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Risk-sharing implications for Roth IRA conversions: Fact and fiction

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Abstract

We investigated the risk-sharing implications of taxation associated with the option to convert a traditional IRA to a Roth IRA. Although the conversion option creates value for savers by potentially reducing their tax burdens, the risk profile of their holdings may change as well. Delaying payment of the conversion tax creates a leveraged equity position for the taxpayer. We show that the conversion decision depends on the dynamics of the underlying asset, including volatility and its path through time. Moreover, how asset dynamics affect the ultimate payoff depends on the financing source for the conversion tax payment. These factors render some conventional wisdom around conversion unreliable.

JEL classification: D91; G11; G2; G23

Keywords: IRA; Roth IRA; IRA Conversion option; Recharacterization; Risk-return profile

1. Introduction

Assets in defined contribution (DC) plans and Individual Retirement Accounts (IRAs) surpassed those in defined benefit (DB) plans many years ago (see Fig. 1). As pension savings shift from DB plans to DC plans, individuals are increasingly bearing responsibility for investment management decisions, including savings strategies, asset allocation, asset location, and withdrawal strategies. Moreover, individuals increasingly need to choose

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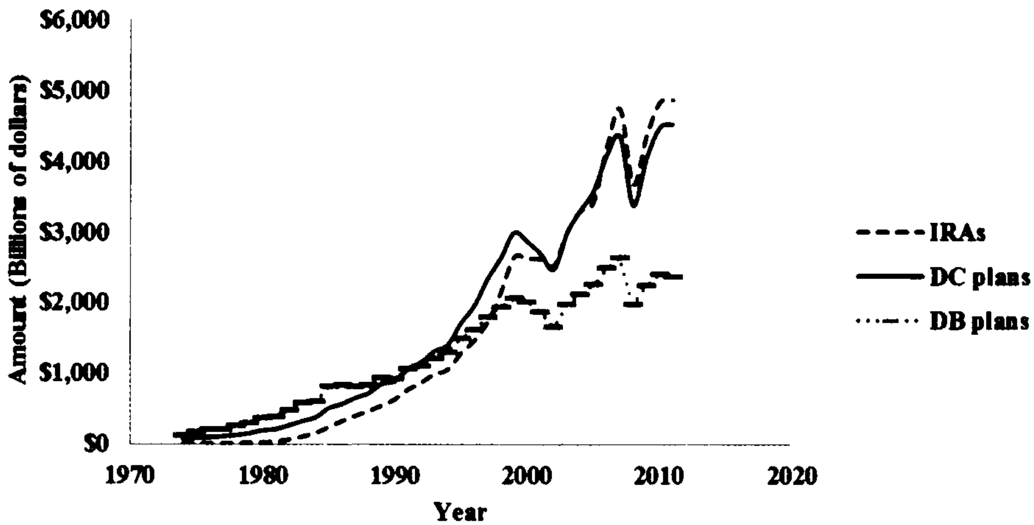

Fig. 1. Assets in defined benefit, defined contribution, and individual retirement accounts.

between taxable entities with front-end loaded tax benefits (e.g., traditional IRAs in the United States and Registered Retirement Savings Plans in Canada) and back-end tax benefits (e.g., Roth IRAs in the United States and Tax-Free Savings Accounts in Canada).

In 2010 alone, assets in Roth IRAs increased from $215 billion to $265 billion as financial advisors (and even politicians) promoted the virtues of converting a traditional IRA to a Roth IRA when income limitations for converting traditional IRAs to Roth IRAs were removed. Moreover, U.S. taxpayers like taxpayers in many other jurisdictions, face the likelihood of increasing marginal tax rates.[1] Both these phenomena increase the attractiveness of IRA conversions all else equal. Therefore, it is important that investors understand determinants of after-tax risk and return associated with the IRA and Roth IRA or the conversion of one to other.

This article highlights overlooked factors in the decision to convert a traditional IRA to a Roth IRA. Specifically, the literature has yet to examine the impact of conversion and the method of financing the conversion tax on an investor's after-tax risk exposure. By converting early in a tax year and delaying payment of the conversion tax, an investor fixes his or her tax liability thereby leveraging their after-tax risk exposure until the conversion tax must ultimately be paid.

Once the tax payment comes due, an investor can choose to borrow, draw on the corpus of IRA assets, or liquidate a taxable account to fund the conversion tax payment. The method of financing the conversion tax has significant implications for an investor's after-tax risk exposure and its impact on the value of conversion. If the taxpayer borrows to finance the conversion tax, for example, the value of conversion increases with the risk of the underlying asset even absent the option to recharacterize (or reverse) the conversion. Financing the conversion tax from a taxable account significantly reduces this volatility effect. Understanding the risk sharing arrangement and the embedded options in these accounts may allow investors to make prudent investment and conversion decisions beyond the superficial analysis offered in the popular and practitioner press.

As an example, conventional financial planning wisdom advises investors to finance IRA conversion tax payments from a taxable account and to convert assets that are likely to appreciate in value. We show here, however, that price appreciation is important only when conversion tax payments are financed through borrowing, which is not part of the conventional advice. The conventional wisdom is based on internally inconsistent assumptions about the source of tax payments and the after-tax risk of the portfolio.

The next section reviews some of the recent IRA literature; especially that related to the risk sharing implications of taxation. The third section establishes the arithmetic foundation for our analysis and concludes that the coefficient of variation for both traditional IRAs and Roth IRAs are equal, holding constant the after-tax investment. The fourth section highlights the overlooked leverage implication of making a conversion decision in one period and paying the associated tax liability in a subsequent period. We explore how asset dynamics affect the value of conversion and how the source of conversion tax financing affects the influence of asset dynamics. In the penultimate section, we explore the taxpayers' ability to recharacterize a Roth IRA conversion in the context of option pricing theory. We offer some final observations in the last section. Essential derivations are included in the Appendix.

2. Literature review

The literature on IRAs and Roth IRAs is reasonably rich (e.g., Reichenstein, 2006a; b; c; Reichenstein, 2007a; b; Jennings, Horan, and Reichenstein, 2010). Most authors agree that the choice between tax-deferred accounts (TDAs) with front-end tax benefits and tax-exempt accounts with back-end tax benefits is driven largely by the relationship between current tax rates and those expected to prevail when funds are withdrawn (e.g., Horan, Peterson, and McLeod, 1997; Horan, 2003; Reichenstein and Jennings, 2003; Horan, 2005). Authors have also demonstrated that investors with multiple types of savings account can significantly improve the longevity of their financial portfolio by properly sequencing retirement withdrawals (e.g., Horan, 2006a; b; Reichenstein, 2006b; c), which illustrates the importance of diversifying taxable entities for taxable investors.

It is also important to view the choice of taxable accounts within the context of an investor's broader portfolio. For example, Reichenstein (2006b, c) examines how retirement account withdrawal strategies interact with Social Security benefits, and Horan and Zaman (2009) examine how an investor's interest in exogenous defined benefit and defined contribution programs impact future tax rates; hence, the initial choice between traditional IRAs and Roth IRAs.

The literature has recently matured to include a discussion about the implications of after-tax risk-sharing between the investor and the government (e.g., Reichenstein, Horan, and Jennings, 2012; Horan and Zaman, 2008). The extant literature has compared the risk profiles of taxable accounts versus TDAs with front-end loaded tax benefits.

Both traditional IRAs and Roth IRAs have embedded options. Hulse (2003) analyzes the option to convert a traditional IRA into a Roth IRA. In a more recent article, Stowe, Fodor, and Stowe (2013) analyze this option using traditional option pricing tools for single period as well as multi period settings and analyze some rollover strategies, incorporating the option to recharacterize (or reverse) an initial conversion. Zaman (2008) analyzes the built in option in Roth IRA that facilitates bequest motives.

For clarity, we use the term TDA to refer to accounts in which contributions are exempt from tax, earnings accrue tax-deferred, and withdrawals are taxed as ordinary income. We use the term tax-free accounts to represent accounts in which contributions are taxable, earnings accrue tax-free, and withdrawals are also exempt from taxation. Although we also adopt the U.S. vernacular of traditional IRA and Roth IRA to distinguish between taxable entities with front-end versus back-end tax benefits, respectively, the issue of tax-efficient investing is of global importance. Most industrialized and developing countries have tax incentives to encourage retirement savings, and this analysis generalizes to those jurisdictions. An international survey of 24 industrialized and developing countries commissioned by the American Council for Capital Formation (ACCF) indicates that tax-advantaged savings accounts are offered to taxpayers by two-thirds of the countries surveyed, including Australia, Canada, Germany, Italy, The Netherlands, and the United Kingdom. All but one of these countries permits tax-deductible contributions.

3. The arithmetic of IRAs

3.1. Expected value

In its most basic form, the choice between a TDA (such as a traditional IRA) and a tax-exempt account (such as a Roth IRA) can be modeled as a ratio of the expected after-tax accumulation of the two accounts over *n* periods. Specifically, the relative value of the TDA to the tax-exempt account can be expressed as:

$$Ratio = \frac{FVIF_{TDA}}{FVIF_{TaxEx}} = \frac{(1+r)^n(1-T_n)}{(1+r)^n(1-T_0)} = \frac{(1-T_n)}{(1-T_0)} \tag{1}$$

where r is the expected rate of return on the investment, T_0 is the current marginal tax rate, and T_n is the expected marginal tax rate at withdrawal. If the tax rate is higher during the withdrawal period (T_n) than the contribution period (T_0), the tax-exempt account has a higher payoff. If the tax rate is lower at withdrawal, the TDA has a higher payoff. The investor is indifferent if the tax rates are equal.[2]

Table 1 summarizes the relative payoffs using U.S. tax brackets prevailing as of this writing. The entries in the upper triangle represent cases when the TDA is superior to the tax-exempt account and their relative magnitude. The lower triangle represents cases when the Roth strategy is superior. The diagonal entrees represent cases in which tax rates remain constant in both contribution and withdrawal period.

This analysis overlooks several important factors. First, it presumes that the initial investment is not bounded by contribution limits. That is, if the pretax contribution is greater than the contribution limit, then the tax savings associated with the initial contribution into a TDA must be invested in a taxable, rather than a tax-deferred account, which creates tax drag on the performance of the TDA strategy (see Horan, 2005; Reichenstein, 2007a). Put differently, tax-exempt accounts allow investors to shield more after-tax dollars in TDAs in the presence of contribution limits. That consideration has been thoroughly investigated and is not discussed further here.

Table 1 Ratio of TDA to tax-exempt accounts

	T_0					
T_n	10%	15%	25%	28%	33%	35%
10%	1	1.06	1.20	1.25	1.34	1.38
15%	0.94	1	1.13	1.18	1.27	1.31
25%	0.83	0.88	1	1.04	1.12	1.15
25%	0.83	0.88	1.00	1	1.12	1.15
33%	0.74	0.79	0.89	0.93	1	1.03
35%	0.72	0.76	0.87	0.90	0.97	1

3.2. Variance

A second factor overlooked by only considering expected values is that tax rates affect the relative risk of the two strategies, which makes a comparison of their expected after-tax accumulations incomplete. The variance of expected after-tax accumulations for the TDA relative to the tax-exempt account is

$$\frac{Var(FVIF_{TDA})}{Var(FVIF_{TaxEx})} = \frac{(1 - T_n)^2}{(1 - T_0)^2}. \tag{2}$$

Like the accumulations themselves, the variances depend on the relationship between the tax rates upon withdrawal and contribution (see the Appendix). TDA investors share their gains as well as their losses with the government proportionately because the TDA is like partnership in which the government owns T_n of the partnership's principal (see Reichenstein, Horan, and Jennings, 2012). The tax-exempt account investor shares risk by ceding to the government their principal interest in the account up front by foregoing tax-deduction on the initial investment. The risk of the two accounts is equal only when the tax rates upon contribution and withdrawal are equal.

If the tax rates are different in two different periods the risk profiles will be different, making a strict comparison of their expected after-tax accumulations incomplete. Specifically, the government shares in more investment risk as the tax rate increases, leaving the investor to bear less risk.

3.3. Risk per unit of return

The after-tax risk differential becomes irrelevant when viewed within the context of after-tax accumulations, however. For example, the coefficient of variation (CV) for both TDAs and tax-exempt accounts are independent of tax rates and equal to each other.

$$CV_{TDA} = CV_{TaxEx} \tag{3}$$

In other words, the risk per unit of accumulation on average remains the same for the two accounts regardless of the tax rate (see the Appendix for a derivation). If the withdrawal tax rate is greater than contribution tax rate ($T_n > T_0$), then greater accumulation in the Roth IRA is exactly offset by the greater risk borne by the taxpayer. The risk and return offset works

Table 2 Differences in mean, standard deviation, and coefficient of variation

	$T_0 = T_n$	$T_0 > T_n$	$T_0 < T_n$
Panel A: Differentials when $\sigma = 0.20$			
Mean	0	121	−121
STD	0	251	−251
Coefficient of variation	0	0	0
Panel B: Differentials when $\sigma = 0.30$			
Mean	0	1,079	−1,079
STD	0	2,821	−2,821
Coefficient of variation	0	0	0

Note: This table provides the difference in mean, standard deviation (STD), and coefficient of variation of the accumulation in IRA and Roth IRA for different tax regimens for contribution and withdrawal years.

in the same way if the contribution tax rate is greater than withdrawal tax rate ($T_0 > T_n$). Although a TDA allows taxpayers to share more risk and return with the government on a larger pretax capital base through payment of tax at the withdrawal phase, saving in the Roth IRAs leaves the taxpayer bearing all risks as well as returns on a smaller after-tax capital base. Their after-tax risk-adjusted exposure, however, is comparable. The greater expected after-tax accumulation that investors expect as a result of, say, a lower withdrawal tax rate is compensation for bearing additional risk that the government is not absorbing through higher taxes.

We illustrate this concept by constructing a binomial stochastic process for our risky asset (as described in Cox, Ross, and Rubinstein, 1979). Assuming $100 is invested in the asset, a risk free rate of 6%, we consider the accumulation after 25 periods in a TDA and a Roth IRA. We use two tax rates 28% and 35% for our numerical example. Table 2 shows the difference of the mean of accumulation, standard deviation, and CV between the TDA and the tax-exempt account.

In Panel A, the volatility of returns is 20%. A lower withdrawal tax rate produces a higher TDA accumulation on average, but the standard deviation is also higher (Column 2). The Roth IRA performs better on average if the withdrawal tax rate is higher (Column 3), but again the standard deviation is higher. In both cases, however, the investor is equally well off in either account on a risk adjusted basis, according to the CV criterion. In Panel B, the volatility of returns is 30%. The differences in average accumulation and standard deviation are higher, but again the two accounts are equivalent on a risk-adjusted basis according to the CV criterion.[3]

Dammon, Spatt, and Zhang (2004), Horan and Zaman (2008), Reichenstein (2007a, b), and others demonstrate how the after-tax risk-return relationship might be incorporated into the optimization process that simultaneously solves for asset allocation and asset location.

The choice between accounts may nonetheless be influenced by more than a strict comparison of expected after-tax accumulations or optimization. Specifically, the option to convert a traditional IRA to a Roth IRA and to recharacterize (i.e., reverse) that conversion provides significant option value for the traditional IRA and depends on features of the conversion process as well as how the conversion tax is financed.

4. The option to convert

In the United States, traditional IRA account holders have the option to convert a traditional IRA to a Roth IRA and pay tax on the principal amount upon conversion up to 15 months after conversion.[4] This section explores the risk implications of the conversion option. Specifically, the mechanics of the conversion process changes the investor's after-tax risk exposure and the source of funds used to pay the conversion tax influences the ultimate value of the conversion option, insights that heretofore have been unexamined in the literature.

4.1. Temporary leverage associated with the conversion option

Because a taxpayer can choose to convert a traditional IRA to a Roth IRA and keep the potential tax liability invested in the tax-sheltered account until the tax must be paid up to 15 months later, taxpayers essentially create a leveraged position on the underlying asset when they initially convert. In corporate finance parlance, the government becomes a debt holder with a fixed claim for 15 months, while the account holder retains the equity interest in the remaining leveraged position.

For example, consider the taxpayer with a $100,000 traditional IRA who chooses to convert to a Roth IRA at the beginning of the tax year. Both the initial and the withdrawal tax rates are 40%.[5] The conversion fixes the government's interest in the IRA at $40,000 for 15 months, while the entire $100,000 principal remains invested. If the account doubles in value $200,000, the taxpayer will pay the $40,000 conversion tax, leaving $160,000. If the account value drops in half, the Roth IRA would have an after-tax value of only $10,000. If, however, the account were not converted and treated strictly as a traditional IRA, the after-tax value of the traditional IRA under those two scenarios would be $120,000 and $30,000, which represents a more narrow range of outcomes than under the Roth IRA conversion scenario. Fig. 2 illustrates this graphically.

The value of the government's fixed debt claim associated with conversation equals T_c of the value of the account. The taxpayer's remaining equity claim is $(1 - T_c)$. In other words, the debt-to-equity ratio from the taxpayer's perspective is equal to $T_c/(1 - T_c)$. Students of corporate finance will recall that Hamada (1972) expresses the expected return on levered equity as the expected return on unlevered equity plus debt-to-equity ratio. The Hamada relationship can be used to understand the impact of the conversion option. In other words, the expected return to a converted Roth IRA (ignoring the option to recharacterize) is equal to the expected return to the traditional IRA times one plus the debt-to-equity ratio, or

$$r_{Roth} = r_{Trad}\left[1 + \frac{T_c}{1 - T_c}\right]. \tag{4}$$

In our example, the expected return (and by extension the risk) of the Roth IRA is 1.67 times that of the traditional IRA. The additional leverage stems from the ability to delay the payment of the conversion tax. Once the conversion tax is due, the taxpayer must choose how to finance its payment.

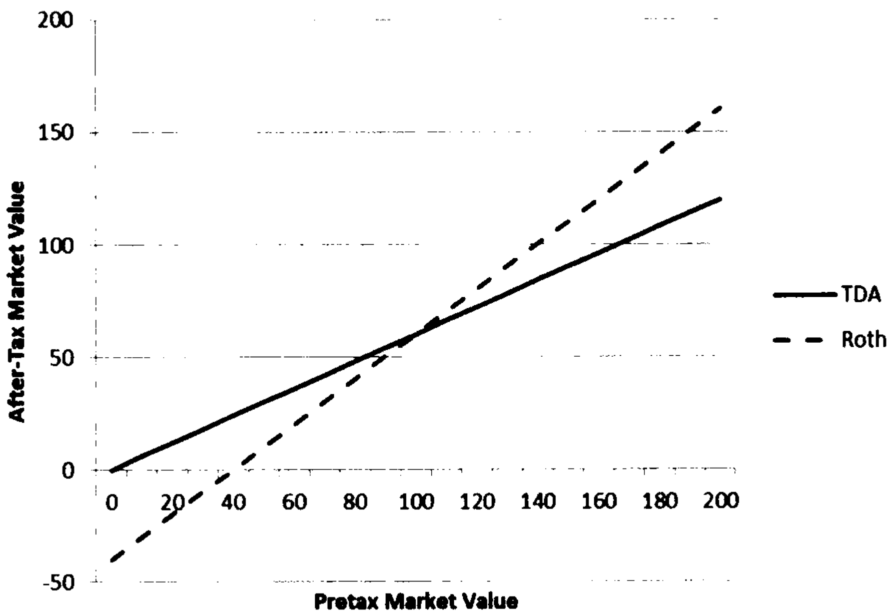

Fig. 2. After-tax market values of a traditional and Roth IRA before option expiration.

4.2. The conversion option, asset dynamics, and the method of financing tax payments

In the previous section, we showed that the conversion decision changes the risk-profile of the IRA for the period over which the taxpayer essentially borrows the conversion tax liability from the government. In this section, we show that the ex post value of the conversion decision depends on the dynamics of the underlying asset, which includes volatility as well as its path over time. Moreover, how asset dynamics affect the ultimate payoff depends on how the conversion tax payment is financed. Put differently, the risk of the underlying assets and their path through time influences the value of the conversion option under certain conditions, and the source of financing for the conversion tax affects not only the value of conversion but also the importance of volatility of the underlying asset for conversion.

Horan (2005) and others demonstrate that the value of the conversion decision depends heavily on the source of the funds used to pay the conversion tax. Specifically, conversion is substantially more attractive when the conversion tax is paid from a separate taxable account rather than the traditional IRA. When the conversion tax is paid from a taxable account, the analysis is identical to the choice between the traditional IRA and Roth IRA when the initial investment is bounded by contribution limits.[6]

As a third alternative, the taxpayer could borrow funds to pay the conversion tax. The source of funds used to pay the conversion tax influences the investor's after-tax risk exposure and hence the value of the conversion option. We address the impact of these three alternatives in turn.

4.3. Borrowing to pay the conversion tax

Suppose we have an asset with current market value of S_0 that moves up and down following a binomial asset process (e.g., Cox and Rubinstein, 1979), such that

$$u = e^{\sigma\sqrt{i}}$$

$$d = u^{-1}$$

where σ is the volatility of the underlying asset and i is the time increment. Consider the four-period case, which we generalize later. Following the binomial process we have the following paths for the asset value.

$$\begin{vmatrix} S_0 & & & & \\ S_0d & S_0u & & & \\ S_0d^2 & S_0ud & S_0u^2 & & \\ S_0d^3 & S_0ud^2 & S_0u^2d & S_0u^3 & \\ S_0d^4 & S_0ud^3 & S_0u^2d^2 & S_0u^3d & S_0u^4 \end{vmatrix}$$

Consider the special case in which the asset value moves down for four periods in a row. Suppose the taxpayer converts at the beginning of the first period at time 0 and borrows at the risk-free rate, to pay the conversion tax, at a rate of T_c, one year later at time 1.[7] The conversion decision is profitable ex post after four periods if:

$$S_0d^4 - S_0T_cR_f^3 > S_0d^4(1 - T_n)$$

where R_f is the continuously compounded return multiple for the risk-free asset, or exp(r). The first term on the left side of the inequality represents the value of the Roth IRA. The second term on the left side is the conversion tax and the cost of financing the tax liability by borrowing at the risk-free rate for three periods. The after-tax value of the same asset in a traditional IRA is on the right hand side where T_n is the tax rate at withdrawal. After rearranging terms, the conversion decision is profitable ex post if

$$\frac{T_n}{T_c} > \frac{R_f^3}{d^4}.$$

In other words, the value of conversion depends on the ratio of the tax rates, borrowing costs, and the path of the underlying asset. If the asset price moves upward for four periods in a row we have

$$\frac{T_n}{T_c} > \frac{R_f^3}{u^4}.$$

The value of the conversion option depends on the prospect of these conditions holding. The success or failure of the conversion is obviously path dependent. However, it is also time dependent. For example, if the saver wants to convert during the third period in our four-period model, the conversion will be successful ex post if either

$$\frac{T_n}{T_c} > \frac{1}{d} \quad or \quad \frac{T_n}{T_c} > \frac{1}{u}.$$

The ultimate value of conversion is still path dependent with a one-year time horizon, but it no longer depends on the borrowing costs because the conversion tax is paid at the end of our finite horizon. We can derive the conditions under which conversion is ex post optimal for each node on the payoff tree. Specifically, conversion is ex post optimal if the ratio of the two tax rates, T_n/T_c, is greater than the following values of each path along the payoff tree.

$$\left| \begin{array}{ccccc} \frac{R_f^3}{d^4} & \frac{R_f^3}{d^3u} & \frac{R_f^3}{d^2u^2} & \frac{R_f^3}{du^3} & \frac{R_f^3}{u^4} \\ \frac{R_f^2}{d^3} & \frac{R_f^2}{d^2u} & \frac{R_f^2}{du^2} & \frac{R_f^2}{u^3} & \\ \frac{R_f}{d^2} & \frac{R_f}{du} & \frac{R_f}{d^2} & & \\ \frac{1}{d} & \frac{1}{u} & & & \end{array} \right|$$

The ultimate payoff to conversion (and the value of the conversion option) depends on the likelihood that any of these possible values are less than the ratio of the two tax rates, T_n/T_c. In the general case, conversion is ex post optimal when:

$$\frac{T_n}{T_c} > \frac{R_f^{n-1}}{u^j d^{n-j}} \quad j = 0, 1, 2, 3, \ldots, n \tag{5}$$

where n is the length of the time horizon and j is the number of upward movements. In other words, value of conversion depends not only on the relationship between the current and withdrawal tax rates, but it also depends on the time horizon, the volatility of the underlying asset, and the cost of borrowing. All else equal, the value of conversion is positively related to the volatility of the underlying asset, if the taxpayer is borrowing to pay the conversion tax. Moreover, volatility's positive impact on the conversion option increases with the time horizon. By borrowing to pay the conversion tax, the investor has essentially created leverage in the underlying asset and thereby increased the value of the conversion option.[8] Note that we have yet to introduce the option to recharacterize (or reverse) the conversion.

4.4. Funding the conversion tax from a taxable account

Paying the conversion tax from the IRA corpus does not affect the investor's after-tax risk exposure (and hence the value of the conversion option) because the two accounts have equivalent after-tax risk (e.g., Jennings, Horan, and Reichenstein, 2012) assuming tax rates are constant. Paying the conversion tax from the IRA corpus is widely discouraged in practice, however, for two reasons. First, it decreases the after-tax principal sheltered by the Roth IRA thereby diluting the tax benefit. Second, and more importantly, it triggers a 10% early withdrawal penalty for taxpayers who convert before age 59½.

Therefore, conventional wisdom is to finance the conversion tax liability from a taxable account. This financing method does not trigger an early withdrawal penalty and falls between the two extremes of borrowing to pay the conversion tax (that increases the investor's after-tax risk exposure and hence the value of the conversion option) and funding the conversion from the TDA corpus (that leaves the investor's risk exposure, and hence the value of the conversion option, unchanged). To our knowledge, the influence of the conversion tax funding strategy on the investor's after-tax risk exposure and hence the value of the conversion option has yet to be considered.

The effect of financing the conversion tax liability from a taxable account can be modeled using the binomial process established above. Suppose the taxable account used to finance the conversion tax is invested in the same underlying asset as the IRA account. Therefore, the taxable account follows the process

$$u_{Taxable} = e^{\sigma\sqrt{i}}e^{1-t_k} = ue^{1-t_k}$$

$$d_{Taxable} = u^{-1}e^{1-t_k} = de^{1-t_k}$$

where t_k is the tax rate in period k. In this case, the conversion decision is profitable ex post after four periods if:

$$S_0d^4 - S_0T_cd^3e^{3(1-t_k)} > S_0d^4(1 - T_n).$$

The terms have the same meaning as before except that the second term on the left hand side represents the cost of financing the tax liability from the taxable account. After rearranging terms, the conversion decision is profitable ex post if

$$\frac{T_n}{T_c} > \frac{e^{3(1-t_k)}}{d}.$$

As before, the ex post value of conversion depends on the relative values of the initial and withdrawal tax rates. When conversion tax is paid from a taxable account holding an equivalent asset, however, the value of conversion depends on interim tax rates, as well. The greater the tax drag on the taxable account, the more valuable the conversion option. In general, conversion is ex post optimal when the conversion tax is financed from a taxable account invested in equivalent asset when:

$$\frac{T_n}{T_c} > \frac{e^{(n-1)(1-t_k)}}{u} \quad j = 0, 1, 2, 3, \ldots, n \tag{6a}$$

if the first movement is upward, or

$$\frac{T_n}{T_c} > \frac{e^{(n-1)(1-t_k)}}{d} \quad j = 0, 1, 2, 3, \ldots, n \tag{6b}$$

if the first movement is downward. The value of conversion is still positively related to the volatility of the underlying asset when the conversion taxes are financed from the taxable account, but less so compared with when the tax is financed through borrowing. Comparing the right hand side of the inequalities of Eq. (5) and Eq. (6) shows that the impact of volatility on the conversion option is less pronounced with the conversion tax is financed from a taxable account then when the taxpayer finances it through borrowing because the denominator in Eq. (6) is relatively less sensitive to volatility.

In fact, the exponent on the denominator of Eq. (6) is always equal to one, implying that the value of conversion is less path dependent when the conversion tax is financed from the taxable account than when it is financed through borrowing. In other words, the only price movement on which the ex post value of conversion depends is that in the first period when the government is essentially financing the conversion tax through delayed payment.

We find it interesting the expression on the right-hand side of Eq. (6) gets larger with the time horizon, suggesting that the threshold for optimal conversion increases (making conversion less valuable) as the time horizon increases (given the first price movement). In other words, given that the first price movement is either up or down, the withdrawal tax rate needs to increase by a greater proportion (or decrease by a lesser proportion) than the current tax rate as the time horizon increases for conversion to become ex post optimal. The withdrawal tax rate need not be larger than the current tax rate. As time passes, however, the withdrawal rate threshold increases. This relationship holds because the opportunity cost of financing the conversion tax from the taxable account increases with the time horizon, which is less so when the conversion tax is financed through borrowing. The value of conversion is far more path dependent when the investor borrows to pay the conversion tax.

These results stand in contrast to conventional financial planning wisdom, which advises investors to finance conversion tax payments from a taxable account and to convert assets that are likely to appreciate in value. We show here that the price path (i.e., appreciation) is important only when conversion tax payments are financed through borrowing. Conventional wisdom is based on internally inconsistent assumptions about the source of tax payments and the after-tax risk of the portfolio. The first recommendation of conventional wisdom precludes borrowing, while the second recommendation presumes it.

5. Option to recharacterize

In addition to the conversion option, taxpayers in the United States have the ability to reverse (or recharacterize) that decision for a period of up to 21.5 months if the original conversion occurs at the beginning of a tax year.[9] In this section, we explore how the option to recharacterize is affected when withdrawal tax rates are different from current tax rates.

Suppose the market value of assets held in a traditional IRA is MV_0, and a taxpayer facing a marginal tax rate T_c converts her investment to Roth IRA at the beginning of the initial period. The marginal income tax rate (when tax is due) at time n or the withdrawal tax rate is T_n. Suppose further that the market value of the assets is MV_1 in the period after conversion when the tax is due. At this point the taxpayer can either (1) pay the conversation tax and maintain the assets in the Roth IRA, or (2) recharacterize the account to a traditional IRA by assessing the following

$$Max\{MV_1(1 - T_n), MV_1 - MV_0T_c\}. \qquad (7)$$

The first term in the brackets represents the after-tax value of the account if it is recharacterized as a traditional IRA. The second value in the brackets represents the value of the account as a Roth IRA after having paid the conversion tax based on the beginning market value and letting the option to recharacterize expire.

After some algebraic manipulation it can be shown that the taxpayer will keep the conversion if $MV_1T_n > MV_0T_c$. If tax rates at the initial conversion and withdrawal are equal ($T_c = T_n$), the conversion condition leads to the well-known result that taxpayers should leave the conversion in place if the value of the assets increases (i.e., $MV_1 > MV_0$).[10] Marginal tax rates play a significant role as well, however. If a decrease in the value of the assets is accompanied by an equal or greater proportional increase in the withdrawal tax rate, the taxpayer may nonetheless optimally choose to keep the conversion. Likewise, if the assets depreciate while the withdrawal tax rate increase in equal or greater proportion, the taxpayer may optimally choose to recharacterize back to a traditional IRA. The extant literature focuses exclusively on asset movements and ignores tax rate differentials.

An example may help illustrate. Consider a taxpayer with a $100,000 traditional IRA that is converted to a Roth IRA on 1 January at 40% conversion tax rate including federal and state taxes, which are paid from taxable assets on 15 April of the same year. If, by October 15 of the following year, the account value increases to $120,000, the taxpayer is well-advised to keep the conversion assuming the expected withdrawal tax rate is expected to remain at 40% because keeping the conversion will yield $80,000 (i.e., $120,000–$40,000) while recharacterizing will yield only $72,000 (i.e., $120,000 [1–40%]). If, however, at some point before October 15 of the following year the taxpayer's expected tax rate when the funds will be withdrawn unexpectedly drops to say 30%, the taxpayer may instead choose to recharacterize because keeping the conversion still yields $80,000 (i.e., $120,000–$40,000) while recharacterizing will yield $84,000 (i.e., $120,000 [1–30%]). The greater the volatility, the greater the difference, which highlights role that volatility in the underlying asset plays in the value of the recharacterization option.

We can use this insight to express the after-tax value of a traditional IRA taking into account the recharacterization option and the possibility of changing tax rates. Specifically, the value of the traditional IRA is equal to its after-tax value without a recharacterization option plus a call option on a Roth IRA with a strike price equal to the initial market value, MV_0. Viewed in this way, the payoff to a traditional IRA that has been "converted" to a Roth IRA at the end of the recharacterization period is:

$$\begin{aligned} IRA\ Payoff &= MV_1(1 - T_n) + Max\{0, MV_1 - MV_0T_c - MV_1(1 - T_n)\} \\ &= MV_1(1 - T_n) + Max\{0, MV_1T_n - MV_0T_c\} \qquad (8) \\ &= MV_1(1 - T_n) + T_cMax\left\{0, MV_1\frac{T_n}{T_c} - MV_0\right\}. \end{aligned}$$

Stowe, Fodor, and Stowe (2013) present a lucid analysis of the conversion and recharacterization option value in a single period and multiperiod setting in the special case when T_c equals T_n. For example, in the previous example in which the conversion tax rate is 40% and the expected withdrawal tax rate is 30%, the payoff to a traditional IRA that has been converted to a Roth IRA at the end of the recharacterization period (in thousands) would be

$$IRA\ Payoff = \$120(1 - .30) + (0.40)Max\left\{0, \$120\frac{0.30}{0.40} - \$100\right\}$$
$$= \$84 + (0.40)Max\{0, \$90 - \$100\}$$
$$= \$84$$

In other words, the payoff to the IRA in this example is simply equal to the after-tax value of the traditional IRA because it was optimal to recharacterize. The conversion option expired worthless (i.e., keep the traditional IRA) because the withdrawal tax rate was sufficiently less than the conversion tax rate to overcome the appreciation in account value.

It is interesting to note that the recharacterization option has a tax shield like interpretation that increases in value as the initial tax rate increases as long as either the asset appreciates (i.e., $MV_1/MV_0 > 1$) or the withdrawal tax increases (i.e., $T_n/T_c > 1$). Again, the recharacterization option depends not only on changes in asset value, but also potential changes in the withdrawal tax rate.

5.1. Put-call parity, differential taxes rates, and the recharacterization decision

Stowe, Fodor, and Stowe (2012) also point out that the recharacterization decision could equivalently be viewed as a Roth IRA with a put option on the underlying asset with a strike price equal to the initial market value. This equivalence can also be modeled within the context of different tax rates upon initial conversion and upon withdrawal. In that case, we have:

$$MV_1(1 - T_n) + T_c Max\left\{0, MV_1\frac{T_n}{T_c} - MV_0\right\} = MV_1 - MV_0T_c + T_c Max\left\{0, MV_0 - \frac{T_n}{T_c}MV_1\right\} \quad (9)$$

The first two terms on the right-hand side of the Eq. (9) represent the value of the Roth IRA after paying the conversion tax. The last term on the right-hand side represents the after-tax value of the put option, which is in the money at expiration if the market value falls proportionately more than the withdrawal tax rate. This interesting equivalence produces the familiar put-call parity in standard option pricing theory. Stowe et al. (2012) refer to this relationship in a footnote. Rearranging terms yields the familiar pay-off expression for put-call parity adjusted for differential tax rates.

$$MV_1 + Max\left\{0, MV_0\frac{T_c}{T_n} - MV_1\right\} - Max\left\{0, MV_1 - MV_0\frac{T_c}{T_n}\right\} = MV_0\frac{T_c}{T_n} \quad (10)$$

The first term on the left hand side is the value of the underlying asset. The second and third terms represent the after-tax value of the long put and short call options, respectively, on those assets with a strike price equaling the initial pretax market value adjusted for the relative tax rates upon conversion and withdrawal. These three positions in combination will always produce a payoff equal to the initial market value times the ratio of the initial tax rate to the withdrawal tax rate.

An important insight from viewing the recharacterization decision in the context of option theory is that the decision to recharacterize (and hence the decision to convert in the first place) depends on the volatility of the underlying assets. The value of the recharacterization option increases as the volatility of the underlying asset and the expected withdrawal tax rate increase. If we assume tax rates are constant (i.e., $T_c = T_n$), then the expression reduces to that outlined by Stowe, Fodor, and Stowe (2013).

6. Conclusion

In this article, we investigate the risk-sharing implications of taxation on the traditional IRA conversion option. Although saving in IRAs allows the taxpayers to share more risk and return with the government on a larger capital base through payment of tax at the withdrawal phase, saving in the Roth IRAs leaves the taxpayer bearing all risks as well as returns on a smaller capital base. Their after-tax risk-adjusted exposure, however, is comparable assuming constant tax rates.

Although traditional IRAs and Roth IRAs have identical coefficients of variation holding the tax rate constant, the conversion decision depends on the dynamics of the underlying asset. Moreover, the influence of asset dynamics depends on how the conversion tax payment is financed because the financing decision implicitly changes the taxpayer's leverage. For example, the volatility effect is greatest when the conversion tax is financed through borrowing and nonexistent when it is financed from the corpus of the traditional IRA. The value of conversion is positively related to the volatility of the underlying asset when the conversion taxes are financed from the taxable account, but less so compared with when the tax is financed through borrowing.

These results contradict conventional wisdom, which advises investors to finance conversion tax payments from a taxable account and to convert assets that are likely to appreciate in value. We show here, however, that the price path (e.g., appreciation) is important only when conversion tax payments are financed through borrowing.

We establish that the success of the conversion strategy depends heavily on asset dynamics and expected tax rate changes at the expiration of the recharacterization option. The recharacterization option embedded in IRA is valuable. We also show that the decision to recharacterize (and hence the decision to convert in the first place) depends on the volatility of the underlying assets. Moreover, the value of these options depends on expected changes in tax rates. Therefore, given the path dependence of the realized value on conversion and saver inertia, strategic conversion may not be suitable for all savers. Comparing traditional IRAs and Roth IRAs on other dimensions, particularly those related to withdrawal phase such as bequest motive and strategic tax smoothing, may lead to superior account selection or conversion decision.

Notes

1 Tax rates may increase in the United States for a number of possible reasons. The health care tax imposes a 3.8% surcharge on individual taxpayers earning more than

$200,000 or couple earning more than $250,000. Furthermore, tax rates are set to revert to their higher pre-Bush era levels by default absent legislation doing otherwise. Finally, most countries are experiencing increased budget deficits and debt levels, creating political pressure to raise taxes.

2 All derivations are available in the Appendix.

3 The figures reported in Table 2 are differences rather than raw values. Therefore, they are not in the form of the ratio, $(1 - T_n)/(1 - T_0)$.

4 Taxpayers have until April 15 of the year after conversion to pay the conversion tax. A taxpayer converting on January 1 borrows the tax liability from the government for 15 months until it must be paid. Although taxpayers have the ability to recharacterize until October 15 of that year, they must pay estimated taxes on April 15 and can no longer borrow from the government after that point. If the conversion tax is funded by the traditional IRA itself, the taxpayer has re-established an equivalent risk profile in both the traditional IRA and Roth IRA. We discuss this more thoroughly later.

5 We ignore the option to recharacterize for the moment and consider that in the next section.

6 See Horan (2005), p. 34.

7 In the United States, taxpayers must pay estimated taxes by April 15 of the year after conversion. The investor still needs to finance the conversion tax liability even if it is ultimately recharacterized before October 15.

8 If increasing leverage were the objective, the investor could borrow money from a broker and increase leverage further.

9 A U.S. taxpayer who converts on January 1 of a given tax year has until October 15 of the following tax year to reverse that decision and recharacterize by filing an amended return.

10 See, for example, Stowe, Fodor, and Stowe (2013), and Reichenstein, Rothermich, and Waltenberger (2009).

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Appendix

Eq. (2):

$$\frac{Var(FVIF_{TDA})}{Var(FVIF_{TaxEx})} = \frac{Var((1+r)^n(1-T_n))}{Var((1+r)^n(1-T_0))} = \frac{(1-T_n)^2 Var((1+r)^n)}{(1-T_0)^2 Var((1+r)^n)} = \frac{(1-T_n)^2}{(1-T_0)^2}$$

Eq. (3):

$$CV_{TDA} = \frac{\sqrt{(1-T_n)^2 Var(1+r)^n}}{E(1-T_n)(1+r)^n} = \frac{(1-T_n)\sqrt{Var(1+r)^n}}{(1-T_n)E(1+r)^n} = \frac{\sqrt{Var(1+r)^n}}{E(1+r)^n}$$

$$CV_{TaxEx} = \frac{\sqrt{(1-T_0)^2 Var(1+r)^n}}{E(1-T_0)(1+r)^n} = \frac{(1-T_0)\sqrt{Var(1+r)^n}}{(1-T_0)E(1+r)^n} = \frac{\sqrt{Var(1+r)^n}}{E(1+r)^n}$$

Eq. (5): sample paths of the asset price movements for a four period model.

$$\begin{vmatrix} S_0 & & & & \\ S_0d & S_0u & & & \\ S_0d^2 & S_0ud & S_0u^2 & & \\ S_0d^3 & S_0ud^2 & S_0u^2d & S_0u^3 & \\ S_0d^4 & S_0ud^3 & S_0u^2d^2 & S_0du^3 & S_0u^4 \end{vmatrix}$$

If a saver converts at time 0, the conversion will be optimal, when the stock declines in value for four consecutive periods, if

$$S_0d^4 - S_0T_cR_f^3 > S_0d^4(1-T_n)$$

$$\Rightarrow \frac{T_n}{T_c} > \frac{R_f^3}{d^4}.$$

Similarly, if a saver converts at time 1, the conversion will be optimal, when the stock declines in value for following three consecutive periods, if

$$S_0d^4 - S_0dT_cR_f^2 > S_0d^4(1-T_n)$$

$$\Rightarrow \frac{T_n}{T_c} > \frac{R_f^2}{d^3}.$$

Following the same logic, we can show the following

$$S_0d^3u - S_0dT_cR_f^2 > S_0d^3u(1-T_n)$$

$$\Rightarrow \frac{T_n}{T_c} > \frac{R_f^2}{d^2u}$$

$$S_0d^2u^2 - S_0dT_cR_f^2 > S_0d^2u^2(1-T_n)$$

$$\Rightarrow \frac{T_n}{T_c} > \frac{R_f^2}{du^2}.$$

After computing the terms for all paths and conversion times we obtain the following for our four period model. The top row lists the terms for conversion at the initial period.

$$\left| \begin{array}{ccccc} \frac{R_f^3}{d^4} & \frac{R_f^3}{d^3u} & \frac{R_f^3}{d^2u^2} & \frac{R_f^3}{du^3} & \frac{R_f^3}{u^4} \\ \frac{R_f^2}{d^3} & \frac{R_f^2}{d^2u} & \frac{R_f^2}{du^2} & \frac{R_f^2}{u^3} & \\ \frac{R_f}{d^2} & \frac{R_f}{du} & \frac{R_f}{d^2} & & \\ \frac{1}{d} & \frac{1}{u} & & & \end{array} \right|$$

Considering the recursive nature of the expressions above, we can generalize the formulation as follows.

$$\frac{T_n}{T_c} > \frac{R_f^{n-1}}{u^j d^{n-j}} \quad j = 0, 1, 2, \ldots, n$$

where n = number of periods after conversion to Roth IRA till withdrawal.

Eq. (6):

This equation is generated by following the same logic as described above. Tax adjustments are made by multiplying the stock value at any given time by the following term

$$e^{1-t_k}.$$

Eq. (8):

$$IRA\ Payoff = MV_1(1-T_n) + Max\left\{0, \left[\overbrace{MV_1 - MV_0T_c}^{\text{Value with conversion}} - \underbrace{MV_1(1-T_n)}_{\text{Value without conversion}}\right]\right\}$$

$$= MV_1(1-T_n) + Max\{0, [MV_1 - MV_0T_c - MV_1 + MV_1T_n]\}$$

$$= MV_1(1-T_n) + Max\{0, [-MV_0T_c + MV_1T_n]\}$$

$$= MV_1(1-T_n) + Max\{0, MV_1T_n - MV_0T_c\}$$

$$= MV_1(1-T_n) + T_cMax\left\{0, MV_1\frac{T_n}{T_c} - MV_0\right\}.$$

Eq. (9): using Eq. (10) we have

$$IRA\ Payoff = MV_1(1 - T_n) + T_c Max\left\{0, MV_1 \frac{T_n}{T_c} - MV_0\right\}$$

$$= MV_1 - MV_1 T_n + T_c Max\left\{0, MV_1 \frac{T_n}{T_c} - MV_0\right\}$$

$$= MV_1 - MV_1 T_n + Max\{0, MV_1 T_n - MV_0 T_c\}$$

$$= MV_1 - MV_1 T_n + Max\{MV_0 T_c, MV_1 T_n\} - MV_0 T_c$$

$$= MV_1 + Max\{MV_0 T_c - MV_1 T_n, MV_1 T_n - MV_1 T_n\} - MV_0 T_c$$

$$= MV_1 + Max\{0, MV_0 T_c - MV_1 T_n\} - MV_0 T_c$$

$$= MV_1 - MV_0 T_c + Max\{0, MV_0 T_c - MV_1 T_n\}$$

$$= MV_1 - MV_0 T_c + T_c Max\left\{0, MV_0 - \frac{T_n}{T_c} MV_1\right\}.$$

Equating the first and last line, we obtain our desired expression

$$MV_1(1 - T_n) + T_c Max\left\{0, MV_1 \frac{T_n}{T_c} - MV_0\right\}$$

$$= MV_1 - MV_0 T_c + T_c Max\left\{0, MV_0 - \frac{T_n}{T_c} MV_1\right\}$$

Eq. (10): using Eq. (9) and some properties of max operator, we obtain the put-call parity relation.

$$MV_1(1 - T_n) + T_c Max\left\{0, MV_1 \frac{T_n}{T_c} - MV_0\right\}$$

$$= MV_1 - MV_0 T_c + T_c Max\left\{0, MV_0 - \frac{T_n}{T_c} MV_1\right\}$$

$$\Rightarrow MV_1 - MV_1 T_n + T_c Max\left\{0, MV_1 \frac{T_n}{T_c} - MV_0\right\}$$

$$= MV_1 - MV_0 T_c + T_c Max\left\{0, MV_0 - \frac{T_n}{T_c} MV_1\right\}$$

$$\Rightarrow -MV_1 T_n + T_c Max\left\{0, MV_1 \frac{T_n}{T_c} - MV_0\right\}$$

$$= -MV_0T_c + T_cMax\left\{0, MV_0 - \frac{T_n}{T_c}MV_1\right\}$$

$$\Rightarrow MV_1T_n - T_cMax\left\{0, MV_1\frac{T_n}{T_c} - MV_0\right\} + T_0Max\left\{0, MV_0 - \frac{T_n}{T_c}MV_1\right\} = MV_0T_c$$

$$\Rightarrow MV_1 - \frac{T_c}{T_n}Max\left\{0, MV_1\frac{T_n}{T_c} - MV_0\right\} + \frac{T_c}{T_n}Max\left\{0, MV_0 - \frac{T_n}{T_c}MV_1\right\} = MV_0\frac{T_c}{T_n}$$

$$\Rightarrow MV_1 - Max\left\{0, MV_1 - MV_0\frac{T_c}{T_n}\right\} + Max\left\{0, MV_0\frac{T_c}{T_n} - MV_1\right\} = MV_0\frac{T_c}{T_n}$$

$$\Rightarrow MV_1 + Max\left\{0, MV_0\frac{T_c}{T_n} - MV_1\right\} - Max\left\{0, MV_1 - MV_0\frac{T_c}{T_n}\right\} = MV_0\frac{T_c}{T_n}.$$

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