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The impact of the Tax Cut and Jobs Act on IRA choice for moderate income investors

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Abstract

While the choice of appropriate individual retirement account (IRA) type involves many factors, it is well known that differences in tax rates during the working and retirement years impact the optimal choice. Lower rates of return on investment may cause an investor to prefer a Traditional IRA whereas higher rates of return often result in higher after-tax future wealth for the Roth IRA. The lower statutory tax rates for individuals resulting from the 2018 Tax Cut and Jobs Act raises the breakeven rate of return where the Roth becomes preferable for many moderate income individuals who invest the amount of the deduction generated by the Traditional IRA. The new tax law significantly increases the breakeven rates for investors who begin investing at an older age. Moderate income investors are defined as those who will be in the 22% marginal tax bracket during their working years. Many investors do not invest the tax savings generated by a qualifying Traditional IRA. For these individuals a spreadsheet model is used to compare contribution and retirement real consumption. The Traditional IRA can be a better choice for many moderate income individuals who want to maximize their total lifetime real consumption rather than retirement consumption, and the compression in tax rates of the new tax law increases the number of outcomes where the Traditional IRA yields higher total consumption.

JEL classification: Paper classifications; G110 portfolio choice; Investment decisions; D140 household saving; Personal finance

Keywords: Financial planning; Retirement account; Personal finance; Personal savings

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1. Introduction

Contributions to Roth individual retirement accounts (IRAs) are not tax deductible, while for many moderate income investors contributions to a Traditional IRA are deductible. Subject to certain rules the withdrawals from a Roth IRA are not taxed, whereas Traditional IRA withdrawals are taxable. The new Tax Cut and Jobs Act (TCJA) generally increases the number of moderate income individuals who may prefer the Traditional over the Roth IRA. Moderate income investors are defined as those who will be in the 22% marginal tax bracket during their working years.[1] When determining whether to choose a Traditional IRA or a Roth IRA conventional wisdom indicates one should consider the individual's tax rate today versus their expected future tax rate (VanZante and Fritzsch, 2013). If a person believes the future tax brackets and tax rates will be lower, or if they will have lower income in retirement, then a Traditional IRA may be the best choice (Grossman and Rose, 2012). In comparison, higher rates of return and contribution amounts lead to higher tax rates on Traditional IRA withdrawals and, thus, favor the Roth IRA. Similarly, lower rates of return on investment and smaller contributions favor the Traditional IRA. The compression of the tax brackets, and the general reduction of the marginal tax rates in the new law, raises the breakeven rate of return beyond which an investor may achieve a higher after-tax future value with a Roth IRA. The breakeven rates of return are calculated before and after the new tax law. The new tax law favors the Traditional IRA for a broader range of returns for individuals who invest the deduction. For older investors with only 15 years to retirement the breakeven rate of return where the Roth provides a greater future value is as high as 21.95% under the new tax law. Most investors are not likely to achieve an average return this high and may be better off with a Traditional IRA.

Adelman and Cross (2010) and Beshears, Choi, Laibson, and Madrian (2017) indicate that many people do not actually invest the deduction generated by contributions to a Traditional IRA, preferring instead to consume the extra income. When comparing future values of the two types of IRAs, the Roth IRA yields higher futures values than the Traditional IRA without the deduction invested in the majority of cases. This has led some authors such as Beshears et al. (2017) to conclude that the Roth provides consistently higher future savings than the Traditional IRA. However, choosing the Roth reduces an investor's real consumption during their working years compared with a Traditional IRA because the Roth contributions are not deductible. Even with the higher future value of a Roth IRA, the Traditional IRA could provide a higher level of lifetime consumption. Monte Carlo simulations were used to determine whether lifetime real consumption is maximized with a Traditional or a Roth IRA for investors who do not invest the deduction generated by a Traditional IRA under various return scenarios. The Traditional IRA provided higher median lifetime consumption than the Roth IRA in the majority of our simulations for moderate income individuals who reduce the risk of their portfolios as they age. The Traditional IRA can be a better choice for many moderate income individuals, regardless of whether they invest the deduction from Traditional IRA contributions if current spending is a concern along with funding retirement. This has not generally been discussed in the literature on retirement investing.[2]

2. IRA usage

According to the Report on the Economic Well Being of Households in 2016 by the Board of Governors of the Federal Reserve System (2017) about 31% of households have an IRA. The most common type IRA is the Traditional IRA, and only a subset of households has a Roth IRA or both types. About half of households have a 401(k), and about 25% have a defined benefit plan, whereas about 28% of households have no retirement investments. The report shows that investors with Roth IRAs are more likely to be higher income, more financially sophisticated and have utilized a financial planner than those who have a Traditional IRA. Smith, Finke, and Huston (2012) find similar results. They show that investors with Roth IRAs were much more likely to be "financially sophisticated" as measured by the extent of their equity investments and/or had consulted a financial planner. Roth IRAs are apparently still not well understood by many households who do not use financial planners, or perhaps planners favor Roth IRAs for their clients. For many investors the best IRA choice depends on many factors such as age, expected portfolio returns over time, risk aversion, liquidity needs, and the willingness to engage in tax management strategies, particularly during retirement. For more on some of the factors that favor the Traditional IRA see Saunders (2018).

2.1. Traditional IRA

An IRA is not an investment per se, but is a tax advantaged investment vehicle. For a Traditional IRA, all deductible contributions and account earnings are subject to income taxation upon disbursement. Thus, an IRA is a type of tax-deferred savings account. If an amount is withdrawn before age 59½, the taxpayer is required to pay tax on the amount withdrawn along with a 10% penalty for the early withdrawal.[3] At age 70½ an investor in a Traditional IRA must begin making withdrawals from the IRA. The withdrawals are termed required minimum distributions (RMDs). RMDs are calculated as the balance from the end of the previous year or life expectancy from the IRS' Uniform Lifetime Table. The table can be found at https://www.irs.gov/pub/irs-tege/uniform_rmd_wksht.pdf. Failure to make the RMD results in a 50% excise tax. Additional tax details are available from the IRS's publication on IRAs found at https://www.irs.gov/retirement-plans/individual-retirement-arrangements-iras. Roth IRAs do not require the investor to make RMDs during their lifetime. A beneficiary of a Roth IRA must make RMDs over the beneficiary's expected life span, but if the beneficiaries are children the required withdrawal is usually small because of a long expected life span. Roth IRAs can, thus, be better for individuals who wish to fund a bequest to their heirs rather than provide funding for their own retirement.

Individuals can open a Traditional IRA as long as they are not older than 70½. In 2018 contributions to IRAs are limited to the lesser of $5,500 ($6,500 if 50 or older) or their taxable compensation for the year; although our model assumes that the IRS, in accordance with Congressional mandates, increases the allowable contribution amount over time to keep up with inflation. The new TCJA calculates the indexing of contribution amounts and tax brackets using the Chained CPI-U index rather than the Traditional CPI-U.[4] The other main tax feature of the Traditional IRA is that, subject to the investor's income and pension

Table 1 Filing status and deductibility with a retirement plan at work (2018 tax year)

Panel A: Filing status and deductibility with a retirement plan at work		
For 2018 if your filing status is . . .	AND your MAGI is. . .	THEN you can take
Single or head of household	$63,000 or less	A full deduction up to your contribution limit
	More than $63,000 but less than $73,000	A partial deduction
	$73,000 or more	No deduction
Married filing jointly or qualified widower	$101,000 or less	A full deduction up to your contribution limit
	More than $101,000 but less than $121,000	A partial deduction
	$121,000 or more	No deduction
Married filing separately	Less than $10,000	A partial deduction
	$10,000 or more	No deduction
Panel B: Filing status and deductibility without a retirement plan at work		
In 2018 if your filing status is . . .	AND your MAGI is. . .	THEN you can take
Single, head of household, or qualifying widower	Any amount	A full deduction up to your contribution limit
Married filing jointly or separately with a spouse who is not covered by a plan at work	Any amount	A full deduction up to your contribution limit
Married filing jointly with a spouse who is covered by a plan at work	$189,000 or less	A full deduction up to your contribution limit
	More than $189,000 but less than $199,000	A partial deduction
	$199,000 or more	No deduction
Married filing separately with a spouse who is covered by a plan at work	Less than $10,000	A partial deduction
	$10,000 or more	No deduction

Note: MAGI = Modified Adjusted Gross Income.

contribution, the contributions to a Traditional IRA may be tax deductible in the year of the contribution.

2.2. Roth IRA

In a Roth IRA the contributions are never tax deductible. However, the contributions and account earnings are not taxable when withdrawn as long as the individual has had the Roth IRA for five years or more and does not make withdrawals before age 59½. Under these conditions, Roth IRA distributions are not subject to income taxation.

2.3. Additional tax considerations for a Traditional IRA

Contributions to a Traditional IRA can usually be used to reduce an individual's Modified Adjusted Gross Income (MAGI). Table 1 Filing Status and Deductibility provides the 2018 taxable year table applicable for individuals that are, or are not, covered by a retirement plan at their place of employment.

Panel A of Table 1 provides deductibility of a Traditional IRA for various filing statuses for individuals that are covered by a retirement plan at work and Panel B of Table 1 provides similar information for those who do not have a retirement plan at work. Withdrawals from a Traditional IRA in retirement can cause Social Security benefits to be taxable, although Adelman and Cross (2010) suggest that this does not usually result in a very large increase in taxes. Medicare premiums may also increase with increased income resulting from a Traditional IRA withdrawal, but not from a Roth. A Traditional IRA also has a valuable option component (Baxendale and Coppage, 2014). Under existing tax rules all or part of Traditional IRAs can be converted to Roth IRAs (termed an IRA rollover). This option is preserved under the 2018 TCJA, although the ability to switch back to a Traditional IRA was eliminated in the new tax bill.

2.4. Additional tax considerations for Roth IRAs

Unlike a Traditional IRA, the principal invested in a Roth IRA can generally be withdrawn without taxation before age 59½ if the funds have been invested for at least five years. Not all investors can make Roth contributions. If an investor makes more than $199,000 in 2018 and has a tax status of married filing jointly then the person cannot contribute to a Roth IRA account, although this income level increases over time. If a person is single, head of household or married filing separately the individual cannot contribute to a Roth if they make more than $135,000, although this income level also increases over time.[5] The contribution limits are the same for the Traditional and the Roth IRA and the limit is cumulative for the two in a given tax year. Excessive contributions to either type of IRA result in a six percent tax penalty that is imposed each year until the excessive contribution and its earnings are removed. An investor must also file Form 5329, or face an additional tax of up to 25% of the excise tax. See the IRS explanation titled, "About Form 5329, Additional Taxes on Qualified Plans (including IRAs) and Other Tax-Favored Accounts" found at https://www.irs.gov/forms-pubs/about-form-5329 or the general discussion provided by Reichert (2011).

2.5. Math models of future values of traditional and Roth IRAs with constant returns and the impact of the TCJA

Examining mathematical models comparing the future value of a Traditional and a Roth IRA can highlight the impacts of the new tax law on the choice. One cannot compare equal dollar investments in a qualifying Traditional and Roth IRA because investments in the Roth are after-tax, but are pre-tax in a Traditional IRA. Most literature comparing the two performs an adjustment to put the two on the same after-tax basis.[6] Because investing X dollars in a Traditional IRA generates a tax deduction that can be invested, many models compare the future value at retirement (or an annuity beginning at retirement) of the Traditional IRA after-tax plus the future value of the extra amount invested as the result of the deduction (see for instance Horan, 2002, 2003). Because the value of the deduction is the tax rate at contribution times the deduction, it is easy to set up a comparison of the future values after-tax of the two alternatives. The latter amount is usually assumed to be invested

in a taxable account. One then compares this sum to the future value of X dollars invested in a Roth IRA. In particular, the Traditional IRA combined with a taxable investment will be preferable to the Roth IRA if the

$$\text{Future Value of Traditional IRA} + \text{Future Value of Taxable Investment} > \text{Future Value of Roth IRA or if } (1 + r)^n (1 - t_w) + t_c[1 + r(1 - t_c)]^n > (1 + r)^n \quad (1)$$

where r is the constant pre-tax rate of return, n is the number of years to retirement, t_c is the tax rate at contribution and t_w is the tax rate upon withdrawal.[7] Withdrawals are assumed to begin after age 59½ and at least 5 years after the funds are invested so that there are no tax penalties. Sibley (2002) and various others model the future values of the two in this way. If the savings from the Traditional IRA are invested in an account with tax deferral benefits, such as non-dividend paying stocks or certain stock mutual funds, then the model understates the future value of the Traditional IRA. For details see Horan (2003, 2006). Higher rates of return, r, and time invested, n, favor the Roth over the Traditional IRA (Al Zaman 2008; Cook, Meyer, and Reichenstein, 2015; Horan, 2003; Horan and Al Zaman, 2009; Reichenstein, 2006; Reichenstein, Horan, and Jennings 2015; Sibley 2002).

Funds invested in any tax deferred annuity (TDA) grow at the pre-tax interest rate r while funds invested in a fully taxable account grow at the after tax rate $r(1-t_c)$. Because of the difference, at higher rates of return the Roth IRA can generate higher retirement income than the after tax value of the combination of the Traditional IRA and a taxable investment even when the tax rate is lower during retirement. Previous literature such as Horan (2003) has shown that while it is often the case that the Traditional IRA combined with a taxable account will yield a higher future value than a Roth IRA if $t_w < t_c$, sometimes the Roth is better even when the tax rate at withdrawal is lower than at the point of contribution if r is high enough. Before the TCJA many moderate income investors were likely to be in the 25% tax bracket during their working years and in the 15% bracket upon retirement. Table 2 compares the breakeven rates of return (r) under the old and new tax laws. At r = 9% or higher the Roth is preferred even if the tax rate at contribution is 25% and at withdrawal is substantially lower at 15%. Before the TCJA of 2018 the personal marginal tax rates started at 10%, increased to 15%, then to 25%, then to 28% and so on up to a maximum of 39.6%. Under the TCJA the personal marginal rates start at 10%, then progress to 12%, 22%, 24%, and so on, up to 37%. As shown in Table 2 the generally lower tax rates under the new law favor the Traditional IRA over the Roth IRA for a broader range of returns earned on invested funds with a given investment horizon.[8]

For a 25 year investment horizon under the 2017 tax rates an investor who had a 25% tax rate during the contribution years and 15% during retirement and who earned a pre-tax rate of return r = 8% on all investments would have been better off in a Traditional IRA. The Traditional is better because the sum of the after-tax future value per dollar invested in the Traditional IRA plus the after-tax future value of the taxable account (= 6.89417) is greater than the future value of the Roth IRA (= 6.848475). If

Table 2 Future value of equal after-tax investments in Traditional IRA plus taxable account compared with future value of Roth IRA

Tax law	t_c	t_w	r	$r_{A\text{-}T}$	*n*	FV Traditional IRA $(1+r)^n(1-t_w)$	FV taxable account $t_c(1+r_{A\text{-}T})^n$	FV Traditional IRA + taxable account Sum	FV Roth $(1+r)^n$	Preference
2017	25%	15%	7.00%	5.25%	25	4.61332	0.89845	5.51177	5.427433	Traditional
	25%	15%	8.00%	6.00%	25	5.82120	1.07297	6.89417	6.848475	Traditional
	25%	15%	9.00%	6.75%	25	7.32962	1.27979	8.60940	8.623081	Roth
	25%	15%	10.00%	7.50%	25	9.20950	1.52458	10.73408	10.83471	Roth
2018	22%	12%	8.00%	6.24%	25	6.02666	0.99914	7.02579	6.848475	Traditional
(TCJA)	22%	12%	9.00%	7.02%	25	7.58831	1.19963	8.78794	8.623081	Traditional
	22%	12%	10.00%	7.80%	25	9.53454	1.43844	10.97298	10.83471	Traditional
	22%	12%	11.00%	8.58%	25	11.95521	1.72254	13.67775	13.58546	Traditional
	22%	12%	12.00%	9.36%	25	14.96006	2.06009	17.02014	17.00006	Traditional
	22%	12%	13.00%	10.14%	25	18.68288	2.46065	21.14353	21.23054	Roth
	22%	12%	14.00%	10.92%	25	23.28649	2.93541	26.22190	26.46192	Roth
	22%	12%	15.00%	11.70%	25	28.96868	3.49745	32.46613	32.91895	Roth

Note: IRA = individual retirement account; TCJA = Tax Cut and Jobs Act; t_c = tax rate at time of contribution; t_w = tax rate upon withdrawal; r = pre-tax rate of return, assumed constant; $r_{A\text{-}T}$ = after tax rate of return on earnings using t_c; *n* = number of years until retirement.

the investor earned nine percent on all alternatives; however, then the Roth generates a higher future value.

Panel A of Table 3 contains the breakeven rates of return under the old and the new tax rates for various investment periods if the deduction generated by the Traditional IRA is invested and is fully taxable at t_c. For instance, with a 25 year time horizon to retirement, the breakeven r under the old tax rates is 8.8024%. At all lower rates of return the Traditional IRA is preferable, but at rates above the breakeven the Roth IRA is preferred, even though the tax rate is substantially lower during retirement. With the new tax law a similar investor may face t_c of 22% and t_w of 12%. In this case the breakeven rate of return is increased to

Table 3 Breakeven return r vs. years to retirement with reinvestment pre- and post-TCJA

Panel A: Breakeven returns with tax deduction invested in a fully taxable account

Years to retirement =	15 years	25 years	30 years	35 years	40 years
Breakeven r old tax law	15.4637%	8.8024%	7.2425%	6.1522%	5.3472%
Breakeven r new tax law	21.9536%	12.2185%	10.0010%	8.4647%	7.3376%
Increase in breakeven r	6.4899%	3.4161%	2.7585%	2.3126%	1.9904%

Panel B: Breakeven returns with tax deduction from Traditional IRA invested with an effective tax rate (t_i) of 10%

Years to retirement =	15 years	25 years	30 years	35 years	40 years
Breakeven r old tax law	50.3346%	25.3536%	20.3129%	16.9441%	14.5337%
Breakeven r new tax law	65.5725%	31.4991%	25.0028%	20.7278%	17.7013%
Increase in breakeven r	15.24%	6.15%	4.69%	3.78%	3.17%

Note: IRA = individual retirement account; TCJA = Tax Cut and Jobs Act.

Table 4 Future value of equal after-tax investments in Traditional IRA with tax savings not invested compared with future value of Roth IRA

Tax law	t_w	t_c	r	n	t_c/t_w	$(1+r)^n$	Preference
2017	15%	25%	2.00%	20	1.6667	1.48595	Traditional
	15%	25%	3.00%	20	1.6667	1.80611	Roth
	15%	25%	4.00%	20	1.6667	2.19112	Roth
2018	12%	22%	2.00%	20	1.8333	1.48595	Traditional
(TCJA)	12%	22%	3.00%	20	1.8333	1.80611	Traditional
	12%	22%	4.00%	20	1.8333	2.19112	Roth
	12%	22%	5.00%	20	1.8333	2.65330	Roth

Note: IRA = individual retirement account; TCJA = Tax Cut and Jobs Act.

12.2185%, and the Traditional IRA is preferred over a broader range of returns. As time to retirement (n) increases, the breakeven rates fall under both tax regimes because higher after-tax future values are produced by the Roth at longer n. The difference between the breakeven rates of return induced by the lower tax rates under the new law is thus reduced as n is increased. This implies that the new tax law should not have as large an influence on the choice of IRA for younger investors. However, older investors facing the same tax rates as depicted above who are starting to invest with a shorter time to retirement such as 15 years may prefer a Traditional IRA for almost all investment portfolios. In this case the breakeven r where the Roth provides a higher future value is 21.95% under the new tax law. Most investors are unlikely to achieve this large of an average return.

Panel B of Table 3 depicts the various breakeven rates of return under the old tax law and the new assuming that the deduction generated by the Traditional IRA is invested in a tax-advantaged investment.[9] Horan (2003, 2006) and others have shown that the ability to invest the deduction in a mutual fund with a tax deferral feature, or in a tax advantaged investment increases the future value of the Traditional IRA. To illustrate the impact on the breakeven rate of return the effective tax rate on the amount invested (t_i) is assumed to be 10% to generate the results in Panel B. The breakeven rates of return are substantially increased under both the old and the new tax rates and the Traditional IRA would likely provide a higher after tax future value under most return scenarios.

Recent work by Adelman and Cross (2010) and Beshears et al., (2017) indicate that many people do not invest the tax savings from the Traditional IRA, preferring instead to consume the extra income. This possibility complicates the choice of the two types because future retirement income will vary with investor behavior.[10] The FV of the Roth will be greater than the FV of the Traditional IRA at lower breakeven rates of return if investors do not reinvest the tax savings because in this case the future value of the Traditional IRA per dollar is $(1+r)^n(1-t_w) + tc$, which is less than the future value of the Roth IRA of $(1+r)^n$ if $t_c/t_w < (1+r)^n$.[11] The Roth will generally provide a higher future value under a broad range of investment returns, especially if n is large. Table 4 provides data on the future values of the Roth and Traditional IRAs for a 20 year work period at different r when the tax savings from the Traditional IRA are not reinvested under the old and the new tax law.[12]

When an individual does not invest the tax savings from the Traditional IRA, the Roth is preferred if $(1+r)^n > t_c/t_w$. The top part of Table 4 depicts rates of return where the

Table 5 Breakeven return vs. years to retirement without reinvestment

Years to retirement =	15 years	20 years	25 years	30 years	40 years
Breakeven r old tax law	3.4642%	2.5870%	2.0643%	1.7173%	1.2853%
Breakeven r new tax law	4.1237%	3.0771%	2.4542%	2.0410%	1.5269%
Difference	0.6595%	0.4900%	0.3899%	0.3237%	0.2416%

Traditional or the Roth IRA are preferred for an investor under the old tax law who is in the 25% tax bracket during their working years, and is in the 15% tax bracket during retirement with 20 years to retirement. In this case the investor should prefer the Roth IRA if their pre-tax rate of return is expected to be 3.00% or higher. The breakeven return is actually 2.5870% as shown in Table 5. Once again the impact of the TCJA is to raise the breakeven rate of return where the Roth is preferable. With the new tax rates the Traditional IRA is still preferred at a 3.00% rate of return, but at a 4.00% return the Roth again provides a higher future value assumption. The actual breakeven rate of return is 3.0771% as shown below, which is the case where $(1+r)^{20} = 1.8333$. The breakeven rates in Table 5 indicate that in most return scenarios the Roth is likely to provide more retirement income than the Traditional IRA given the low breakeven rates even with the new tax law.

3. Lifetime consumption versus retirement consumption

Choosing the Traditional IRA generates more spending power in the working years than the Roth on a dollar for dollar basis. Varying time preference for consumption and liquidity needs may still cause an investor who does not reinvest the tax savings to prefer the Traditional IRA even at rates of return above the breakeven rates shown above. It is possible to model real consumption over the working and retirement years from the two alternatives. The Traditional IRA can be optimal with a lifetime consumption decision variable, particularly given uncertain reinvestment rates and low tolerance for risk, both of which will reduce the average return earned. Consider the case for a couple who are married filing jointly, neither of whom are covered by a plan at work, who do not reinvest the tax savings generated by the deductibility of contributions to a Traditional IRA. Choosing this filing status limits the likelihood of running afoul of income limits on deductibility of IRA contributions. It is assumed that the couple will use the standard deduction under the new TCJA, and then real consumption in year t during their working years after investing in a Traditional IRA is:

$$\textit{Real Consumption}_t = \frac{\textit{Income}_t - \textit{Standard Deduction}_t - \textit{Traditional IRA Contribution}_t - \textit{Taxes}_t + \textit{Standard Deduction}_t}{(1 + \textit{Deflator})_t} \quad (2)$$

where the deflator represents cumulative inflation so that real consumption is measured in terms of the date when the IRA contributions begin. This model is drawn from Bodie, Kane, and Marcus (2008). The Traditional IRA contribution reduces the couple's taxable income and, thus, taxes owed in year t because these IRA contributions are deductible. The sum of

the first three terms in the numerator of Eq. (2) is taxable income in year t. The Standard Deduction in time t is then added back after taxes are calculated on taxable income.

Ignoring Social Security benefits and other income during retirement, the cumulative savings from the future value of the invested IRA contributions can be annuitized upon retirement. For simplicity our hypothetical couple retires at the same time. A Nominal Annuity amount is then used as the only source of income during retirement. Real Consumption$_t$ in year t during retirement is thus:

$$Real\ Consumption_t = \frac{Nominal\ Annuity - Standard\ Deduction_t - Taxes_t + Standard\ Deduction_t}{(1 + Deflator)_t} \quad (3)$$

If the couple chooses a Roth IRA instead of the Traditional IRA then Real Consumption$_t$ during the working years is found as:

$$Real\ Consumption_t = \frac{Income_t - Standard\ Deduction_t - Taxes_t - Roth\ IRA\ Contribution_t + Standard\ Deduction_t}{(1 + Deflator)_t} \quad (4)$$

In this case the Taxes$_t$ are calculated from the Income minus the Standard Deduction before considering the Roth IRA contribution as Roth contributions are not tax deductible.

Real Consumption$_t$ in year t during retirement for the Roth is thus:

$Real\ Consumption_t = \frac{Nominal\ Annuity}{(1 + Deflator)_t}$ because no taxes are owed on the Roth withdrawals.

Compared with the Roth, the Traditional IRA provides extra real consumption during the working years (t = 1 to n), but at a cost of reduced consumption during the retirement years (t = n+1 to End of Life) because of taxes that will have to be paid as shown below:

$$\sum_{t=1}^{n} \frac{t_c(Traditional\ IRA\ Contribution_t)}{(1 + Deflator_t)} - \sum_{t=n+1}^{Life} \frac{t_w(Nominal\ Annuity - Standard\ Deduction_t)}{(1 + Deflator_t)} \quad (5)$$

The additional consumption during the working years is t_c(Traditional IRA Contribution$_t$) per year, but choosing the Traditional IRA results in additional taxes in retirement on the annuity as compared with the Roth. This retirement income is taxed at the rate t_w. The taxable income is the Nominal Annuity – Standard Deduction$_t$. The size of the Nominal Annuity is dependent on the number of years of retirement, the returns on the contributions, the number of years of contributions and the contribution amount. To have a net gain in Real Consumption the additional consumption during the working years (the first term above) must be larger in aggregate than the additional taxes that occur during retirement (the second term). The larger the Nominal Annuity the less likely the net gain will be positive, although this can be offset by a higher Standard Deduction if tax law allows indexing the deduction. In addition, if t_w is sufficiently lower than t_c the net gain can be positive. A lower tax rate in retirement may occur because the investor will be in a lower tax bracket, or because

Table 6 Portfolio risk and return based on Damodaran data

	Stocks	Long term (LT) government bonds	T-bills		Stocks LT government bonds	Stocks T-bills	LT government bonds T-bills
Average return	9.65%	4.88%	3.39%	ρ	−0.028	−0.030	0.296
σ	19.62%	7.72%	3.05%	Cov	−0.000418339	−0.000178894	0.000698036
High risk	70%	30%	0%	0.0192257			
Medium risk	60%	40%	0%	0.0146133	Portfolio variances		
Low risk	30%	50%	20%	0.0049861			

Risk	Portfolio average return	Portfolio σ
High	8.22%	13.87%
Medium	7.74%	12.09%
Low	6.01%	7.06%

statutory tax rates are lower. Higher inflation will increase the deflator more rapidly and will reduce the real value of consumption in retirement for both IRA types. However, if higher inflation raises the investment rate of return, then inflation will favor the Roth because higher average nominal returns generate more taxes in retirement and favor the Roth in general. Greater risk aversion, as indicated by reducing risk at an earlier age and, thereby, lowering the average return, favors the Traditional IRA because it lowers the lifetime average return on investment and, thus, potentially, the taxes paid in retirement.

3.1. The impact of the TCJA on lifetime consumption for the Traditional and Roth IRA

The model can be used to demonstrate the impact of the TCJA on the choice of Traditional and Roth IRA on lifetime real consumption. In the model, tax brackets are assumed to be indexed to inflation as they have been in the past.[13] Investment returns are based on historical geometric average returns, correlations, and standard deviations of major asset classes such as stocks, bonds and bills using data from Damodaran (2018). The model incorporates the concept of reducing portfolio risk as the investors approach retirement. All contributions cease at retirement. The model ignores other income and Social Security benefits. The invested amount at retirement is annuitized over the remaining expected lifetime.

The model used allows an investor to choose at what age they plan to reduce risk in the portfolio by shifting more of the portfolio from stocks to Treasury bonds and Treasury bills. The return data and portfolio weights based on Damodaran's (2018) data are given in Table 6.

The asset allocation is shown above for assumed high risk, medium risk, and low risk portfolios. The choice of age at which an investor switches from a high to medium to low risk fund is a proxy for risk aversion. Greater risk aversion is indicated by reducing risk at an earlier age and/or choosing a lower percentage in stocks in each portfolio. The spreadsheet model provides stochastic rates of return to determine future values based on the input data. This is substantially different than in much of the literature where many studies assume a fixed rate of return, or allow only a small amount of variation in returns.[14] For simplicity the

Table 7 Representative simulation of Traditional vs. Roth IRA lifetime consumption pre- and post-TCJA

	No. runs Traditional IRA had higher lifetime consumption	No. runs Roth had higher lifetime consumption	Median lifetime consumption traditional	Median lifetime consumption Roth	Difference in median lifetime consumption
Pre TCJA choice of IRA	383 (77%)	117 (23%)	$5,078,552	$5,059,391	$19,161
Post TCJA choice of IRA	361 (72%)	139 (28%)	$5,049,170	$5,015,551	$33,619

Note: IRA = individual retirement account; TCJA = Tax Cut and Jobs Act.

model does not have any excess contributions, which are rare in practice (see Sibley, 2002), and there are no RMDs because of the focus on lifetime real consumption rather than bequests.

3.2. Impact of IRA choice on consumption pre- and post-TCJA

The real consumption outcomes for a hypothetical married couple filing jointly that are not covered by a plan at work who are 30 years old, will retire at age 65, and fund their retirement to age 90 is shown below using the 2017 tax rates and rules. In 2018 the life expectancy of a 30 year old U.S. male is 71 and for a female is 75 according to countryeconomy.com. Funding to age 90 should be amply sufficient to ensure an investor's funds do not run out. The 2017 progressive tax rates and brackets are used and the brackets are indexed to inflation as per IRS practice as mandated by Congress. The IRS normally adjusts the standard deduction for inflation as well, and it is also increased at age 65, and is higher for taxpayers that meet certain conditions.[15] The couple starts with a high risk portfolio that has an average return of 8.22% with a standard deviation of 13.87%, reduces to medium risk at age 50 with an average return of 7.74% with a portfolio standard deviation of 12.09%, and reallocates to a low risk portfolio at retirement that has an average return of 6.01% and a standard deviation of 7.06%. The couple's starting income is $80,000 between the two of them at age 30; subsequently, their income grows at six percent per year and inflation is three percent per year. The couple contributes $10,000 total to either a Roth or a Traditional IRA each year until they retire. Annual rates of return are generated from a normal distribution with the given geometric average return and standard deviation using Monte Carlo simulation. The cumulative savings at retirement is annuitized over the given life expectancy using the low risk portfolio return. A simulation of 500 different outcomes was created with a spreadsheet macro.[16] The results are presented in Table 7. Each row in Table 7 gives the results of 500 different trial runs with different returns in each trial. Table 7 shows that using the 2017 tax rules in place before the TCJA, the Traditional IRA provided higher lifetime consumption in 383 out of the 500 trials (77%), with the Roth IRA doing better in only 117 runs (23%). The median lifetime consumption from the Roth was $5,059,391 whereas the median consumption for the Traditional IRA was $5,078,552.[17] The second row replicates the results using the same inputs except that the TCJA progressive tax rates and the new standard deduction (with no personal exemptions) was used. In this case the Traditional IRA provided higher lifetime real consumption in 361 (72%) out of the 500 trials and the Roth

provided more consumption in 139 trial runs (28%).[18] The TCJA modestly increases the median lifetime consumption, but the simulation indicates the TCJA does not have a major impact on IRA choice when the decision variable is lifetime consumption. Higher rates of return and higher incomes will increase the number of times that the Roth provides more favorable outcomes. Similarly if Congress decides to not increase the brackets or the standard deduction with inflation, then the Roth IRA will provide better outcomes in the large majority of simulation runs because the retirement tax liability is then much greater for the Traditional IRA. Calculations for the scenario outputs shown below are provided in the Appendix.

In the majority of cases the Traditional IRA provided higher median lifetime consumption than the Roth IRA pre- and post-TCJA. For moderate income individuals where current spending is a primary concern as much as funding retirement, the Traditional IRA can be the better choice. Higher levels of starting income imply a higher tax burden in retirement and favor the Roth IRA.

4. Conclusions

The impact of the new lower rates in the TCJA should make the Traditional IRA more attractive for moderate income investors who invest the tax deduction. The impact of the tax law is to raise the breakeven rates of return where the Roth IRA becomes the better alternative in terms of future value for many investors who may be in the 22% tax bracket in their working years and in the 12% tax bracket in retirement. This is likely to include a large number of investors. Depending on the length of the contribution period, the breakeven rate of return is increased by between 2% to as much as 6.5% for individuals who invest the tax savings from their Traditional IRAs. There are only small changes in breakeven for investors who do not invest the difference and are looking to maximize retirement income. Individuals of modest income who are seeking to maximize their lifetime consumption, however, may still prefer the Traditional IRA to the Roth. Simulations with reasonably realistic investment strategies that reduce risk as the investor ages and incorporate the new tax brackets and standard deduction indicate that in many cases the Traditional IRA provides greater median lifetime consumption than the Roth. This result does not hold in simulations where tax brackets are not indexed and/or when the standard deduction is not increased by inflation, so future tax rules are critical in the choice of IRA. Finally, investors and planners should be aware that many variables should be considered in the choice of IRA, and analyzing after tax returns is not sufficient to fully inform the decision. Behavioral characteristics such as whether the tax savings will be invested, the investor's risk tolerance, their desire to fund working years' consumption versus retirement consumption, expected market returns and the investor's willingness and ability to engage in tax management strategies should be considered in the choice (Horan, 2006). If investors (or their planners) are willing to engage in tax management strategies then having both may be optimal; nevertheless, the Traditional IRA remains a good choice for many investors.

Notes

1 For the 2018 tax year a moderate income investor that is married and is filing jointly must have modified adjusted gross income (MAGI) over $77,401 according to the IRS.
2 In reality many factors other than future value or consumption can affect the optimal IRA type as discussed below. Beshears et al. (2017) indicate that factors other than future value should be considered in the choice of IRA type.
3 There are several "personal hardship" and other exemptions that allow an investor to withdraw money before age 59½ without facing a tax penalty. Nevertheless, it is generally not a good idea to withdraw funds invested for retirement unless absolutely necessary.
4 The CBO estimates the Chained CPI (C-CPI-U) results in about a 0.25% lower average inflation rate than the CPI. The chained version is thought to be more accurate because it allows for substitutions to lower cost items as relative prices change and corrects for a small size sampling bias whereas the traditional CPI measure does not. For more detail see CBO's Projections of Demographic and Economic Trends found at https://www.cbo.gov/system/files?file=2018-06/53919-2018ltbo-appendixa.pdf.
5 A phase-out of the amount contributed applies for lower income limits regardless of filing status. An investor can still create a "backdoor" Roth IRA if their MAGI is too high to directly contribute to a Roth IRA. The procedure is to contribute to a non-deductible IRA and then roll it over to a Roth IRA. There is no MAGI limit on the rollover. If the investor has a deductible IRA then part of the rollover is taxable. For more information see https://www.irs.gov/retirement-plans/retirement-plans-faqs-regarding-iras-rollovers-and-roth-conversions or the discussion in Harline (2014).
6 An exception is Horan (2003) who compares equal pre-tax investments as well as equal after-tax investments. The pre- or after-tax method of comparisons are equivalent assuming that the tax deductions generated by the Traditional IRA are invested in the pre-tax case. Thus, one need only compare an equivalent pre-tax investment amount in the Traditional and Roth IRA and vary whether the deduction is invested.
7 This model assumes the money in both IRAs is withdrawn upon retirement. Alternatively, n may be considered the time to when the investor begins withdrawing from the IRAs. This is the time to age 70½ at the maximum for the Traditional IRA, but n could be longer for a Roth IRA.
8 Throughout the discussion it is assumed that the changes in the tax code from the TCJA will persist after 2025 when they are scheduled to sunset. This discussion centers on investors who are in the 25%/15% pre-TCJA tax brackets and 22%/12% post-TCJA brackets during their working years and retirement years, respectively. Post-TCJA this includes investors whose gross income is up to $165,000 in their working years and $77,400 during their retirement years in today's dollars. The same income numbers for pre-TCJA were $153,100 and $75,900, respectively.
9 The breakeven interest rate is found by solving the following for r: $(1+r)^n(1-t_w)+t_c[1+(r(1-t_i)]^n = (1+r)^n$ where t_i is set to 10% and n is varied as shown in the table.
10 It is likely that many investors do not think about the tax savings as an amount that could be invested unless a planner points this out.

11 The future value component $[1 + r(1-t_c)]^n$ drops out if the tax savings are not reinvested.
12 Alternatively, once could compare a $5,000 qualifying contribution to a Traditional IRA versus $5,000(1–22%) = $3,900 in a Roth IRA. Some investors may choose this alternative rather than investing the deduction generated by the Traditional IRA. The relative advantage in future value of the two IRA types in this case is completely determined by whether t_c is greater than or less than t_w. Using the $5,000 pre-tax contribution amount, the future value of the Traditional IRA is greater than the future value of the Roth IRA if $\$5{,}000(1+r)^n(1-t_w) > \$5{,}000(1-t_c)(1+r)^n$, which holds if $t_c > t_w$ and not otherwise. Adelman and Cross (2010) make a similar point. In the literature it is more common to model the comparison of not investing the deduction as done here: $\$5{,}000(1+r)^n(1-t_w)+t_c > \$5{,}000(1+r)^n$.
13 The model incorporates the higher deduction upon retirement and the additional amount that can be contributed from age 50 onward. The model also incorporates indexed standard deductions and IRA contributions. Results are available from the authors. Indexing deductions tends to favor the Traditional IRA by reducing taxes due in retirement. Indexing contributions favors the Roth IRA because bigger contributions increase retirement income and thus taxes in retirement. The Roth avoids these higher taxes in retirement.
14 The option value of the ability to convert a Traditional IRA to a Roth IRA (the rollover option) is ignored.
15 The spreadsheet incorporates the increase in deduction at age 65.
16 Providing a simulation of multiple outputs is a better method to evaluate the preferable type of IRA than providing a single point estimate of future value. Note that the model uses realistic estimates of portfolio returns at the chosen risk levels and starts with a modest income amount.
17 The simulation contains some runs with high returns. For the Roth these tend to result in higher consumption, whereas for the Traditional the higher incomes that result lead to higher taxes that offset at least some of the income. Thus, choosing the Roth IRA can result in higher average lifetime consumption, even though the median is lower. In other words choosing the Traditional IRA forfeits the positive skewness of returns and consumption that the Roth may generate.
18 Simulation results (not shown) indicate that higher returns increase the number of trials where the Roth provided higher consumption, but the Traditional IRA still pre-dominates. However, when the brackets and/or the deductions are not indexed with inflation the Roth dominates in almost all scenarios.

Appendix: Scenario calculations

1. More on the spreadsheet model and simulation

Larger contribution amounts favor the Roth IRA in the spreadsheet outcomes, which is consistent with most of the literature that concentrates on maximizing retirement income. A

Appendix Table 1 Simulation results and sample calculations selected years pre-TCJA

Enter number of trials (max = 1,000): 500

Lifetime real consumption			Age start contribution	Age medium risk	Age low risk	Age retire	Life expectancy
Traditional	Roth	Run simulation	30	50	60	65	90
Minimum 4,339,991	4,256,488		Starting income	Income growth	Rate of inflation	Contribution	
Maximum 7,170,880	7,643,988	500					
Median 4,974,776	4,929,163		$80,000	6.00%	3.00%	$10,000	
Average 5,078,552	5,059,391					Deduction adjustment	100%
Better 383	117		Change in tax rate after ret		0.00%		3.00%
						Bracket adjustment	3.00%

Age start contribution	Age medium risk	Age low risk	Age retire	Life expectancy
30	50	60	65	90
Starting income	Income growth	Rate of inflation	Contribution < age 50	Standard deduction and exemption
$80,000	6.00%	3.00%	$10,000	$25,200
Growth in tax rate after retirement		0.00%	3.00%	Bracket adjustment 3.00%

	Working	Retired	Lifetime		Cumulative savings	1,782,738
Income years	35	25	60	Lifetime tax rate	Nominal annuity	139,630
Income	9,529,669	3,490,752	13,020,422		Real annuity	49,622
Taxes, Traditional IRA	1,310,342	63,981	1,374,323	14.42%	Risk / Average return / Standard deviation	
Taxes, Roth IRA	1,465,915	0	1,465,915	15.38%	High 8.22%	13.87%
Real consumption, Traditional IRA	3,966,697	845,519	4,812,216	Better	Medium 7.74%	12.09%
Real consumption, Roth IRA	3,883,195	864,079	4,747,274		Low 6.01%	7.06%

	Income, contributions, exemptions				Traditional IRA				Roth IRA				Investment/savings		
Age	Income	Deflator	Indexed IRA contributions	Indexed deduction	Taxable income	Marginal tax rate	Taxes	Real consumption	Taxable income	Marginal tax rate	Taxes	Real consumption	Average return	Standard deviation	Cumulative savings
30	80,000	1.00000	10,000	25,200	44,800	15%	5,788	64,213	54,800	15%	7,288	62,713			10,000
31	84,800	1.03000	10,300	25,956	48,544	15%	6,321	66,193	58,844	15%	7,866	64,693	8.219%	13.866%	21,483
32	89,888	1.06090	10,609	26,735	52,544	15%	6,892	68,231	63,153	15%	8,484	66,731	8.219%	13.866%	33,235
33	95,281	1.09273	10,927	27,537	56,817	15%	7,504	70,329	67,745	15%	9,143	68,829	8.219%	13.866%	48,859
34	100,998	1.12551	11,255	28,363	61,380	15%	8,158	72,488	72,635	15%	9,846	70,988	8.219%	13.866%	55,078
35	107,058	1.15927	11,593	29,214	66,252	15%	8,857	74,709	77,844	15%	10,596	73,209	8.219%	13.866%	57,439
48	228,347	1.70243	17,024	42,901	168,421	25%	27,596	107,920	185,446	25%	31,852	105,420	8.219%	13.866%	450,111
49	242,048	1.75351	17,535	44,188	180,325	25%	30,137	110,850	197,860	25%	34,521	108,350	8.219%	13.866%	608,614

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Appendix Table 1 (Continued)

Age	Income, contributions, exemptions				Traditional IRA				Roth IRA				Investment/savings		
	Income	Deflator	Indexed IRA contributions	Indexed deduction	Taxable income	Marginal tax rate	Taxes	Real consumption	Taxable income	Marginal tax rate	Taxes	Real consumption	Average return	Standard deviation	Cumulative savings
50	256,571	1.80611	19,061	45,514	191,996	25%	32,606	113,450	211,057	25%	37,372	110,812	7.742%	12.089%	780,970
51	271,965	1.86029	19,603	46,879	205,483	25%	35,516	116,565	225,086	25%	40,417	113,931	7.742%	12.089%	859,261
56	363,951	2.15659	22,566	54,346	287,039	25%	53,380	133,546	309,605	25%	59,022	130,930	7.742%	12.089%	1,528,337
57	385,788	2.22129	23,213	55,976	306,598	25%	57,719	137,243	329,811	25%	63,522	134,630	7.742%	12.089%	1,586,665
58	408,935	2.28793	23,879	57,656	327,400	25%	62,351	141,047	351,279	28%	68,351	138,424	7.742%	12.089%	1,417,598
59	433,471	2.35657	24,566	59,385	349,520	25%	67,296	144,961	374,086	28%	73,836	142,185	7.742%	12.089%	1,335,645
60	459,479	2.42726	25,273	61,167	373,040	28%	72,616	148,970	398,312	28%	79,693	146,055	6.013%	7.061%	1,454,968
61	487,048	2.50008	26,001	63,002	398,045	28%	78,663	152,949	424,046	28%	85,943	150,037	6.013%	7.061%	1,418,925
62	516,271	2.57508	26,751	64,892	424,628	28%	85,122	157,043	451,379	28%	92,613	154,134	6.013%	7.061%	1,631,547
63	547,247	2.65234	27,523	66,839	452,885	28%	92,021	161,255	480,408	28%	99,728	158,350	6.013%	7.061%	1,674,730
64	580,082	2.73191	28,319	68,844	482,919	28%	99,387	165,590	511,238	28%	107,316	162,687	6.013%	7.061%	1,600,100
65	614,887	2.81386	29,139	77,944	507,804	28%	105,280	170,750	536,943	28%	113,439	167,851	6.013%	7,061%	1,782,738
Working	9,529,669		648,759	1,601,588	7,279,321	22%	1,310,342	3,966,697	7,928,081	23%	1,465,915	3,883,195			1,782,738

Age	Retirement			Traditional IRA				Roth IRA			
	Nominal withdraw	Deflator	Indexed deduction	Taxable income	Marginal tax rate	Taxes	Real consumption	Taxable income	Marginal tax rate	Taxes	Real consumption
66	139,630	2.89828	80,282	59,348	15%	6,200	46,038			0	48,177
67	139,630	2.98523	82,691	56,939	15%	5,757	44,845			0	46,774
68	139,630	3.07478	85,172	54,459	10%	5,446	43,640			0	45,411
69	139,630	3.16703	87,727	51,903	10%	5,190	42,450			0	44,089
70	139,630	3.26204	90,358	49,272	10%	4,927	41,294			0	42,805
71	139,630	3.35990	93,069	46,561	10%	4,656	40,172			0	41,558
72	139,630	3.46070	95,861	43,769	10%	4,377	39,083			0	40,347
73	139,630	3.56452	98,737	40,893	10%	4,089	38,025			0	39,172
84	139,630	4.93412	136,675	2,955	10%	295	28,239			0	28,299
85	139,630	5.08215	140,776	0	10%	0	27,475			0	27,475
86	139,630	5.23461	144,999	0	10%	0	26,674			0	26,674
87	139,630	5.39165	149,349	0	10%	0	25,897			0	25,897
88	139,630	5.55340	153,829	0	10%	0	25,143			0	25,143
89	139,630	5.72000	158,444	0	10%	0	24,411			0	24,411
90	139,630	5.89160	163,197	0	10%	0	23,700			0	23,700

Note: IRA = individual retirement account; TCJA = Tax Cut and Jobs Act. Selected year sample calculations for one run for the pre-TCJA scenario for real consumption.

Appendix Table 2 Simulation results and sample calculations selected years post-TCJA

	Enter number of trials (max = 1,000): 500							
	Lifetime real consumption			Age start contribution	Age medium risk	Age low risk	Age retire	Life expectancy
	Traditional	Roth	Run simulation	30	50	60	65	90
Minimum	4,379,631	4,308,333		Starting income	Income growth	Rate of inflation	Contribution	
Maximum	7,767,850	8,301,183	500					
Median	5,049,170	5,015,551		$80,000	6.00%	3.00%	$10,000	
Average	5,148,771	5,134,029					Deduction adjustment	100%
Better	361	139		Change in tax rate after ret		0.00%		3.00%
							Bracket adjustment	3.00%

						Working	Retired	Lifetime		Cumulative savings	2,701,449
Age start contribution	Age medium risk	Age low risk	Age retire	Life expectancy	Income years	35	25	60		Nominal annuity	211,587
					Income	9,529,669	5,289,666	14,819,335	Lifetime tax rate	Real annuity	75,194
30	50	60	65	90	Taxes, Traditional IRA	1,129,436	262,257	1,391,692	14.60%	Risk / Average return	Standard deviation
Starting income	Income growth	Rate of inflation	Contribution < Age 50	Standard deduction and exemption	Taxes, Roth IRA	1,262,646	0	1,262,646	13.25%	High 8.22%	13.87%
					Real consumption, Traditional IRA	4,055,191	1,240,651	5,295,842	Better	Medium 7.74%	12.09%
$80,000	6.00%	3.00%	$10,000	$24,000	Real consumption, Roth IRA	3,983,893	1,309,371	5,293,264		Low 6.01%	7.06%
Growth in tax rate after retirement		0.00%	3.00%	Bracket adjustment	3.00%						

	Income, contributions, exemptions				Traditional IRA				Roth IRA				Investment/savings		
Age	Income	Deflator	Indexed IRA contributions	Indexed deduction	Taxable income	Marginal tax rate	Taxes	Real consumption	Taxable income	Marginal tax rate	Taxes	Real consumption	Average return	Standard deviation	Cumulative savings
30	80,000	1.00000	10,000	24,000	46,000	12%	5,139	64,861	56,000	12%	6,339	63,661			10,000
31	84,800	1.03000	10,300	24,720	49,780	12%	5,581	66,911	60,080	12%	6,817	65,711	8.219%	13.866%	21,401
32	89,888	1.06090	10,609	25,462	53,817	12%	6,054	69,022	64,426	12%	7,327	67,822	8.219%	13.866%	36,505
33	95,281	1.09273	10,927	26,225	58,129	12%	6,559	71,193	69,056	12%	7,870	69,993	8.219%	13.866%	42,522
34	100,998	1.12551	11,255	27,012	62,731	12%	7,099	73,428	73,986	12%	8,449	72,228	8.219%	13.866%	62,601
35	107,058	1.15927	11,593	27,823	67,643	12%	7,675	75,728	79,235	12%	9,067	74,528	8.219%	13.866%	84,492
48	228,347	1.70243	17,024	40,858	170,464	22%	23,677	110,222	187,489	22%	27,422	108,022	8.219%	13.866%	586,722
49	242,048	1.75351	17,535	42,084	182,429	22%	25,894	113,270	199,964	22%	29,752	111,070	8.219%	13.866%	668,702
50	256,571	1.80611	19,061	43,347	194,163	22%	28,048	115,974	213,224	22%	32,242	113,652	7.742%	12.089%	807,053

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Appendix Table 2 (Continued)

Age	Income, contributions, exemptions				Traditional IRA				Roth IRA				Investment/savings		
	Income	Deflator	Indexed IRA contributions	Indexed deduction	Taxable income	Marginal tax rate	Taxes	Real consumption	Taxable income	Marginal tax rate	Taxes	Real consumption	Average return	Standard deviation	Cumulative savings
51	271,965	1.86029	19,603	44,647	207,715	22%	30,590	119,214	227,318	22%	34,903	116,895	7.742%	12.089%	762,895
56	363,951	2.15659	22,566	51,758	289,627	22%	46,204	136,874	312,192	22%	51,169	134,572	7.742%	12.089%	1,455,913
57	385,788	2.22129	23,213	53,311	309,264	22%	49,999	140,718	332,477	22%	55,106	138,419	7.742%	12.089%	1,513,688
58	408,935	2.28793	23,879	54,910	330,145	22%	54,052	144,674	354,025	22%	59,305	142,378	7.742%	12.089%	1,676,058
59	433,471	2.35657	24,566	56,558	352,348	22%	58,379	148,745	376,913	22%	63,783	146,451	7.742%	12.089%	1,879,849
60	459,479	2.42726	25,273	58,254	375,952	22%	62,998	152,933	401,225	24%	68,572	150,637	6.013%	7.061%	1,799,649
61	487,048	2.50008	26,001	60,002	401,045	22%	67,927	157,243	427,046	24%	73,938	154,839	6.013%	7.061%	2,019,080
62	516,271	2.57508	26,751	61,802	427,718	24%	73,242	161,656	454,469	24%	79,663	159,163	6.013%	7.061%	2,265,820
63	547,247	2.65234	27,523	63,656	456,068	24%	79,164	166,103	483,591	24%	85,770	163,612	6.013%	7.061%	2,241,135
64	580,082	2.73191	28,319	65,566	486,197	24%	85,486	170,678	514,516	24%	92,283	168,190	6.013%	7.061%	2,365,918
65	614,887	2.81386	29,139	74,849	510,900	24%	90,479	176,011	540,038	24%	97,472	173,525	6.013%	7.061%	2,701,449
Working	9,529,669		648,759	1,525,939	7,354,971	19%	1,129,436	4,055,191	8,003,731	20%	1,262,646	3,983,893			2,701,449

Age	Retirement				Traditional IRA				Roth IRA		
	Nominal withdraw	Deflator	Indexed deduction	Taxable income	Marginal tax rate	Taxes	Real consumption	Taxable income	Marginal tax rate	Taxes	Real consumption
66	211,587	2.89828	77,094	134,492	12%	15,035	67,817			0	73,004
67	211,587	2.98523	79,407	132,180	12%	14,724	65,946			0	70,878
68	211,587	3.07478	81,789	129,797	12%	14,404	64,129			0	68,814
69	211,587	3.16703	84,243	127,344	12%	14,075	62,365			0	66,809
70	211,587	3.26204	86,770	124,816	12%	13,735	60,653			0	64,863
71	211,587	3.35990	89,373	122,213	12%	13,385	58,990			0	62,974
72	211,587	3.46070	92,055	119,532	12%	13,025	57,376			0	61,140
73	211,587	3.56452	94,816	116,770	12%	12,654	55,809			0	59,359
84	211,587	4.93412	131,248	80,339	10%	8,034	41,254			0	42,882
85	211,587	5.08215	135,185	76,401	10%	7,640	40,130			0	41,633
86	211,587	5.23461	139,241	72,346	10%	7,235	39,039			0	40,421
87	211,587	5.39165	143,418	68,169	10%	6,817	37,979			0	39,243
88	211,587	5.55340	147,720	63,866	10%	6,387	36,950			0	38,100
89	211,587	5.72000	152,152	59,435	10%	5,943	35,952			0	36,991
90	211,587	5.89160	156,717	54,870	10%	5,487	34,982			0	35,913

Note: IRA = individual retirement account; TCJA = Tax Cut and Jobs Act. Sample calculations for one run of the post-TCJA simulation.

shorter time to retirement favors the Traditional IRA in terms of lifetime consumption. Consistent with the literature, a lower tax rate during retirement than in the working years favors the Traditional IRA, but this situation does not always hold. At longer times to retirement, larger investment amounts, greater income and higher investment returns the Roth IRA performs increasingly well even if tax rates fall during retirement. At lower amounts saved the Traditional IRA can be better even with higher tax rates in retirement. These results are consistent with most of the prior literature and help validate the model.

The model is not a complete, or even a nearly complete, depiction of which type of IRA is preferable for all investors. The model is not for those who wish to maximize retirement consumption income rather than overall lifetime income.

The spreadsheet model only applies for investors that are married, filing jointly, and are not covered by a plan at work. The model does not allow contributions to continue after retirement, nor ensure that RMDs are made. It also does not consider estate planning, other income and the impact on taxation of Social Security benefits. However, the model indicates that from the perspective of lifetime consumption, the Roth IRA is not necessarily always the best choice. Simulating a large variety of returns using actual market data also gives a richer understanding than assuming a fixed return with no risk.

In Appendix Table 1 above Taxable Income = Income – Standard Deduction – IRA Contributions for the Traditional IRA and Income – Standard Deduction for the Roth IRA, respectively, for one run of the simulation. The taxes used are from the 2017 progressive tax table for married filing jointly (see www.IRS.gov) with the tax rules in place before the TCJA. In the contribution years Real Consumption = Income – IRA contributions – Taxes, adjusted for inflation with the deflator column. Annual rates of return are drawn from a normal distribution with the given geometric average return and standard deviation. The cumulative savings at retirement is annuitized over the given life expectancy. The nominal annual withdrawal during the retirement years is a constant amount as shown and real consumption declines each year because of inflation. The low amount of taxation during the retirement years for the Traditional IRA is an artifact of indexing the tax brackets and the standard deduction to match inflation. If the brackets or the deductions are not indexed the Roth IRA pre-dominates in most scenarios. The choice of IRA is thus very dependent on whether the IRS will continue to index deductions and tax brackets. The consumption outcomes at the top of the table are for one trial run. Providing a simulation of multiple outputs rather than a single point estimate of future value is a better method to determine the preferred choice. Note that the model uses realistic estimates of portfolio returns at the chosen risk levels. This provides investors better information to choose between the IRA types.

2. Post-TCJA scenario

In the following scenario the same inputs were used, but the new TCJA tax brackets and standard deduction were applied. Rates of return are randomly drawn so they are different from the pre-TCJA scenario. Nevertheless, the Traditional IRA still pre-dominates in terms of real consumption in 361 out of the 500 trials. See Appendix Table 2.

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