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A reexamination of tax-deductible IRAs, Roth IRAs, and 401(k) investments

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Abstract

Choosing among various tax preferred investment vehicles for retirement planning requires individuals or financial planners to make assumptions about how potential tax savings are to be invested. This paper extends the work of previous studies that assume tax savings are invested in vehicles that are either tax-deferred or taxed each year as ordinary income. We assume tax savings are invested in a typical taxable mutual fund that contains implicit tax-deferral characteristics and find that the results are sensitive to these assumptions. We also extend the analysis to examine employer-sponsored 401(k) plans that match some or all of an employee's contributions and find that only modest employer contributions are necessary for 401(k)s to dominate Roth IRAs. © 2001 Elsevier Science Inc. All rights reserved.

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1. Introduction

The Tax Relief Act of 1997 (TRA) introduced the Roth IRA as a retirement investment option. Like the tax-deductible IRA, it allows investment returns to accrue free of tax. Unlike the tax-deductible IRA, it allows investors to withdraw funds tax-free. In other words, some of the Roth IRA tax benefit is back-end loaded whereas the tax-deductible IRA tax benefit is front-end loaded in that contributions are tax-deductible (Burman, Gale, & Weiner, 2001). The introduction of the Roth IRA sparked a wave of research to help investors and financial planners choose between different investment choices. Interestingly, researchers have arrived at different conclusions about the relative attractiveness of these

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two investment options. Research is silent with respect to the impact of recent tax law changes since the enactment of the Economic Growth and Tax Relief Reconciliation Act of 2001 (EGTRRA) which reduces marginal tax rates for all tax brackets, increases contribution limits for both IRAs and 401(k)s, and provides taxpayers 50 years of age and older with additional contribution options (Bunn, Whittenburg, & Venable, 2001).

The first purpose of this paper is to reexamine the optimal choice between a tax-deductible IRA and a Roth IRA, paying particular attention to assumptions about how tax savings from tax-deductible retirement options are invested and to tax law changes resulting from the EGTRRA. Prior research has made various assumptions about investment opportunities for the tax savings associated with a tax-deductible IRA. For example, Crain and Austin (1997) implicitly assume these tax savings are invested in another tax-deferred vehicle, and Krishnan and Lawrence (2001) assume the tax savings are invested in a fully taxable investment such that returns are taxed each year as ordinary income. The analysis in this paper assumes tax savings from the deductible IRA are invested in a mutual fund that has inherent tax-deferral and capital gains benefits. The results suggest that these assumptions are critical in choosing between different retirement investment options.

From a tax perspective, tax-deductible IRAs and employer sponsored 401(k) plans are quite similar. The second goal of this paper is to develop an analysis for the choice between contributing to a Roth IRA and a 401(k), especially when an employer provides some level of matching contributions. We demonstrate that only modest employer matching is necessary for 401(k) plans to dominate Roth IRAs even if an investor's contribution and withdrawal tax rates remain unchanged. The implication is that taxpayers should exercise caution in substituting Roth IRA contributions for employer-matched 401(k) investments.

The models and simulations presented in this paper provide investors and financial planners with guidance and tools that can be used to make the decision between investment options. The next section reviews some of the more recent literature that motivates and most directly relates to this study. Section 3 examines the IRA decision using a model that assumes tax savings from the deductible IRA are invested in a mutual fund. Section 4 examines the same decision using break-even withdrawal tax rates. Section 5 develops a model for deciding between a Roth IRA and a 401(k) plan with employer matching. Section 6 concludes and offers avenues for future research.

2. IRA literature and methodology

With few exceptions, most studies that examine the IRA investment decision use simulation analysis. Shortly after the introduction of the tax-deductible IRA, Burgess and Meddeo (1980), and O'Neil, Saftner, and Dillaway (1983) examined the effect of the 10% withdrawal penalty using simulation analysis to determine break-even points. They find that, except for short investment horizons, the tax benefits of the IRA outweigh the early withdrawal penalty. Yarri and Fabozzi (1985) find that the indifference point may be as short as 2 years.

More recently, the TRA motivated Crain and Austin (1997) to develop a mathematical model that analyzes the choice between taxable investments, deductible IRAs, nondeductible

IRAs and Roth IRAs. Making a distinction between ordinary income tax rates and capital gain tax rates, they build on the work of Randolf (1994) who examines similar issues with mutual funds that make periodic taxable distributions. Although Randolf makes no distinction between ordinary and capital gains tax rates, he demonstrates that mutual funds with high turnover and distributions (such as some aggressive growth funds) should be in IRAs, while mutual funds with low turnover and distributions (such as index funds) should be placed in taxable accounts when both tax-deferred and taxable savings accounts are used. Crain and Austin establish that, when investors expect to be in a lower (higher) tax bracket upon withdrawal than upon contribution, deductible IRAs accumulate more (less) than Roth IRAs. They also find that Roth IRAs accumulate more than nondeductible traditional IRAs.

Crain and Austin also solve for the proportion of return distributed as capital gain that makes investors indifferent between nondeductible IRA investments and taxable investments in the same mutual fund. They recognize that a trade-off exists between deferring a tax liability and accepting a lower capital gains tax sooner. Their analysis is limited to investors facing a 31% marginal tax rate throughout the investment horizon and upon withdrawal.

Horan, Peterson, and McLeod (1997) extend their analysis by developing a more robust model that allows investors to drop into lower tax brackets upon withdrawal of retirement assets. This approach is motivated by a Panel Study of Income Dynamics (PSID) as interpreted by Bernheim, Skinner, and Wienberg (1997) who show that, on average, retirement income is about 64% of pre-retirement income, suggesting that marginal tax rates for retirees are likely to fall over their investment horizon. Horan et al. (1997) find that declining withdrawal tax rates significantly increase the tax-deducible IRA's attractiveness.

Krishnan and Lawrence (2001) note that the aforementioned studies compare the different investment options holding the pre-tax investment constant. Implicitly, this approach is equivalent to standardizing the after-tax investment and assuming the tax savings from the deductible IRA are invested in another tax-deferred account, which seems unlikely in their estimation. Instead, they assume that tax savings are invested in a fully taxable investment, the returns from which are taxed each year as ordinary income, and find that the Roth IRA becomes significantly more attractive. This paper is an alternative approach and assumes tax savings are invested in a typical mutual fund that is taxed more aggressively than tax-deferred investments but less aggressively than fully taxable investments. The use of these tax savings significantly affects optimal taxpayer decisions.

3. Tax-deductible IRAs and Roth IRAs

A fundamental decision in modeling the choice between a tax-deductible IRA and a Roth IRA is choosing how the tax savings associated with the tax-deductible IRA will be invested. Crain and Austin (1997) implicitly assume these tax savings are invested in a tax-deferred account. Krishnan and Lawrence (2001) assume the tax savings are invested in a taxable account with returns taxed each year as ordinary income. This paper considers that investors may be likely to invest the tax savings in an investment vehicle (like a mutual fund) with an

annual return composed of three components—ordinary income, realized capital gains, and unrealized capital gains—all of which are taxed differently. The portion of mutual fund return composed of ordinary income is taxable to the investor annually at their marginal rate. The realized capital gain component of mutual fund returns is generally taxed at the capital gains rate of 20%, which is much lower than the rate on ordinary income for many investors. Finally, much of a mutual fund's return is often in the form of unrealized capital gains, which accrue tax-deferred until they are realized. Therefore, mutual funds have some tax advantages over fully taxable accounts in the form of lower capital gains tax rates and a significant tax-deferral component, but these advantages fall short of those in tax-deferred accounts.

To model the decision between investing in a tax-deductible IRA and a Roth IRA, we estimate that after-tax accumulation associated with each option assuming that tax savings associated with the tax-deductible IRA is invested in a mutual having three components of return, all of which are taxed differently. Each after-tax dollar invested in a Roth IRA accumulates tax-free and can be withdrawn tax-free. The after-tax accumulation after n years then is simply

$$\mathrm{FV}_{\mathrm{Roth}} = \$1(1+r)^n \tag{1}$$

where r is the pre-tax annual return on the investment. In comparing the accumulation in Eq. (1) to a comparable accumulation of an after-tax investment in a tax-deductible IRA, we assume the tax savings are invested in a mutual fund that distributes a portion of its annual earnings as ordinary income and realized capital gains that are typically taxed at 20%. The remainder of the return represents unrealized capital gains having a deferred tax liability. The accumulation of each after-tax dollar invested in a deductible IRA then is

$$\begin{aligned}\mathrm{FV}_{\mathrm{ded}} = {} & (1+r)^n(1-T_{\mathrm{n}}) + T_{\mathrm{o}}\Big\{(1+r-rp_{\mathrm{oi}}t_{\mathrm{oi}}-rp_{\mathrm{cg}}t_{\mathrm{cg}})^n \\ & - t_{\mathrm{cg}}\Big[((1+r-rp_{\mathrm{oi}}t_{\mathrm{oi}}-rp_{\mathrm{cg}}t_{\mathrm{cg}})^n - 1) \\ & - rp_{\mathrm{oi}}(1-t_{\mathrm{oi}})\frac{(1+r-rp_{\mathrm{oi}}t_{\mathrm{oi}}-rp_{\mathrm{cg}}t_{\mathrm{cg}})^n - 1}{r-rp_{\mathrm{oi}}t_{\mathrm{oi}}-rp_{\mathrm{cg}}t_{\mathrm{cg}}} \\ & - rp_{\mathrm{cg}}(1-t_{\mathrm{cg}})\frac{(1+r-rp_{\mathrm{oi}}t_{\mathrm{oi}}-rp_{\mathrm{cg}}t_{\mathrm{cg}})^n - 1}{r-rp_{\mathrm{oi}}t_{\mathrm{oi}}-rp_{\mathrm{cg}}t_{\mathrm{cg}}}\Big]\Big\}\end{aligned} \tag{2}$$

where T_{n} is the ordinary marginal tax rate on income upon withdrawal, t_{oi} the intermediate marginal tax rate on ordinary income over the term of the investment, t_{cg} the intermediate marginal tax rate on capital gains over the term of the investment, p_{oi} the percent of annual return distributed to shareholders as ordinary income, and p_{cg} is the percent of annual return distributed to shareholders as capital gains.

The first term of Eq. (2), $(1+r)^n(1-T_{\mathrm{n}})$, represents the after-tax accumulation for each before-tax dollar invested in a tax-deductible IRA. The large second term represents the after-tax accumulation of the invested tax savings assuming they are invested in a mutual fund. It has several components. T_{o} is the amount of tax savings for each dollar invested in the tax-deductible IRA. The first term inside the pointed brackets represents the after-tax

accumulation for each dollar invested in the mutual fund. The pre-tax return r is reduced by the taxes attributable to distributions of ordinary income and realized capital gains paid each year, resulting in an annual after-tax return, $(1 + r - rp_{oi}t_{oi} - rp_{cg}t_{cg})$. The second term inside the pointed brackets reduces this amount by the capital gains tax paid when mutual fund shares are sold at the time of withdrawal. The capital gain is the future market value of the IRA account, $(1 + r - rp_{oi}t_{oi} - rp_{cg}t_{cg})^n$, less the adjusted basis, which is increased by the amount of taxes that have been previously paid annually.

The mutual fund investment offers two tax advantages. First, a significant portion of earnings is typically unrealized capital gains that are not taxed until the fund sells the appreciated securities or until shareholders sell their fund shares. As a result, mutual funds have an inherent, albeit partial, tax-deferral feature. Second, the portion of earnings distributed as realized capital gains and typically taxed at 20%, which is usually substantially lower than the marginal tax rate on ordinary income. As a result, mutual funds have significant tax advantages over investments with returns taxed each year as ordinary income.

Table 1 presents the choice between the tax-deductible IRA and Roth IRA for different investment returns and time horizons when an investor's tax rate falls from an initial 31% upon investment to 28% upon withdrawal. Considering the effect of marginal tax rates

Table 1
Ratio of the future value of a Roth IRA divided by the future value of a tax-deductible IRA assuming (a) tax savings are invested in a typical growth mutual fund and taxed accordingly, and (b) the investor's initial tax bracket is 31% and withdrawal tax rate is 28%

r	Investment horizon (years) (n)							
	5	10	15	20	25	30	35	40
1	0.974	0.977	0.980	0.982	0.985	0.988	0.990	**0.993**
2	0.977	0.982	0.988	0.993	**0.998**	**1.002**	**1.007**	1.011
3	0.979	0.987	0.995	**1.002**	1.009	1.015	1.021	1.027
4	0.982	0.992	**1.002**	1.011	1.019	1.027	1.034	1.041
5	0.985	0.997	1.008	1.019	1.028	1.037	1.045	1.053
6	0.987	**1.001**	1.014	1.026	1.037	1.046	1.056	1.065
7	0.989	1.006	1.020	1.033	1.044	1.055	1.065	1.075
8	0.992	1.010	1.025	1.039	1.052	1.063	1.074	1.085
9	0.994	1.013	1.030	1.045	1.059	1.071	1.083	1.094
10	0.996	1.017	1.035	1.051	1.065	1.078	1.091	1.103
11	0.998	1.021	1.039	1.056	1.071	1.085	1.099	1.111
12	**1.000**	1.024	1.044	1.061	1.077	1.092	1.106	1.119
13	1.002	1.027	1.048	1.066	1.083	1.098	1.113	1.127
14	1.004	1.030	1.052	1.071	1.088	1.104	1.119	1.134
15	1.006	1.033	1.056	1.075	1.093	1.110	1.126	1.141
16	1.008	1.036	1.059	1.080	1.098	1.116	1.132	1.147
17	1.010	1.039	1.063	1.084	1.103	1.121	1.138	1.154
18	1.011	1.041	1.066	1.088	1.108	1.126	1.144	1.160
19	1.013	1.044	1.069	1.092	1.112	1.131	1.149	1.166
20	1.014	1.046	1.072	1.095	1.116	1.136	1.154	1.172

Bold figures indicate the approximate break-even point between the tax-deductible IRA and the Roth IRA.

falling between the time the contribution in made and the time withdrawals are taken is important because retirement income is, on average, 64% of pre-retirement income. Hence, retirees are likely to be in lower tax brackets. In addition, the EGTRRA lowers tax rates in all existing tax brackets by three percentage points by 2006 (Bunn et al., 2001). Therefore, even taxpayers remaining in the same tax bracket will have lower marginal tax rates by that time.

In constructing Table 1, the percent of annual return distributed as ordinary income and capital gain is determined by average distribution rates of growth funds reported by Crain and Austin (1997), i.e., $p_{oi} = 0.0699$ and $p_{cg} = 0.4423$. Results using average distributions for growth and income funds ($p_{oi} = 0.2046$ and $p_{cg} = 0.4536$) are available from the authors. They are qualitatively similar and do not affect our conclusions. It is important to note that even when IRA withdrawals commence in the near future, the investment horizon is not necessarily short. For example, suppose a 55-year-old investor starts making withdrawals at age 60. Suppose further that other assets are already in place such that withdrawals would begin at age 60, whether or not the considered investment was made. In this case, n is not equal to 5 years. Rather, n is equal to the time until the *marginal* IRA withdrawal is made. If marginal withdrawals (as a result of the investment made at age 55) begin at age 70, $n = 15$ years.

Table 1 displays the ratio of the Roth IRA accumulation to deductible IRA accumulation. Values greater than 1 indicate the Roth IRA is a better investment option, and values less than 1 indicates the tax-deductible IRA is more attractive. According to the results, the Roth IRA is a superior investment option as the investment horizon increases and as investment returns increase. The intuition for this result is that the tax liability associated with investing the tax savings increases as the return and investment horizon increase. For investment horizons as short as 5 years, however, a traditional IRA is more attractive.

Results change dramatically for investors who may drop from the 28% tax bracket to the 15% tax bracket upon withdrawal of retirement funds. Table 2 shows that when investors drop into the 15% tax bracket upon withdrawal from the 28% tax bracket when the investment is made, the tax-deductible IRA is almost always more attractive than the Roth IRA. Such a drastic drop in tax rates may seem extreme at first glance, but this situation is likely to apply to many investors. For example, in the 2001 tax year, the 15% tax rate applies to income up to $45,200 for married couples filing jointly. This seems to be a reasonable retirement income and corresponds to a $900,000 retirement savings fund, assuming a 5% draw. Although the Roth IRA becomes more advantageous for longer investment horizons and higher returns, it does not perform better than the tax-deductible IRA until both are extremely high.

4. Break-even withdrawal tax rates

We augment the analysis by solving for the break-even withdrawal tax rate that would make an investor indifferent between the tax-deductible IRA and the Roth IRA assuming the tax savings from the deductible IRA contribution are invested in a typical growth mutual fund. Setting Eqs. (1) and (2) equal to each other and solving for T_n, the break-even

Table 2
Ratio of the future value of a Roth IRA divided by the future value of a tax-deductible IRA assuming (a) tax savings are invested in a typical growth mutual fund and taxed accordingly, and (b) the investor's initial tax bracket is 28% and withdrawal tax rate is 15%

r	Investment horizon (years) (n)							
	5	10	15	20	25	30	35	40
1%	0.887	0.889	0.891	0.894	0.896	0.897	0.899	0.901
2%	0.889	0.893	0.897	0.901	0.905	0.908	0.912	0.915
3%	0.891	0.897	0.903	0.908	0.913	0.918	0.922	0.927
4%	0.893	0.901	0.908	0.915	0.921	0.926	0.932	0.937
5%	0.895	0.904	0.913	0.920	0.927	0.934	0.940	0.946
6%	0.897	0.908	0.917	0.926	0.934	0.941	0.948	0.954
7%	0.899	0.911	0.921	0.931	0.939	0.947	0.955	0.962
8%	0.901	0.914	0.925	0.936	0.945	0.953	0.961	0.969
9%	0.902	0.917	0.929	0.940	0.950	0.959	0.967	0.975
10%	0.904	0.919	0.932	0.944	0.954	0.964	0.973	0.982
11%	0.905	0.922	0.936	0.948	0.959	0.969	0.979	0.988
12%	0.907	0.924	0.939	0.952	0.963	0.974	0.984	0.993
13%	0.908	0.927	0.942	0.955	0.967	0.978	0.989	**0.999**
14%	0.910	0.929	0.945	0.959	0.971	0.983	0.993	1.004
15%	0.911	0.931	0.948	0.962	0.975	0.987	0.998	1.009
16%	0.912	0.933	0.950	0.965	0.978	0.991	**1.002**	1.013
17%	0.914	0.935	0.953	0.968	0.982	0.995	1.007	1.018
18%	0.915	0.937	0.955	0.971	0.985	0.998	1.011	1.022
19%	0.916	0.939	0.958	0.974	0.988	**1.002**	1.015	1.026
20%	0.917	0.941	0.960	0.976	0.991	1.005	1.018	1.030

Bold figures indicate the approximate break-even point between the tax-deductible IRA and the Roth IRA.

withdrawal tax rate, we find that

$$T_{\mathrm{n}} = T_{\mathrm{o}} \frac{\begin{aligned}&(1 + r - rp_{\mathrm{oi}}t_{\mathrm{oi}} - rp_{\mathrm{cg}}t_{\mathrm{cg}})^n - t_{\mathrm{cg}}\{[(1 + r - rp_{\mathrm{oi}}t_{\mathrm{oi}} - rp_{\mathrm{cg}}t_{\mathrm{cg}})^n - 1]\\ &- rp_{\mathrm{oi}}(1 - t_{\mathrm{oi}})[(1 + r - rp_{\mathrm{oi}}t_{\mathrm{oi}} - rp_{\mathrm{cg}}t_{\mathrm{cg}})^n - 1]/(r - rp_{\mathrm{oi}}t_{\mathrm{oi}} - rp_{\mathrm{cg}}t_{\mathrm{cg}})\\ &- rp_{\mathrm{cg}}(1 - t_{\mathrm{cg}})[(1 + r - rp_{\mathrm{oi}}t_{\mathrm{oi}} - rp_{\mathrm{cg}}t_{\mathrm{cg}})^n - 1]/(r - rp_{\mathrm{oi}}t_{\mathrm{oi}} - rp_{\mathrm{cg}}t_{\mathrm{cg}})]\}\end{aligned}}{(1 + k)^n} \tag{3}$$

Table 3 displays the break-even tax rates assuming the tax savings are invested in a typical growth mutual fund where $p_{\mathrm{oi}} = 0.0699$ and $p_{\mathrm{cg}} = 0.4423$. Again, results using average distributions for growth and income funds ($p_{\mathrm{oi}} = 0.2046$ and $p_{\mathrm{cg}} = 0.4536$) are qualitatively similar and do not affect our conclusions. If the withdrawal tax rate is lower than this break-even rate, the tax-deductible IRA provides a larger accumulation than the Roth IRA. Panel A reports results for investors in the 15% tax bracket when the contribution is made. This panel also assumes that an investor's tax bracket will immediately increase to 28% the following year, an assumption that dramatically favors the Roth IRA. This scenario is not uncommon, however, for young wage earners in the beginning of their professional careers. For example, an investor with a 20-year investment horizon and 12% annual return is better off with a Roth IRA unless his/her tax rate upon withdrawal is 10.8% or less.

Table 3
Break-even withdrawal tax rates for tax-deductible IRAs and Roth IRAs assuming tax savings are invested in a typical growth mutual fund and taxed accordingly

Investment horizon (years)	Annual pre-tax investment return			
	6%	8%	10%	12%
Panel A: 15% initial tax rate and 28% intermediate tax rate				
5	14.2%	13.9%	13.7%	13.5%
10	13.5%	13.1%	12.7%	12.4%
15	12.9%	12.4%	11.9%	11.5%
20	12.3%	11.7%	11.2%	10.8%
25	11.8%	11.2%	10.6%	10.1%
30	11.4%	10.7%	10.0%	9.5%
35	11.0%	10.2%	9.5%	8.9%
40	10.6%	9.8%	9.0%	8.4%
Panel B: 28% initial tax rate and 28% intermediate tax rate				
5	26.5%	26.0%	25.6%	25.3%
10	25.2%	24.4%	23.8%	23.2%
15	24.0%	23.1%	22.2%	21.5%
20	23.0%	21.9%	20.9%	20.1%
25	22.1%	20.8%	19.8%	18.8%
30	21.3%	19.9%	18.7%	17.7%
35	20.5%	19.0%	17.8%	16.6%
40	19.8%	18.2%	16.9%	15.7%
Panel C: 31% initial tax rate and 31% intermediate tax rate				
5	29.3%	28.8%	28.4%	27.9%
10	27.8%	27.0%	26.3%	25.6%
15	26.5%	25.5%	24.5%	23.7%
20	25.4%	24.2%	23.1%	22.1%
25	24.4%	23.0%	21.8%	20.7%
30	23.5%	21.9%	20.6%	19.4%
35	22.6%	21.0%	19.5%	18.3%
40	21.8%	20.0%	18.5%	17.2%

Results for the more common investor in the 28 and 31% tax brackets are reported in Panels B and C, respectively. The break-even withdrawal tax rate for a 28% tax bracket investor with a 20-year investment horizon and a 12% annual return is substantially higher at 20.1%. For investors with a 40-year time horizon and a 12% return, the break-even withdrawal tax rate is 15.7%. The results in Panel C are similar for investors in the 31% tax bracket. The break-even withdrawal tax rate for our 20-year investor with a 12% return is 22.1%. If one assumes tax savings are invested in a fully taxed investment, break-even withdrawal tax rates fall by five to nine percentage points (see, e.g., Krishnan & Lawrence, 2001). This result suggests that tax-deductible IRAs are significantly more attractive to taxpayers that invest tax savings in a typical mutual fund rather than a fully taxed investment.

Since the EGTRRA decreases tax rates on all tax brackets by three percentage points over 5 years, a traditional IRA can be superior even for investors that remain in the same tax bracket. For example, the marginal rate in the 28% tax bracket for 2001 will be 25% in 2006.

The new 25% tax rate is below the 5-year time horizon break-even withdrawal tax rates in Panel B, indicating that a tax-deductible IRA is better than a Roth IRA for these investors. Similarly, marginal rates in the 31% tax bracket will drop to 28%, which is below the 5-year break-even withdrawal tax rates in Panel C. As a result, taxpayers should recognize that tax-deductible IRAs become increasingly attractive in the decreasing tax rate environment created by EGTRRA.

The EGTRRA also increases contribution limits for IRAs from $2,000 in 2001 to $5,000 in 2006 (Bunn et al., 2001). Although this tax law change does not affect the choice between tax-deductible IRAs and Roth IRAs directly, it has an indirect effect because it increases the economic importance of the decision. The significance is even greater for taxpayers of age 50 and older as the new tax law increases contribution limits for them by an additional $500.

5. 401(k) Plans with employer matching contributions

Since tax-deductible IRAs and 401(k) plans are treated similarly for tax purposes, choosing between these two options is generally straightforward. The 401(k) is preferred over the tax-deductible IRA as along as the employer matches any of the employee contributions. The decision is more complex, however, when an employee is choosing between an employer-matched 401(k) and a Roth IRA. Like the foregoing discussion, analyzing the choice between an employer-matched 401(k) and a Roth IRA requires an assumption about how tax savings are invested. If tax savings are invested into the 401(k) whereby the individual investor simply increases their 401(k) contribution in anticipation of a reduced tax liability, the decision can be modeled using a modified Crain and Austin (1997) analysis. The future accumulation of the employer-matched 401(k) is simply the future value of the tax-deductible IRA grossed up by the matching percentage. In this case, the 401(k) will be preferred with any amount of employer matching. Re-investing expected tax saving into the 401(k) may be reasonable since contribution limits for 401(k)s are much higher than contribution limits to IRAs. Furthermore, the EGTRRA increases the 401(k) contribution limit from $10,500 in 2001 to $15,000 by 2006 (Bunn et al., 2001).

If one alternatively assumes that expected 401(k) contribution tax savings are invested in a taxable mutual fund, the analysis is less clear and a modification of Eq. (2) is appropriate. For example, the after-tax accumulation of a one dollar 401(k) investment in which the employer matches π of the employee's investment and the tax savings are invested in a mutual fund is

$$\begin{aligned} FV_{401(k)} = (1+\pi)(1+r)^n(1-T_n) + T_o\Bigg\{ & (1+r-rp_{oi}t_{oi}-rp_{cg}t_{cg})^n \\ & - t_{cg}\Bigg[((1+r-rp_{oi}t_{oi}-rp_{cg}t_{cg})^n - 1) \\ & - rp_{oi}(1-t_{oi})\frac{(1+r-rp_{oi}t_{oi}-rp_{cg}t_{cg})^n - 1}{r-rp_{oi}t_{oi}-rp_{cg}t_{cg}} \\ & - rp_{cg}(1-t_{cg})\frac{(1+r-rp_{oi}t_{oi}-rp_{cg}t_{cg})^n - 1}{r-rp_{oi}t_{oi}-rp_{cg}t_{cg}}\Bigg]\Bigg\} \end{aligned} \tag{4}$$

Table 4
Ratio of the future value of a Roth IRA divided by the future value of a 401(k) with various levels of employer matching assuming (a) tax savings are invested in a typical growth mutual fund and taxed accordingly, and (b) the investor's initial tax bracket is 31% and withdrawal tax rate is 28%

π	Investment horizon (years) (n)							
	5	10	15	20	25	30	35	40
5%	0.966	0.987	**1.006**	**1.022**	1.037	1.051	1.063	1.076
10%	0.933	0.954	0.971	0.986	**1.000**	**1.012**	1.024	1.036
15%	0.903	0.922	0.938	0.952	0.965	0.977	**0.988**	**0.998**
20%	0.874	0.892	0.907	0.921	0.933	0.944	0.954	0.964
25%	0.848	0.865	0.879	0.891	0.902	0.913	0.922	0.931
30%	0.823	0.838	0.852	0.863	0.874	0.884	0.893	0.901
35%	0.799	0.814	0.826	0.837	0.847	0.856	0.865	0.873
40%	0.777	0.791	0.803	0.813	0.822	0.831	0.839	0.846
45%	0.755	0.769	0.780	0.790	0.798	0.807	0.814	0.821
50%	0.735	0.748	0.759	0.768	0.776	0.784	0.791	0.798
55%	0.716	0.729	0.739	0.747	0.755	0.762	0.769	0.775
60%	0.698	0.710	0.719	0.728	0.735	0.742	0.748	0.754
65%	0.681	0.692	0.701	0.709	0.716	0.723	0.729	0.734
70%	0.665	0.675	0.684	0.691	0.698	0.704	0.710	0.715
75%	0.649	0.659	0.668	0.675	0.681	0.687	0.692	0.698
80%	0.635	0.644	0.652	0.659	0.665	0.670	0.676	0.680
85%	0.620	0.629	0.637	0.643	0.649	0.655	0.659	0.664
90%	0.607	0.616	0.623	0.629	0.634	0.639	0.644	0.649
95%	0.594	0.602	0.609	0.615	0.620	0.625	0.630	0.634
100%	0.581	0.589	0.596	0.602	0.607	0.611	0.616	0.620

Bold figures indicate the approximate break-even point between the 401(k) and the Roth IRA.

Taking the ratio of values in Eq. (1) to those in Eq. (4), we can examine the relative accumulations of a Roth IRA investment and a 401(k) investment. Table 4 reports this ratio for investors that drop from the 31% tax bracket when the contribution is made to the 28% tax bracket upon withdrawal. Using the approximate historical return for large capitalization stocks of 12% and assuming tax savings are invested in a typical growth mutual fund, Table 4 suggests that only very modest employer matching is necessary to make the 401(k) more attractive than the Roth IRA. Only when employer contributions are very low and the investment horizon very long does the Roth IRA dominate.

It is obvious why the Roth IRA becomes less attractive as employer matching increases. But why the Roth IRA becomes more attractive for long investment horizons is less transparent. The reason is that the invested tax savings from the 401(k) do not grow as quickly as the Roth IRA investment and this effect is amplified for long investment horizons. Simulations using a more modest 10% return are qualitatively identical. Although the results are not reported here in the form of a table, investors dropping from the 28% tax bracket upon contribution to the 15% upon withdrawal are always better off with a 401(k) for any investment horizon and for employer matching as low as 5%.

Table 5 reports results for investors who remain in the 28% tax bracket for the entire investment horizon, that is, from contribution to withdrawal. The results are quite

Table 5
Ratio of the future value of a Roth IRA divided by the future value of a 401(k) with various levels of employer matching assuming (a) tax savings are invested in a typical growth mutual fund and taxed accordingly, and (b) the investor's initial tax bracket is 28% and withdrawal tax rate is 28%

π	Investment horizon (years) (n)							
	5	10	15	20	25	30	35	40
5%	0.991	1.012	1.030	1.045	1.059	1.072	1.084	1.095
10%	0.957	0.977	**0.993**	**1.007**	**1.020**	1.032	1.043	1.054
15%	0.925	0.944	0.959	0.972	0.984	**0.995**	**1.006**	**1.015**
20%	0.896	0.913	0.927	0.939	0.950	0.961	0.970	0.980
25%	0.868	0.884	0.897	0.908	0.919	0.929	0.938	0.946
30%	0.841	0.856	0.869	0.880	0.890	0.899	0.907	0.915
35%	0.817	0.831	0.842	0.853	0.862	0.870	0.878	0.886
40%	0.793	0.807	0.818	0.827	0.836	0.844	0.851	0.858
45%	0.771	0.784	0.794	0.803	0.812	0.819	0.826	0.833
50%	0.750	0.762	0.772	0.781	0.789	0.796	0.802	0.808
55%	0.731	0.742	0.751	0.759	0.767	0.773	0.780	0.786
60%	0.712	0.723	0.732	0.739	0.746	0.753	0.758	0.764
65%	0.694	0.704	0.713	0.720	0.727	0.733	0.738	0.744
70%	0.677	0.687	0.695	0.702	0.708	0.714	0.719	0.724
75%	0.661	0.670	0.678	0.685	0.691	0.696	0.701	0.706
80%	0.646	0.655	0.662	0.668	0.674	0.679	0.684	0.688
85%	0.631	0.639	0.646	0.652	0.658	0.663	0.667	0.672
90%	0.617	0.625	0.632	0.637	0.643	0.647	0.652	0.656
95%	0.604	0.611	0.618	0.623	0.628	0.633	0.637	0.641
100%	0.591	0.598	0.604	0.609	0.614	0.618	0.622	0.626

Bold figures indicate the approximate break-even point between the 401(k) and the Roth IRA.

similar to those in Table 4. Investors are only better off with the Roth IRA if the employer contribution is very low and the investment horizon very long. In sum, the models developed in the previous two sections for choosing between tax-deductible IRAs and Roth IRA do not generalize well when considering employer subsidized 401(k) investments.

We report the break-even tax rate between the 401(k) and Roth IRA investment as well. Setting Eq. (4) equal to Eq. (1) and solving for T_n, we find that the break-even withdrawal tax rate can be expressed as

$$
\begin{aligned}
T_n = \Bigg\{ & \frac{T_o}{(1+k)^n} \Bigg[(1 + r - rp_{oi}t_{oi} - rp_{cg}t_{cg})^n \\
& - t_{cg} \Bigg([(1 + r - rp_{oi}t_{oi} - rp_{cg}t_{cg})^n - 1] \\
& - rp_{oi}(1 - t_{oi}) \frac{(1 + r - rp_{oi}t_{oi} - rp_{cg}t_{cg})^n - 1}{r - rp_{oi}t_{oi} - rp_{cg}t_{cg}} \\
& - rp_{cg}(1 - t_{cg}) \frac{(1 + r - rp_{oi}t_{oi} - rp_{cg}t_{cg})^n - 1}{r - rp_{oi}t_{oi} - rp_{cg}t_{cg}} \Bigg) \Bigg] - 1 \Bigg\} \frac{1}{1 + \pi} + 1
\end{aligned}
\tag{5}
$$

Table 6
Break-even withdrawal tax rates for 401(k) with a 20% employer contribution and Roth IRAs assuming tax savings are invested in a typical growth mutual fund and taxed accordingly

Investment horizon (years)	Annual pre-tax investment return			
	6%	8%	10%	12%
Panel A: 15% initial tax rate and 28% intermediate tax rate				
5	28.5%	28.3%	28.1%	27.9%
10	27.9%	27.6%	27.3%	27.0%
15	27.4%	27.0%	26.6%	26.3%
20	26.9%	26.4%	26.0%	25.6%
25	26.5%	26.0%	25.5%	25.1%
30	26.2%	25.6%	25.0%	24.6%
35	25.8%	25.2%	24.6%	24.1%
40	25.5%	24.8%	24.2%	23.7%
Panel B: 28% initial tax rate and 28% intermediate tax rate				
5	38.7%	38.4%	38.0%	37.7%
10	37.6%	37.0%	36.5%	36.0%
15	36.7%	35.9%	35.2%	34.6%
20	35.8%	34.9%	34.1%	33.4%
25	35.1%	34.0%	33.1%	32.4%
30	34.4%	33.3%	32.3%	31.4%
35	33.8%	32.5%	31.5%	30.5%
40	33.2%	31.9%	30.7%	29.7%
Panel C: 31% initial tax rate and 31% intermediate tax rate				
5	41.1%	40.7%	40.3%	39.9%
10	39.9%	39.2%	38.6%	38.0%
15	38.8%	37.9%	37.1%	36.4%
20	37.8%	36.8%	35.9%	35.1%
25	37.0%	35.8%	34.8%	33.9%
30	36.2%	34.9%	33.8%	32.9%
35	35.5%	34.1%	32.9%	31.9%
40	34.9%	33.4%	32.1%	31.0%

Table 6 reports break-even tax rates between a 401(k) plan with a modest 20% employer contribution and a Roth IRA for different returns and investment horizons. The usual assumptions for the tax savings hold. If the withdrawal tax rate is lower than this break-even rate, the tax-deductible account provides a larger accumulation than the Roth IRA. Panel A displays the results for young investors who are currently in the 15% tax bracket, but will quickly enter the 28% tax bracket. The break-even withdrawal tax rates are quite high—about twice as large as those reported in Table 3. Panels B and C indicate that, regardless of the initial tax bracket, break-even withdrawal tax rates are generally higher than the taxpayers current tax rate.

Again, employer contributions have a significant impact for investors choosing between a 401(k) investment and a Roth IRA. Investors should therefore refrain from making Roth IRA contributions in lieu of employer-matched 401(k) contributions. Obviously, many other scenarios are possible. The purpose of this paper, however, is not to report simulations that

exhaust all possibilities. Instead, we offer expository simulations and, more importantly, models that investors and financial planners can use and modify for their special circumstances.

6. Conclusion

Developing models that help investors choose among investment options with different tax benefits requires assumptions about investment returns for tax savings associated with tax-deductible investment alternatives. This paper develops models that assume that tax savings are invested in taxable mutual funds that have implicit tax-deferral features and accommodate changing tax brackets over the life of the investment. The results indicate that, compared to Roth IRAs, tax-deductible IRAs are more attractive when tax savings are invested in mutual funds instead of investments that are taxed as ordinary income each year. Specifically, the tax-deductible IRA is almost always better than the Roth IRA for investors in the 28% tax bracket who drop to the 15% tax bracket when the funds are withdrawn. We also demonstrate that break-even withdrawal tax rates (which make investors indifferent between the two investment choices) are about five to nine percentage points higher than models that assume tax savings are invested in a fully taxed vehicle, indicating that the optimal choice is sensitive to the assumption about investing tax savings. As a result, tax-deductible IRAs are significantly more attractive to taxpayers that invest tax savings in a typical mutual fund rather than a fully taxed investment.

Since investors must often choose between investing in a Roth IRA or an employer-sponsored 401(k), we analyze this choice as well, allowing for the possibility of employers making matching contributions. We find that the 401(k) becomes more attractive than the Roth IRA with only very modest employer contributions. In fact, 401(k)s with any employer matching are always superior to Roth IRAs if the tax savings are re-invested in the 401(k) itself, which is quite likely since contribution limits for 401(k)s typically exceed the $2,000 contribution limit for Roth IRAs. We find that break-even withdrawal tax rates between Roth IRAs and 401(k)s with only modest employer matching are quite high, indicating that investors should not forego employer subsidized 401(k)s to invest in Roth IRAs.

The EGTRRA of 2001 will phase in increased contribution limits for IRAs and 401(k)s. Taxpayers of age 50 years and older are allowed to make additional contributions. Although contribution limit increases do not directly affect the choice between different retirement options, they do increase the economic importance of the decision. In addition, the EGTRRA reduces the marginal tax rates in all tax brackets by three percentage points. Our analysis indicates that even this modest decrease in marginal tax rates is sufficient to make tax-deductible IRAs optimal for investors with short time horizons who remain in the same tax bracket.

These results should be interpreted with two caveats. First, an investor's investment horizon is often deceptively long. It is equal to the length of time for the marginal withdrawal upon retirement, not necessary the first withdrawal. Second, this paper compares after-tax accumulations of different investment options and hence does not consider the added flexibility of the Roth IRA. For example, Roth IRAs permit investors to withdrawal

funds early without penalty under certain circumstances, which increases the attractiveness of the Roth IRA. Valuing this flexibility is difficult, but presents a fruitful avenue for future research. Nonetheless, comparing after-tax accumulations remains an important element for choosing between different investment options and is sensitive to implicit assumptions about how tax savings from tax-deductible alternatives are invested.

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References

Bunn, R., Whittenburg, G. E., & Venable, C. F. (2001). Analysis of the Economic Growth and Tax Relief Reconciliation Act of 2001. *National Public Accountant*, *26*(8), 8–12.

Burman, L. E., Gale, W. G., & Weiner, D. (2001). The taxation of retirement saving: Choosing between front-loaded and back-loaded options. *National Tax Journal*, *54*(3), 689–702.

Bernheim, B. D., Skinner, J. S., & Wienberg S. (1997). *What accounts for the variation in retirement wealth among U.S. households*? Mimeo, Stanford University.

Burgess, R. D., & Maddeo, S. A. (1980). A simulation study of tax sheltered retirement plans. *Journal of the American Taxation Association*, *1*, 34–41.

Crain, T. L., & Austin, J. R. (1997). An analysis of the trade-off between tax-deferred earnings in IRAs and Preferential Capital Gains. *Financial Services Review*, *6*(4), 227–242.

Horan, S. M., Peterson, J. H., & McLeod, R. (1997). An analysis of non-deductible IRA contributions and Roth IRA conversions. *Financial Services Review*, *6*(4), 243–256.

Krishnan, V. Sivarama, & Lawrence, S. (2001). Analysis of investment choices for retirement: A new approach and perspective. *Financial Services Review*, forthcoming.

O'Neil, C. J., Saftner, D. V., & Dillaway, M. P. (1983). Premature withdrawals from retirement accounts: A break-even analysis. *Journal of the American Taxation Association*, *4*, 35–43.

Randolf, W. L. (1994). The impact of mutual fund distributions on after-tax returns. *Financial Services Review*, *3*(2), 127–141.

Yarri, U., & Fabozzi, F. J. (1985). Why IRA and Keogh plans should avoid growth stocks. *Journal of Financial Research*, *8*(3), 203–215.