs not existed? This question is the focus of the current section[37]. Tax-deferred accounts may also affect saving indirectly, for example by displacing other types of pensions. I consider the available evidence on some indirect effects in Section 5.

4.1. Individual Retirement Accounts

The US government first permitted individuals without pensions to open Individual Retirement Accounts (IRAs) in 1974. These accounts featured tax-deductible contributions up to a fixed limit, tax-free accumulation, taxation of principal and interest on withdrawal, and penalties for early withdrawal. Congress extended eligibility to all workers in 1981, and raised annual contribution limits to $2000 for an individual worker, or $2250 for a married couple with one earner. The Tax Reform Act of 1986 restricted eligibility for *deductible* contributions, based on adjusted gross income (AGI). Deductibility was phased out for AGI between $40 000 and $50 000 for joint filers, and between $25 000 and $35 000 for single filers. Individuals with higher levels of AGI remained eligible to make non-deductible contributions up to the same annual limits, and continued to benefit from tax-free accumulation. Beginning in January, 1998, taxpayers could also make contributions to Roth IRAs, which feature non-deductible contributions up to the same fixed limit, tax-free accumulation, tax-free withdrawal of contributions and earnings, and penalty-free early withdrawal of contributions.

Prior to the Tax Reform Act of 1986, IRAs had become quite popular. Annual contributions grew from roughly $5 billion in 1981 to roughly $38 billion in 1986, representing approximately 20 percent of personal saving. Contributions plummeted after 1986, falling to less than $10 billion in 1990. While it is indisputable that the flow of saving through IRAs was substantial, there is considerable controversy concerning to the extent to which this flow represented new saving. The existing evidence on the efficacy of IRAs falls into five general categories.

4.1.1. Direct survey evidence

One approach to measuring the effect of IRAs on saving is simply to ask people how they funded their contributions. In one such survey [Johnson (1985)], about half of respondents said that they would have saved the money anyway, about 10 percent said that they would have spent all of it, and about 40 percent said that they would have saved some and spent some. Johnson concludes that, on average, individuals reduced consumption by roughly 32 cents to fund each dollar of IRA saving.

[37] Other useful surveys include Hubbard and Skinner (1996), Poterba, Venti and Wise (1996a,b), Engen, Gale and Scholz (1996a,b) and Bernheim (1997c).

Evidence of this type suffers from a variety of problems. The relevant survey question asks individuals to imagine what they would have done in a counterfactual and purely hypothetical situation. Respondents may not think very hard about the hypothetical. If they think about it, they may assess the costs and benefits of various decisions differently than they would have in practice. They may accurately report what their *intention* would have been in the hypothetical situation, but actions and intentions do not always coincide. They may also misrepresent their probable intentions in the hypothetical situation, particularly if they believe that some answer is more "virtuous", or if they think that the interviewer is looking for a particular response.

4.1.2. Evidence on the frequency of limit contributions

Historically, roughly seventy percent of all IRA contributors save at exactly the contribution limit [Burman, Cordes and Ozanne (1990), Gravelle (1991b)]. Some analysts contend that the IRA program does not encourage thrift among these limit contributors because it fails to reduce their implicit price of future consumption, relative to current consumption, on the margin (the substitution effect). If this premise is valid, then IRAs may actually reduce saving through an inframarginal income effect (see Section 2.1.1).

As a matter of theory, there is no compelling reason to accept the premise mentioned in the previous paragraph. In the most basic life cycle model, individuals always wish to surpass contribution limits even if this requires them to borrow or shift assets (see Section 2.1.1). Consequently, binding contribution limits do indeed reflect the absence of a substitution effect, and the impact of IRAs is dominated by the inframarginal income effect. However, this basic model also has the counterfactual implication that *all* individuals should make the maximum allowable contribution. In fact, many households do not contribute at all, 30 percent of contributors do not reach the limit, and 70 percent of contributors fall short of the limit at least once over a three-year period [Hubbard and Skinner (1996)].

To account for non-limit contributors in the context of the life-cycle model, one must assume that individuals face borrowing restrictions and value liquidity (see sections 2.2.2 and 2.2.3). In that case, the substitution effect is certainly present for non-limit contributors. More to the point, it may also be present for limit contributors[38]. IRAs may encourage some individuals to increase their long-term, illiquid saving until they reach the contribution limit, and this increase may come at the expense of consumption, rather than liquid saving.

[38] Since the existence of the contribution limit induces a kink in the individual's budget constraint, it is simply incorrect to argue that a limit contributor's marginal rate of return is the same as in the absence of IRAs. Rather, the marginal rate of return on tax-deferred investments is not well-defined at the kink. The marginal rate of return on long-term, illiquid investments is well-defined (and unaffected by the existence of the IRA) only if the limit contributor has additional investments of this kind.

If one credits behavioral alternatives to the life-cycle hypothesis (Section 2.3), then evidence on the frequency of limit contributors is even less pertinent. Contribution limits may encourage saving by validating specific saving targets. IRAs may increase awareness of the need for retirement saving, or enhance efforts to impose self-discipline. Even if IRAs do not stimulate *inflows* into households' long-term savings, they may deter *outflows* [Thaler (1994)].

4.1.3. Correlations between IRA and non-IRA saving

A number of authors have attempted to measure the effects of IRAs on saving through more rigorous econometric analysis. Most of these studies have, with varying degrees of sophistication, examined the underlying correlations between IRA and non-IRA saving activity.

Before describing these studies, it is useful to begin by describing an ideal experiment for assessing the effects of IRAs. The contrast between the ideal data and the available data explains why the measurement of IRA effects has proven so difficult. Imagine that we are given some large sample of individuals, and that we randomly partition this sample into two subsamples. We treat the individuals in these subsamples exactly the same in all respects (identical initial assets, wages, fringe benefits, working conditions, and so forth), but we permit the individuals in one subsample to contribute to IRAs (the "experimental" group), while withholding this opportunity from the other subsample (the "control" group). In this way, we create exogenous variation in IRA eligibility. We then compare the total saving of individuals in the two subsamples to determine the effects of IRAs.

Unfortunately, between 1982 and 1986, there is no exogenous variation in IRA eligibility. Instead, we observe variations in participation. One could imagine attempting to mimic the ideal experiment by using this variation to identify new "experimental" and "control" groups, in effect asking whether the saving or assets of IRA contributors are higher than, lower than, or the same as the saving or assets of non-contributors. Evidence based on this approach reveals that IRA contributors do not save less in other forms than non-contributors; in fact, they save a good deal more [see e.g. Hubbard (1984)[39]]. Unfortunately, this finding tells us very little about the extent to which IRAs displace other saving. Some households save a lot, while some save little. This is presumably attributable to differences in preferences. Since the decision to contribute is endogenous, contributors probably consist of households with stronger preferences for saving. Therefore, one should not be surprised to discover that those who contribute to IRA accounts also save more in other forms than those who choose not to contribute.

[39] Hubbard's (1984) data are drawn from the 1979 President's Commission on Pension Policy, and therefore include some non-contributors who were ineligible for IRAs. Thus, the sample-selection problem discussed in the text is perhaps less pronounced than for estimates based on data collected between 1982 and 1986.

In principle, one solution to this problem would be to identify some exogenous variation in IRA contributions that is unrelated to preferences towards saving. One could then use instrumental variables to estimate a specification explaining non-IRA saving or total saving as a function of IRA saving. Since eligibility was universal from 1982 to 1986, a potential source for this variation is difficult to imagine, let alone measure.

Rather than attempt to identify an instrumental variable, the literature has proceeded by re-examining the relation between IRA saving and non-IRA saving, controlling for initial wealth. This procedure is based on the assumption that two individuals with the same initial wealth must have the same underlying preferences towards saving; thus, the source of the spurious upward bias between IRA saving and total saving is supposedly removed. This approach has been followed in a study by Feenberg and Skinner (1989) and a series of studies by Venti and Wise (1986–1988, 1990–1992). Analysis of a variety of data sources (including the Michigan Tax Panel, the Survey of Consumer Finances, the Consumer Expenditure Surveys, and the Survey of Income and Program Participation) uniformly demonstrate that total saving is positively correlated with IRA saving, even when one controls for initial wealth. The conditional correlation between IRA saving and non-IRA saving is typically non-negative. Some studies have interpreted these findings as indicating that IRA contributions are new wealth.

The central problem with this strategy is that initial wealth may be a relatively poor control for an individual's current underlying disposition toward saving. One problem is that wealth varies for reasons unrelated to tastes for saving (such as the receipt of unexpected inheritances). Another difficulty is that an individual's disposition to save may change through time due to fluctuations in income, household composition, perceived needs, or other factors; thus, the individual's disposition to save during any time period may differ from the dispositions that led to the accumulation of initial wealth at the start of the period. Even if wealth were perfectly correlated with the relevant aspects of tastes, it is well known that asset values are measured with a great deal of error. Any residual unobserved variation in the current inclination to save that is left after controlling for initial wealth will continue to bias the correlation between IRA saving and non-IRA saving upward: those who, for unobserved reasons, are inclined to save more overall will probably save more in both forms.

The underlying econometric justification for this procedure is also suspect. Even if it were possible to control perfectly for all aspects of tastes that determine non-IRA saving, this would not allow one to calculate the extent to which IRA contributions displace other saving, unless one could identify some significant exogenous variation in IRA contributions independent of tastes for saving. But with universal eligibility, it is hard to imagine any significant factor that would have affected IRA saving without also directly affecting non-IRA saving. If there is no source of exogenous variation in contributions, the relation of interest is presumably not identified.

In some of their work, Venti and Wise also place additional structure on the data. Specifically, they estimate the parameters of a model in which an individual maximizes a utility function defined over consumption, IRA saving, and non-IRA

saving. The specification allows for a range of elasticities of substitution between the two forms of saving. Based on estimates of this model, Venti and Wise conclude that IRA contributions represented new saving, in the sense that they were funded almost entirely by reductions in consumption and income taxes.

The low estimates of the substitution parameter that emerge from estimation of the Venti–Wise model appear to be driven by two considerations. The first consideration is the non-negative correlation (noted above) between IRA saving and non-IRA saving, conditional on initial wealth (which appears in the Venti–Wise model through the budget constraint). For reasons that I have already discussed, this correlation is probably a poor barometer for the true degree of substitutability.

The second consideration has to do with a technical feature of the model. As formulated, the model implies that, if IRA saving and non-IRA saving are perfect substitutes, then no individual would be willing to engage in non-IRA saving until reaching the IRA contribution limit. Since this prediction is manifestly false (many individuals who saved something did not contribute to IRAs), Venti and Wise's estimation strategy automatically guarantees the result that the two forms of saving are imperfect substitutes. This inference is unwarranted. Although it is evident that IRA saving and non-IRA saving must not be perfect substitutes for savers who do not contribute to IRAs (perhaps due to differences in liquidity), it does not follow that these two forms of saving are poor substitutes for individuals who do contribute to IRAs. On the contrary, one could easily imagine that, among IRA contributors, IRAs are quite good substitutes for other saving. This could occur if, for example, IRA contributors tend to save a lot in all forms, and are therefore relatively unconcerned (on the margin) about liquidity.

Gale and Scholz (1994b) estimate an alternative econometric model, in which they permit the parameters of the saving relation to vary according to whether or not an individual is an IRA contributor. This is intended to capture the possibility that those who do not contribute to IRAs may have different attitudes towards IRA and non-IRA saving than those who do contribute. In this way, Gale and Scholz avoid the automatic bias towards low substitution that is present in the analysis of Venti and Wise.

Intuitively, Gale and Scholz identify the degree of substitution between IRA and non-IRA saving as follows. Suppose we measure the marginal propensity to save (out of income) in IRAs ($\text{MPS}_{I,N}$), and the marginal propensity to save in other forms ($\text{MPS}_{O,N}$) for non-limit contributors, as well as the marginal propensity to save in other forms ($\text{MPS}_{O,L}$) for limit contributors. If all IRA saving is new saving, then we should find $\text{MPS}_{O,L} = \text{MPS}_{O,N}$. On the other hand, if IRA saving simply displaces other saving dollar-for-dollar, we would expect to find $\text{MPS}_{O,L} = \text{MPS}_{O,N} + \text{MPS}_{I,N}$. On the basis of this kind of comparison, Gale and Scholz conclude that a negligible fraction of IRA contributions represent new saving[40].

[40] According to Poterba, Venti and Wise (1996a), this central finding of Gale and Scholz is sensitive to changes in the specification and in the criteria used for selecting the sample.

The analysis of Gale and Scholz suggests that the conclusions of Venti and Wise are sensitive to assumptions about the nature and distribution of unobserved preferences. This does not imply, however, that their particular procedure generates reliable estimates of the extent to which IRAs substitute for other forms of saving. Identification of the Gale–Scholz model depends on the assumption that all IRA contributors have the same preferences towards saving, conditional on a list of covariates, regardless of whether they are limit contributors. There is an obvious tension between this assumption and the motivating premise of their analysis, which holds that attitudes towards saving differ according to IRA participation status even when conditioned on the same list of covariates.

To understand the potential bias resulting from the Gale–Scholz homogeneity assumption, consider the following illustrative example. Suppose that there are three types of savers, with (respectively) low, medium, and high inclinations to save. Those with greater inclinations to save are assumed to have larger average and marginal saving propensities. Low savers never contribute to IRAs, and are therefore of no further interest to us. As long as moderate savers are not constrained by the IRA contribution limit, they save 5 cents out of each dollar in IRAs, and 5 cents in other forms. If they are constrained by the contribution limit, they still save 5 cents out of each dollar in other forms. As long as high savers are not constrained by the IRA contribution limit, they save 10 cents out of each dollar in IRAs, and 10 cents in other forms. If they are constrained by the contribution limit, they still save 10 cents out of each dollar in other forms. Our final assumption is that all moderate savers end up contributing less than the contribution limit, while all high savers turn out to be limit contributors.

Note that, in this example, all IRA contributions represent new saving. However, applying the Gale–Scholz procedure, one would calculate that $\text{MPS}_{O,L} = 0.10 = 0.05 + 0.05 = \text{MPS}_{O,N} + \text{MPS}_{I,N}$, and infer incorrectly than IRA saving completely displaces other forms of saving. I have constructed this particular example to demonstrate that the bias could be quite large. Obviously, hypothetical examples cannot establish the magnitude of the actual bias. However, the principle (and therefore the direction of the bias) generalizes: heterogeneity among those who contribute to IRAs typically implies that those who contribute more (and who therefore have higher average propensities to save) will also tend to have higher marginal propensities to save. As a result, the data will appear to show that the marginal propensity to save in forms other than IRAs rises as contributions pass the allowable limit. But this is precisely the pattern that Gale and Scholz would interpret as evidence of displacement.

Some authors argue that correlations between IRA saving and non-IRA saving are particularly informative for new contributors. Using 1984 and 1985 data from the Survey of Income and Program Participation (SIPP), Venti and Wise (1995a) demonstrate that the inception of IRA contributions for a household does not coincide with a significant decline in other financial assets. They interpret this to mean that even new contributors engage in very little asset shifting to fund contributions, and that these contributions must therefore represent new saving. Yet the observed patterns

do not rule out the possibility that many new contributors were simply people with positive current shocks to saving, in which case these individual would have increased non-IRA savings in the absence of IRAs. Consequently, the evidence is consistent with significant asset shifting.

Attanasio and De Leire (1994) undertake a similar exercise, but suggest that it is appropriate to evaluate the behavior of new contributors treating old contributors as a control group. If new contributions come from consumption and if new and old contributors have similar preferences, then (it is argued) new contributors should exhibit slower consumption growth, and essentially the same growth in non-IRA assets, as old contributors. In contrast, if new contributions come from saving, then new contributors should exhibit the same growth in consumption, but slower growth in non-IRA assets than old contributors. The authors implement this test using the Consumer Expenditure Surveys, and find the second of these patterns. They conclude that IRA contributions primarily reflect asset reshuffling, rather than new saving.

Unfortunately, there does not appear to be any compelling justification for using old IRA contributors as a control group. It is natural to conjecture that old contributors opened IRA accounts earlier than new contributors because they have stronger innate predispositions to save. Obviously, this would account for their higher rates of saving. In principle, Attanasio and De Leire rule this possibility out by showing that consumption does not grow more rapidly for old contributors than for new contributors[41]. However, as a practical matter, consumption growth rates appear to be poor indicators of intrinsic thrift [see Bernheim, Skinner and Weinberg (2001)].

Even if old contributors were a valid control group, Attanasio and De Leire's inference would not follow. If new and old contributors have similar preferences and if IRA contributions reflect asset shifting for both groups, then one should not observe any systematic differences in either saving or consumption, contrary to the authors' findings. The observed pattern would instead suggest that contributions among new participants reflect asset shifting, while contributions among old participants represent new saving.

4.1.4. Exogenous changes in eligibility

Another possible approach to mimicking the ideal experiment is to exploit the exogenous variation in IRA eligibility that existed prior to 1982 and after 1986. For example, one could imagine estimating a regression explaining non-IRA saving as a function of IRA contributions using eligibility as an instrument, or directly as a function of eligibility. There are two problems with this suggestion; one is conceptual, the other practical. Conceptually, a problem arises because, in contrast

[41] If differences in saving result from differences in the pure rate of time preference and if the intertemporal elasticity of substitution is positive, then, under the LCH, those who prefer to save more would experience more rapid consumption growth.

to the ideal experiment, IRA eligibility was non-random. Eligibility was triggered by the absence of pension coverage prior to 1982, and by a combination of pension coverage and AGI after 1986. Since both pension coverage and income are potentially important determinants of household saving, concerns about correlations with underlying preferences are still present. The practical problem arises because, with certain data sources, eligibility is difficult to assess. Information on pension coverage is sometimes unavailable, incomplete or inaccurate, and one must extrapolate AGI from income.

The concern that IRA eligibility (prior to 1982 or after 1986) might have been correlated with preferences towards saving leads to a slightly more sophisticated suggestion. If the heterogeneity in preferences is captured by an individual-specific fixed effect, then it should be possible to eliminate this heterogeneity by differencing saving. One can then relate changes in saving to changes in eligibility, which differed across individuals both in 1982 and 1987. The impact of IRAs is then, in effect, inferred from differences in differences. For example, using panel data that crosses 1982, one attempts to determine whether those who became eligible for IRAs increased their saving by more than those who remained eligible.

This is the general approach taken in Joines and Manegold (1995) and Engen, Gale and Scholz (1994). Both of these studies make use of the IRS/University of Michigan Tax Panel. Unfortunately, this data set contains no information on pension coverage, and therefore provides no way to measure IRA eligibility prior to 1982. Of course, individuals who contributed to IRAs prior to 1982 must have been eligible. Joines and Manegold therefore propose using this as the control group. By defining the control group in this way, they tend to select individuals who have the highest predispositions to save among the eligible population. To counteract this selection effect, they use as their experimental group a sample of individuals who also contributed to IRAs (and therefore who also have high predispositions to save), but who began to contribute after 1982. While this experimental group includes some individuals who were eligible prior to 1982, it also includes many individuals who became eligible as of 1982. Therefore, on average, allowable contributions increased by a larger amount for members of the experimental group than for members of the control group. Both studies nevertheless demonstrate that there is relatively little difference between the changes in saving across 1982 for the experimental and control groups. Their preferred estimates suggest that IRAs had a moderate effect on saving (raising the contribution limit by one dollar raises saving by less than 30 cents).

One difficulty encountered by Joines–Manegold and Engen–Gale–Scholz is that the IRS/University of Michigan Tax Panel does not contain measures of either saving or wealth. The authors are compelled to impute wealth from dividend and interest income. They then difference estimated wealth to obtain a measure of saving. This variable is the focus of their differences-in-differences analysis. Thus, their key results are based on third differences (twice across time and once across subgroups) of an imputed variable. One must seriously question how much "news" is left over after these

operations. Not surprisingly, the authors obtain a wide range of estimates, and the key effects are generally estimated with large standard errors.

The selection criteria used to construct the control subgroup and the experimental subgroup are also potentially problematic. It is doubtful that these groups have comparable characteristics or similar dispositions to save. The differences-in-differences procedure is ostensibly designed to handle this problem, since it removes the fixed effect for each group. However, the validity of this solution depends critically on two assumptions: that tastes enter the saving equation additively, and that tastes do not affect the size of the response to a given change in the policy variable. In this context, these assumption are objectionable.

To further explore this point, suppose that the saving of group i at time t is given by the following equation:

$$s_{i,t} = \mu_i + \alpha_t + \eta_i M_{it}, \tag{27}$$

where μ_i and η_i are fixed group-specific coefficients, α_t is a time effect, and M_{it} is the IRA contribution limit applicable to this group. One would expect μ_i and η_i to be positively correlated, since higher savers are more likely to respond to an increase in the contribution limit. The differences-in-differences estimator is then

$$\Delta s_{e\,t} - \Delta s_{c\,t} = [\eta_e \Delta M_{e\,t} - \eta_c \Delta M_{c\,t}] \tag{28}$$

(where "e" indicates the experimental group, and "c" indexes the control group). Note that one will correctly estimate the effect of the policy change on the experimental group as long as $\eta_e = \eta_c$ (i.e. if there is no heterogeneity in the response to a given change in policy), or if $\Delta M_{c\,t} = 0$ (i.e. the control group does not experience a change in the policy variable)[42]. In this instance, neither condition applies: it is likely that heterogeneity in preferences towards saving (as reflected in η_i) remains, and contribution limits were raised for the control group (albeit to a lesser extent than for the experimental group, so that $\Delta M_{e\,t} > \Delta M_{c\,t} > 0$).

The resulting bias in the estimates depends on whether the control group is innately more inclined to save or less inclined to save than the experimental group. Suppose for the moment the control group consists of particularly high savers, so that $\eta_c > \eta_e$. Then the sign of the differences-in-differences estimator becomes ambiguous, even if an increase in the contribution limit actually stimulates saving for both groups. To take an example, if a \$2000 increase in the contribution limit induces a \$1000 increase

[42] Even if one of these conditions were satisfied, one would still obtain a biased estimate of η_e in practice. Recall that the experimental group is contaminated by the inclusion of households that were eligible to make IRA contributions prior to 1982, and that therefore properly belong in the control group. By ignoring this problem, these studies overstate the average change in the contribution limit for members of the experimental group ($\Delta M_{e\,t}$). If the true value of η_e is positive, this implies that the estimated value of η_e is biased downward [since it equals $(\Delta s_{e\,t} - \Delta s_{c\,t})/(\Delta M_{e\,t} - \Delta M_{c\,t})$].

in the average IRA saving of the control group and a $250 increase in the average saving of the experimental group (because the control group largely consists of more highly motivated savers), then a $500 increase in the contribution limit for the control group (e.g., from $1500 to $2000) and a $2000 change in the contribution limit for the experimental group (e.g., from $0 to $2000) will have the same total effect on saving ($250).

Unfortunately, with the available data, it is impossible to test whether the control group is more or less predisposed to undertake long-term saving than the experimental group. However, the following is suggestive. Prior to 1982, only a tiny fraction of those eligible for IRAs actually made contributions. While these individuals had one characteristic that might be indicative of a predisposition for low saving (no employer pension), they were nevertheless a very highly selected subset of this population. The fact that they both discovered and took advantage of a little-known IRA provision suggests that they may have been exceptionally motivated to save for retirement. In contrast, since a much larger segment of the population contributed to IRAs after 1982, and since IRAs were more widely publicized, the experimental group may be less highly selected. If this is the case, then the differences-in-differences estimator understates the true effect on saving of an increase in the IRA limit. Of course, if the opposite proposition is true, then the differences-in-differences estimator overstates the effect[43].

As is well known, the differences-in-differences estimator may go awry for other reasons as well. One obvious possibility is that other changes in the economic environment may have affected the two groups differently. Since the changes in IRA eligibility were accompanied by other significant tax changes, as well as a variety of important macroeconomic developments (including large changes in inflation and interest rates, as well as business-cycle effects), attributing the difference-in-difference of saving exclusively to relative changes in IRA eligibility is dicey.

Finally, it is important to realize that, under some of the behavioral alternatives to the LCH, the procedure used by Joines–Manegold and Engen–Gale–Scholz would be incapable of detecting certain kinds of links between IRAs and personal saving. Suppose, for example, that the expansion of the IRA program stimulated saving by enhancing awareness of retirement issues, creating peer-group effects, and triggering aggressive promotion of investment vehicles (see the discussion of the evidence on psychological effects, immediately below). If these developments affected members of the control group and the experimental group equally, the differences-in-differences estimator would falsely indicate no increase in saving.

[43] Engen, Gale and Scholz (1994) replicate Joines and Manegold's procedure, but also estimate a fixed-effects model using the full sample, treating all non-contributors prior to 1982 as if they were ineligible. In effect, this enlarges the Joines–Manegold experimental group by adding households that were eligible prior to 1982, but that never contributed to an IRA. This increases the likelihood that members of the experimental group are, on average, less inclined to save than members of the control group, and is therefore more likely to build in a bias against the hypothesis that IRAs added to total saving.

4.1.5. Evidence of psychological effects

The theoretical arguments that lead one to doubt the efficacy of IRAs are largely predicated on the view that saving is a consequence of rational and deliberate life-cycle planning. It is therefore possible to shed light on the key issue by asking whether other aspects of individuals' responses to IRAs are consistent with the predictions of standard life-cycle theory. If they are not consistent, then one should be very cautious about drawing inferences concerning the efficacy of IRAs from anything but the most direct evidence.

The literature identifies a number of patterns in IRA contributions that appear to be anomalous from the perspective of the standard model. The following four are particularly provocative.

First, it is difficult to account for the explosion of IRAs after 1982 and the collapse of IRA contributions after 1986, unless one credits the role of visibility and promotion [Long (1990), Venti and Wise (1992)]. Recall that only 1 percent of taxpayers made contributions to IRAs prior to 1982, despite the fact that roughly half were eligible to contribute up to $1500. This figure rose to 15 percent by 1986. Recall also that many individuals remained eligible to make deductible IRA contributions after 1986 (those with sufficiently low AGIs, or without pension coverage); moreover, all other individuals could still make non-deductible contributions and benefit from tax-free accumulation. Yet the fraction of taxpayers contributing to IRAs dropped to 4 percent by 1990. IRA contributions may have followed promotional activity (which exploded after 1982 and contracted after 1986) much more closely than actual economic incentives[44].

Second, there has been a pronounced tendency for individuals to delay their IRA contributions until the end of a tax year [Summers (1986)]. This is puzzling because minimization of tax liabilities requires taxpayers to make these contributions as early as possible. To some extent, the tendency to delay contributions may result from the desire to maintain liquidity throughout the tax year [Engen, Gale and Scholz (1994)]. But, even allowing for the potential importance of liquidity, it is difficult to explain why more IRA contributors (particularly those with significant non-IRA assets) do not at least make a series of smaller contributions during the course of the tax year [Bernheim (1994b)].

Third, individuals are significantly more likely to make IRA contributions if they owe the IRS money at the end of the tax year. Feenberg and Skinner (1989) interpret

[44] Engen, Gale and Scholz (1994) argue that IRA contributions may have declined after 1986 because of reductions in marginal tax rates and limits on deductibility. But unless one believes that the interest elasticity of saving is enormous, this could not have accounted for the magnitude of the decline in contributions. They also attribute the decline in IRA saving to the increased availability of 401(k)s and/or the possible depletion of non-IRA financial assets. There is little evidence to support this claim, and it is doubtful that either phenomenon can account for the sharpness of the decline in IRA contributions.

this as an indication that, psychologically, individuals would rather write a check to an IRA account than write a somewhat smaller check to the IRS. It is conceivable that this result could reflect spurious correlations of both underwithholding and IRA contributions with third factors, such as income, tax filing status, or asset holdings [Gravelle (1991b)]. However, the pattern is apparent even when Feenberg and Skinner include plausible controls for these factors.

Fourth, there is evidence of "focal point" saving. Engen, Gale and Scholz (1994) find that, among those who could have contributed more than $2000 but who contributed less than the limit, 47 percent contributed exactly $2000. This finding invites the interpretation that the well-publicized, "officially endorsed" $2000 figure created a focal target for saving, and that the very existence of this target may have influenced the behavior of many less serious savers (such as those contributing less than the limit)[45].

4.2. 401(k)s

Congress originally authorized employers to establish 401(k) plans in 1978, but this option remained unpopular until after the Treasury issued clarifying regulations in 1981. In many ways, 401(k)s are similar to IRAs: contributions are tax-deductible up to specified limits, the returns to investments are accumulated tax free, and there are restrictions on early withdrawals. There are also a number of important differences. Contribution limits are significantly higher and bind much less frequently. Consequently, there is general agreement that 401(k)s increase the marginal after-tax rate of return for most eligible households. This effect is often reinforced through provisions whereby employers match employee contributions. From a behavioral perspective, higher contribution limits may provide authoritative validation for higher saving targets. Moreover, 401(k)s may be more conducive to the exercise of self-discipline because contributions occur through regular payroll deductions rather than through discretionary deposits. Finally, since 401(k)s are organized around the workplace, they may create positive spillovers between employees (e.g., through conversations among employees and other "peer-group" effects).

[45] One alternative explanation for this phenomenon concerns transactions costs. While single-earner married couples could contribute up to $2250 per year, contributions in excess of $2000 would have required them to open a second account. A contribution of $250 might seem insufficient to justify the effort. However, it is important to bear in mind that the one-time costs of opening the account must be weighed not against the benefits of a single $250 contribution, but rather against the benefits of a $250 contribution that recurs for many years. Moreover, even among those with a $4000 limit, 38 percent of those contributing less than the limit contributed exactly $2000. Others have argued that the focal-point saving phenomenon results from bargaining among spouses with conflicting objectives [Burman, Cordes and Ozanne (1990)]. Yet it is hard to see how this would emerge in a formal model of household bargaining, without the introduction of significant transactions costs.

From the perspective of econometric modeling, one of the most salient differences between IRAs and 401(k)s is that eligibility for 401(k)s is determined at the level of the employer. This has two implications. First, at all points in time there is substantial variation in 401(k) eligibility across households. Second, at least some of the variation in eligibility (and therefore in contributions) arises from sources that are plausibly exogenous to the individual. These considerations make it easier *in principle* to identify the effects of 401(k)s.

Studying 401(k)s *in practice* is made considerably more difficult by the relative scarcity of good data. For example, none of the available waves of the Survey of Consumer Finances contains a clean measure of 401(k) eligibility. Of the standard public-use data sources, only the SIPP contains good information on eligibility, participation, and asset balances for 401(k)s. Unfortunately, the SIPP does not provide longitudinal information that is useful for studying these plans. The literature has therefore treated the SIPP as a series of three cross-sections (1984, 1987, and 1991). An additional limitation of these data is that 401(k) plan balances are not available in 1984. Taken together, these limitations seriously handicap efforts to measure the behavioral effects of 401(k)s. Nevertheless, the literature has developed and explored several estimation strategies that attempt to finesse these limitations.

4.2.1. Exploiting exogenous variation in eligibility

Imagine for the moment that each firm's decision to offer a 401(k) is completely random. Then 401(k)s would provide the perfect experimental setting for studying the effects of saving incentives. Eligibility is certainly not random, since it is demonstrably correlated with a variety of individual characteristics (such as income). But as long as variation in 401(k) eligibility is orthogonal to the unobserved individual characteristics that determine saving, the experiment is still a clean one.

Poterba, Venti and Wise (1994, 1995) proceed from the assumption that 401(k) eligibility is exogenous to the process that determines saving. Using the 1987 and 1991 waves of the SIPP, they demonstrate that, controlling for other relevant factors, eligibility is significantly correlated with median financial wealth. Indeed, eligibility has very little effect on median non-401(k) financial wealth. They interpret this finding as an indication that virtually all 401(k) contributions represented new saving.

The central problem with this procedure is that 401(k) eligibility is probably not exogenous. On the contrary, there are several reasons to suspect that eligibility would be significantly correlated with the underlying predisposition to save [Bernheim (1994c), Engen, Gale and Scholz (1994)]. First, employees with tastes for saving probably tend to gravitate towards jobs that provide good pension coverage, including 401(k)s. Second, employers frequently install 401(k) plans as a direct response to expressions of employee interest [Buck Consultants (1989)].

Asset ownership patterns are consistent with the view that 401(k) eligibility is endogenous. Specifically, differences in median financial assets between eligibles and non-eligibles are often several times as large as 401(k) balances for eligibles

[Poterba, Venti and Wise (1994), Engen, Gale and Scholz (1994), Bernheim and Garrett (2002)][46]. Either 401(k)s crowd-in other forms of saving at the implausible rate of four or five to one, or eligibility is strongly correlated with the innate inclination to save.

As in the case of IRAs, one could attempt to control for differences in tastes by using initial wealth as a taste proxy in a model explaining flow saving [see Bernheim and Garrett (2002)]. Unfortunately, as discussed in Section 4.1.3, observed wealth varies for many reasons that are unrelated to underlying tastes for saving. Consequently, some correlation between 401(k) eligibility and unobserved tastes for saving may remain, even when one conditions on initial wealth. This continues to bias the coefficient of interest[47].

4.2.2. Exploiting transitional effects

A second approach to measuring the effects of 401(k)s does not require one to assume that eligibility is exogenous. Instead, this approach exploits the fact that the legislative authorization for 401(k)s was relatively recent. To understand this approach, first imagine two idealized worlds, one in which 401(k)s have always been available, and one in which 401(k)s have never been available. Suppose for simplicity that each economy has converged to a steady state with a stable cross-sectional age–wealth profile. This profile may well be higher for the world in which 401(k)s have always been available, but this does not necessarily indicate that 401(k)s stimulate saving, since there may be other differences (such as tastes) between the two worlds. Now imagine a world in which 401(k)s have never been available in the past (so that this economy has also converged to a steady-state cross-sectional age–wealth profile), but where they are established unexpectedly as of some point in time (without any change in tastes). At that point, each individual departs from his or her initial wealth trajectory, and begins to move along some new wealth trajectory. Eventually, the cross-sectional age–wealth profile will converge to a new steady state. But during the transition period,

[46] This may seem inconsistent with the earlier statement that eligibility bears little relation to median non-401(k) financial wealth. Both statements are nevertheless accurate. The apparent anomaly occurs because median financial assets do not equal the sum of median 401(k) assets and median non-401(k) financial assets.

[47] Once one conditions on initial wealth, the direction of the bias is no longer clear. This is because the partial correlation between 401(k) eligibility and tastes for saving may be either positive or negative. To understand how it could be negative, imagine two individuals who are the same in all observable respects (including initial wealth), except that one is eligible for a 401(k), while the other is not. Suppose for the moment that 401(k)s actually stimulate saving to some unknown extent. It is very likely (due to the presence of high serial correlation in eligibility) that the eligible individual was also eligible in past years. Thus, without eligibility, this individual's initial wealth would have been lower than that of the individual who is actually ineligible. Consequently, under identical conditions (including eligibility), the eligible individual would have accumulated less wealth than the ineligible individual. This suggests that the ineligible individual is more inclined to save (given the observation that initial wealth is the same). If so, then assuming that 401(k)s stimulate saving, the estimated coefficient of eligibility would be biased downward.

if 401(k)s stimulate saving, this profile should begin to shift upwards relative to the profile from any world in which eligibility is unchanged.

In the ideal implementation of this strategy, one would identify a large group of workers who became eligible for 401(k)s relatively soon after the enabling legislation (say before 1984) and who remained eligible in all subsequent years, as well as a large group of workers who never became eligible for 401(k)s. One would then follow these same individuals through time, estimating cross-sectional age–wealth profiles for each group in each year. The relative amplitudes of these profiles in any particular year would prove nothing, since eligibility may be related to preferences. However, as time passes, the number of years of accumulated eligibility for the first group increases. Therefore, the cross-sectional age–wealth profiles for the eligible group should shift upward relative to the profile of the ineligible group.

Unfortunately, as mentioned above, good panel data on 401(k)s are not available. Poterba, Venti and Wise (1995) therefore implement this strategy for a series of cross-sections (1984, 1987, 1991) obtained from the SIPP. In each year, they compare the accumulated financial assets of those who are eligible for 401(k)s and those who are not eligible. The data unmistakably show the predicted upward shift in relative financial assets held by those who are eligible for 401(k)s. Indeed, there is no noticeable decline in the relative level of non-401(k) financial assets held by this group. According to the authors, this finding supports the hypothesis that individuals funded 401(k) contributions through a combination of reduced taxes and spending, and not by diverting funds that they would have saved in any event.

Of course, Poterba, Venti and Wise depart from the ideal strategy by using an unrelated sequence of cross-sections. It is important to consider how this affects their results. If successive cross-sections of eligibles (and ineligibles) are simply random draws from the same population of eligibles (ineligibles), then there is no problem. A problem only arises if the average innate inclination to save among eligibles (or ineligibles) changes systematically through time.

Since new workers became eligible for 401(k)s over time, it is virtually certain that some compositional changes occurred between the successive surveys used by Poterba, Venti and Wise[48]. Moreover, these compositional changes are necessarily problematic[49]. Recall that this methodology is motivated by the observation that the average innate inclination to save differs between eligibles and ineligibles. But then

[48] As noted by Engen and Gale (1997), some eligible workers also became ineligible over time, and the effects of this migration were most likely opposite those noted in the text. However, the predominant flow during this period was into the eligible pool.

[49] One obvious implication is that, as one moves forward in time by, say, four years, the average length of exposure to 401(k)s within the eligible population increases by less than four years. One can imagine cases in which this could create problems. For example, if 401(k)s pass through a period of sufficiently rapid growth, the average length of eligibility among eligibles could actually decline. However, under more plausible assumptions, the effect would simply be to slow the observed *rate* at which the assets profile of the eligible population shifts relative to the profile of the ineligible population.

the movement of individuals from the ineligible population into the eligible population must, of necessity, change the average innate inclination to save among eligibles, ineligibles, or both.

The duration and magnitude of the resulting bias depends on the characteristics of newly eligible workers. These individuals are probably systematically different from those who have been eligible for longer periods. The most motivated "serious" savers probably sought out employers who offered 401(k)s, or encouraged their existing employers to provide 401(k)s, relatively soon after these plans became available. Less motivated, "occasional" savers were probably less likely to seek out or agitate for 401(k)s, and more likely to drift into these plans slowly through time. Thus, as time passes, the eligible population becomes increasingly skewed towards less motivated savers. Bernheim (1994b) refers to this as the "dilution" effect[50]. It is likely that the dilution effect became more severe after 1986, when more demanding non-discrimination requirements were established for private pensions. Since dilution creates a *downward* shift in the estimated cross-sectional age–wealth profile of eligible workers, it has the potential to partially offset, completely offset, or even reverse any upward shift due to the behavioral effect of 401(k)s.

Were this the only effect of dilution, the direction of the resulting bias would be clear. However, migration of workers from the ineligible population into the eligible population also changes the composition of the ineligibles. Though newly eligible workers are probably less serious savers on average than those who have been eligible for longer periods, they are probably more serious savers on average than those who remain ineligible. Thus, as time passes, the ineligible population may *also* become increasingly skewed towards less motivated savers. Since this leads to a downward shift in the estimated cross-sectional age–wealth profile of ineligibles, it has the potential to create the spurious appearance that the profile for eligibles has shifted upward relative to the profile for ineligibles.

[50] To determine whether dilution occurs in practice, one can examine changes through time in the relations between 401(k) eligibility and variables that provide stable proxies for underlying tastes. One plausible proxy for the predisposition to save is ownership of an IRA. It is doubtful that this taste proxy is stable for the period of universal IRA eligibility (prior to 1987), since dilution probably affected the set of IRA participants in the same way that it affected the set of 401(k) participants. However, dilution of the IRA population probably declined significantly once eligibility for IRAs was restricted since the frequency of new participation fell dramatically. It is therefore plausible that IRA ownership is a stable taste proxy for the 1987–1991 period. Notably, the fraction of individuals eligible for 401(k)s who owned IRAs declined significantly (relative to ineligibles) between 1987 and 1991. This is a good indication of the dilution effect. Engen and Gale (1997) note that 401(k) participation rates have risen over time, and they assert that this is evidence of reverse dilution. Given the overall increase in 401(k) eligibility, it is more likely that rising participation results from other factors, such as increased familiarity with 401(k)s or the intensification of employer efforts to encourage participation. Since there is also a certain amount of "stickiness" to 401(k) participation decisions, one would also naturally expect participation rates to ratchet upward over time even without any change in the eligible population.

The net effect of dilution is theoretically ambiguous. If newly eligible workers are typical of the eligible population, then there will be a spurious downward shift in the cross-sectional age–wealth profile of the ineligible population, and no spurious shift in the profile of the eligible population. In that case, the approach would overstate the effects of 401(k)s. If newly eligible workers are typical of the ineligible population, then there will be a spurious downward shift in the cross-sectional age–wealth profile of the eligible population, and no spurious shift in the profile of the ineligible population. In that case, the approach would understate the effects of 401(k)s.

Engen, Gale and Scholz (1994) use the same approach as Poterba, Venti and Wise, but restrict attention to selected subgroups of the eligible and ineligible populations. Specifically, they compare cross-sectional age–wealth profiles for 401(k) *contributors* to profiles for individuals with IRAs who are ineligible for 401(k)s. The purpose of this strategy is to homogenize the unobserved preferences of eligibles and ineligibles by focusing in each instance on "high savers". The authors find that the cross-sectional age–financial wealth profile of 401(k) contributors actually shifted downward between 1987 and 1991, whereas the profile for the selected ineligibles shifted upward. They interpret this as indicating that 401(k)s did not increase personal saving. It is important to realize, however, that this approach continues to suffer from the dilution problem because it does not eliminate unobserved variation in tastes for saving. By changing the selection criteria used to define the samples, the authors have probably altered the nature and extent of dilution for the eligible and ineligible groups. Bernheim (1994b) argues that these changes reverse the direction of the dilution effect for the ineligibles, and thereby create a bias against the finding that 401(k)s increase saving[51].

It is also important to emphasize that Poterba, Venti and Wise focus exclusively on financial assets. This is a potential limitation, since 401(k)s may displace other forms of wealth. To evaluate the importance of this limitation, Engen and Gale (1997) make similar calculations using a broader definition of wealth. Their results indicate that mortgages grew and home equity fell in successive cross-sections for the 401(k)-eligible population (both IRA participants and IRA non-participants), resulting in smaller overall wealth growth than for the control groups. They interpret this finding as an indication that 401(k) saving was offset almost completely by larger mortgages.

Bernheim (1997c) questions the plausibility of the Engen–Gale results by arguing that, if 401(k)s do displace other saving, they are more likely to reduce the accumulation of financial assets than to encourage greater borrowing against homes. Concerns about plausibility are compounded by problems with Engen and Gale's evidence. While the absolute decline in home equity was greater for the 401(k)-eligible population than for the ineligible population, the 401(k)-eligible group started out with more housing wealth; the percentage decline was essentially identical for the two

[51] The argument is that there may have been migration out of IRA accounts after eligibility was restricted in 1986, and that those retaining their IRA accounts were presumably the most serious savers. This would lead to a spurious upward shift in the estimated cross-sectional age–wealth profile for ineligibles.

groups. This suggests that the phenomenon may be attributed to unrelated third factors. Naturally, the Engen–Gale procedure continues to suffer from the problems associated with dilution[52]. In addition, the results for total wealth are extremely imprecise. Engen and Gale typically cannot rule out (at conventional levels of confidence) the possibility that 401(k)s contributed significantly to total wealth accumulation. This raises the possibility that their finding might not be robust. Using the same data, Poterba, Venti and Wise (1996b) conclude that the timing of changes in mortgage debt and net home equity over time is inconsistent with a causal relationship between 401(k) contributions and mortgage debt. These conflicting findings are not easily reconciled.

Engen and Gale also point out that the cross-sectional age–wealth profiles of 401(k)-eligible renters did not shift upward relative to those of ineligible renters between 1987 and 1991[53]. This suggests that Poterba, Venti and Wise's central result may not be robust when one focuses on the population segment for which non-financial wealth is relatively unimportant. While these findings are thought-provoking, their proper interpretation is unclear. Renters as a whole are a peculiar group in that they save practically nothing to begin with [US Congressional Budget Office (1993)]. Those who are eligible for 401(k)s do accumulate significant financial assets (though significantly less than comparable homeowners); however, the median net worth of renters who are not eligible for 401(k)s is near zero. These observations have two implications. First, the sample of eligible renters appears to be more highly selected than the sample of eligible homeowners. As a result, eligibility for 401(k)s may be more strongly related to underlying tastes among renters than among homeowners. Sample selection biases and the associated effects of dilution should therefore play out differently in the two samples. It would not be surprising if eligible renters, being more highly selected to begin with, were subject to greater dilution with the passage of time. Second, sample-selection issues aside, the absence of significant wealth among ineligible renters can potentially invalidate the methodology used to draw inferences about the effects of 401(k)s. If economic forces were tending to depress saving by renters during the relevant time period, then the absence of a downward shift in the age–wealth profile for eligible renters would indicate that 401(k)s stimulated saving by this group. In theory, the Engen–Gale procedure would detect this by noting a downward shift in the age–wealth profile for ineligible renters. However, in practice, liquidity constraints would have prevented this downward shift from occurring.

[52] Alert to this issue, they attempt to control for unobserved preferences by including a measure of IRA participation status. Poterba, Venti and Wise employ a similar approach in some of their work. Unfortunately, this does not solve the problem. The trend in the probability that the typical 401(k) worker owns an IRA is properly regarded as a symptom of dilution, rather than as the source of the underlying problem [Bernheim (1994b)]. It is highly unlikely that this single binary variable adequately controls for the full variation of preferences towards saving among eligibles and ineligibles.

[53] There is some evidence of an upward shift between 1984 and 1991, but Engen and Gale argue that the 1987–1991 comparison is more reliable due to data limitations affecting the 1984 survey.

4.2.3. *Exploiting variation in matching rates*

Employers frequently match employee contributions to 401(k) plans, and there are substantial differences across employers both in the matching rates and in the amounts matched. The economic rewards associated with 401(k) saving therefore vary considerably, even among eligible workers. In principle, one could attempt to assess the effects of economic incentives (including taxes) on saving by exploiting this variation.

To date, relatively few studies have attempted to relate 401(k)-plan provisions, such as employer matches, to the choices of employees. Moreover, the existing studies focus exclusively on 401(k) contributions. Even if 401(k) contributions respond strongly to employer matching provisions, it is conceivable that this could reflect asset shifting rather than new saving. Thus, a high elasticity of contributions with respect to the match rate would not necessarily establish that individuals save more when the returns to saving are more generous. If, however, contributions do not rise with the match rate, then it seems unlikely that total saving would respond to changes in the after-tax rate of return.

The evidence on the effect of 401(k) match rates is mixed. Using survey data gathered by the General Accounting Office, Poterba, Venti and Wise (1992) conclude that the existence of a match rate is correlated with higher participation, but that the level of the match has little effect. Papke, Petersen and Poterba (1993) survey a small sample of firms and corroborate this finding. Papke (1992) analyzes data drawn from IRS Form 5500 filings, and finds that the effect of higher match rates is positive at low match rates, but negative at high match rates. Her results are somewhat sensitive to the introduction of fixed effects. Andrews (1992) studies household-level data from the May 1988 Current Population Survey, and concludes that, while the existence of a match increases participation, there is actually a negative relation between the match rate and contributions. Kusko, Poterba and Wilcox (1998) analyze employee-level data for a single company, and find that contributions and participation are relatively insensitive to changes in the matching rate through time. Scott (1994) argues that most of the negative results on the effects of matching provisions are attributable to the use of *ex post* rather than *ex ante* match rates. Using the 1985–1989 Employee Benefit Surveys (for which *ex ante* match rates are available), he finds some evidence that the size of the match matters; however, even Scott's results indicate that most of the effect is attributable to the existence of the match, rather than to its magnitude.

The evidence on match rates is therefore somewhat puzzling. Within the context of the traditional life-cycle hypothesis, it is surprising (though conceivable) that employees would respond so differently to match rates of 0% and 5%, but behave almost identically with match rates of 5% and 100%. Naturally, these findings could be spurious if the existence of a match is positively correlated with the underlying preferences for saving among employees. This would occur if, for example, high-saving workers sort themselves into plans with matches, or demand that their employers provide matches. It is, however, hard to understand why the same considerations would not induce a correlation between contributions and the size of the match. There is also

some reason to believe that matching provisions are adopted as remedial measures to stimulate contributions in instances where employees are predisposed against saving [Bernheim and Garrett (2002)]. In that case, the available results would understate the impact of a match.

The evidence on matching provisions is potentially reconcilable with alternative behavioral hypotheses. The availability of a match may focus employee attention on the 401(k) plan, authoritatively validate the importance of long-term saving objectives, undermine the resistance of impatient selves (due to the immediacy of the match), and provide additional impetus for establishing a private rule. Conceivably, these effects could emerge discontinuously with the introduction of a match, irrespective of its size.

4.3. General evidence from the US experience

In Section 4.2.2, I discussed the manner in which transitional phenomena generated by the relative novelty of 401(k)s have been used to assess their effects. More generally, one could regard the 1980s as a grand experiment with several different types of tax-favored accounts, and ask whether these accounts had the effect of shifting up the age–wealth profiles of entire cohorts. To take an example, if tax incentives were effective, then the typical individual reaching age 65 in, say, 1991 should have had more wealth than the typical individual reaching retirement in, say, 1984 (due to differences in years of eligibility for tax-favored saving).

Venti and Wise (1993) examine this hypothesis. Their analysis, which primarily relies on the SIPP, documents a substantial upward shift in financial asset profiles[54]. More recent cohorts have greater wealth at the same ages as older cohorts, and the difference is roughly equal to accumulated balances in 401(k)s and IRAs. While these patterns are interesting, it is potentially misleading to ascribe all differences in saving between cohorts to tax incentives. The same pattern could emerge if, for example, younger cohorts are wealthier on a lifetime basis.

4.4. Evidence from countries other than the United States

Although the existing literature has focused primarily on IRAs and 401(k)s, tax-deferred and/or subsidized savings accounts are not unique to the United States. Other programs include Canadian registered retirement savings plans, or RRSPs [Burbidge and Davies (1994)], and registered home-ownership savings plans, or RHOSPs [Engelhardt (1996)], British tax-exempt special savings accounts, or TESSAs, and personal equity plans, or PEPs [Banks and Blundell (1994)], the German *Vermögensbildungsgesetz* and *Bausparkassen* incentive programs [Börsch-Supan (1994)], the Italian treatment of life-insurance policies [Jappelli and Pagano (1994)],

[54] Engen, Gale and Scholz (1996b) identify several problems with the underlying data, and argue that the upward shift may be overstated.

Japanese *Maruyu* accounts [Ito and Kitamura (1994)], and French individual-savings plans, or PEPs, building society savings accounts, or CELs, and building-society savings plans, or PELs [Fougère (1994)].

Unfortunately, there is relatively little evidence on the effectiveness of these policies. A few studies use techniques similar to those discussed in sections 4.1 and 4.2 to analyze some of these programs; Venti and Wise (1995b) and Milligan (1998) study RRSPs, while Engelhardt (1996) examines RHOSPs. Others have attempted to deduce the effects of saving incentives from cross-country comparisons.

Although the generosity of the incentives embodied in tax-favored savings accounts differs significantly across countries, one cannot reliably infer the saving effects of these programs from simple cross-country correlations or regressions. If, for example, the political process is more favorable to the adoption of saving incentives in countries where voters care more about saving, then rates of saving will tend to be correlated with saving incentives even if these incentives have no effect on behavior.

A somewhat more subtile approach to international comparisons exploits the fact that different countries implemented their tax incentives at different points in time. This allows one to examine whether the saving rates of different countries converged or diverged when incentives were introduced. In this spirit, Carroll and Summers (1987) compare historical rates of saving for Canada and the United States. They demonstrate that these rates diverged when Canada expanded its system of Registered Retirement Saving Plans (RRSPs) during the mid-1970s. While this pattern is interesting, an inference of causality requires a leap of faith, particularly since there are other possible explanations for the increase in Canadian saving during this period. Moreover, the adoption of tax incentives in the USA did not result in measurable convergence between the two countries. More recent studies cast doubt on the hypothesis that tax-incentive programs account for relative movements of saving rates in the USA and Canada [see Sabelhaus (1997) and Burbidge, Fretz and Veall (1998)].

5. Evidence on other links between taxation and saving

Even if the interest elasticity of saving is low and households do not alter their behavior very much as a direct consequence of targeted tax incentives for saving, it might still be possible to influence personal saving through tax policy. In Section 2.3.1, I mentioned that non-neutralities in the tax system may encourage various kinds of third-party activities that have the potential to affect the level of personal saving. Specifically, non-neutralities may encourage employers to adopt various kinds of pension plans or to substitute one kind of plan for another, and may influence the activities of employers in the context of these plans. The tax system may also create incentives for corporations to save, or for the vendors of tax-favored financial vehicles to market and otherwise promote their products. In this section, I briefly summarize the evidence on each of these possibilities.

5.1. The size and scope of the pension system

Since pensions provide a tax-favored mechanism for compensating employees, tax policy may have played an important role in stimulating the development of the pension system. To assess the ultimate impact on personal saving, one must answer two questions. First, to what extent is the size and scope of the pension system responsive to changes in tax rates? Second, to what degree does pension saving displace other forms of personal saving? I consider these questions in turn.

5.1.1. Incentives for pension saving

It is indisputable that there is a substantial tax incentive for pension formation. Ippolito (1986) estimates that the optimum exploitation of opportunities to defer compensation through pensions can reduce lifetime tax liabilities by 20 to 40 percent. However, this does not imply that the growth of the pension system is exclusively, or even primarily attributable to the tax system. Pensions may enhance the productivity of the work force in a variety of ways. They may bond the workforce against union activity, voluntary job turnover, or poor job performance[55]. Employers may use defined-benefit plans to induce a desired pattern of retirement[56]. Mandatory pensions may also provide an effective device for overcoming the problems with adverse selection that characterize the market for private annuities[57]. Thus, it is conceivable that an extensive private pension system would exist even in the absence of tax incentives.

A number of studies provide empirical evidence on the relative importance of tax and non-tax determinants of pension coverage[58]. The central methodological problem in this literature is to identify an appropriate source of variation in marginal tax rates from which one can reliably infer tax effects. Time-series variation is primarily associated with a handful of significant tax reforms, and it is difficult to separate tax effects from confounding events. Since pension coverage can affect marginal tax rates, cross-sectional variation is potentially endogenous. To treat this problem, one must identify valid instrumental variables that are related to cross-sectional differences in marginal tax rates, but unrelated to the process that determines pension coverage.

Reagan and Turner (1995) adopt this approach, relying chiefly on cross-sectional variation in state income tax rates to identify the tax effect [see also Gentry and Peress

[55] See e.g., Ippolito (1985, 1986), Parsons (1986, 1995), Williamson (1992) and Allen, Clark and McDermed (1993).

[56] See e.g., Burkhauser (1979, 1980), Lazear (1984), Fields and Mitchell (1984), Ippolito (1986), Lazear and Moore (1988), Kotlikoff and Wise (1989), Stock and Wise (1990) and Quinn, Burkhauser and Myers (1990).

[57] See Ippolito (1986). Kotlikoff and Spivak (1981) discuss the nature of market failure in private annuity markets.

[58] Pertinent references includes Ippolito (1986), Bloom and Freeman (1992), Reagan and Turner (1995), Kruse (1995), Allen and Clark (1987), Woodbury and Bettinger (1991), Woodbury and Huang (1993), Clark and McDermed (1990), Feldstein (1994), Gentry and Peress (1994) and Gustman and Steinmeier (1995).

(1994)]. Their results imply that a one-percentage-point increase in marginal tax rates leads to a 0.4-percentage-point increase in pension coverage rates. The validity of this estimate presupposes the exogeneity of the state-income-tax variables. Conceivably, variation in tax rates across states could be related to differences in average income (which could in turn be correlated with the household's permanent income), or with other factors such as occupation or industry. Reagan and Turner attempt to control for these factors when explaining pension coverage, but their measure of permanent income is based on limited information, and their controls for occupation and industry are coarse.

5.1.2. Do pensions crowd out other personal saving?

The extent to which pensions displace other forms of personal saving probably depends on the characteristics of the pension. For our purposes, it is important to distinguish between employer-controlled pensions that provide the employee with no choice concerning the level of participation, and participant-controlled plans (such as 401(k)s) that permit the employee to determine contributions. I have already discussed the existing evidence on the extent to which contributions to participant-controlled plans crowd out other personal saving (Section 4.2). In this section, I focus on employer-controlled plans.

The existing literature contains more than a dozen studies that attempt to measure the degree of substitutability between pensions and other saving. The usual approach is to estimate a cross-sectional relation between either saving or wealth and some measure of pension coverage. The two earliest studies on this topic [Cagan (1965) and Katona (1965)] conclude that pensions actually crowd *in* other forms of saving. Cagan rationalizes this finding by arguing that pensions induce workers to recognize the need for retirement planning; he suggests that individuals may intensify their efforts to provide adequately for retirement because a pension renders this objective more feasible. Several subsequent studies corroborate the Cagan–Katona finding [Schoeplein (1970), Green (1981), Venti and Wise (1993), Bernheim and Scholz (1993a)]. More commonly, investigators have found either no effect, or a small effect [Munnell (1974), Kotlikoff (1979), Blinder, Gordon and Wise (1980), King and Dicks-Mireaux (1982), Diamond and Hausman (1984), Hubbard (1986), Wolff (1988), Samwick (1995), Gustman and Steinmeier (1998)]. Only a few studies have found substantial rates of crowding out [Munnell (1976), Dicks-Mireaux and King (1984), Avery, Elliehausen and Gustafson (1986), Gale (1995)], and most of these provide ranges of estimates that include relatively small effects. There is also some evidence that the rate of displacement rises with education [Bernheim and Scholz (1993b), Gale (1995)].

While there are many methodological concerns that bear on the reliability (both absolutely and relatively) of these various studies, three issues stand out as particularly salient. The first concerns the possibility that pension coverage is correlated with underlying tastes for saving. In contrast to the literature on 401(k)s, no existing study

has come to grips with this issue. The direction of the resulting bias is ambiguous[59]. The second issue concerns the measurement of compensation. For the most part, the studies listed above control for income, rather than total compensation (which would include the accrual of pension wealth). If the creation of a pension typically entails a shift in the form of compensation rather than incremental compensation, then this practice does not yield the appropriate displacement rate. Bernheim and Scholz (1993a) and Gale (1995) propose different solutions to this problem, and obtain very different results. The final issue concerns the definition of wealth. Although one can point to a number of exceptions, there is some tendency (as in the 401(k) literature) to find higher rates of displacement when one uses a broader measure of wealth. The issues here are similar to those mentioned in Section 4.2.2.

While the extent of crowding out is therefore not a settled issue, one is hard pressed to find convincing support in any study for the hypothesis that the rate of displacement is dollar-for-dollar. Indeed, there appears to be a significant likelihood that the true offset is much smaller. The importance of this finding becomes obvious when one considers that, between 1980 and 1990, the real change in pension assets exceeded the real change in national wealth by a wide margin [Shoven (1991)]. Thus, the effect of tax incentives on saving through the stimulation (or retardation) of pensions may be substantial, even if the rate of displacement is relatively high. Using estimates from the available literature, Engen and Gale (1996b) calculate that, following the replacement of the current income tax with a consumption tax, the reduction in saving due to changes in pensions could substantially or completely offset any increase in non-pension saving.

5.2. Employer-controlled pensions vs. participant-controlled pensions

In evaluating the extent to which 401(k)s contribute to personal saving (Section 4.2), I have abstracted from the degree to which these plans substitute for other pensions. If the rate of substitution is low, then policies that stimulate 401(k)s will tend to increase saving if and only if 401(k) contributions are not fully offset by reductions in non-pension saving. In contrast, if the rate of substitution is high, then policies that stimulate 401(k)s may increase or decrease saving, depending upon whether 401(k) contributions displace non-pension saving at (respectively) a lower or higher rate than other kinds of pensions.

Much has been written about the magnitude and probable causes of the shift from defined-benefit to defined-contribution pension plans in general, and to 401(k)s in particular [see, e.g., Parsons (1995), or Papke, Petersen and Poterba (1993), for

[59] Highly motivated savers may self-select into jobs with pension plans. But it is also conceivable that the workers who are most inclined to save, and who have the least problems with self-discipline, sort themselves into jobs that are covered by pension plans with the greatest discretion, such as 401(k)s. Those who are interested in saving, but who have problems with self-discipline, may prefer traditional employer-controlled plans.

selective reviews of this literature]. The existence of this shift does not, however, establish that 401(k)s have substituted for more traditional plans, since aggregate trends could in principle be driven by changes in the composition and organization of economic activity.

Papke, Petersen and Poterba (1993) examine data on individual firms, and conclude that wholesale replacement of existing plans (particularly defined-benefit plans) occurs in a minority of cases. While informative, this evidence does not resolve the central issue, since 401(k)s may displace other pension plans even if they do not directly replace these plans. For example, firms that adopt 401(k)s as supplementary plans may be less inclined to increase, and more inclined to decrease, the generosity of other pension plans. The available evidence also indicates that changes in industrial composition and the structure of firms cannot fully account for the aggregate shift to defined-contribution plans [see Clark and McDermed (1990), Gustman and Steinmeier (1992) and Kruse (1995)]. Since the unexplained component of the aggregate shift is large, it is possible that 401(k)s have substituted for other pension plans to a significant degree.

5.3. Taxation and corporate saving

Taxation affects corporate saving through two channels. First, an increase in the corporate tax rate reduces after-tax earnings. Unless corporations adjust dividends or share repurchases, retained earnings must fall. Second, both personal and corporate taxes may affect payout policy. For example, when the dividend tax rate rises relative to the effective tax rate for capital gains, corporations may pay smaller dividends.

There is a substantial body of theoretical and empirical work examining the effects of taxation on corporate payout and retention decisions. A review of this literature is beyond the scope of the current chapter; the interested reader should consult Alan Auerbach's chapter (19) in this Handbook. In this section, I consider the following related question: is it possible to stimulate total private saving through policies that encourage greater corporate saving?

In principle, private saving may be unresponsive to policies that successfully motivate corporations to save more. The reason is that households own corporations. When a corporation decides to pay dividends instead of retaining earnings, sophisticated shareholders should understand that the corporation is saving less on their behalf, and each shareholder should increase personal saving by an offsetting amount to reestablish his or her optimal life-cycle allocation.

Greater corporate saving might add to private saving if shareholders were liquidity constrained. In practice, however, share ownership is concentrated among higher-income individuals who are likely to have ample liquidity. At a minimum, these individuals have the option to borrow against or to sell their securities. Alternatively, shareholders might be irrational or myopic. One version of this view holds that investors suffer from a "bird-in-the-hand" fallacy: they believe that capital gains are transitory, and that income is more secure once it is actually received. Another version

of this view emphasizes the role of mental accounting: since dividend checks are cash-in-hand, they may be more spendable than an equivalent capital gain. Ultimately, the degree of substitutability between corporate saving and personal saving is an empirical question.

Early econometric studies of this issue involved the estimation of aggregated reduced form consumption functions. According to Feldstein (1973), for the USA, the marginal propensity to consume out of retained earnings is roughly two-thirds as large as the marginal propensity to consume out of disposable income [Feldstein and Fane (1973), obtain similar results for the UK]. Feldstein concludes that changes in private saving imperfectly offset changes in corporate saving, at the rate of 67 cents on the dollar. There are, however, alternative interpretations of Feldstein's findings. If retained earnings and disposable income have different stochastic properties (e.g., if the shocks to disposable income are more permanent than the shocks to retained earnings), then their coefficients in a reduced-form consumption function will differ. However, this implies nothing about the effects of shifting a deterministic dollar (or, for that matter, an income stream with fixed stochastic properties) between dividends and retained earnings. Feldstein's reduced-form consumption function approach also suffers from a variety of standard problems, including the potential endogeneity and/or imperfect measurement of key variables.

Poterba (1987, 1991) improves upon Feldstein's regressions in several respects[60]. Most notably, he uses a variable measuring the tax burden on dividends relative to capital gains as an instrument to treat the endogeneity of retained earnings[61]. To some extent, this also addresses the problem of interpretation mentioned above, since it yields a direct estimate of the effect on consumption of dollars shifted between retentions and payouts. Poterba finds that consumption rises significantly in response to tax changes that disfavor corporate saving. Notably, most of this effect occurs in the form of durable consumption, which is arguably another form of saving.

Poterba also examines the response of consumption to involuntary realizations of capital gains resulting from cash takeover transactions. In the absence of myopia or irrationality, one would expect shareholders to reinvest all of these gains. Yet Poterba's aggregate reduced-form consumption function estimates imply that investors increase consumption by about 60 cents for each dollar realized in such transactions. Once again, this effect is particularly strong for durable goods. These results appear to be driven by a limited set of events: personal saving declined sharply during the 1980s while takeover activity exploded. Since there are many other explanations for the decline in saving, the correlation could be coincidental.

[60] In addition to instrumenting retained earnings, he makes some important adjustments to the underlying data, distinguishes between durable and non-durable consumption, and estimates specifications in both levels and differences.

[61] One can criticize this choice of an instrument on the grounds that both tax rates belong in the consumption function regression.

Auerbach and Hassett (1991) adopt a much different approach to this same set of issues: they estimate aggregate-consumption Euler equations, and investigate whether changes in consumption are related to predictable changes in different components of income. The advantage of this approach is that it removes the informational effects that accompany unexpected changes in income and contaminate estimates of the marginal propensity to consume. Disadvantages include the usual range of objections to aggregate consumption Euler equations (see Section 3.2). Like others, Auerbach and Hassett find that consumption is sensitive to predictable changes in labor income[62]. In contrast, predictable changes in dividends and other forms of capital income have no effect on consumption. This finding undermines several hypotheses under which consumption would be sensitive to the division of corporate earnings between retentions and payouts. For example, it is inconsistent with the view that shareholders are liquidity constrained or more likely to spend cash-in-hand. It does not, however, rule out the possibility that individuals irrationally capitalize otherwise equivalent income streams of dividends and retained earnings at different rates, since changes in consumption would then occur only in response to unexpected changes in payout policy.

5.4. Other activities undertaken by employers

Aside from encouraging employers to provide various kinds of pensions, tax policy may also induce employers to engage in other activities that have the potential to influence saving. In some instances, this effect is indirect: by stimulating pensions, tax policy may also encourage activities that are complementary to pensions. In other cases, subtle features of the tax code may directly affect the activity in question.

Employer-based investment and retirement education is an example of an activity that is complementary to the provision of a pension plan. Tax policies that stimulate pensions in general, and especially participant-controlled plans, may also stimulate complementary educational initiatives [see Bernheim and Garrett (2002), Bayer, Bernheim and Scholz (1996) and Employee Benefit Research Institute (1995)]. Subtle features of the tax code, such as non-discrimination requirements, may also encourage employer-based retirement education more directly [in addition to the preceding references, see Garrett (1995)]. Generally, the impact of education is not subsumed in estimates of the relation between pensions and saving, since most of the growth of these offerings post-dates the most commonly used sources of data on household financial behavior.

There are a number of reasons to expect that retirement education might have an important effect on household saving. Various studies document low levels of financial literacy among adult Americans. This phenomenon is accompanied by an apparently widespread failure to appreciate financial vulnerabilities [Bernheim (1995)]. Although

[62] This is sometimes interpreted as evidence of liquidity constraints for those receiving labor income.

there is little direct evidence on the impact of educational programs, some recent studies conclude that employer-based offerings significantly stimulate both voluntary pension contributions and total household saving [see Bernheim and Garrett (2002), and Bayer, Bernheim and Scholz (1996), Bernheim (1998), Clark and Schieber (1998)]. Since the availability of employer-based retirement education may be correlated with employees' preferences, these studies potentially suffer from the usual kinds of sample-selection problems. However, there is some evidence that employers adopt these programs as remedial measures when employees have low predispositions to save (as indicated, for example, by low participation and contribution rates prior to adoption). In that case, the available evidence would understate the effects of educational interventions.

5.5. Marketing and promotion of financial products

The expansion of IRA eligibility to all taxpayers in 1981 was accompanied by a great deal of media fanfare. Perhaps more importantly, the existence of these retirement-saving vehicles created profit opportunities for financial institutions. Although the IRA tax incentive was targeted at households, it generated considerable impetus for private firms to promote saving through a blend of education and marketing. Similar phenomena occur in the context of other tax-deferred savings instruments, such as long-term life-insurance policies and variable annuities.

It is natural to wonder whether these promotional activities affect personal saving. Unfortunately, there is virtually no direct evidence on this issue. There are, however, two particularly interesting anecdotes. One concerns the introduction and subsequent scaling-back of IRAs, which I have discussed in Section 4.1.5. The other concerns experience with saving promotion in Japan [Central Council for Savings Promotion (1981)]. After World War II the Japanese government launched a national campaign to promote saving. Promotional activities included the organization of monthly seminars that extolled the virtues of saving and provided workers with financial guidance, the sponsorship of children's banks, the appointment of private citizens as savings promotion leaders, and the extensive dissemination of literature. While the Japanese rate of saving rose precipitously over the relevant time period, other factors were also at work, including the existence of strong tax incentives for saving, as well as various aspects of post-War reconstruction. One can therefore only speculate about the extent to which the increase in saving was attributable to promotion.

6. Concluding comments

From the discussion in the preceding sections, it is readily apparent that questions concerning taxation and saving have stimulated an enormous amount of research since the publication of Sandmo's (1985) survey in the original *Handbook of Public Economics*. This research has led to significant theoretical advances in our

understanding of the positive and normative implications of taxing the returns to saving, and has produced important contributions to our empirical knowledge of household behavior. Still, the critical analysis contained in this chapter underscores the limitations and shortcomings of the extant literature.

As an economist, one cannot review the voluminous literature on taxation and saving without being somewhat humbled by the enormous difficulty of learning anything useful about even the most basic empirical questions. Having been handed two grand "experiments" with tax policy during the 1980s (IRAs and 401(k)s), it would seem that we ought to have learned more, and to have achieved greater consensus, than we have. In our defense, it can be said that we have done our best with the information at our disposal. As I have mentioned at various points in this chapter, it is often easy to identify the kinds of data that would have allowed us to answer the pressing policy questions with much greater confidence. Unfortunately, we have had to make do with data that is, at best, a caricature of the ideal.

During the next decade, there will undoubtably be new experiments, and new opportunities to learn something useful about taxation and saving. The introduction of Roth IRAs in January 1998 provides one such opportunity, and I would expect this to generate a flurry of research activity once pertinent data become available. However, the prospects for significant advances in empirical methodology will be severely limited unless researchers have access to higher-quality data. When one thinks of the budgetary costs of tax incentives, and of what is at stake in terms of economic growth and efficiency, it seems a shame that ongoing, comprehensive, microeconomic data collection has been such a low social priority.

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