

## IRAs under progressive tax regimes and income growth

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### Abstract

This article investigates the choice between a traditional IRA and a Roth IRA in the presence of a progressive tax regime, income growth, and exogenous retirement income. These factors affect the tax rate that applies to deductible IRA contributions and taxable distributions and can therefore influence the optimal choice. Assuming constant income tax rates or exogenously determined tax rates for working years and retirement years, which has been popular in the literature, may lead to misleading conclusions. For aggressive savers enjoying high rates of return or high levels of other retirement income, the Roth IRA can be a better choice than a traditional IRA. © 2009 Academy of Financial Services. All rights reserved.

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### 1. Introduction

Choosing between savings vehicles with front-end loaded tax benefits (such as 401(k) plan or traditional IRA) and those with back-end loaded tax-benefits (such as the Roth IRA or Roth 401(k)) in the presence of market frictions and government regulations can be challenging. Reichenstein (2006, 2007), Reichenstein and Jennings (2003), and Horan (2007a, b) show how the portions of principal effectively owned by, returns received by, and risk borne by individual investors may vary depending on the saving vehicle they use. A substantial body of literature has emerged to understand these savings vehicles and their effectiveness

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as savings vehicles (see, for example, Horan (2005) for a summary of literature). To make the problem tractable, however, authors make simplifying assumptions that may inadvertently lead to suboptimal decision making. In this article, we focus on the importance of incorporating progressive tax rates, income growth, and exogenous retirement income in comparing the performance of savings vehicles with front-end and back-end loaded tax benefits, such as the traditional IRA and Roth IRA, respectively.

Retirement planning requires careful consideration of the accumulation phase as well as decumulation, or withdrawal, phase. Much of the literature has focused on the accumulation phase (see Horan (2005) for a review). Analysis of the withdrawal phase, when the savers retire and tap into their retirement resources, is equally important but has received less attention. Notable exceptions include Zaman (2008), Horan (2006a, b), Kaplan (2006), Spitzer and Sandeep (2006), Caliendo and Lewis (2002), Hughen et al. (2002), and Spitzer, Strieter, and Singh (2008) who discuss the importance of withdrawal patterns.

A proper analysis of traditional IRAs and Roth IRAs is predicated upon their usefulness in the context of both accumulation and the decumulation phases, which requires a consideration of other sources of income during retirement, such as social security, defined-benefit pension plans, and defined contribution plans. These alternative sources of income determine the marginal tax rate in retirement and hence the relative value of a traditional IRA compared to a Roth IRA. Ignoring them may therefore lead many savers choose the wrong savings vehicle. Early work assumes marginal tax rate in working years and retirement years are equal (e.g., Crain and Austin (1997), Krishnan and Lawrence (2001)). Subsequent studies incorporate tax rates that vary from working to retirement years (e.g., Horan, Peterson, and McLeod (1997), Horan and Peterson (2001), Horan (2005), and Reichenstein (2003, 2007)), but the process of determination of the marginal tax rate is not considered.

In reality, savers face progressive tax rates during working years as well as retirement years. Horan (2006a, b) shows that progressive tax rates can affect a retiree's optimal withdrawal strategy from tax-deferred or tax-exempt accounts. Progressive tax rates may affect the optimal choice of accumulation vehicles (e.g., traditional IRA or Roth IRA), as well. In short, the marginal tax rate affects after-tax amounts that savers receive from their saving vehicles. It is important to recognize the rate at which retirement withdrawals are taxed can be endogenously determined by the saving strategy itself and exogenously determined by other retirement income.

In this article, we use sensitivity and scenario analysis to estimate the impact of income growth and progressive tax rates on the choice between a traditional IRA and Roth IRA in the presence of other retirement savings and income, such as a 401(k) plan and Social Security. We also examine how savings rates and investment returns affect the selection of the accounts for optimizing after-tax payoffs in this context.

The next section presents the conventional analysis regarding the choice between a traditional IRA and a Roth IRA. In the third, we present the basic model for the sensitivity and scenario analysis. The fourth and fifth sections report our findings on the performance of the saving vehicles with income growth and varying rate of return. The penultimate section summarizes the findings graphically, while the final section concludes.

Table 1 Ratios of after-tax annuity payments of traditional IRAs to Roth IRAs

Tax rate (retirement years)	10%	15%	25%	28%	33%	35%
Tax rate (working years)						
10%	1	0.94	0.83	0.80	0.74	0.72
15%	<i>1.06</i>	1	0.88	0.85	0.79	0.76
25%	<i>1.20</i>	<i>1.13</i>	1	0.96	0.89	0.87
28%	<i>1.25</i>	<i>1.18</i>	<i>1.04</i>	1	0.93	0.90
33%	<i>1.34</i>	<i>1.27</i>	<i>1.12</i>	<i>1.07</i>	1	0.97
35%	<i>1.38</i>	<i>1.31</i>	<i>1.15</i>	<i>1.11</i>	<i>1.03</i>	1

The entries with italic fonts indicate instances when IRA performs better than the Roth IRA.

## 2. Standard analysis of IRA and Roth IRA

When the after-tax contribution to a tax-deferred savings account is less than the contribution limit, a traditional IRA is preferred over the Roth IRA if the tax rate is expected to be lower during retirement years relative to the working years. Otherwise, a Roth IRA is preferred. For a given pre-tax investment ( $I_{BT}$ ), 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. Using the standard future value formula, the future value of a Roth IRA after  $n$  years is

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

where  $r$  is the expected annual pre-tax return on the investment. Now consider the future value of a traditional IRA when the after-tax contribution is less than or equal to the contribution limit. Because an investor does not pay tax on the contribution, the entire pre-tax investment will accumulate earnings. An investor pays tax when withdrawing funds at the then prevailing tax rate, say  $T_n$ . Therefore,

$$FV_{Trad} = I_{BT}(1 + r)^n(1 - T_n) \quad (2)$$

The ratio of accumulations of the traditional IRA and the Roth IRA whether considered as a lump sum withdrawal or as an annuity is

$$\frac{FV_{Trad}}{FV_{Roth}} = \frac{1 - T_n}{1 - T_o} \quad (3)$$

Table 1 presents the ratio in Eq. (3) using tax rates corresponding to the prevailing tax brackets in the U.S at the time of this writing. The ratio is less than one when the tax rate in the retirement years is higher, indicating clear superiority of Roth IRA in generating higher after-tax payments. However, when the tax rate in retirement years is lower, the ratio is greater than 1 and the traditional IRA performs better. The accounts perform equally well when the tax rates are the same. The difference in magnitude of the ratio is driven by the wedge between the two tax rates.

The analysis requires modification when the after-tax contribution exceeds the contribution limit. In this case, the tax savings from the traditional IRA must be invested in an entity

with more tax drag, which decreases the attractiveness of the traditional IRA (see, e.g., Horan (2003, 2005) for a more detailed discussion). For example, Horan (2003) shows that approaches that standardize either the pre-tax or after-tax investments of both accounts can be reconciled. In any case, however, making a Roth IRA investment equal to the contribution limit requires one to make an assumption about how the tax savings associated with the traditional IRA alternative are invested. If the contribution limit has been met, then the tax savings must necessarily be invested in a vehicle that does not enjoy the same tax-sheltered status of the traditional IRA, which thus creates a tax draft for the traditional IRA strategy.

Authors have examined the breakeven tax rate in retirement that is necessary to overcome the tax drag of investing the tax savings of the traditional IRA investment in a less tax efficient vehicle (e.g., Horan (2004, 2005)). In any case, the relative attractiveness of the traditional IRA and the Roth IRA is determined in large part by the relative tax rates during working years and retirement years, and the analysis in the remainder of this article is governed by the case in which the after-tax contribution is less than the contribution limit. Nonetheless, prior studies ignore the endogeneity of the prevailing tax rate in retirement with respect to saving behavior. This article addresses that issue.

### **3. Base case**

For the remainder of the article, we consider hypothetical savers who start working at age 25, work for 40 years, retire at age 65, and live in retirement for another 25 years. During their working years, they contribute 5%, 10%, or 15% of their wage income to 401(k) plans and a fixed pre-tax amount to either a traditional IRA or a Roth IRA. Horan (2003) demonstrates that the approaches of standardizing the pre-tax investment or the after-tax investment can be reconciled with each other and lead to identical conclusions. U.S. tax law allows 401(k) plan participants to contribute to a Roth IRA. The opportunity to invest in a traditional IRA despite being covered by a qualified retirement plan such as a 401(k) is restricted, but is subject to relatively high-income limitations.

Even if a participant in a 401(k) plan is restricted from contributing to a traditional IRA, the analysis in this article remains relevant for at least two reasons. First, an additional 401(k) contribution is identical to a traditional IRA contribution from a tax perspective. Therefore, even if a taxpayer is prevented from contributing to a traditional IRA, the option to increase his or her 401(k) plan contribution in lieu of an investment in a Roth IRA does not change the analysis from a tax perspective. Of course, a taxpayer's ability to make 401(k) plan contributions is also restricted by contribution limits. However, the analysis we construct examines income levels and savings rates that permit plenty of additional 401(k) saving. Second, even if an employee is covered under a 401(k) plan and is constrained by its contribution limits, he or she may still be able to contribute to a spousal traditional IRA, which again is identical to a traditional IRA from a tax perspective.

Initial income levels for savers when they start working are assumed to be between \$30,000 and \$250,000. We examine two general scenarios. The first is one in which wages rise only by the rate of inflation, resulting in no real wage growth. Nominal income tax brackets and other nominal elements of the tax code, such as contribution limits, are typically

adjusted for inflation over time, as well, leaving their real values relative constant over time. Therefore, we examine real income (with no real wage growth) and real tax rate brackets by holding both constant through time.

It is typical for wages to grow by more than the rate of inflation, however. The second general scenario therefore assumes income grows by 3% per year in real terms. We use 2008 tax rates and brackets for a married couple filing jointly.<sup>1</sup> The maximum allowable contribution for an IRA is assumed to be \$5,000 held constant in real terms over time. The marginal tax rates and tax brackets assume the couple uses personal exemptions and standard deductions, which totaled \$17,900 in 2008.

Given the progressivity of the tax rate, taxpayers may move from one tax bracket to another as their real taxable income changes either during their working years or during retirement. For example, Table 2 profiles income and marginal tax rates for the working years. It shows that savers with initial income of \$30,000 start their career in 10% marginal tax bracket. As their income grows, they move to either the 15% or even the 25% tax bracket. The same phenomenon of progressing into higher tax brackets holds for higher wage earners, as well.

Savers are assumed to contribute 5%, 10%, or 15% of their pre-tax income to 401(k) plans, which will grow on a tax-deferred basis. In addition, they will contribute to either a traditional IRA or a Roth IRA every year during the working years. The primary focus of our investigation is the optimal choice between these two options. Contributions to traditional IRAs will be tax-deductible and grow in a tax-deferred basis, but withdrawals will be taxed at their relevant marginal rate during retirement. Contributions to a Roth IRA receive no tax-deduction but will be exempt from taxation thereafter. In any case, we standardize the pre-tax contribution for comparability. Initially, we assume a 5% real rate of return for all of these savings vehicles but check the sensitivity of the results to lower rates of return later on.<sup>2</sup>

In retirement, savers have access to their balances in the 401(k) plans and any balances in either their traditional IRA or Roth IRA. We assume that they annuitize their payments from their 401(k) plans and their IRAs over a 25-year period. We use the term annuity in its generic sense—equal payments over a fixed period of time assuming a fixed rate of return—rather than to represent a specific insurance product that may or may not incorporate longevity insurance or other features.

In the withdrawal phase, the annuity payments from the 401(k) plans and the traditional IRA are taxed. Annuity payments from the Roth IRA are not. The marginal tax rate for traditional IRA distributions is determined by their combined income from the 401(k) plan and the IRA. Therefore, their after-tax income in retirement is determined by applying the progressive tax rate schedule to their combined pre-tax income. The marginal tax rate for Roth IRA savers is determined only by their 401(k) plan. Therefore, their after-tax annual income is the net after-tax income from 401(k) annuity plus the annuity payment from their Roth IRA.

The key point to note is that the marginal tax rate for traditional IRA distributions is determined in part by the annuity payment from the 401(k) plans and in part by the size of the traditional IRA distribution. Therefore, the tax rate is determined partially exogenously by other retirement income and partially endogenously by the level of IRA savings and the

Table 2 Income and marginal tax profile with income growth

Age	Inc.	Tax	Inc.	Tax	Inc.	Tax	Inc.	Tax	Inc.	Tax	Inc.	Tax	Inc.	Tax
25	30.00	10	40.00	15	50.00	15	100.00	25	150.00	28	200.00	28	250.00	33
26	30.90	10	41.20	15	51.50	15	103.00	25	154.50	28	206.00	28	257.50	33
27	31.83	10	42.44	15	53.05	15	106.09	25	159.13	28	212.18	28	265.23	33
28	32.78	10	43.71	15	54.64	15	109.27	25	163.91	28	218.55	33	273.18	33
29	33.77	10	45.02	15	56.28	15	112.55	25	168.83	28	225.10	33	281.38	33
30	34.78	15	46.37	15	57.96	15	115.93	25	173.89	28	231.85	33	289.82	33
31	35.82	15	47.76	15	59.70	15	119.41	25	179.11	28	238.81	33	298.51	33
32	36.90	15	49.19	15	61.49	15	122.99	25	184.48	28	245.97	33	307.47	33
33	38.00	15	50.67	15	63.34	15	126.68	25	190.02	28	253.35	33	316.69	33
34	39.14	15	52.19	15	65.24	15	130.48	25	195.72	28	260.95	33	326.19	33
35	40.32	15	53.76	15	67.20	15	134.39	25	201.59	28	268.78	33	335.98	33
36	41.53	15	55.37	15	69.21	15	138.42	25	207.64	28	276.85	33	346.06	33
37	42.77	15	57.03	15	71.29	15	142.58	25	213.86	28	285.15	33	356.44	33
38	44.06	15	58.74	15	73.43	15	146.85	25	220.28	33	293.71	33	367.13	33
39	45.38	15	60.50	15	75.63	15	151.26	28	226.89	33	302.52	33	378.15	35
40	46.74	15	62.32	15	77.90	15	155.80	28	233.70	33	311.59	33	389.49	35
41	48.14	15	64.19	15	80.24	15	160.47	28	240.71	33	320.94	33	401.18	35
42	49.59	15	66.11	15	82.64	15	165.28	28	247.93	33	330.57	33	413.21	35
43	51.07	15	68.10	15	85.12	25	170.24	28	255.36	33	340.49	33	425.61	35
44	52.61	15	70.14	15	87.68	25	175.35	28	263.03	33	350.70	33	438.38	35
45	54.18	15	72.24	15	90.31	25	180.61	28	270.92	33	361.22	33	451.53	35
46	55.81	15	74.41	15	93.01	25	186.03	28	279.04	33	372.06	33	465.07	35
47	57.48	15	76.64	15	95.81	25	191.61	28	287.42	33	383.22	35	479.03	35
48	59.21	15	78.94	15	98.68	25	197.36	28	296.04	33	394.72	35	493.40	35
49	60.98	15	81.31	15	101.64	25	203.28	28	304.92	33	406.56	35	508.20	35
50	62.81	15	83.75	25	104.69	25	209.38	28	314.07	33	418.76	35	523.44	35
51	64.70	15	86.26	25	107.83	25	215.66	28	323.49	33	431.32	35	539.15	35
52	66.64	15	88.85	25	111.06	25	222.13	33	333.19	33	444.26	35	555.32	35
53	68.64	15	91.52	25	114.40	25	228.79	33	343.19	33	457.59	35	571.98	35
54	70.70	15	94.26	25	117.83	25	235.66	33	353.48	33	471.31	35	589.14	35
55	72.82	15	97.09	25	121.36	25	242.73	33	364.09	33	485.45	35	606.82	35
56	75.00	15	100.00	25	125.00	25	250.01	33	375.01	33	500.02	35	625.02	35
57	77.25	15	103.00	25	128.75	25	257.51	33	386.26	35	515.02	35	643.77	35
58	79.57	15	106.09	25	132.62	25	265.23	33	397.85	35	530.47	35	663.08	35
59	81.96	15	109.28	25	136.60	25	273.19	33	409.79	35	546.38	35	682.98	35
60	84.42	25	112.55	25	140.69	25	281.39	33	422.08	35	562.77	35	703.47	35
61	86.95	25	115.93	25	144.91	25	289.83	33	434.74	35	579.66	35	724.57	35
62	89.56	25	119.41	25	149.26	25	298.52	33	447.78	35	597.05	35	746.31	35
63	92.24	25	122.99	25	153.74	28	307.48	33	461.22	35	614.96	35	768.70	35
64	95.01	25	126.68	25	158.35	28	316.70	33	475.05	35	633.41	35	791.76	35

Wage income (Inc.) is expressed in thousands of dollars and marginal tax rate (Tax) is expressed in percentage terms. Income growth rate is assumed to be 3% per year.

choice of savings account. However, the marginal tax rate for Roth IRA savers is determined only by the annuity payment from the 401(k) plans only. The size of these annuity payments is determined by the 401(k) plan contribution size, contributions to the IRA or Roth, income growth, marginal tax rate, and rate of return.

Finally, we incorporate the impact of Social Security payments, as well. Social Security benefits are based on the 35 highest earning years before retirement according to the Social Security Administration's benefit schedule.<sup>3</sup> These benefits are part of the saver's retirement

annuity, and we assume that 85% of the benefits are taxable in the withdrawal phase as a factor in determining the relevant tax rate applicable to distributions from a traditional IRA.

#### 4. Comparison of IRA and Roth IRA strategies

##### 4.1. No real wage growth and aggressive saving rates

In this section, we consider a traditional IRA savings strategy and a Roth IRA savings strategy with and without real income growth. Panel A of Table 3 presents the retirement outcome for savers with no real income growth and who contribute \$2,000 (pre-tax) to their traditional IRA or Roth IRA. We consider higher contribution levels below. The Wage column denotes their starting income level. The 401(k) Annuity column shows the pre-tax annuity payments resulting from their 401(k) savings plan, which naturally increases as income increases since 401(k) savings are assumed a percentage of income. Trad IRA Annuity represents the pre-tax annuity payments received from their traditional IRAs, which is the same for all levels of income because the pre-tax savings is assumed a constant pre-tax \$2,000 per year. SS represents the portion of the annuity from Social Security. Tax Rate denotes the marginal tax rate because of the combined income from 401(k) plans and IRAs.

After-Tax Annuity represents the after-tax cash flow of annuity payments from both the 401(k) plan and the traditional IRA using the taxpayer's progressive tax rate schedule. The marginal tax rates in retirement for traditional IRA savers varies from 15% to 35%. As expected, the after-tax annuity payments increase with income level. For the traditional IRA strategy, 401(k) annuity payments increase with income level whereas traditional IRA annuity payments remain fixed.

In a similar fashion, the remaining columns represent cash flows associated with a Roth IRA saving strategy. The annuity payments for the Roth IRA decrease with income level because the marginal tax for higher wage earners increases thereby decreasing the after-tax contribution to the Roth IRA. However, because Roth IRA distributions are untaxed, 401(k) distributions have the potential to be taxed at a lower marginal tax rate in retirement. For example, in Panel A that displays results for no real wage growth and a 15% contribution to the Pension Plan savers with initial wages of \$40,000 have a 15% marginal tax rate in retirement under that Roth IRA strategy, but a 25% marginal tax rate under the traditional IRA strategy.

Panel A also shows that the Roth IRA strategy produces more retirement income for a \$2,000 annual contribution under the no real wage growth scenario (Panel A) although the difference is somewhat modest. As a result, Roth IRA savers are better off than traditional IRA savers in this situation as noted by the figures in bold. Although the accumulations in the 401(k) plan are the same for both traditional IRA and Roth IRA savers in the same income level, the after-tax annuity payments from the traditional IRA and Roth IRA are different. The saver with an initial wage of \$30,000 has the same marginal tax rate in retirement, but still enjoys a higher after-tax annuity payment because the traditional IRA contributions for these investors received a tax deduction of only 10% (see Table 2). The

Table 3 After-tax annuity values assuming pre-tax contributions of \$2,000 annually

Wage	Traditional IRA strategy					Roth IRA strategy				
	401(k) annuity	Trad IRA annuity	SS	Tax rate	After-tax annuity	401(k) annuity	Roth IRA annuity	SS	Tax rate	After-tax annuity
<i>Panel A: No real income growth with 15% contribution to the pension plan</i>										
30	38.57	17.14	12.56	15%	61.52	38.57	15.43	12.56	15%	<b>62.38</b>
40	51.43	17.14	15.28	25%	74.67	51.43	14.57	15.28	15%	<b>74.76</b>
50	64.28	17.14	18.00	25%	86.36	64.28	14.57	18.00	15%	<b>88.00</b>
100	128.57	17.14	24.92	28%	139.12	128.57	12.86	24.92	25%	<b>139.64</b>
150	192.85	17.14	31.30	33%	188.84	192.85	12.34	31.30	28%	<b>189.70</b>
200	257.13	17.14	37.67	33%	236.18	257.13	12.34	37.67	33%	<b>237.04</b>
250	321.41	17.14	44.05	35%	283.38	321.41	11.49	44.05	33%	<b>283.52</b>
<i>Panel B: Three percent real income growth with 5% contribution to the pension plan</i>										
30	20.10	17.14	19.83	15%	52.01	20.10	14.71	19.83	10%	<b>52.14</b>
40	26.81	17.14	22.39	15%	<b>59.87</b>	26.81	14.26	22.39	10%	59.57
50	33.51	17.14	24.94	15%	<b>67.74</b>	33.51	14.02	24.94	10%	67.18
100	67.01	17.14	37.71	25%	<b>103.19</b>	67.01	12.51	37.71	15%	102.84
150	100.52	17.14	50.47	28%	<b>137.33</b>	100.52	11.93	50.47	25%	136.91
200	134.03	17.14	63.24	28%	<b>170.64</b>	134.03	11.54	63.24	25%	169.84
250	167.53	17.14	76.01	33%	<b>201.84</b>	167.53	11.34	76.01	28%	201.69
<i>Panel C: Three percent real income growth with 10% contribution to the pension plan</i>										
30	40.21	17.14	19.83	15%	69.09	40.21	14.71	19.83	15%	<b>69.23</b>
40	53.61	17.14	22.39	25%	81.64	53.61	14.26	22.39	15%	<b>82.35</b>
50	67.01	17.14	24.94	25%	93.61	67.01	14.02	24.94	15%	<b>94.77</b>
100	134.03	17.14	37.71	28%	152.26	134.03	12.51	37.71	25%	<b>152.43</b>
150	201.04	17.14	50.47	33%	207.18	201.04	11.93	50.47	28%	<b>207.62</b>
200	268.05	17.14	63.24	33%	260.63	268.05	11.54	63.24	33%	<b>260.69</b>
250	335.07	17.14	76.01	35%	313.03	335.07	11.34	76.01	33%	<b>313.23</b>
<i>Panel D: Three percent real income growth with 15% contribution to the pension plan</i>										
30	60.31	17.14	19.83	25%	84.75	60.31	14.71	19.83	15%	<b>86.32</b>
40	80.42	17.14	22.39	25%	101.75	80.42	14.26	22.39	15%	<b>103.16</b>
50	100.52	17.14	24.94	25%	118.74	100.52	14.02	24.94	25%	<b>119.90</b>
100	201.04	17.14	37.71	33%	198.63	201.04	12.51	37.71	28%	<b>199.65</b>
150	301.56	17.14	50.47	33%	274.53	301.56	11.93	50.47	33%	<b>274.97</b>
200	402.08	17.14	63.24	35%	348.29	402.08	11.54	63.24	35%	<b>348.69</b>
250	502.60	17.14	76.01	35%	421.93	502.60	11.34	76.01	35%	<b>422.13</b>

All figures are expressed in thousands of dollars except where noted. Wage represents the income level at which savers start their careers. 401(k) Annuity is the pre-tax annuity payment they receive from their 401(k) plan. Trad IRA Annuity is the pre-tax annuity payments they receive from their traditional IRA. SS is Social Security benefits. Tax rate is the marginal tax rate because of their combined income from 401(k) plans and IRAs. After-Tax Annuity represents the net after-tax cash flow that savers receive from their 401(k) plan and IRA in retirement. Similarly, in the remaining columns savers are considered who are saving in 401(k) plans and Roth IRA plans. Income growth rate and rate of return are assumed to be 3% and 5%, respectively. The number of working years and retirement years are assumed to be 40 and 25 years, respectively.

distributions, however, are subject to a higher 15% tax rate thereby decreasing the attractiveness of the traditional IRA strategy. As a result, the Roth IRA is more attractive. This analysis demonstrates that even when the marginal retirement tax rate is the same between the traditional IRA and Roth IRA strategy, savers can be better off with a Roth IRA strategy

if their initial contributions would only receive a small tax benefit. The differences for all wage earners range from 0% to 1.9% extra after-tax income annually.

#### *4.2. Real wage growth and moderate savings rates*

In Panel B through Panel D of Table 3, we report scenarios when income grows at a 3% real rate annually. Because saving 15% of one's income in addition to contributing to an IRA is a relatively aggressive savings plan, especially for savers in the United States, we also examine scenarios with more modest savings rates of 5% and 10% in these Panels.

At a lower pension saving rate of 5%, savers of almost all wealth levels are better off using a traditional IRA (Panel B). In this case, the marginal tax rate in retirement falls substantially enough to make the traditional IRA a more attractive alternative. As individuals save more aggressively, however, the marginal tax rate in retirement increases making the Roth IRA more attractive. Panel C, for example, presents results for individuals saving 10% of their income in their pension plan in which case the Roth IRA become slightly more attractive.

Panel D displays results for pension savings of 15%. The marginal retirement tax rates for some savers increase compared to the no real wage growth case, which assumes the same savings rate. In addition, the Roth IRA annuity payments decrease with income level (as in Panel A) because the after-tax contribution to the Roth IRA decreases as the contribution tax rate increases with income. Similar to the no real income growth case, the Roth IRA strategy results in higher total after-tax annuity payments because at least some of the traditional IRA contributions in the early years receive a relatively small tax deduction but their distributions are taxed relatively heavily as income grows and the marginal tax rate increases. In addition, like the no real income growth case, differences for all wages earners range from 0% to 1.9% extra after-tax income annually.

#### *4.3. Larger IRA contributions*

Table 4 presents a similar analysis for a \$5,000 annual contribution. The results are qualitatively similar to the \$2,000 contribution, but the differences are more pronounced because the increase in marginal tax rates (from the contribution years to the retirement years) is more pronounced. For example, consider the saver with an initial wage of \$30,000. Her initial marginal tax rate after personal exemptions and standard deductions when she begins contributing is 10% (see Table 2). If she experiences 3% real wage growth and pursues a traditional IRA strategy with an aggressive 15% savings rate in her pension plan, however, her marginal tax rate in retirement increases to 25% (see Table 4, Panel D). This increase in marginal tax rate severely penalizes the traditional IRA strategy and favors the Roth IRA strategy. The differences for all wages earners range from 0.6% to 3.1% extra after-tax income annually. The Roth IRA is often still better for many savers with more moderate pension plan saving rates (Panel B and Panel C). One exception is higher income wage earners saving 5% of their income in pension plans (Panel B).

This analysis demonstrates that the process for determining the marginal tax rate is a key ingredient in comparing a traditional IRA savings strategy with a Roth IRA saving strategy. In the presence of a progressive tax rate and other sources of retirement income such as a

Table 4 After-tax annuity values assuming pre-tax contributions of \$5,000 annually

Wage	Traditional IRA strategy					Roth IRA strategy				
	401(k) annuity	Trad IRA annuity	SS	Tax rate	After-tax annuity	401(k) annuity	Roth IRA annuity	SS	Tax rate	After-tax annuity
<i>Panel A: No real income growth</i>										
30	38.57	42.86	12.56	25%	82.28	38.57	38.57	12.56	15%	<b>85.52</b>
40	51.43	42.86	15.28	25%	93.96	51.43	36.43	15.28	15%	<b>96.62</b>
50	64.28	42.86	18.00	25%	105.64	64.28	36.43	18.00	15%	<b>109.86</b>
100	128.57	42.86	24.92	28%	157.64	128.57	32.14	24.92	25%	<b>158.92</b>
150	192.85	42.86	31.30	33%	206.07	192.85	30.86	31.30	28%	<b>208.21</b>
200	257.13	42.86	37.67	33%	253.41	257.13	30.86	37.67	33%	<b>255.55</b>
250	321.41	42.86	44.05	35%	300.10	321.41	28.71	44.05	33%	<b>300.75</b>
<i>Panel B: Three percent real income growth with 5% contribution to the pension plan</i>										
30	20.10	42.86	19.83	15%	73.86	20.10	36.77	19.83	10%	<b>74.21</b>
40	26.81	42.86	22.39	25%	80.82	26.81	35.66	22.39	10%	<b>80.96</b>
50	33.51	42.86	24.94	25%	87.77	33.51	35.04	24.94	10%	<b>88.21</b>
100	67.01	42.86	37.71	25%	<b>122.47</b>	67.01	31.28	37.71	15%	121.61
150	100.52	42.86	50.47	28%	<b>155.84</b>	100.52	29.82	50.47	25%	154.80
200	134.03	42.86	63.24	33%	<b>188.06</b>	134.03	28.85	63.24	25%	187.16
250	167.53	42.86	76.01	33%	<b>219.06</b>	167.53	28.35	76.01	28%	218.70
<i>Panel C: Three percent real income growth with 10% contribution to the pension plan</i>										
30	40.21	42.86	19.83	25%	88.96	40.21	36.77	19.83	15%	<b>91.30</b>
40	53.61	42.86	22.39	25%	100.93	53.61	35.66	22.39	15%	<b>103.75</b>
50	67.01	42.86	24.94	25%	112.90	67.01	35.04	24.94	15%	<b>115.79</b>
100	134.03	42.86	37.71	28%	170.77	134.03	31.28	37.71	25%	<b>171.20</b>
150	201.04	42.86	50.47	33%	224.41	201.04	29.82	50.47	28%	<b>225.51</b>
200	268.05	42.86	63.24	33%	277.86	268.05	28.85	63.24	33%	<b>278.00</b>
250	335.07	42.86	76.01	35%	329.75	335.07	28.35	76.01	33%	<b>330.24</b>
<i>Panel D: Three percent real income growth with 15% contribution to the pension plan</i>										
30	60.31	42.86	19.83	25%	104.04	60.31	36.77	19.83	15%	<b>108.38</b>
40	80.42	42.86	22.39	25%	121.03	80.42	35.66	22.39	15%	<b>124.55</b>
50	100.52	42.86	24.94	28%	137.46	100.52	35.04	24.94	25%	<b>140.92</b>
100	201.04	42.86	37.71	33%	215.85	201.04	31.28	37.71	28%	<b>218.42</b>
150	301.56	42.86	50.47	35%	291.37	301.56	29.82	50.47	33%	<b>292.86</b>
200	402.08	42.86	63.24	35%	365.01	402.08	28.85	63.24	35%	<b>366.00</b>
250	502.6	42.86	76.01	35%	438.64	502.6	28.35	76.01	35%	<b>439.14</b>

All figures are expressed in thousands of dollars except where noted. Wage represents the income level at which savers start their careers. 401(k) Annuity is the pre-tax annuity payment they receive from their 401(k) plan. Trad IRA Annuity is the pre-tax annuity payments they receive from their traditional IRA. SS is Social Security benefits. Tax rate is the marginal tax rate because of their combined income from 401(k) plans and IRAs. After-Tax Annuity represents the net after-tax cash flow that savers receive from their 401(k) plan and IRA in retirement. Similarly, in the remaining columns savers are considered who are saving in 401(k) plans and Roth IRA plans. Income growth rate and rate of return are assumed to be 3% and 5%, respectively. The number of working years and retirement years are assumed to be 40 and 25 years, respectively.

pension and social security, the marginal tax rate for retirement distributions may be ambiguous. Nonetheless, the tension between progressivity in the tax rate (which creates the possibility that retirement could be taxed lightly) and other retirement accumulations (that tends to increase the marginal withdrawal tax rate) needs to be recognized in selecting IRA

or Roth IRA. In general, though, less (more) aggressive saving rates outside the IRA strategy favor the traditional (Roth) IRA.

#### 4.4. *Investment returns*

To this point, we have assumed that funds accumulate at a fairly generous 5% real rate of return, resulting in retirement income replacement rates (i.e., retirement income relative to preretirement income) that exceed 100%. A panel study of income dynamics as interpreted by Bernheim, Skinner, and Wienberg (1997) shows that retirement income tends to be less than pre-retirement income. A priori, we would expect higher rates of return to increase tax rates in retirement and therefore favor the Roth IRA strategy. We explore the impact of return for real rates of return ranging from 2.5% to 6%, and perform a similar analysis using the lower contribution amount of \$2,000 and income growth. The results are reported in Table 5.

Naturally, retirement income varies directly with return. The traditional IRA is relatively more attractive for lower rates of return (Panel A) because the retiree experiences a lower marginal tax rate in retirement. The Roth IRA becomes relative more attractive for higher returns because tax rates in retirement increase. The difference in after-tax annual income is also larger, up to 2.5% depending on the extent to which the retirement tax rate increases.

The results presented here have implications for an IRA switching strategy. In reality, an investor need not commit to a specific IRA strategy for the whole of their working life. That is, they could certainly begin their savings strategy with Roth IRAs when their marginal contribution tax rates are low. If they pursue a more aggressive investment strategy at that time, they might have an additional reason to begin using a Roth IRA. As the wage earner progresses through the life cycle into higher tax brackets, they may then switch to a traditional IRA strategy when the front-end tax deduction is more valuable. We leave a more complete analysis of switching strategies for future research.

### 5. **Summary comparisons**

We start this section with some key observations from the results presented earlier. Table 6 presents the percentage increases in after-tax income from the Roth IRA strategy compared to the traditional IRA strategy. The second and sixth columns show the extra returns from the Roth IRA strategy without and with real income growth assuming a \$2,000 annual pre-tax contribution and a 6% real return for aggressive savers (e.g., saving 15% of income in the pension plan). The Roth IRA strategy generates an extra 0.05% to 2.50% after-tax income. As we have seen before, column three shows the traditional IRA becomes relatively more attractive when pension saving is more moderate and the rate of return is low.

For a larger \$5,000 annual contribution, income improvements range from 0.11% to 4.17%. Again, the relative value of a Roth IRA saving strategy is positively related to an investor's pension savings rate.

The differences are not monotonic in income because they are driven by changes in marginal tax rates from working years to retirement years rather than by income level per se.

Table 5 After-tax annuity values assuming pre-tax contributions of \$2,000 annually for different rates of return

Wage	Traditional IRA strategy					Roth IRA strategy				
	401(k) annuity	Trad IRA annuity	SS	Tax rate	After-tax annuity	401(k) annuity	Roth IRA annuity	SS	Tax rate	After-tax annuity
<i>Panel A: Three percent real income growth and 2.5% rate of return</i>										
30	28.18	7.32	19.83	15%	50.52	28.18	6.23	19.83	10%	<b>50.53</b>
40	37.58	7.32	22.39	15%	<b>60.68</b>	37.58	6.02	22.39	15%	60.48
50	46.97	7.32	24.94	15%	<b>70.83</b>	46.97	5.90	24.94	15%	70.51
100	93.95	7.32	37.71	25%	<b>116.02</b>	93.95	5.29	37.71	25%	115.82
150	140.92	7.32	50.47	28%	<b>159.34</b>	140.92	5.04	50.47	25%	159.12
200	187.89	7.32	63.24	33%	<b>200.34</b>	187.89	4.90	63.24	28%	200.33
250	234.87	7.32	76.01	33%	<b>240.37</b>	234.87	4.82	76.01	33%	240.29
<i>Panel B: Three percent real income growth and 3.5% rate of return</i>										
30	38.07	10.26	19.83	15%	61.43	38.07	8.76	19.83	15%	<b>61.47</b>
40	50.76	10.26	22.39	25%	<b>74.35</b>	50.76	8.49	22.39	15%	74.15
50	63.45	10.26	24.94	25%	85.78	63.45	8.32	24.94	15%	<b>86.41</b>
100	126.91	10.26	37.71	28%	142.18	126.91	7.45	37.71	25%	<b>142.24</b>
150	190.36	10.26	50.47	33%	195.41	190.36	7.10	50.47	28%	<b>195.64</b>
200	253.82	10.26	63.24	33%	246.48	253.82	6.88	63.24	33%	<b>246.49</b>
250	317.27	10.26	76.01	35%	296.99	317.27	6.77	76.01	33%	<b>297.10</b>
<i>Panel C: Three percent real income growth and 5% rate of return</i>										
30	60.31	17.14	19.83	25%	84.75	60.31	14.71	19.83	15%	<b>86.32</b>
40	80.42	17.14	22.39	25%	101.75	80.42	14.26	22.39	15%	<b>103.16</b>
50	100.52	17.14	24.94	25%	118.74	100.52	14.02	24.94	25%	<b>119.90</b>
100	201.04	17.14	37.71	33%	198.63	201.04	12.51	37.71	28%	<b>199.65</b>
150	301.56	17.14	50.47	33%	274.53	301.56	11.93	50.47	33%	<b>274.97</b>
200	402.08	17.14	63.24	35%	348.29	402.08	11.54	63.24	35%	<b>348.69</b>
250	502.60	17.14	76.01	35%	421.93	502.60	11.34	76.01	35%	<b>422.13</b>
<i>Panel D: Three percent real income growth and 6% rate of return</i>										
30	82.42	24.21	19.83	25%	106.64	82.42	20.83	19.83	15%	<b>109.31</b>
40	109.89	24.21	22.39	28%	128.94	109.89	20.22	22.39	25%	<b>131.21</b>
50	137.36	24.21	24.94	28%	150.56	137.36	19.89	24.94	25%	<b>153.02</b>
100	274.72	24.21	37.71	33%	252.73	274.72	17.73	37.71	33%	<b>254.24</b>
150	412.08	24.21	50.47	35%	351.09	412.08	16.90	50.47	35%	<b>352.25</b>
200	549.44	24.21	63.24	35%	448.67	549.44	16.34	63.24	35%	<b>449.27</b>
250	686.8	24.21	76.01	35%	546.25	686.80	16.04	76.01	35%	<b>546.55</b>

All figures are expressed in thousands of dollars except where noted. Wage represents the income level at which savers start their careers. 401(k) Annuity is the pre-tax annuity payment they receive from their 401(k) plan. Trad IRA Annuity is the pre-tax annuity payments they receive from their traditional IRA. SS is Social Security benefits. Tax rate is the marginal tax rate because of their combined income from 401(k) plans and IRAs. After-Tax Annuity represents the net after-tax cash flow that savers receive from their 401(k) plan and IRA in retirement. Similarly, in the remaining columns savers are considered who are saving in 401(k) plans and Roth IRA plans. Income growth rate and rate of return are assumed to be 3% and 5%, respectively, and investors are assumed to saving 15% of their income in a separate defined-contribution pension plan. The number of working years and retirement years are assumed to be 40 and 25 years, respectively.

If income tax rates increase substantially in retirement, the Roth IRA strategy performs better. This analysis show that progressive tax rates may alter the conclusions one makes

Table 6 Summary comparison of gains from saving in Roth IRA relative to IRA

Wage (\$)	Pre-tax contribution \$2,000					Pre-tax contribution \$5,000	
	Without income growth (Return = 6%)	With income growth (Return = 2.5%)	With income growth (Return = 3.5%)	With income growth (Return = 5%)	With income growth (Return = 6%)	Without income growth	With income growth (Return = 5%)
30,000	1.40	0.02	0.07	1.85	2.50	3.94	4.17
40,000	0.12	-0.33	-0.27	1.39	1.76	2.83	2.91
50,000	1.90	-0.45	0.73	0.98	1.63	3.99	2.52
100,000	0.37	-0.17	0.04	0.51	0.60	0.81	1.19
150,000	0.46	-0.14	0.12	0.16	0.33	1.04	0.51
200,000	0.36	0.00	0.00	0.11	0.13	0.84	0.27
250,000	0.05	-0.03	0.04	0.05	0.05	0.22	0.11

Gains (%) obtained in after-tax annuity payments by saving in the Roth IRA as opposed to IRA. Listed wages are the wages that savers start with in the beginning of their working career. If there is growth in income, it is assumed to be 3% per year, and investors are assumed to saving 15% of their income in a separate defined-contribution pension plan.

compared to assuming fixed tax rates. It also demonstrates that comparing one's tax rate during working years and retirement years is a challenging task. It depends on, among other things, the aggressiveness of one's savings plan, the realized returns of those investments, and the presence of other retirement income.

We examine the impact of rate of return more broadly in Table 7, which presents the ratio of after-tax dollar cash flow received by traditional IRA savers to that of Roth IRA savers for various income levels, contribution levels, and rates of return. The investor is assumed to be aggressively saving in the pension plan, which favors the Roth IRA. The traditional IRA strategy performs better for low real rates of return, such as 1% and 3%, as denoted by ratios greater than one. For higher real rates of return, the Roth IRA strategy is better, denoted by ratios less than one. For a given rate of return, the ratios tend to increase as the level of initial income increase especially for higher rates of return, indicating the superior gains from the Traditional IRA strategy for savers with lower initial income level. For example, for \$2,000 contribution level with 5% rate of return, the ratio is 0.9818 for an income of \$30,000. At \$250,000 of income, it is 0.9995. The patterns are not monotonic, however, because they are driven by changes in pre- and post-retirement tax rates rather than by income levels, per se.

As the contribution level increases, the benefit of saving in the Roth IRA also increases. For example, if we consider the initial income level of \$30,000 and rate of return of 5%, the ratios for contributions of \$2,000, \$3,000, \$4,000, and \$5,000 are 0.9818, 0.9734, 0.9662, and 0.9599, respectively. This pattern holds true for all income levels and return levels because greater contributions lead to greater increases in post-retirement tax rates. Fig. 1 shows the relative value of the traditional IRA strategy compared to the Roth IRA strategy for various rates of return graphically, assuming \$30,000 of initial income. All income levels show similar patterns.

The relationship between the ratio and rate of return is non-linear and negative, indicating

Table 7 Ratios of after-tax annuity payments from a traditional IRA to a Roth IRA for various returns and contribution levels

Return	1%	3%	5%	7%
<b>Contribution</b>				
<b>\$2,000</b>				
30	1.0003	0.9996	0.9818	0.9689
40	1.0031	1.0032	0.9864	0.9763
50	1.0042	0.9980	0.9903	0.9744
100	1.0016	1.0003	0.9949	0.9912
150	1.0024	1.0001	0.9984	0.9962
200	1.0016	1.0000	0.9989	0.9985
250	1.0003	1.0003	0.9995	0.9994
<b>Contribution</b>				
<b>\$3,000</b>				
30	1.0005	0.9994	0.9734	0.9562
40	1.0045	1.0046	0.9809	0.9655
50	1.0061	0.9949	0.9859	0.9636
100	1.0024	1.0001	0.9925	0.9873
150	1.0035	0.9996	0.9975	0.9945
200	1.0023	1.0000	0.9983	0.9977
250	1.0004	1.0005	0.9993	0.9991
<b>Contribution</b>				
<b>\$4,000</b>				
30	1.0006	0.9992	0.9662	0.9456
40	1.0058	1.0053	0.9760	0.9535
50	1.0079	0.9922	0.9804	0.9541
100	1.0031	1.0000	0.9903	0.9836
150	1.0045	0.9991	0.9962	0.9929
200	1.0031	1.0000	0.9978	0.9970
250	1.0006	1.0007	0.9991	0.9988
<b>Contribution</b>				
<b>\$5,000</b>				
30	1.0007	0.9991	0.9599	0.9367
40	1.0070	1.0008	0.9717	0.9432
50	1.0096	0.9896	0.9754	0.9458
100	1.0038	0.9999	0.9882	0.9803
150	1.0051	0.9987	0.9949	0.9913
200	1.0038	1.0000	0.9973	0.9964
250	1.0007	1.0008	0.9989	0.9985

Under each contribution level initial income levels are listed. The assumed income growth is 3%, and investors are assumed to be saving 15% of their income in a separate defined-contribution pension plan.

the gains to the Roth IRA increase at a decreasing rate (see Fig. 1). As the rate of return increases, the benefit from saving in the Roth IRA also increases, but the marginal benefit obtained declines as well. In addition, as the contribution increases, the curves shift downward confirming the notion that the Roth IRA is relatively more attractive for aggressive savers whereas the traditional IRA is relatively more attractive for less aggressive savers because larger contributions increase the marginal tax rate in retirement.

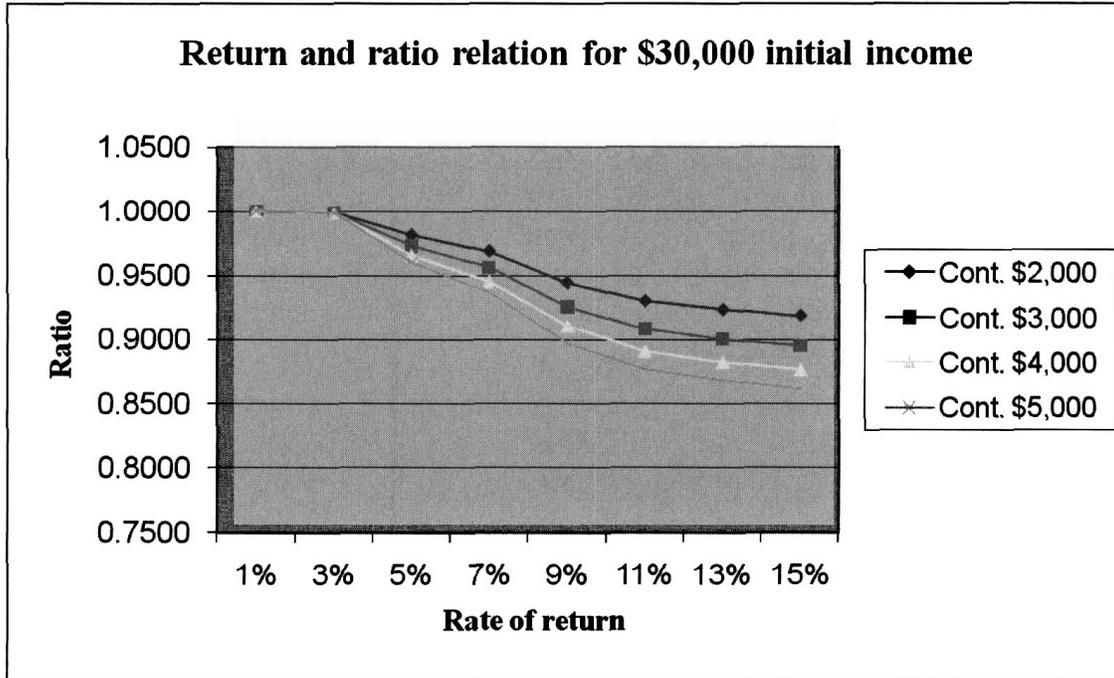


Figure 1.

## 6. Conclusions

We examine the impact of income growth, progressive tax rates, exogenous retirement income, and rates of return on the optimal choice of retirement saving vehicles in the presence of other pension income (such as income from 401(k) plans). For aggressive savers enjoying high rates of return, the Roth IRA can be a better choice than a traditional IRA. The intuition for this result is that these conditions create high-income replacement rates, which in turn increase the rate at which traditional IRA distributions are taxed. For similar reasons, retirees with relatively high retirement income from other sources, such as defined-benefit pension plans, may face high tax rates under a progressive regime, and therefore favor a Roth IRA. Less aggressive savers, those with little other retirement income, and those experiencing lower investment returns may prefer the traditional IRA because their withdrawal tax rate is likely to be more modest under a progressive tax rate regime.

These results depend heavily on the presence of other retirement income, such as pension income and social security. The Roth IRA becomes relatively more attractive as other taxable retirement income increases because the marginal tax rate will increase, as well. The positive relationship between return and gains from the Roth IRA is non-linear with decreasing marginal gains as return increases.

This article shows the value of incorporating progressive tax rate and income growth in retirement saving analysis as opposed to the fixed tax rate and income assumptions, which are common in the literature. Most of the analysis is based on sensitivity and scenario analysis, so the results are an artifact of the specific parameterization. However, we have considered a wide range of scenarios that provide intuitive results even beyond the scenarios

considered here. It also provides a framework by which planners might build their own models to estimate the relevant tax rate for retirement withdrawals.

Future research might examine the impact of required minimum distributions and stochastic investment returns. Our prediction is that stochastic investment returns will have the effect of increasing accumulations in the accumulation phase through dollar cost averaging and therefore favor the attractiveness of the Roth IRA. Another opportunity for future investigation is articulating a more robust switching strategy in which a saver might switch from one savings vehicle to another. In any case, this article demonstrates the importance of understanding a retiree's likely tax posture in retirement when making the choice between a traditional IRA and a Roth IRA.

## Notes

1. Tax brackets typically increase annually in nominal term so this feature of the model is a moving target. As noted above, however, tax brackets often remain constant in real terms. Moreover, although we assume tax brackets for a married couple filing jointly, the general concept of incorporating wage growth, progressive tax rate, pension saving, and social security remains relevant for all filing statuses. However, updates to the tax code will not detract from the qualitative conclusions derived here.
2. Here we use fixed rates for simplicity, however, varying rate of return can be easily incorporated and our qualitative conclusions are not expected to change. Our analysis generalizes for risky assets and richer tax details the types discussed in Horan (2005).
3. See, for example, <http://www.ssa.gov/pubs/10070.html>.

## References

- Bernheim, B. D., Skinner, J. S., & Wienberg, S. (1997). *What Accounts for the Variation in Retirement Wealth Among U.S. Households?* Mimeo (Stanford University).
- Caliendo, F., & Cris Lewis, W. (2002). Myths and truths of IRA investing. *Journal of Financial Planning*, 15, 86–94.
- Crain, T. L., & Austin, J. R. (1997). An analysis of the tradeoff between tax deferred earnings in IRAs and Preferential Capital Gains. *Financial Services Review*, 4, 227–242.
- Horan, S. M. (2007a). An alternative approach to after-tax valuation. *Financial Services Review*, 16, 167–182.
- Horan, S. M. (2007b). Applying after-tax asset allocation. *Journal of Wealth Management*, 10, 84–93.
- Horan, S. M. (2006a). Withdrawal location with progressive tax rates. *Financial Analysts Journal*, 62, 77–87.
- Horan, S. M. (2006b). Optimal withdrawal strategies for retirees with multiple savings accounts. *Journal of Financial Planning*, 19, 62–75.
- Horan, S. M. (2005). *Tax-Advantaged Savings Accounts and Tax-Efficient Wealth Accumulation*. Charlottesville, VA: Research Foundation of CFA Institute.
- Horan, S. M. (2004). Breakeven holding periods for tax advantaged savings accounts with early withdrawal penalties. *Financial Services Review*, 13, 233–247.
- Horan, S. M. (2003). Choosing between tax-advantaged savings accounts: A reconciliation of standardized pre-tax and after-tax frameworks. *Financial Services Review*, 12, 339–357.
- Horan, S. M., & Peterson, J. H. (2001). A reexamination of tax-deductible IRAs, Roth IRAs, and 401(k) investments. *Financial Services Review*, 10, 87–100.

- Horan, S. M., Peterson, J. H., & McLeod, R. (1997). An analysis of non-deductible IRA contributions and Roth IRA conversions. *Financial Services Review*, 6, 243–256.
- Hughen, J. C., Laatsch, F. E., & Klein, D. P. (2002). Withdrawal pattern and rebalancing cost for taxable portfolios. *Financial Services Review*, 11, 341–366.
- Kaplan, P. D. (2006). Asset allocation with annuities for retirement income management. *Journal of Wealth Management*, 8, 27–40.
- Krishnan, V. S., & Lawrence, S. (2001). Analysis of investment choices for retirement: A new. *Approach and Perspective*, 10, 75–86.
- Reichenstein, W. (2007). Implications of principal, risk, and returns sharing across savings vehicles. *Financial Services Review*, 16, 1–17.
- Reichenstein, W. (2006). After-tax asset allocation. *Financial Analysts Journal*, 62, 16–26.
- Reichenstein, W., & Jennings, W. (2003). *Integrating Investments and the Tax Code*. Hoboken, NJ: John Wiley and Sons.
- Spitzer, J. J., & Singh, S. (2006). Extending retirement payouts by optimizing the sequence of withdrawals. *Journal of Financial Planning*, 19, 52–61.
- Spitzer, J. J., Strieter, J. C., & Singh, S. (2008). Adaptive withdrawals. *Journal of Investing*, 17, 104–113.
- Zaman, A. A. (2008). Reconsidering IRA and Roth IRA keeping bequests and other options in mind. *The Journal of Wealth Management*, 11, 82–92.