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Discounting Trillions of Dollars in Pension Obligations: A Better Alternative to Using the Expected Return or Risk-Free Rate

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Abstract

This paper proposes a new discount rate that pension funds can use to discount their future obligations. If the payouts of a pension fund depend on the return of the fund's assets, then neither the risk-free rate nor the expected return is an equitable way to discount future liabilities. Using the newly proposed rate, the expected utilities of a particular stream of payments are the same in each period. This proposed rate is higher than the discount rate that is used by some pension funds but lower than the rate that the U.S. States are required to use.

Keywords: Discount rate, Pension fund obligations, valuation future obligations

JEL codes: G20, G28, H60, H55, H50

1. Introduction

Trillions of dollars and the welfare of millions of people are at stake when pension funds and other organizations discount their future liabilities. Pension funds use a discount rate in order to value the current cost of their obligations. The states in the U.S. are required to use the expected return on the pension fund's assets as the discount rate. In contrast, Dutch pension funds are required to discount using the risk-free rate. This paper argues that neither rate is equitable if the future payments of a pension fund depend on future returns. Examples of such funds are the Dutch pension funds and funds for which cost of living adjustments (COLA) depend on the funding rate, such as the New Jersey state pension funds and the Rhode Island state pension funds. The proposed rate is also useful for other pension funds that are underfunded by using either the risk-free rate or the expected return. Underfunding is a feature of the pension funds of

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all the U.S. States, as documented by Novy-Marx and Rauh (2011), and Andonov, Bauer, and Cremers (2017).

A standard view in financial economics is that future payments should be discounted at a rate that reflects their risk (Modigliani and Miller (1958)), and particularly their covariance with priced risks (Sharpe (1964), Lintner (1965), Cochrane (2011)). This seems to suggest that pension funds should discount future payments at the expected rate of return. However, under risk aversion, the utility of a certain payment is higher than the expected utility of an uncertain payment with the same expected value. Thus, a pension fund may want to keep the expected utility of payments to a pensioner constant. In such a case, using the expected rate of return is not a good option. We show that the pension funds can use a discount rate that ensures that the expected utility of future payouts equals the utility of the current payout. This discount rate is lower than the expected rate of return but higher than the risk-free rate. Following the labeling in macro growth models by Phelps (1966) and others, we call this the *Golden Rule discount rate*.

Under the assumption that the pension payments are a given amount and must be paid, the risk-free rate is the correct discount rate according to many authors; see, for example, Brown and Wilcox (2009) and Novy-Marx and Rauh (2011). However, the Dutch pension funds let their future payments depend on future returns, so the risk-free rate is not the correct discount rate for them. The Dutch Central Bank, de Nederlandsche Centrale Bank, regulates the Dutch pension funds. These have 1.56 trillion Euros in assets[2]; the largest is the Algemeen Burgerlijk Pensioenfonds for civil servants with 0.476 trillion Euros in assets[3]. A large pension fund for a private company is Shell Pension Fund, with 30 billion Euros in assets[4].

A pension fund that invests in risk-free assets and uses the risk-free rate to discount its future obligations can increase the expected utility of the pensioners by using the Golden Rule discount rate and by investing part of its funds in risky assets. Suppose that the pensioners receive the same payments every year when the pension fund only invests in the risk-free asset. Using the Golden Rule discount rate and investing in some risky assets increases the payout in the current year proportionally to the 'risk-free rate' payouts. All the future payments yield the same expected utility as the current period payment, and these expected utilities are higher than the utilities of the 'risk-free rate' payouts.

Further, the pension funds of most U.S. States promise certain payments, but they are required by Government Accounting Standards Board (GASB) ruling 25 and Actuarial Standards of Practice (ASOP) item 27 to use the expected return on pension assets as a discount rate. The U.S. state pension funds are all underfunded when they use the expected rate of return, according to Andonov, Bauer, and Cremers (2017). If they used the lower risk-free rate, as advocated by Brown and Wilcox (2009), then these pension funds would be even more underfunded. Of course, the U.S. states could have used the risk-free rate and set more assets aside, but none of the states chose to do so. In this paper, we consider the case where the future payments depend

[2]Nederlandsche Centrale Bank (2020)
[3]Stichting Algemeen Burgerlijk Pensioenfonds 2019 Jaarverslag.
[4]Stichting Shell Pensioenfonds 2019 Jaarverslag.

on future returns, which is currently the case for the Rhode Island and New Jersey pension funds, as well as for other pension funds with trillions of dollars in assets. Other states may join Rhode Island and New Jersey and let their future payments depend on their future investment results. A dramatic way for a state to do so is to default. Ergungor (2017) reviews the law and history of states that have defaulted in the past.

Private firms in the U.S. are required to discount using the yield on high quality corporate bonds, which is close to the expected return of a balanced portfolio consisting of stocks and government bonds. The Golden Rule discount rate can be useful for firms because it takes the uncertainty of returns into account. A concept that is somewhat related to the Golden Rule discount rate is Asset and Liability Management.[5] However, Asset and Liability Management does not imply a discount rate for future liabilities and does not give guidance on dividing the assets of an underfunded pension fund.

Andonov, Bauer, and Cremers (2017) show that underfunded pension funds increase their risky investments in an attempt to boost their expected returns, thereby increasing the discount rate of future pension obligations under current rules. Such gaming of the system is not possible under the Golden Rule discount rate, because when the variance of investments goes up, then the discount rate goes down. Using an example and an empirical application, we show the benefits of the 'even-handed' approach of the Golden Rule discount rate rather than the use of expected returns or the risk-free rate.

2. The Golden Rule Discount Rate

In this section, we present an example to illustrate the Golden Rule discount rate and then state a proposition showing its most important properties under more general conditions.

Example:

Let w denote the assets of a pension fund whose obligation is to care for its participants. Half of the participants will live for one period while the other half will live for two periods. Let R denote the discount rate for future obligations. If the discount rate R is close to zero, then about two thirds of the assets w will be used in the current period and about one third in the future period. In particular, $w\frac{1+R}{3+2R}$ is used per group in the first period, while $w\frac{1}{3+2R}$ is set aside for the next period. Assuming the constant relative risk aversion utility function $U(C) = -\frac{1}{\gamma C^{\gamma}}$ for $\gamma \neq 0$ and $U(C) = \ln(C)$ for $\gamma = 0$, the utility in the first period is

$$U(C_1) = -\frac{1}{\gamma\left(w\frac{1+R}{3+2R}\right)^{\gamma}}$$

[5]See for example Svetlozar Rachev, Yesim Tokat (2019) for a recent overview.

per group. Approximating a portfolio using a log normal distribution is standard in finance; see, for example, Bodie, Kane, and Marcus (2017) for using the log normal distribution for stock market returns. The skewness and excess kurtosis of a balanced portfolio are smaller than those of the stock market so that the log normal approximation is relatively good[6].

Let r and σ^2 denote the mean and variance of the log real return of the portfolio. The expected utility in the second period is then

$$EU(C_2) = -\frac{1}{\gamma}\left(\frac{w}{3+2R}\right)^{-\gamma} e^{-\gamma r+\gamma^2\frac{\sigma^2}{2}}.$$

If a pension fund uses the expected return, i.e. $R = R_{expected} = e^{r+\frac{\sigma^2}{2}} - 1$, then the utility in the first period is

$$U(C_1) = -\frac{1}{\gamma}\left(w\frac{1+R_{expected}}{3+2R_{expected}}\right)^{-\gamma} = -\frac{1}{\gamma}\left(\frac{w}{1+2e^{r+\frac{\sigma^2}{2}}}\right)^{-\gamma} e^{-\gamma r-\gamma\frac{\sigma^2}{2}}$$

per group. The expected utility in the second period is

$$EU(C_2) = -\frac{1}{\gamma}\left(\frac{w}{3+2R_{expected}}\right)^{-\gamma} e^{-\gamma r+\gamma^2\frac{\sigma^2}{2}} = -\frac{1}{\gamma}\left(\frac{w}{1+2e^{r+\frac{\sigma^2}{2}}}\right)^{-\gamma} e^{-\gamma r+\gamma^2\frac{\sigma^2}{2}}.$$

The utility in the first period equals the expected utility in the second period if $\gamma = -1$, i.e. risk neutrality. Under risk aversion, i.e. $\gamma > -1$, the expected utility is less in the second period. The proposition below shows that $EU(C_2) < U(C_1)$ under risk aversion for a very large class of utility functions and data-generating processes for portfolio returns.

The Golden Rule discount rate uses R*=$e^{r-\gamma\frac{\sigma^2}{2}} - 1$ for the case with constant relative risk aversion and log normal returns. This yields that the utility in the first period and the expected utility in the second period are

$$U(C_1) = EU(C_2) = -\frac{1}{\gamma}\left(w\frac{e^{r-\frac{\gamma\sigma^2}{2}}}{1+2e^{r-\frac{\gamma\sigma^2}{2}}}\right)^{-\gamma}.$$

One can express R* in terms of $R_{expected}$: R*= (1+$R_{expected}$)$e^{-\frac{(1+\gamma)\sigma^2}{2}} - 1$. Note that for $\gamma > -1$, we have that R*<$R_{expected}$. That is, under risk aversion the golden rate discount rate is lower than the expected return. This lower discount rate implies that less is consumed in period one, so that we have the following inequalities:

$$U(C_1)_{R_{expected}} > U(C_1)_{R*} = EU(C_2)_{R*} > EU(C_2)_{R_{expected}}.$$

[6] In the application, we use a portfolio consisting of 60% stocks (S&P 500) and 40% government bonds (10-year government bonds). We use fifty years of data, 1970-2019. The yearly skewness and excess kurtosis are -0.682 and 0.558, respectively. Over a 2-year horizon, the skewness reduces to -0.324 while the excess kurtosis is -0.849, i.e. it is just negative.

Now consider the risk-free rate R_{safe}. If the pension fund invests in the risk-free asset, then the utility in the first period is the same as the (expected) utility in the second period. However, if some of the fund's portfolio is invested in risky assets in order to maximize expected utility, then the expected utility is higher in the second period, i.e.

$$U(C_1)_{R_{safe}} < EU(C_2)_{R_{safe}}.$$

We now generalize this example to a proposition. In the example, the group that lives for one period is twice as large as the group that lives for two periods. More generally, size of the group that lives for one period divided by the other group can be denoted by δ, so that δ=2 in the example, $\delta = 1$ when the groups are of the same size, and $\delta = 0$ when everybody lives for two periods.

Proposition

Let $C_1 = w\frac{1+R_{expected}}{1+\delta(1+R_{expected})}$ and $C_2 = w\frac{1+S}{1+\delta(1+R_{expected})}$, where the endowment $w > 0$, $\delta \geq 0$, $E(S) = R_{expected}$ and $variation(S) > 0$. Let the function $U(C)$ be strictly concave. Then, $U(C_1) > EU(C_2)$.

Further, let $C_1 = w\frac{1+R_{safe}}{1+\delta(1+R_{safe})}$ and $C_2 = w\frac{1+S}{1+\delta(1+R_{safe})}$, where the endowment $w > 0$, and $\delta \geq 0$. The pension fund can invest in the risk-free asset and earn R_{safe} on its endowment. Instead, it chooses the return S since it yields a higher expected utility, so $U(C_1) < EU(C_2)$.

Using the expected return in the context of Government Accounting Standards Board (GASB) ruling 25 means using a single discount rate. For cases in which a U.S. State does not fully guarantee the payments, one can use the Golden Rule discount rate. Of course, one can let the discount rate depend on how far in the future the liabilities are due. A reason to do this could be that the risk-free rate has a yield curve that is not flat. All approaches can accommodate this. Further, the risk-free discount rate, the expected return discount rate, and the Golden Rule discount rate all have simple representations in continuous time. In particular, for the latter two, we have under log normality of the returns,

$$R_{expected}(t)=e^{t(r+\frac{\sigma^2}{2})} - 1, \text{ and}$$

$$R^*(t)=e^{t(r-\gamma\frac{\sigma^2}{2})} - 1.$$

We applied the three discount rates to balanced portfolios of 60% stocks (S&P 500) and 40% government bonds (10-year government bonds). This balance of 60% risky assets and 40% safe assets is common among pension funds; see the empirical study of Andonov, Bauer, and

Cremers (2017). We use fifty years of data[7], 1970-2019. The value of gamma for which a 60/40 portfolio is optimal is $\gamma = 1.4$. This is in the range of values found credible by Havránek (2015), and it is the value we use. We consider investing over a 20-year horizon starting at the beginning of 1970, 1980, 1990, and 2000. An endowment is consumed by one group (over a 20-year period) and, for every year, we calculate the future liabilities using a discount rate. We use 5.9% as the real expected return, as this was the average return over the sample periods. We estimate the portfolio variance, using the last 20 years of the balanced portfolio, i.e. using 1950 through 1969 for 1970. We use this estimated variance to calculate the Golden Rule discount rate for every year; the average value of this discount rate in our sample is 4.5%. The average value of the risk-free rate is 2.3%. All rates are real.

Using the risk-free rate, we find that the average utility is -36.52 in the first ten years and -25.04 in the remaining ten years. This is in agreement with the proposition theorem that states that the expected utility will be higher in the second period, i.e. it causes such inequality in expectation. For the expected return discount rate, we found -29.16 and -33.87, respectively, which is also consistent with the proposition since the utility decreases with time. Finally, for the Golden Rule discount rate, we found that the utility varied less: -31.05 in the first ten years and -30.12 in the remaining ten years. Thus, in this sample, the Golden Rule discount rate produces utilities that vary less over time compared to the other discount rates.

3. Conclusion

This paper proposes a new discount rate that pension funds can use to discount their future obligations. If the payouts of a pension fund depend on the return of the fund's assets, then neither the risk-free rate nor the expected return is appropriate to discount future liabilities. Using the proposed Golden Rule discount rate, the expected utilities of a particular stream of payments are the same in each period. In a two-period model, the (expected) utility is higher in the first period than in the second period when the expected return is used as the discount rate. Using the risk-free rate as a discount rate yields the reverse. Such differences can be problematic if the make-up of the groups changes with time. The proposed rate avoids such problems. Further, this rate is higher than the discount rate that is used by some pension funds but lower than the rate that the U.S. States are required to use.

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