Review of Financial Economics 28 (2016) 1–20

Contents lists available at ScienceDirect

Review of Financial Economics

journal homepage: www.elsevier.com/locate/rfe

Is a pure TIPS strategy truly risk free?

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ARTICLE INFO

Article history:
Received 17 June 2014
Received in revised form 8 March 2015
Accepted 24 September 2015
Available online 3 October 2015

JEL classification:
G2

Keywords:
Inflation-indexed bonds
TIPS
Shortfall risk
Portfolio management
Inflation

ABSTRACT

A Treasury Inflation-Protected Security (TIPS) is virtually risk free. As an obligation of the U.S. Treasury, it is mostly free of default risk. As an inflation-indexed security held to maturity, it is risk free in terms of purchasing power. However, investing in a TIPS-only portfolio for retirement is not risk free. This paper presents the results of a simulation analysis designed to evaluate the performance of a portfolio of inflation-indexed Treasury coupon bonds. This study demonstrates that significant shortfall risk exists for TIPS-only portfolios across a range of savings plans and the securities selection rules.

1. Introduction

A portfolio of Treasury Inflation Protected Securities (TIPS) appears to be an ideal candidate for achieving a target level of real consumption in retirement. TIPS have virtually no default risk and are indexed for inflation. By comparison, stocks expose investors to considerable risk, and even conventional Treasury bonds held to maturity have inflation risk. For these reasons, Professor Zvi Bodie argues that most investors should invest most if not all of their retirement savings in Treasury inflation-indexed bonds (e.g.Bodie & Clowes, 2003, Chevreau, 2009a, 2009b, Light, 2009).

This paper evaluates the shortfall risk of TIPS-only portfolios held for retirement. Consider a household earning an income at the median for U.S. households in 2012. Suppose that their objective is to maintain the corresponding level of real income in retirement. This paper shows that, across a range of savings plans and security selection rules, the probability is significant that this household will not accumulate sufficient wealth in a TIPS-only portfolio to achieve its goal.

The most obvious reason is that TIPS offer relatively low real returns. An investor could boost the level of savings in the TIPS-only portfolio. But this paper demonstrates that an investor would need to save prodigiously in order to reduce shortfall risk to minimal levels. Another solution is to delay retirement. But the reduction in the probability of a shortfall generally comes at a significant cost in the form of lower utility of consumption in retirement as well as loss of leisure time (i.e., less time in retirement). Social Security benefits reduce shortfall risk, but an investor who saves for retirement in a TIPS-only portfolio still must contribute at high levels in order to minimize this risk.

Low real returns are not the only factor. Uncertainty about future real yields creates uncertainty in how much real savings are required to meet the investor's objectives. The analysis in this paper takes this factor into account by simulating uncertain real yields over time. This paper also examines the effects on shortfall risk of market friction and risk of involuntary, early permanent retirement (e.g., due to disability). In addition, not all TIPS selection strategies perform the same. This paper shows that the choice of security selection rules can have a significant effect on shortfall risk.

2. Material and methods

2.1. Simulated investors

This paper evaluates investment performance in terms of shortfall risk. This approach is consistent with Bodie and Clowes (2003), who justify an all-TIPS portfolio on the grounds that it minimizes the risk of falling short of one's retirement goals. Suppose that investors are saving to buy an inflation-indexed annuity at retirement. Shortfall risk can be measured as $P\{\omega : C_{t(S;\omega)}(S;\omega) < \chi\}$, where S is a strategy in the investment strategy space, Θ; ω is a simulated history for one investor; $t(S;w)$ is the actual date of retirement; $C_\tau(S;w)$ is the inflation-indexed monthly consumption supported by an immediate inflation-indexed annuity purchased at time τ, given strategy S followed by the investor;

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http://dx.doi.org/10.1016/j.rfe.2015.09.003
1058-3300/

and χ is the minimum acceptable level of real monthly consumption in retirement. Equivalently, we can reformulate this probability in terms of actual pre-tax real retirement income versus an income target. In this paper, the latter interpretation generally is more convenient for the purpose of comparing retirement outcomes with the level of monthly savings before retirement.

For consistency when comparing simulated investor histories, real values are in terms of purchasing power at the investor's 25th birthday, regardless of when the investor starts and stops saving. Hence, throughout this paper, the term "real value" refers to the investor's purchasing power at age 25 unless I specify otherwise.

This paper addresses a claim about shortfall risk of TIPS-only portfolios. However, expected utility of each strategy is reported as an alternative measure of the relative benefits when comparing two strategies with different shortfall risk. Results are for a time separable utility of consumption in retirement, where the utility function is the natural log of consumption. Expected utility at retirement is discounted back to the investor's 25th birthday in all cases (using the same time discount factor applied to calculate the expected utility) for consistency when comparing investors with different retirement dates. In order to focus on standard of living in retirement, bequests have no utility in the analysis.

For convenience in the analysis, I replace monthly real after-tax consumption in retirement with monthly real pre-tax retirement income. This income may arise solely from a TIPS-only retirement portfolio liquidated to purchase an inflation-indexed annuity, or it may also include other inflation-indexed retirement income such as Social Security benefits. With the natural log of utility and the size of payments in this study, the effect of shifting from after-tax consumption to before-tax income on utility is small. For example, if monthly pre-tax annuity payments are $4000 and the effective average tax rate is 10%, then the ratio of the log of consumption to the log of annuity payment is 0.987. Moreover, the effect is proportional and thus does not change relative ordering of expected utilities. Hence, an analysis of shortfall risk in terms of pre-tax retirement income at the median household level will lead to approximately the same conclusions in this paper as an analysis in terms of after-tax consumption.

A simulated investor adopts a lifetime investment strategy that consists of a savings plan and a securities selection rule. A savings plan either consists of constant monthly real dollar contributions or monthly real dollar contributions that grow at a constant rate. Each month during the accumulation phase, the investor pools the new contribution with cash flows from coupon payments and par from maturing TIPS and attempts to invest in TIPS that satisfy the security selection rule. In all cases, the investor buys an inflation-indexed immediate annuity at retirement.

Each investment strategy is evaluated under three scenarios: (a) no secondary market friction and no risk of involuntary early retirement; (b) secondary market friction and no risk of involuntary early retirement; and (c) secondary market friction and risk of involuntary early retirement. When the simulated investor is at risk of involuntary early retirement, the risk begins at age 52. This risk is based on the National Institute on Aging survey data reported by Hodes and Suzman (2007). The probability of involuntary retirement in each month after the investor's 52nd birthday is determined by a quadratic model fit to annual data from Figure 2-2, "Retirement Pattern for Career Workers in the First HRS Cohort: 1992–2002." Although this data includes retirement for all reasons, health was the primary factor in early retirement for more than half of all men and more than one third of all women in the survey. Achieving sufficient financial wealth does not appear to have been a significant factor in the reported retirement rates, because more than one third of respondents said that they had saved nothing for retirement, and three-fourths said that they had not saved enough. The survey data is for retirement in the age range 52 to 70 years; in the simulation, the probability of involuntary early retirement after the 70th birthday is assumed to be the same as the rate at age 70.

To determine the monthly inflation-indexed annuity payment that a given level of wealth can buy, the simulator calculates the immediate pension annuity factor, assuming discrete, real monthly payouts conditional on the investor's age at retirement. (Please see Appendix A for details.) To determine the real payout, the simulator divides the investor's wealth by the immediate pension annuity factor. The following simplifying assumptions apply to all cases.

- The investor saves in a tax-deferred retirement account, and the annuity at retirement is held in this account. This assumption is consistent with the growing role of tax-deferred defined contribution plans in the United States.
- The investor has an accumulation phase before retirement and a payout phase after retirement. The investor has earned income only during the accumulation phase. This assumption is reasonable, because earned income typically falls sharply at retirement.
- The investor uses all wealth in the retirement account to purchase the annuity at retirement. Hence, strategies only concern investment decisions in the accumulation phase.
- The annuity is indexed with no lag to the Consumer Price Index for All Urban Consumers, non-seasonally adjusted (CPI-U). The annuity has no risk of default and no insurance features. Also, assume that the CPI-U tracks the investor's personal purchasing power in retirement.
- The annuity is the investor's only source of income in retirement with one exception. Defined benefit pensions and income from working in retirement are not considered in this analysis. To the extent that another source of inflation-indexed income is available, the investor could lower the target real consumption that must be supported by the retirement account. Due to the importance of Social Security benefits to many retirees, I evaluate the effect on shortfall risk if inflation-indexed Social Security payments are available.
- Probability of death is modeled as a random event consistent with the mortality rates in the Society of Actuaries (2014). Mortality rates in this simulation are unisex rates for the total U.S. population calculated as a simple average of the Society of Actuaries (SOA) mortality rates for men and women. I splice the SOA series for juveniles, employees, and healthy annuitants.
- Calculation of shortfall risk is based on real annuity payments expected at time of retirement.

2.2. Target savings

In the simulation, I set the target real dollar, pre-tax retirement account payout equal to $51,915 per year or, equivalently, $4326.25 per month. This value is the median pre-tax annual income among U.S. households in 2012 (Noss, 2014). Throughout this paper, "median pre-tax family income" refers to this dollar amount which also is defined to be in age 25 dollars from the perspective of the simulated investor.

A pair of important related questions arises concerning the realism of this target. What, in fact, is the retirement income target for a family retiring with a median income; and does a retired household need the same real income in retirement as before retirement?

Interpolating from survey data reported by the Employee Benefit Research Institute (Fig. 27 in Helman, Adams, Copeland, & VanDerhei, 2014), the median amount of savings that workers in 2012 thought they need for retirement was $368,056. Assuming a continuously compounded annual real rate of return of 3% and retirement at age 65, the corresponding annual real annuity would be $24,657. For the sake of argument, assume also that this value is the target for workers earning the median family income just prior to retirement. Although Helman et al. do not report whether respondents considered Social Security benefits to count as savings, it is reasonable to assume that the respondents excluded those benefits when asked about anticipated *savings* needed.

Expected Social Security benefits could range widely. Consider a worker who began earning the minimum wage in 1973 at age 25