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Choosing between tax-advantaged savings accounts: a reconciliation of standardized pretax and after-tax frameworks

Stephen M. Horan*

Department of Finance, St. Bonaventure University, St. Bonaventure, NY 14778, USA

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Abstract

Previous research models the choice between a traditional IRA and Roth IRA by standardizing either the pretax investment or the after-tax investment. This paper synthesizes these two approaches and develops a unified model that accommodates changing tax rates and different types of tax structures during the accumulation phase. Simulations indicate that the investor's withdrawal tax rate is important in making the optimal choice. We also argue that uncertainty about future tax rates increases the value of the traditional IRA, but that in any case investors benefit from having a portfolio of both traditional IRAs and Roth IRAs when withdrawals are made. © 2003 Academy of Financial Services. All rights reserved.

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1. Introduction

Since the introduction of the Roth IRA, researchers have analyzed the optimal choice between a traditional (i.e., tax-deductible) IRA and Roth IRA. Some authors have compared these investment options by equalizing the pretax investment in both accounts. Under this framework one assumes that pretax investments are less than the after-tax contribution limit [e.g., Crain and Austin (1997)]. Otherwise, one makes an assumption about how a portion of

* Tel.: +1-716-375-2091; fax: +1-716-375-2191.
E-mail address: shoran@sbu.edu (S.M. Horan).

the pretax investment in excess of the after-tax contribution limit for the traditional IRA is to be invested [e.g., Stout and Barker (1998)]. Other researchers have standardized the after-tax investment, which requires an assumption about how tax savings from the deductible IRA strategy are to be invested. Some authors have assumed that the tax savings are invested in a fully taxable investment [e.g., Krishnan and Lawrence (2001)], while others have assumed that tax savings are invested in a typical mutual fund (e.g., Horan and Peterson (2001)]. Not surprisingly, authors arrive at different conclusions regarding the relative attractiveness of these investment accounts because they make different assumptions. As a result, investors and financial planners can be left confused.

An after-tax approach is appropriate in the sense that investors make consumption and investment choices with after-tax dollars. A pretax approach may be appropriate, however, if investors or financial planners seek to maximize the amount of pretax income invested in tax-sheltered investment vehicles. The first purpose of this paper is to reconcile the two approaches of standardizing either the pretax or the after-tax investment by developing a unified framework.

The second goal of this study is to analyze the choice between a traditional IRA and a Roth IRA using a generalized model that is nominally predicated on a pretax framework and can be applied in a broad array of situations. The model developed in this paper allows for tax rates to change over time from the initial contribution, through the accumulation phase, and upon withdrawal. Allowing for temporal tax rate changes is important because evidence suggests that investors are likely to fall into lower tax brackets upon retirement [e.g., Bernheim, Skinner, and Wienberg (1997)]. In addition, the analysis incorporates different tax rates on ordinary income and capital gains during the accumulation phase, allowing a portion of the return to be taxed as either. The analysis is placed in the context of the recent Jobs and Growth Tax Relief Reconciliation Act (JGTRRA) of 2003 recently passed by Congress in May of 2003. Finally, this paper considers other issues pertaining to the IRA decision, such as the effect of withdrawal patterns, the uncertainty of future tax rates, and the benefit of having a portfolio of both traditional IRAs and Roth IRAs at retirement.

This paper is organized as follows. Section 2 reviews the literature most closely related to the choice between traditional IRAs and Roth IRAs. Section 3 illustrates the relationship between the standardized pretax and after-tax investment frameworks. A model that analyzes the investment choice for a standardized pretax investment is developed in Section 4, and simulations of that model are reported in Section 5. In Section 6, we discuss some additional considerations, including the pattern of withdrawals and the uncertainty of the withdrawal tax rate. Section 7 concludes.

2. Literature review

Motivated by the passage of the Tax Relief Act of 1997, Crain and Austin (1997) model the choice between a traditional IRA and a Roth IRA. They compare the after-tax accumulation between a traditional IRA and Roth IRA for equal pretax investments. For example, consider an investor in the 25% tax bracket who commits $3,000 of pretax income to an IRA. The entire $3,000 can be invested in the traditional IRA because such contributions are tax-exempt. This account will be taxed as funds are withdrawn. For the Roth IRA, only \$2,250 [i.e., \$3,000 × (1− 0.25)] can be invested because contributions are taxable. But the account is never taxed again. Under these conditions, Crain and Austin (1997) show that the choice between the traditional IRA and the Roth IRA simply amounts to comparing contribution and withdrawal tax rates. The traditional (Roth) IRA is more beneficial if the contribution tax rate is higher (lower) than the withdrawal tax rate because the tax shelter is most valuable when tax rates are high. The traditional IRA will frequently be more attractive because investors are likely to drop into lower tax brackets when they retire [see Berhneim, Skinner, and Wienberg (1997)].

Crain and Austin's (1997) pretax approach, however, is limited to situations in which the pretax investment is less than or equal to the after-tax contribution limit. The after-tax contribution limit for both IRAs is \$3,000 through 2004 and is scheduled to increase to \$5,000 by 2008. As of this writing, the maximum pretax investment into the Roth IRA for the 25% tax bracket investor is therefore \$4,000 [i.e., \$3,000/(1−0.25)]. A comparable pretax investment in a tax-deductible IRA is not possible since the limit is \$3,000. Such a strategy then requires a \$1,000 non-IRA investment on a pretax basis, or \$750 on an after-tax basis. Stout and Barker (1998) analyze this pretax scenario assuming the return on the non-IRA investment is fully taxed on an annual basis. This assumption is reasonable if the non-IRA investment is a fixed income instrument. But if the non-IRA investment is a mutual fund with a more complex tax structure having inherent tax deferral characteristics, this approach may not be appropriate.

Krishnan and Lawrence (2001) take an ostensibly different approach, by standardizing the after-tax investment. For example, if our hypothetical investor were to make a \$3,000 after-tax investment in a Roth IRA, the comparable after-tax investment for the traditional IRA is also \$3,000. But since the traditional IRA investment generated \$750 of tax savings (i.e., \$3,000 × 0.25), one must make as assumption about how the tax savings are to be invested. Because the contribution limits for the IRA have been met, Krishnan and Lawrence (2001) assume the tax savings are invested in a non-IRA investment with a fully taxed return. They conclude that, under these circumstances, the Roth IRA is the better choice in many circumstances, especially for individuals with long time horizons and higher levels of expected return. They note further that the Roth IRA has additional flexibility associated with early withdrawals, no required distribution age, and the ability to contribute at any age.

Horan and Peterson (2001) offer a similar analysis, but assume that tax savings from the traditional IRA alternative are invested in a mutual fund with some inherent tax deferral characteristics rather than a fully taxed investment. They find that the choice between the traditional IRA and Roth IRA is sensitive to this assumption and the withdrawal tax rate in that the traditional 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. They 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.

Table 1
Example of standardized pre-tax investments (I_{BT}) in a traditional IRA and a Roth IRA for an investor in the 25% tax bracket (T_o) and a $3,000 after-tax contribution limit (L)

	Traditional IRA	Roth IRA
Panel A: $I_{BT} \leq L$		
Pretax investment (I_{BT})	$3,000	$3,000
After-tax investment:		
IRA investment	3,000	2,250
Non-IRA investment	0	-
Total after-tax investment	$3,000	$2,250
Panel B: $I_{BT} = L/(1 - T_o)$		
Pretax investment (I_{BT})	$4,000	$4,000
After-tax investment:		
IRA investment	3,000	3,000
Non-IRA investment $[(I_{BT} - L)(1 - T_o)]$	750	-
Total after-tax investment	$3,750	$3,000
Panel C: $L < I_{BT} < L/(1 - T_o)$		
Pretax investment (I_{BT})	$3,500	$3,500
After-tax investment:		
IRA investment	3,000	2,625
Non-IRA investment $[(I_{BT} - L)(1 - T_o)]$	375	-
Total after-tax investment	$3,375	$2,625

3. A reconciliation of the pretax and after-tax approach

To better understand a standardized pretax approach and its relation to a standardized after-tax approach, consider our hypothetical investor currently in the 25% tax bracket (denoted as T_o) wishing to make a $3,000 investment before taxes (I_{BT}). The IRA contribution limit (L) for both traditional and Roth IRAs is $3,000. Table 1 displays standardized pretax investments for various contribution levels. In Panel A, the standardized pretax investment is $3,000. The resulting after-tax investment for the traditional IRA is $3,000. For the Roth IRA, the resulting after-tax investment is $2,250 [i.e., $3,000 × (1–0.25)], which is consistent with the approach of Crain and Austin (1997). Although the after-tax investment is lower for the Roth IRA, withdrawals from the traditional IRA are taxed, which will decrease its future accumulation.

One can equivalently view the scenario in Panel A as a standardized $2,250 after-tax investment. As previously indicated, one must make an assumption about how tax savings are to be invested in an after-tax framework. The traditional IRA alternative will generate an initial tax savings of $562.50 (i.e., $2,250 × 0.25). Since the IRA contribution limit has not been met, one can assume the tax savings are reinvested in the traditional IRA. Since this contribution is tax deductible, it will create yet more tax savings. The total amount of tax savings that can be reinvested in the traditional IRA is $750 [i.e., $562.50/(1–0.25)], yielding a total traditional IRA investment of $3,000. This equivalency between the two approaches holds for any pretax investment up to and including the IRA contribution limit ($I_{BT} \leq L$). Therefore, a standardized pretax investment less than or equal to the IRA contribution limit is equivalent to a standardized after-tax investment in which the tax savings are assumed to be invested in the deductible IRA.

Investing the tax savings in a tax-deductible, tax-deferred account may not be reasonable, or even possible, if an investor maximizes the IRA contribution ($I_{BT} = L/(1 - T_o)$). In this case, a non-IRA investment in some kind of taxable investment is required. For example, the maximum amount of pretax income that can be invested in the Roth IRA is $4,000 [i.e., $3,000/(1–0.25)] as shown in Panel B. Because up to $3,000 can be invested tax-free in the traditional IRA, the remaining $1,000 of the pretax investment is taxed as ordinary income, leaving $750 [i.e., $1,000 × (1–0.25)] to be invested in a non-IRA vehicle. As a result, the traditional IRA alternative comprises a combination of tax-sheltered investment and taxable investment.

One can equivalently view the scenario in Panel B, however, as a standardized after-tax investment of $3,000. An investor contributing $3,000 after-tax dollars into a traditional IRA will generate $750 of tax savings that will be invested in some kind of taxable investment. The type of taxable investment is a matter to be considered below. In a standardized after-tax framework, the $750 is the tax savings from the IRA strategy. In a pretax framework, it is the after-tax investment in excess of the IRA contribution limit. The main point is that a standardized pretax investment equal to the maximum allowable pretax allocation to an IRA is equivalent to a standardized after-tax investment equal to the IRA contribution limit and the tax savings are invested in some kind of taxable account.

The only remaining case is when the pretax investment is greater than the contribution limit but less that the maximum pretax Roth IRA investment [$L < I_{BT} < L/(1 - T_o)$]. Panel C of Table 1 reviews an example of a $3,500 pretax contribution. In this case, $2,625 [i.e., $3,500(1 – 0.25)] is invested in the Roth IRA. Because the contribution limit is $3,000, only a portion of the $3,500 pretax investment can be allocated toward the traditional IRA, leaving $500 pretax dollars for a taxable investment. The result is a $375 [i.e., $500(1–0.25)] non-IRA investment.

Notice that the total after-tax investment for the traditional IRA strategy is $750 greater compared to the Roth IRA in all three cases. The difference between the cases rests in how the $750 is invested. In the first case, the entire $750 can be reinvested in the traditional IRA. In the second case, the $750 is invested in a taxable, non-IRA account. In this last case, a portion can be allocated to the traditional IRA ($375) and the remainder ($375) is invested in a non-IRA vehicle. This last scenario does not map directly into an analogous standardized after-tax framework, but represents a hybrid of the two scenarios described above in which the $750 is invested entirely in either the traditional IRA or a taxable investment. The main point is that the standardized pretax and after-tax frameworks are consistent with each other.

4. A generalized model

The previous section reconciles the standardized pretax and after-tax investment frameworks. The goal of this section is to develop a generalized model that synthesizes the two frameworks, applies to all the possible situations described above, and accommodates different tax structures for the non-IRA portion of the traditional IRA investment strategy.

The non-IRA portion can be fully taxed each year as ordinary income, as in the case of a fixed income instrument, or invested in a mutual fund that has a more complex tax structure with inherent tax deferral characteristics.

For a given allocation of pretax income (I_{BT}), the after-tax investment for a Roth IRA is $I_{BT}(1 - T_o)$, where T_o is the initial marginal tax rate on ordinary income at the time of the contribution. The after-tax future value of a Roth IRA after n years is

$$FV_{Roth} = I_{BT}(1 - T_o)(1 + r)^n \tag{1}$$

where r is the expected annual pretax return on the investment. For the traditional IRA strategy, the after-tax investment has two components—the IRA contribution up to the contribution limit (L) and a non-IRA contribution for any investment in excess of the limit—or

$$I_{AT,Trad} = \min[I_{BT},L] + \max[0,(I_{BT} - L)(1 - T_o)]. \tag{2}$$

The first term of Eq. (2) represents the after-tax investment in the deductible IRA up to the IRA contribution limit, L. The second term represents the amount, if any, applied in a non-IRA, nondeductible investment.

Crain and Austin (1997) have already analyzed the choice between a traditional IRA and Roth IRA when the pretax investment is less than the after-tax contribution limit, or when $I_{BT} < L$, in which case the second term of Eq. (2) equals zero. Restricting our analysis then to situations where $I_{BT} \geq L$, the total after-tax investment of the traditional IRA strategy is $L + (I_{BT} - L)(1 - T_o)$. Each term is taxed differently during the accumulation phase and at the time of withdrawal, resulting in a different future value interest factor applied to each term. If withdrawals from the IRA portion of the after-tax investment are taxed at T_n and returns on the non-IRA portion are fully taxed each year as ordinary income at t_{oi}, then the after-tax future value of the traditional IRA strategy is

$$FV_{TradFullTax} = L(1 + r)^n(1 - T_n) + (I_{BT} - L)(1 - T_o)[1 + r(1 - t_{oi})]^n. \tag{3}$$

The first term represents the future value of the traditional IRA after the withdrawal tax has been paid, while the second term represents the future value of the non-IRA portion using the after-tax return, $r(1 - t_{oi})$ as the rate. If the non-IRA portion were invested instead in a mutual fund, then a portion of the annual return is distributed to shareholders as ordinary income (p_{oi}) and taxed at t_{oi}. Another portion is distributed to shareholders as capital gains (p_{cg}) and taxed at t_{cg}. Using the model introduced by Crain and Austin (1997) and refined by Horan (2002) to calculate after-tax future accumulations in a mutual fund, the future value of the traditional IRA strategy is

$$FV_{Trad} = L(1 + r)^n(1 - T_n) + (I_{BT} - L)(1 - T_o)[(1 + r^*)^n(1 - T^*) + T^*] \tag{4}$$

where

$r^* = r - rp_{oi}t_{oi} - rp_{cg}t_{cg}$, or the annual after-tax return; and

$T^* = t_{cg}(1 - p_{oi} - p_{cg})/(1 - p_{oi}t_{oi} - p_{cg}t_{cg})$.

The coefficient in the brackets of the second term is the future value of a dollar invested in a mutual fund. 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 is typically taxed at 15%, according to the JGTRRA of 2003, which is substantially lower than the marginal tax rate on ordinary income. As a result, mutual funds have significant tax advantages over investments having returns that are taxed each year as ordinary income.

Eq. (3), which assumes that the entire return is taxed annually as ordinary income, is simply a special case of Eq. (4) in which $p_{oi} = 1$ and $p_{cg} = 0$. To reduce the number of equations, we use the more general formulation in Eq. (4), which can then be related to Eq. (1) to determine whether the traditional IRA or the Roth IRA yields a greater after-tax accumulation after n years. The ratio of the future values of the traditional IRA to the Roth IRA can be expressed as

$$\frac{FV_{Trad}}{FV_{Roth}} = \frac{L(1 - T_n)}{I_{BT}(1 - T_o)} + \left(1 - \frac{L}{I_{BT}}\right)\frac{[(1 + r^*)^n(1 - T^*) + T^*]}{(1 + r)^n} \tag{5}$$

A derivation is found in Appendix (A.1.). When Eq. (5) is greater (less) than 1, the traditional IRA is more (less) beneficial than that Roth IRA. The next section uses this expression to run simulations for various levels of expected return and time horizons to provide guidance in choosing between the two investment choices.

Alternatively, Eq. (5) can be set equal to 1 to solve for the breakeven future tax rate, T_n, at which investors would be indifferent between the two accounts. Doing so and solving for T_n yields

$$T_n = T_o - (1 - T_o)\left(\frac{I_{BT}}{L} - 1\right)\left\{1 - \frac{[(1 + r^*)^n(1 - T^*) + T^*]}{(1 + r)^n}\right\}. \tag{6}$$

A derivation is located in Appendix (A.2.). Eq. (6) can be considered a breakeven withdrawal tax rate. That is, if an investor's expected withdrawal tax rate is less (greater) than the breakeven withdrawal tax rate, then the future value of the traditional IRA is greater (less) than the future value of the Roth IRA. Eq. (6) looks ominous and unintuitive. However, it becomes greatly simplified in two of the three scenarios described in Table 1 as will be demonstrated in the next section.

5. Results

5.1. Pretax investment less than or equal to the contribution limit

When the pretax investment is equal to the IRA contribution limit (i.e., $I_{BT} = L$), it is easily shown that the breakeven withdrawal tax rate in Eq. (6) reduces to $T_n = T_o$, which is identical to the Crain and Austin (1997) analysis. If an investor's withdrawal tax rate is less (greater) than the current tax rate, the traditional IRA (Roth IRA) is preferred. More generally, this result applies to situations in which $I_{BT} \leq L$. Recall, that this scenario is equivalent to equalizing the after-tax investment and investing the deductible IRA contribution tax savings in another tax-deductible, tax-deferred investment vehicle.

5.2. Maximum tax-sheltered investment

When an investor seeks to maximize the amount of pretax income invested in tax-sheltered investment vehicles such that $I_{BT} = L/(1 - T_o)$, the ratio of the future values of the traditional IRA to the Roth IRA from Eq. (5) reduces to

$$\frac{FV_{Trad}}{FV_{Roth}} = 1 - T_n + T_o\frac{[(1 + r^*)^n(1 - T^*) + T^*]}{(1 + r)^n} \tag{7}$$

The breakeven withdrawal tax rate from Eq. (6) then becomes

$$T_n = T_o\frac{[(1 + r^*)^n(1 - T^*) + T^*]}{(1 + r)^n} \tag{8}$$

Recall, that this situation is identical to standardizing the after-tax investment and investing the tax savings from the deductible IRA contribution in some kind of taxable account akin to the approach of Krishnan and Lawrence (2001) and Horan and Peterson (2001).

According to Eqs. (7) and (8), the traditional IRA becomes more attractive as the coefficient on T_o increases. Since $r^* < r$ and $(1 - T^*) < 1$, the numerator of the coefficient will increase less quickly than the denominator as n increases. As a result, the relative attractiveness of the traditional IRA decreases as the investor's time horizon increases. By similar logic, the traditional IRA becomes relatively less attractive as the expected return, r, increases. These results are confirmed in the following simulation analysis and by analyzing partial derivatives that are found in the Appendix (A.3.). The intuition for this result is that the traditional IRA strategy requires a non-IRA investment that is taxed more heavily than the Roth IRA. The tax disadvantage of the taxable non-IRA investment is amplified for high returns and long time horizons.

Two salient features of the JGTRRA of 2003 are revised lower tax brackets for ordinary income and lower taxes on dividends and capital gains. The new tax brackets are 10%, 15%, 25%, 28%, 33%, and 35%. Tax rates on dividends and capital gains have been reduced to 15% for taxpayers in all but the two lowest tax brackets. Using these figures as inputs, we calculate relative values of traditional and Roth IRAs, and breakeven withdrawal tax rates for various levels of expected return and different time horizons assuming that the non-IRA investment is a typical equity mutual fund. We use the average distribution rates for ordinary income and capital gains reported by Crain and Austin (1997) for their sample of growth funds, which are 6.99% and 44.23%, respectively. That is, $p_{oi} = 0.0699$ and $p_{cg} = 0.4423$.

For example, consider an investor in the 28% tax bracket who is seeking to maximize their pretax investment in an IRA. The relative values of the traditional IRA and Roth IRA are displayed in Table 2. Since retirement income is about 64% of preretirement income [see Bernheim, Skinner, and Wienberg (1997)], the investor is likely to drop into a lower tax bracket when the funds are withdrawn. Panel A therefore displays the relative values for a

Table 2
Ratio of the future value of a traditional IRA divided by the future value of a Roth IRA assuming a.) the investor is in the 28% tax bracket and makes the maximum allowable investment in either IRA, b.) non-IRA investments are invested in a typical taxable mutual fund, and c.) dividends and capital gains are taxed at 15% through the accumulation phase.

	Investment Horizon in years (n)							
r	5	10	15	20	25	30	35	40
Panel A: 25% Withdrawal Tax Rate								
3%	1.024	1.019	1.014	1.009	1.004	**1.000**	0.996	0.993
4%	1.022	1.015	1.009	1.003	**0.998**	0.993	0.988	0.984
5%	1.021	1.012	1.005	**0.998**	0.992	0.986	0.981	0.976
6%	1.019	1.009	**1.001**	0.993	0.986	0.980	0.974	0.969
7%	1.017	1.006	0.997	0.989	0.981	0.975	0.968	0.962
8%	1.016	1.004	0.994	0.985	0.977	0.969	0.963	0.956
9%	1.014	**1.001**	0.990	0.981	0.972	0.965	0.957	0.951
10%	1.013	0.999	0.987	0.977	0.968	0.960	0.953	0.945
11%	1.011	0.997	0.985	0.974	0.965	0.956	0.948	0.940
12%	1.010	0.994	0.982	0.971	0.961	0.952	0.943	0.935
13%	1.009	0.992	0.979	0.968	0.958	0.948	0.939	0.931
14%	1.007	0.990	0.977	0.965	0.954	0.944	0.935	0.927
15%	**1.006**	0.989	0.974	0.962	0.951	0.941	0.931	0.922
Panel B: 15% Withdrawal Tax Rate								
3%	1.124	1.119	1.114	1.109	1.104	1.100	1.096	1.093
4%	1.122	1.115	1.109	1.103	1.098	1.093	1.088	1.084
5%	1.121	1.112	1.105	1.098	1.092	1.086	1.081	1.076
6%	1.119	1.109	1.101	1.093	1.086	1.080	1.074	1.069
7%	1.117	1.106	1.097	1.089	1.081	1.075	1.068	1.062
8%	1.116	1.104	1.094	1.085	1.077	1.069	1.063	1.056
9%	1.114	1.101	1.090	1.081	1.072	1.065	1.057	1.051
10%	1.113	1.099	1.087	1.077	1.068	1.060	1.053	1.045
11%	1.111	1.097	1.085	1.074	1.065	1.056	1.048	1.040
12%	1.110	1.094	1.082	1.071	1.061	1.052	1.043	1.035
13%	1.109	1.092	1.079	1.068	1.058	1.048	1.039	1.031
14%	1.107	1.090	1.077	1.065	1.054	1.044	1.035	1.027
15%	1.106	1.089	1.074	1.062	1.051	1.041	1.031	1.022

Note: **Bold** figures indicate approximate indifference points between the traditional IRA and the Roth IRA.

25% withdrawal tax rate. Values greater (less) than one indicate that the traditional IRA (Roth IRA) is more attractive. Investors are indifferent when the ratio is one.

As suggested above, the traditional IRA is more advantageous only for relatively short time horizons or low rates of expected return. For example, an investor with a 10-year time horizon expecting a 9% return is indifferent between the traditional IRA and Roth IRA. Although not reported here, the indifference points when the non-IRA investment is fully taxed are about 5 years shorter than those reported in Panel A. Panel B reports the relative values for investors dropping into the 15% tax bracket. The same trends obtain, but in this case the traditional IRA is better than the Roth IRA in every case, suggesting that the choice between the two IRA accounts is quite sensitive to the tax rate upon withdrawal.

Table 3 reports the breakeven withdrawal tax rates in Eq. (8) using the assumptions above for various time horizons and returns. When an investor expects a withdrawal tax rate less (greater) than the breakeven withdrawal tax rate, the traditional (Roth) IRA is more attractive than the Roth IRA. Therefore, high breakeven withdrawal tax rates favor the traditional IRA, while low ones favor the Roth IRA. A reading of Panel A indicates that an investor in the 28% tax bracket should consider a traditional IRA only if he or she expects to be in a lower tax bracket upon retirement. This result holds for investors in all tax brackets. The bold figures correspond approximately to the revised tax brackets from the JGTRRA of 2003.

Panel B reports breakeven withdrawal tax rates assuming the tax saving from the traditional IRA strategy are invested in a fully taxable instrument, such as a bond. A comparison of Panels A and B shows that breakeven withdrawal tax rates when the non-IRA investment is fully taxed are very close to those when the non-IRA investment is taxed as a mutual fund, especially for short time horizons and low returns. Even for a 40-year time horizon and 10% return, the withdrawal tax rates differ by only 3.3% percentage points. Again, for almost every scenario, an investor dropping into the 15% tax bracket will have a greater accumulation with the traditional IRA strategy. This table indicates that the optimal choice between the traditional and Roth IRA is relatively insensitive to how the non-IRA portion of the traditional IRA strategy is invested, but quite sensitive to the investor's tax rate upon withdrawal.

The same basic trends (albeit more accentuated) are evident in Table 4, which displays the breakeven tax rates for investors in the 33% tax bracket. Compared to investors in the 28% tax bracket, breakeven tax rates are higher. In addition, the time horizons are longer and the returns are higher for breakeven tax rates that correspond with the next lower tax bracket for the investor. The benefit of the traditional IRA is stronger for investors in the 33% tax bracket because the incremental drop to the next lower tax bracket is five percentage points rather that three percentage points and because the marginal benefit of the lower 15% tax rate on dividends and capital gains for the non-IRA investment (which affects the traditional IRA strategy but not the Roth IRA strategy) is greater for investors in higher tax brackets. Unreported results indicate that the benefit of the traditional IRA is stronger for investors in the 35% tax bracket, as well.

It is interesting to note that the tax rate on dividend income and capital gains applicable during the accumulation phase drops to 5% for taxpayers currently in the 10% and 15% tax brackets. In other words, dividends and capital gains received during the accumulation phase are nearly tax-free for these investors. This situation approximates a scenario in which tax

Table 3

Breakeven withdrawal tax rates assuming a.) the investor is in the 28% tax bracket and makes the maximum allowable investment in either IRA, and b.) dividends and capital gains are taxed at 15% through the accumulation phase.

	Investment Horizon in years (n)							
r	5	10	15	20	25	30	35	40
Panel A: Non-IRA Investment Taxed as a Mutual Fund								
3%	27.4%	26.9%	26.4%	25.9%	25.4%	**25.0%**	24.6%	24.3%
4%	27.2%	26.5%	25.9%	25.3%	**24.8%**	24.3%	23.8%	23.4%
5%	27.1%	26.2%	25.5%	**24.8%**	24.2%	23.6%	23.1%	22.6%
6%	26.9%	25.9%	**25.1%**	24.3%	23.6%	23.0%	22.4%	21.9%
7%	26.7%	25.6%	24.7%	23.9%	23.1%	22.5%	21.8%	21.2%
8%	26.6%	25.4%	24.4%	23.5%	22.7%	21.9%	21.3%	20.6%
9%	26.4%	**25.1%**	24.0%	23.1%	22.2%	21.5%	20.7%	20.1%
10%	26.3%	24.9%	23.7%	22.7%	21.8%	21.0%	20.3%	19.5%
11%	26.1%	24.7%	23.5%	22.4%	21.5%	20.6%	19.8%	19.0%
12%	26.0%	24.4%	23.2%	22.1%	21.1%	20.2%	19.3%	18.5%
13%	25.9%	24.2%	22.9%	21.8%	20.8%	19.8%	18.9%	18.1%
14%	25.7%	24.0%	22.7%	21.5%	20.4%	19.4%	18.5%	17.7%
15%	25.6%	23.9%	22.4%	21.2%	20.1%	19.1%	18.1%	17.2%
Panel B: Non-IRA Investment Fully Taxed								
3%	27.4%	26.8%	26.2%	25.7%	**25.1%**	24.6%	24.0%	23.5%
4%	27.2%	26.4%	25.7%	**24.9%**	24.2%	23.5%	22.9%	22.2%
5%	27.0%	26.1%	**25.1%**	24.3%	23.4%	22.6%	21.8%	21.0%
6%	26.8%	25.7%	24.6%	23.6%	22.6%	21.7%	20.8%	19.9%
7%	26.7%	25.4%	24.1%	23.0%	21.9%	20.8%	19.8%	18.9%
8%	26.5%	**25.0%**	23.7%	22.4%	21.2%	20.0%	18.9%	17.9%
9%	26.3%	24.7%	23.2%	21.8%	20.5%	19.3%	18.1%	17.0%
10%	26.1%	24.4%	22.8%	21.3%	19.9%	18.5%	17.3%	16.2%
11%	26.0%	24.1%	22.4%	20.8%	19.3%	17.9%	16.6%	**15.4%**
12%	25.8%	23.8%	22.0%	20.3%	18.7%	17.2%	15.9%	14.6%
13%	25.7%	23.5%	21.6%	19.8%	18.1%	16.6%	**15.2%**	14.0%
14%	25.5%	23.2%	21.2%	19.3%	17.6%	16.0%	14.6%	13.3%
15%	25.4%	23.0%	20.8%	18.9%	17.1%	15.5%	14.0%	12.7%

Note: **Bold** figures correspond approximately to the revised tax brackets from the JGTRRA of 2003.

Table 4

Breakeven withdrawal tax rates assuming a.) the investor is in the 33% tax bracket and makes the maximum allowable investment in either IRA, and b.) dividends and capital gains are taxed at 15% through the accumulation phase.

	Investment Horizon in years (n)							
r	5	10	15	20	25	30	35	40
Panel A: Non-IRA Investment Taxed as a Mutual Fund								
3%	32.3%	31.7%	31.1%	30.5%	30.0%	29.5%	29.0%	28.6%
4%	32.1%	31.3%	30.5%	29.8%	29.2%	28.6%	**28.1%**	**27.5%**
5%	31.9%	30.9%	30.0%	29.2%	28.5%	**27.8%**	27.2%	26.6%
6%	31.7%	30.5%	29.6%	28.7%	**27.9%**	27.1%	26.4%	25.8%
7%	31.5%	30.2%	29.1%	**28.1%**	27.3%	26.5%	25.7%	**25.0%**
8%	31.3%	29.9%	28.7%	27.7%	26.7%	25.9%	**25.1%**	24.3%
9%	31.1%	29.6%	28.3%	27.2%	26.2%	25.3%	24.4%	23.6%
10%	31.0%	29.3%	**28.0%**	26.8%	25.7%	**24.8%**	23.9%	23.0%
11%	30.8%	29.1%	27.6%	26.4%	25.3%	24.3%	23.3%	22.4%
12%	30.6%	28.8%	27.3%	26.0%	**24.9%**	23.8%	22.8%	21.9%
13%	30.5%	28.6%	27.0%	25.7%	24.5%	23.3%	22.3%	21.3%
14%	30.3%	28.3%	26.7%	25.3%	24.1%	22.9%	21.8%	20.8%
15%	30.2%	**28.1%**	26.4%	**25.0%**	23.7%	22.5%	21.4%	20.3%
Panel B: Non-IRA Investment Fully Taxed								
3%	32.3%	31.6%	30.9%	30.2%	29.6%	28.9%	**28.3%**	**27.7%**
4%	32.1%	31.1%	30.3%	29.4%	28.6%	**27.7%**	27.0%	26.2%
5%	31.8%	30.7%	29.6%	28.6%	**27.6%**	26.6%	25.7%	**24.8%**
6%	31.6%	30.3%	29.0%	**27.8%**	26.7%	25.6%	**24.5%**	23.5%
7%	31.4%	29.9%	28.5%	27.1%	25.8%	**24.5%**	23.4%	22.2%
8%	31.2%	29.5%	**27.9%**	26.4%	**25.0%**	23.6%	22.3%	21.1%
9%	31.0%	29.1%	27.4%	25.7%	24.2%	22.7%	21.3%	20.0%
10%	30.8%	28.8%	26.9%	**25.1%**	23.4%	21.9%	20.4%	19.1%
11%	30.6%	28.4%	26.4%	24.5%	22.7%	21.1%	19.5%	18.1%
12%	30.4%	**28.1%**	25.9%	23.9%	22.0%	20.3%	18.7%	17.3%
13%	30.2%	27.7%	25.4%	23.3%	21.4%	19.6%	17.9%	16.4%
14%	30.1%	27.4%	**25.0%**	22.8%	20.7%	18.9%	17.2%	15.7%
15%	29.9%	27.1%	24.5%	22.2%	20.1%	18.2%	16.5%	**15.0%**

Note: **Bold** figures correspond approximately to the revised tax brackets from the JGTRRA of 2003.

savings are invested in a tax-deferred investment, which favors the traditional IRA. Therefore, investors in the 10% or 15% tax brackets may have a strong preference for traditional IRAs even when they are maximizing their pretax contribution. The same logic applies to taxpayers likely to drop into the 15% tax bracket shortly after contribution. Therefore, investors nearing retirement may find the traditional IRA particularly attractive.

5.3. Pretax investment less than maximum allowed

If the IRA contribution is not maximized but is greater than the after-tax contribution limit, such that $L < I_{BT} < L/(1 - T_o)$, then only a portion of the tax savings needs to be invested in a taxable instrument. The remainder can be allocated to fund the tax-deductible and tax-deferred IRA up to the contribution limit. Table 5 presents an example of this situation in which the pretax contribution is midway between the contribution limit, L, and the maximum pretax contribution, $L/(1 - T_o)$. Panel A displays the relative after-tax accumulations for the traditional IRA and the Roth IRA assuming the investors drops into the 25% tax bracket upon withdrawal. In this case, the choice between traditional IRA and Roth IRA does not appear to be very meaningful because all the ratios are close to one.

Furthermore, a comparison of Panel A of Table 5 with Panel A of Table 2 indicates that being able to invest a portion of the traditional IRA tax savings in a tax free manner significantly increases the attractiveness of the traditional IRA. The indifference points in Table 5 are 15 to 25 years longer than those reported in Table 2 in which the pretax contribution is maximized, and the marginal value of traditional IRA is measurably greater than those in Panel B of Table 2. These results suggest that, in addition to the withdrawal tax rate, the optimal choice between the traditional and Roth IRA is sensitive to whether or not the IRA investment is maximized.

6. Related issues and discussion

6.1. Withdrawal patterns

Research indicates that withdrawal patterns from a tax-sheltered account affect the account's after-tax present value. Building on the work of Sibley (2002), Horan (2002) shows that an annuitized withdrawal pattern significantly decreases the after-tax value of both traditional IRAs and Roth IRAs compared to a single withdrawal at the end of the withdrawal annuity time horizon. Therefore, one may speculate that an investor should consider their expected withdrawal pattern in choosing between types of tax-sheltered accounts. Fortunately, this potential complexity is not relevant because the withdrawal pattern affects the traditional IRA and Roth IRA in identical ways. The effect of the withdrawal pattern enters the analysis as a constant that would be multiplied on both the numerator and denominator of Eq. (5). As such, the relative values of the traditional IRA and Roth are unchanged, leaving the investor's choice between the two unchanged, as well.

Table 5

Ratio of the future value of a traditional IRA divided by the future value of a Roth IRA assuming a.) the investor is in the 28% tax bracket and makes less than the maximum allowable investment in either IRA, b.) non-IRA investments are invested in a typical taxable mutual fund, and c.) dividends and capital gains are taxed at 15% through the accumulation phase.

	Investment Horizon in years (n)							
r	5	10	15	20	25	30	35	40
Panel A: 25% Withdrawal Tax Rate								
3%	1.031	1.028	1.025	1.023	1.020	1.018	1.015	1.013
4%	1.030	1.026	1.023	1.019	1.016	1.013	1.011	1.008
5%	1.029	1.025	1.020	1.016	1.013	1.009	1.006	1.003
6%	1.028	1.023	1.018	1.013	1.010	1.006	1.002	**0.999**
7%	1.027	1.021	1.016	1.011	1.007	1.003	**0.999**	0.995
8%	1.027	1.020	1.014	1.009	1.004	**1.000**	0.996	0.992
9%	1.026	1.018	1.012	1.006	1.001	0.997	0.993	0.989
10%	1.025	1.017	1.010	1.004	**0.999**	0.994	0.990	0.986
11%	1.024	1.015	1.008	1.002	0.997	0.992	0.987	0.983
12%	1.023	1.014	1.007	**1.000**	0.995	0.989	0.985	0.980
13%	1.022	1.013	1.005	0.999	0.993	0.987	0.982	0.977
14%	1.022	1.012	1.004	0.997	0.991	0.985	0.980	0.975
15%	1.021	1.011	**1.003**	0.995	0.989	0.983	0.978	0.972
Panel B: 15% Withdrawal Tax Rate								
3%	1.148	1.145	1.142	1.139	1.136	1.134	1.132	1.129
4%	1.147	1.143	1.139	1.136	1.132	1.130	1.127	1.124
5%	1.146	1.141	1.136	1.133	1.129	1.126	1.123	1.120
6%	1.145	1.139	1.134	1.130	1.126	1.122	1.119	1.116
7%	1.144	1.137	1.132	1.127	1.123	1.119	1.115	1.112
8%	1.143	1.136	1.130	1.125	1.120	1.116	1.112	1.108
9%	1.142	1.134	1.128	1.123	1.118	1.113	1.109	1.105
10%	1.141	1.133	1.126	1.121	1.115	1.111	1.106	1.102
11%	1.140	1.132	1.125	1.119	1.113	1.108	1.103	1.099
12%	1.140	1.131	1.123	1.117	1.111	1.106	1.101	1.096
13%	1.139	1.129	1.122	1.115	1.109	1.104	1.098	1.094
14%	1.138	1.128	1.120	1.113	1.107	1.101	1.096	1.091
15%	1.137	1.127	1.119	1.112	1.105	1.099	1.094	1.089

Note: **Bold** figures indicate approximate indifference points between the traditional IRA and the Roth IRA.

6.2. Uncertainty of the withdrawal tax rate

The model developed in this paper incorporates an uncertain tax rate upon withdrawal. Krishnan and Lawrence (2001) argue that the uncertainty cannot be said to favor either type of IRA "because tax rates are just as likely to go up as they are to go down." (p. 82). However, retirees are likely to be in lower tax brackets upon withdrawal since retirement income tends to be much lower than their preretirement income. Moreover, future tax rates may be more likely to decrease rather than increase (or vice versa) depending on the current and expected political climate. For example, the passage of JGTRRA of 2003 reflects a political environment of declining tax rates and portends lower withdrawal tax rates for many investors.

Even if tax rates are equally like to increases as decrease, it is useful to remember that investors have decreasing marginal utility with respect to wealth. If rates are equally likely to go up or down, the extra dollar of tax if rates go up has less marginal utility associated with it than the marginal utility associated with one fewer dollars of tax. As result, uncertainty associated with uncertain future tax cash outflows favors the traditional IRA, from an expected utility perspective. Lewellen (1977) makes an alternative argument based on the notion that uncertain cash outflows (like future taxes) essentially have negative systematic risk, which hedges the positive systematic risk of cash inflows, thereby decreasing the risk (i.e., discount rate) of the combined cash flows and increasing their present value. Consequently, the uncertainty surrounding future tax rates favors the traditional IRA.

6.3. Portfolio of IRAs

Finally, it is important to recognize that uncertain future tax rates increase the value for an investor to have the option to choose the type of account from which to make withdrawals upon retirement. For example, an investor with only traditional IRAs or only Roth IRAs at retirement is forced to make withdrawals from only one type of account. However, an investor with both types of accounts may choose the account from which withdrawals are made before the mandatory withdrawal age of 71.5 years. This choice has value because, in low tax rate regimes, investors can withdrawal from the traditional IRA. In high tax rate regimes, the Roth IRA can produce tax-free retirement income. Even if an investor is required to make withdrawals from the traditional IRA, the choice can still have value if withdrawals exceed the minimum mandatory amounts. Having both types of accounts available when making withdrawals creates diversification and valuable flexibility for retirees akin to a real option in a capital budgeting context.

7. Summary

This paper seeks to reconcile the standardized pretax investment and after-tax investment frameworks used in prior research to evaluate the optimal choice between a traditional IRA and a Roth IRA. Interestingly, standardized pretax investment scenarios correspond exactly to specific standardized after-tax scenarios. The model in this paper, which is nominally predicated on a pretax investment framework, applies to various contribution levels and allows for different tax rates for the initial contribution, the accumulation phase, and the withdrawal phase. The analysis also incorporates different tax rates on ordinary income and capital gains during the accumulation phase, allowing a portion of the return to be taxed as either.

We show that the traditional IRA becomes relatively less attractive as the time horizon increases and the investment return increases. The model also indicates that an investor must have a lower withdrawal tax rate than initial contribution tax rate to benefit from a traditional IRA. We also show that the choice between the traditional and Roth IRA is sensitive to an investor's withdrawal tax rate and whether the pretax contribution exceeds the contribution limit, but not whether non-IRA investments are fully taxed as ordinary income or partially taxed as a mutual fund. Regardless of an investor's current tax bracket, the traditional IRA yields a greater accumulation when the withdrawal tax rate drops to 15%. The benefit of the traditional IRA is greater for investors in higher tax brackets because the marginal benefit of the lower 15% tax rate on dividends and capital gains (which affects the traditional IRA strategy but not the Roth IRA strategy) is greater for investors in higher tax brackets.

Finally, this paper shows that the withdrawal pattern from a tax-sheltered account does not affect the optimal choice between the types of account. We argue, however, that contrary to conventional wisdom, uncertainty regarding future tax rates favors the traditional IRA because it decreases the magnitude of the present value of cash outflows, just as it does for cash inflows. Future tax rate uncertainty also creates value for investors to have a portfolio of both traditional and Roth IRAs upon retirement so that withdrawals can be tailored to the prevailing tax rate environment.

Although the model in this paper synthesizes existing research into a unified framework, it remains incomplete. First of all, tax rates may change during the accumulation or withdrawal phase rendering the model unfit. Furthermore, the Roth IRA and other back-end loaded tax sheltered accounts typically have more flexibility regarding early withdrawals and contribution limits, which favors the Roth IRA and is not factored into this analysis. Investors also have the ability to convert existing traditional IRAs to Roth IRAs, which we do not consider. These refinements represent opportunities for future research that might use this model as a foundation.

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Appendix

A.1. Derivation of relative values of traditional IRAs and Roth IRAs

The relative future value of the traditional IRA and the Roth IRA is the ratio of Eq. (1) to Eq. (4), or

$$\frac{FV_{Trad}}{FV_{Roth}} = \frac{L(1 + r)^n(1 - T_n) + (I_{BT} - L)(1 - T_o)[(1 + r^*)^n(1 - T^*) + T^*]}{I_{BT}(1 - T_o)(1 + r)^n} \tag{A1}$$

Dividing the first term of the numerator through by $(1 + r)^n$, distributing $(1 - T_o)$ in the second term of the numerator, and dividing through by $(1 - T_o)$ yields

$$\frac{FV_{Trad}}{FV_{Roth}} = \frac{L(1 - T_n)}{I_{BT}(1 - T_o)} + \frac{I_{BT}[(1 + r^*)^n(1 - T^*) + T^*]}{I_{BT}(1 + r)^n} - \frac{L[(1 + r^*)^n(1 - T^*) + T^*]}{I_{BT}(1 + r)^n} \tag{A2}$$

Dividing to unity and collecting terms yields Eq. (5)

$$\frac{FV_{Trad}}{FV_{Roth}} = \frac{L(1 - T_n)}{I_{BT}(1 - T_o)} + \left(1 - \frac{L}{I_{BT}}\right)\frac{[(1 + r^*)^n(1 - T^*) + T^*]}{(1 + r)^n} \tag{A3}$$

A.2. Derivation of the breakeven withdrawal tax rate

The breakeven withdrawal tax rate is found by setting Eq. (A3) to one. Doing so and subtracting one from both sides, we have

$$0 = \frac{L(1 - T_n)}{I_{BT}(1 - T_o)} - 1 + \left(1 - \frac{L}{I_{BT}}\right)\frac{[(1 + r^*)^n(1 - T^*) + T^*]}{(1 + r)^n} \tag{A4}$$

Dividing through by L, multiplying through by $I_{BT}(1 - T_o)$, and distributing I_{BT}/L through the third term, we have

$$0 = (1 - T_n) - \frac{I_{BT}(1 - T_o)}{L} + (1 - T_o)\left(\frac{I_{BT}}{L} - 1\right)\frac{[(1 + r^*)^n(1 - T^*) + T^*]}{(1 + r)^n} \tag{A5}$$

We add T_n to both sides, then add and subtract T_o on the right hand side for

$$T_n = T_o + (1 - T_o) - \frac{I_{BT}(1 - T_o)}{L} + (1 - T_o)\left(\frac{I_{BT}}{L} - 1\right)\frac{[(1 + r^*)^n(1 - T^*) + T^*]}{(1 + r)^n} \tag{A6}$$

Finally, collecting terms around $-(1 - T_o)$ and $(I_{BT}/L - 1)$ yields Eq. (6),

$$T_n = T_o - (1 - T_o)\left(\frac{I_{BT}}{L} - 1\right)\left\{1 - \frac{[(1 + r^*)^n(1 - T^*) + T^*]}{(1 + r)^n}\right\}. \quad \text{(A7)}$$

A.3. Partial derivatives of the future value ratio

Because Eq. (A3) applies when $I_{BT} \geq L$, the traditional IRA becomes more attractive as $[(1 + r^*)^n(1 - T^*) + T^*]/(1 + r)^n$ increases. Defining this expression as V and manipulating, we have

$$V \equiv (1 - T^*)\frac{(1 + r^*)^n}{(1 + r)^n} + \frac{T^*}{(1 + r)^n} \quad \text{(A8)}$$

Taking the partial derivative with respect to n using the quotient rule and exponent rule simultaneously,

$$\frac{\partial V}{\partial n} = (1 - T^*)\left[\frac{(1 + r)^n(1 + r^*)^n \ln(1 + r^*) - (1 + r^*)^n(1 + r)^n \ln(1 + r)}{(1 + r)^{2n}}\right] + T^*\left[\frac{-(1 + r)^n \ln(1 + r)}{(1 + r)^{2n}}\right]. \quad \text{(A9)}$$

Dividing $(1 + r)^n$ to unity and factoring out $(1 + r^*)^n$ yields

$$\frac{\partial V}{\partial n} = (1 - T^*)\frac{(1 + r^*)^n}{(1 + r)^n}[\ln(1 + r^*) - \ln(1 + r)] + T^*\left[\frac{-\ln(1 + r)}{(1 + r)^n}\right] < 0 \quad \text{(A10)}$$

Since $r^* < r$, the coefficient in brackets in the first term is negative. Because the coefficient in brackets in the second term is also negative, the partial derivative of V with respect to n is negative, implying that the traditional IRA becomes relatively less attractive as the investor's time horizon increases.

Now we evaluate the partial derivative of V with respect to r. Recall, that $r^* = r - rp_{oi}t_{oi} - rp_{cg}t_{cg}$. Therefore, $\delta r^*/\delta r = -p_{oi}t_{oi} - p_{cg}t_{cg}$, which is less than zero. Taking the partial derivative of Eq. (8) with respect to r using the quotient rule,

$$\frac{\partial V}{\partial r} = (1 - T^*) \cdot \left[\frac{n(1 + r)^n(1 + r^*)^{n-1}(-p_{oi}t_{oi} - p_{cg}t_{cg}) - n(1 + r^*)^n(1 + r)^{n-1}}{(1 + r)^{2n}}\right] + T^*(-n)(1 + r)^{-n-1} < 0. \quad \text{(A11)}$$

The term in brackets is negative, as is the second term. Therefore, as the return increases the traditional IRA becomes less attractive.

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