The Bond Ladder Fallacy

David G. Tucek
Value Economics, LLC
13024 Vinson Court
St. Louis, MO 63043
Tel: 314/434-8633
Cell: 314/440-4925
David.Tucek@valueeconomics.com

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Abstract

This paper identifies several fallacies underlying the rationale for using a current bond ladder to calculate the present value of estimated future losses. The paper concludes that assuming a plaintiff will invest in a fixed portfolio of securities is at odds with expected behavior. Additionally, the paper concludes that current rates – whether expressed as a bond ladder or for a single maturity – do not represent the expected return a plaintiff can or will achieve over the course of the future loss period. Finally, the case is made for use of a discount rate based on the 10-year Treasury rate.

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I Introduction

Whether to discount future losses to the present on the basis of current or historical average interest rates is an issue that has long been debated by forensic economists. For example, Hickman (1977) noted that in personal injury and wrongful death cases "most economists appearing as expert witnesses have based their estimate of the future average interest rate on some historical average" and characterizes this approach as the "traditional discount method". Hickman then proposed an alternative method that relied on a portfolio of current corporate bonds to produce the estimated lost income through the plaintiff's life expectancy – the present value of the income loss or "the cost at the present time" is set equal to the cost of acquiring this portfolio. By comparison, Edwards (1975) eschewed the "current practice" of discounting with current government bond rates in favor of current rates offered by depository savings institutions. That is, he assumed that a current rate is typically used and offered his recommendation for picking that rate. It is clear then, that as far back as the mid-seventies, practitioners of forensic economics relied on both current and historical interest rates for discounting purposes. This issue remains unresolved today. For example, in the 2015 survey of forensic economists by Brookshire, *et al.*, 38.1 percent of the survey respondents indicated they relied on current interest rates, while 39.8 percent relied on historical interest rates.

The immediate focus of this paper is not the broad issue of whether future losses should be discounted to the present on the basis of historical average or current interest rates. Rather, the paper addresses the position, adopted by a subset of the current-interest-rate camp, that discount rates should be based on a current ladder of securities, most commonly U.S. Treasury securities. This position was the heart of Hickman's 1977 paper, though he proposed relying on high-grade corporate bonds. More recently, use of a bond ladder has been proffered in the forensic economic literature by Rosenberg (2010), who advocated discount rates based on a ladder of nominal zero-coupon bonds, noting "This approach offers a straightforward way to provide default risk free (but not inflation risk free) cash flows that match the future earnings stream in timing and amounts based on the same inflation assumptions, and avoids having to choose an average discount rate based on an arbitrary selection of past time periods." The bond-ladder approach has also been promoted via the profession's e-mail discussion lists and, based on my experience, in both deposition and trial testimony. The arguments in favor of the bond-ladder approach implicitly or explicitly include (1) the assertion that the plaintiff can only invest at today's current rates; (2) the plaintiff could (though not necessarily "will") invest in the securities upon which the ladder is based; and (3) investing the award in the bond ladder will provide the plaintiff with the cash flows needed to replace future annual losses.

The bond-ladder approach and its supporting rationale are subject to four major fallacies that make it unsuitable for calculating the present value of future damages. These fallacies are identified and explained below. Additionally, the paper concludes that current rates do not represent the expected return a plaintiff can or will achieve over the course of the future loss period and makes the case for use of a discount rate based on the 10-year Treasury rate.

II <u>Fallacy #1: The Bond Ladder Will Generate the Projected Future Lost Dollar Amounts</u>

As typically constructed, a bond ladder cannot be expected to generate the projected lost dollar amounts used in the present value calculations. It has long been recognized, even if the bonds are held to maturity, that the actual return on a portfolio consisting of regular coupon-bearing Treasuries depends on the rate at which any excess intervening coupon payments are reinvested (Fisher and Weill, 1971; Bell and Taub, 1988). So, if the present value of future losses is based on a laddered portfolio of regular coupon-bearing Treasuries, the portfolio will not necessarily provide the plaintiff with the cash flows equal to the projected future annual losses – it may over- or underfund those future losses depending on the actual reinvestment rate realized. Additionally, it is possible that circumstances may require the plaintiff to sell a holding in the portfolio before it matures.[1] If sold at a loss, this serves to underfund replacement of the plaintiff's future losses, while selling at a gain may serve to overfund the plaintiff's future losses, other things remaining the same. Consequently, it is a fallacy to maintain that a ladder of regular coupon-bearing Treasuries will produce cash flows equal to the projected future annual losses.

In response to this criticism, it is sometimes postulated that the plaintiff will invest the award in a portfolio of zero-coupon Treasuries: by eliminating the intervening coupon payments, the need to reinvest those payments is done away with. Also, by purchasing bonds maturing in each year in the amount equal to the projected loss for that year, it is alleged that the need to sell a bond at a gain or loss is also ostensibly eliminated. However, because zero-coupon bonds create an annual tax liability on the imputed or "phantom" interest that accrues each year with no corresponding generation of cash, most investors will not hold them in a taxable account. Consequently, it is unlikely that a plaintiff would invest any award in a zero-coupon Treasuries and it is a fallacy to maintain that they would replace future losses by doing so.[2] Given that the plaintiff did invest in a laddered portfolio of zero-coupon bonds, he would likely face the need to sell one or more of the bonds prior to maturity in order to meet the tax liability on the imputed interest. Even if a gain is realized by doing so, any bond sold prior to its maturity will not be available to fund the projected loss in the year it was scheduled to mature. Consequently, whether the bond ladder consists of zero-coupon or regular coupon-bearing Treasuries, it is a fallacy to maintain that a bond ladder will produce cash flows equal to the projected future annual losses.

There is an exception to this fallacy, however. Given that regular coupon-bearing bonds exist in sufficient maturities, it is possible to construct a bond portfolio that will replicate any desired set of future cash flows. See Tuckman and Serrat (2011) for a discussion of replicating portfolios.[3] Nevertheless, and as is discussed below, the possibility of constructing a portfolio of regular coupon-bearing bonds that replicates the projected future losses does not overcome the remaining bond-ladder fallacies.

III Fallacy #2: The Bond Ladder Will Generate the Actual Lost Dollar Amounts

It is rare that a forensic economist can estimate future losses with certainty: even in the case where the future annual loss is known precisely, the duration of the loss likely depends on the continued survival of the plaintiff. There are various ways in which this uncertainty concerning the future loss period is handled. For an earnings loss, the forensic economist might assume the loss persists with certainty through the end of work life expectancy (front loading); or the economist might evenly spread the loss through an assumed retirement age, based on the ratio of the remaining work life to the years remaining until that age is reached (uniform loading). Alternatively, the forensic economist may explicitly calculate the probability of labor force activity and use these probabilities to reduce the loss in each future year. Finally, some forensic economists may ignore work life expectancy altogether, and assume the loss exists with certainty through some arbitrary age such as the plaintiff's (or decedent's) full Social Security retirement age.[4]

Whatever method is used, it is clear that the cash flows being modeled will almost certainly not represent the actual loss the plaintiff experiences in an *ex post*, or after-the-fact, sense. If an earnings loss is modeled via front loading or with certainty through any given age, the resulting cash flows are but one of an infinite set of possible streams of losses. If losses are modeled via uniform loading or using the probability of labor force activity, the cash flows being modeled in each year are the *expected* losses – these will always be less than the actual loss, given that a loss is or would be experienced in a particular year. That is, absent death, injury, sickness or some other reason that would keep the plaintiff (or would have kept the decedent) out of the labor force, the actual loss will be greater than the expected dollar amount being discounted to the present.[5] Put another way, a mismatch between the funds that will be needed in future years and the funds that would be available from the laddered portfolio exists due to the mere fact that cumulative survival at any particular future date will actually be either 100 or zero percent, while the laddered portfolio assumes a fractional cumulative survival based on mortality probabilities at trial.

Moreover, even if the laddered portfolio could match a lost earnings stream exactly, once presented with an award it is not likely that the plaintiff will seek to exactly match withdrawals with that lost earnings stream. For one thing, even if the projected dollar amounts exactly matched what the actual earnings would have been, 100 percent would likely not have been consumed at the time earned – some would be saved and consumed in retirement. In the case of a life care plan, the plaintiff is faced with the possibility that he may live longer than expected or may incur greater future expenses than those underlying the forensic economist's present value calculation.[6] Finally, with respect to the future loss of household services, the desired amount will change in response to changes in relative prices, or in response to the plaintiff's changed circumstances.

These circumstances give rise to the second fallacy underlying the bond-ladder approach to calculating the present value of future losses: even if the ladder could produce cash flows exactly equal to those assumed in the present value calculation, those cash flows will likely exceed or fall short of both the *ex post* losses of the plaintiff and the amounts that the plaintiff will actually require in each future loss period. Consequently, it is a fallacy to maintain that a bond ladder would or could replace the plaintiff's future losses.

IV Fallacy # 3: The Plaintiff Will Invest the Award in a Dedicated Portfolio

A central premise of the bond-ladder approach is that it is based on a dedicated portfolio with a known return. It has already been demonstrated that, whether the portfolio consists of regular coupon-bearing or zero-coupon Treasuries, the return on the portfolio is not known due either to the need to reinvest future coupon payments or to the need to sell a security prior to its maturity. In other words, unless a replicating portfolio is developed, because the portfolio's return is uncertain, the cash flows it generates are uncertain, and there is no advantage to investing in a dedicated portfolio.

Likewise, the premise that the plaintiff will invest in a dedicated portfolio throughout the loss period does not withstand scrutiny, because such a portfolio would not replace the plaintiff's future losses or the amounts that the plaintiff will need in each future loss period. Again, because the required cash flows are uncertain, it is not certain that the portfolio will produce what is required and there is no advantage to investing in a dedicated portfolio.

Even absent these shortcomings of the bond-ladder approach, there is no reason to expect a plaintiff to invest in such a portfolio. A basic result of modern portfolio theory is that all but the most risk-averse investor will hold a portfolio consisting of both risk-free and risky assets. This is illustrated in Figure 1, a diagram that should be familiar to most forensic economists.

The vertical axis in this figure measures the expected return on a portfolio, while the horizontal axis corresponds to the portfolio's risk. The curves labeled I_1 and I_2 represent indifference curves between risk and return for an individual investor. They are upward sloping because it is assumed that the individual is risk-averse – that is, in order to willingly take on more risk, an increase in the expected return is required. And, like all indifference curves for a given individual, they cannot cross. Note that a completely risk-averse individual would have a single indifference curve corresponding to the vertical axis, indicating that he will only hold the risk-free asset. Typically, the risk-free asset is described as a near-cash substitute such as short-term Treasury bills. However, it can also be thought of as a portfolio of Treasury securities if "risk" is defined to refer to the risk of default rather than the variation in the expected portfolio return.

The upward-sloping portion of the red hyperbola is the efficient frontier – it is the set of portfolios of risky assets each with the feature that no other portfolio exists with a higher expected return for a given degree of risk. In the absence of a risk-free asset, the investor will choose a portfolio on the efficient frontier that is just tangent to an indifference curve: all other indifference curves will either be higher and consequently unachievable, or lower, producing less "utility" to the investor. The point r_{RF} on the vertical axis is the expected return of the risk-free asset. The blue line that goes through this point and is tangent to the efficient frontier is known as the Capital Market Line (CML). (This line is also called the CAL or

Capital Allocation Line). It shows the return and risk combinations of portfolios made up of the risk-free asset and the market portfolio (point M) of all risky assets. With a risk-free asset, the CML becomes the efficient frontier. Unless an investor is completely risk-averse (has a return/risk indifference curve lying along the vertical axis), the optimal utility-maximizing portfolio, R, will be some combination of the risk-free asset and the market portfolio of risky assets at point M. And, because r_{RF} and the efficient frontier will shift through time, the combination of the risk-free asset and the market portfolio of risky assets will change through time. Thus, it is a fallacy of the bond-ladder approach to assume the plaintiff will invest in a dedicated portfolio of risk-free securities. The structure of whatever portfolio the plaintiff selects, and its expected return, is unknowable.

V Fallacy #4: The Plaintiff Can Only Invest the Award at Current Rates

The assertion that the plaintiff can only invest at current rates is perhaps the most common, and most superficially compelling, argument in favor of calculating the present value of projected future losses using current interest rates in general, and of relying on a current bond-ladder portfolio in particular. However, the argument is only valid if it is assumed that the plaintiff invests the award in a dedicated portfolio, never having to reinvest cash realized from the maturing of the securities held in the portfolio. The three fallacies identified above make it clear that this is not the case, and that the plaintiff will invest the award not only at current rates but also at future (and unknown) rates. Consequently, it is a fallacy to claim that the plaintiff can only invest at current rates.

VI Discussion

The arguments presented above demonstrate that the rationale for using a bond-ladder approach to calculate the present value of future losses does not withstand scrutiny. All of the identified fallacies lead to the rejection of the arguments supporting the bond-ladder approach enumerated in the introduction: (1) the assertion that the plaintiff can only invest at today's current rates; (2) the assertion that the plaintiff could invest in the securities upon which the ladder is based; and (3) the assertion that investing the award in the bond ladder will provide the plaintiff with the cash flows needed to replace future annual losses.

More important, however, the fallacies and the shortcomings of the underlying arguments make it clear that the plaintiff will not invest in a laddered portfolio of risk-free bonds and, barring constraints to the contrary, the present value of the future losses should be based on a discount rate that reflects the returns on a portfolio of both risk-free and risky assets.

The key phrase in the above statement is “barring constraints to the contrary”. Forensic economists are constrained in their choice of a discount rate. Specifically, *Jones & Laughlin Steel Corp. v. Pfeifer* (103 S. Ct. 2541, or 462 U.S. 523, 1983) found:

> The discount rate should be based on the rate of interest that would be earned on "the best and safest investments." Once it is assumed that the injured worker would definitely have worked for a specific term of years, he is entitled to a risk-free stream of future income to replace his lost wages; therefore, the discount rate should not reflect the market's premium for investors who are willing to accept some risk of default.

Thus, even if the plaintiff can reasonably be expected to invest an award in a portfolio of both risk-free and risky assets, it is clear that the present value of the plaintiff’s expected losses should be calculated on the basis of a default-free rate such as a U.S. Treasury rate.[7] Although *Pfeifer* imposes a default-free constraint on the discount rate(s) used in the present value calculations, it is silent on the mix of such qualifying securities. Moreover, because the plaintiff’s cash flow needs will almost certainly vary from the projected losses, it is reasonable to expect that the plaintiff will sell securities held in the portfolio before they mature. Thus, at a minimum, the forensic economist must be concerned with the expected <u>total</u> return on a portfolio of U.S. Treasuries, or other suitable securities. Additionally, the issue of the mix of maturities held in the portfolio as well as the consistency between the rate used to discount future dollar amounts to the present and the growth rate used to project those amounts into the future must be addressed.[8]

One source of historical data on the total return on a portfolio of U.S. Treasuries is Ibbotson’s SBBI valuation yearbook: this publication contains the monthly total returns realized from holding portfolios of

U.S. Treasury bills, intermediate U.S. bonds (actually, notes), and long-term U.S. Treasury bonds. Specifically, Ibbotson's three total-return series correspond to the combined income and capital appreciation returns from holding 1-year Treasury bills, 5-year U.S. Treasury notes, and 20-year U.S. Treasury bonds. The monthly total returns for each of these series is shown in Figure 2, for the period from April 1953 through December 2014. Beyond showing that the intermediate and long-term returns appear to be stationary and more volatile than the total returns for bills, Figure 2 is not very useful. A more interesting portrayal of the data appears in Figure 3.

In each panel of Figure 3, the solid red line shows the rolling actual realized annual 10-year return for bills, intermediate and long-term U.S. Treasuries based on the three Ibbotson series in Figure 2.[9] In each instance, the actual returns are compared to the then-current 10-year Treasury rate at the start of each rolling 10-year period. The 10-year Treasury rate tracks the subsequent actual 10-year returns fairly well, particularly in the lower two panels. This is not surprising, since the 10-year rate reflects the market's expectations for the return that will be realized over the next 10 years. The relationship isn't exact because of differences in the maturities of the underlying securities and because market expectations aren't always realized.

The issue of maturity-mix issue is problematical. Not only is the initial mix unknowable, it can be expected to change through time as individual holdings age or are sold and as new securities are purchased. Additionally, because each of the Ibbotson series is based on a single maturity, none of them on their own serve as a proxy for the returns that a portfolio of U.S. Treasuries would have produced. Nevertheless, it is possible to gain an understanding of what such a portfolio would have returned by specifying the percentage held in bills and assuming that the balance of the portfolio was equally split between intermediate and long-term Treasuries as defined by Ibbotson. The results for two such mixes are presented in Figure 4. In this figure, the solid blue line represents the actual 10-year return of a portfolio with a bills/intermediate/long-term mix of 20/40/40, and the red dotted line corresponds to a 0/50/50 mix. The results for intervening portfolios would lie between these two bracketing mixes.

The black dashed line in Figure 4 again shows the 10-year Treasury yield at the start of each 10-year holding period. It is clear that the 10-year Treasury yield tracks the portfolio results throughout the entire period, although there are stretches where the deviation between the 10-year yield and the 10-year portfolio returns is persistently large. The most notable of these periods is the mid-seventies, a period of stagflation brought on by the end of the Bretton Woods Agreement, overly expansive monetary and fiscal policy, and the 1973 oil crisis. Still, the relationship between the 10-year market expectation and subsequent actual returns is strong throughout this period and for other subperiods. This is shown in Table 1, which presents the correlation coefficients between the 10-year yield and the subsequent 10-year returns for various portfolio mixes and for time periods defined by the tenure of the Federal Reserve chairman. As shown in the table, the correlation between the 10-year Treasury rate and subsequent actual returns is consistent across portfolio mixes and time periods, with the exception of the seventies.

Table 2 presents the average difference between the 10-year Treasury rate and the subsequent actual returns for the same time periods and portfolio mixes as shown in Table 1. The preponderance of negative entries for all but the first row and for the entire period indicates that, on balance, the 10-year rate underestimated the subsequent returns. Again, because of differences in the average maturity of each portfolio and because the market expectations embodied in the 10-year rate are not always realized, the relationship with the actual subsequent returns isn't exact.

Figure 4 and Tables 1 and 2 are consistent with the proposition that the current 10-year rate reflects market expectations for the return that will be realized over the next 10 years, and suggest that a discount rate based on the 10-year Treasury rate serves as a proxy for the total return that would be realized from a portfolio of Treasury securities whose mix falls in the range given in Figure 4. However, this conclusion does not mean that the present value of future losses should be calculated using the current 10-year Treasury rate as discount rate, unless the loss period is coincidentally close to 10 years. The reason for this is that the plaintiff will likely be required to reinvest cash generated by the portfolio as securities mature or are sold. What is needed is some estimate of the average 10-year rate over the loss period. There are three possible ways in which this estimate may be obtained.

First, a forecast of the 10-year rate over the expected loss period could be used to discount the future dollar amounts to the present. Such a forecast could be obtained from a government source like the Congressional Budget Office (CBO) or purchased from a private vendor like Moody's Analytics or Global Insight.

Second, it is possible to calculate the expected 10-year Treasury return for three successive 10-year intervals, based on the current Treasury rates for 10-, 20-, and 30-year maturities. The expected return for the first 10-year interval is just the current 10-year rate, Y_{10}. The expected return for the second and third 10-year intervals are calculated as

$$[(1+ Y_{20})^{20} \div (1+ Y_{10})^{10}]^{1/10} - 1$$

and

$$[(1+ Y_{30})^{30} \div (1+ Y_{20})^{20}]^{1/10} - 1,$$ respectively where Y_{20} and Y_{30} are the current 20- and 30-year Treasury rates. These three estimates of the expected 10-year return over each interval determine the discount rate used in each year of the interval.[10]

Finally, the third possible way in which the estimate of the 10-year rate over the loss period may be obtained is to calculate an average of the 10-year rate over some historical period.

The rate used for discounting cannot be determined in a vacuum: at a minimum, there is the need for the interest rates used to discount future dollar amounts to the present to be consistent with the growth rates used to project the dollar amounts into the future. For example, one would clearly not discount using today's current interest rates while projecting growth on the basis of average inflation (or wage growth) over the past 30 years. Similarly, because interest rates are forward-looking, they reflect expectations of future real growth.[11] Consequently, the need for consistency between the discount rate and the growth rate exists even if both are expressed in real terms.

Superficially, using a forecasted growth rate in conjunction with a forecast of the 10-year Treasury rate from the same source would meet this consistency requirement. However, because it is impossible to separate the impact of judgment on the forecast or to say how much it affects the outlook for growth and interest rates, no conclusion on consistency can be reached. Moreover, without detailed knowledge and analysis of the underlying forecast process, any claim of consistency is nothing more than speculation. So, absent accompanying support, use of a government – or a purchased – forecast of growth and interest rates fails to meet the consistency criteria.

Relying on the current 10-, 20- and 30-year rates as outlined above clearly removes any speculation about market expectations concerning future interest rates. However, it leaves unanswered the question of what expectations for growth are consistent with the expected future interest rates. While those expected future rates are easily derived from current rates, there is no market measure from which to derive the market expectations for future growth even though those expectations are part and parcel of the current and future rates. Consequently, reliance on estimates of future interest rates based on current levels founders because it is not possible to show what future growth rates are consistent with the future interest rate estimates.

This leaves the third approach – calculating an average over some historical period – as the only possible viable option. The key word here is "possible" – the forensic economist must still demonstrate consistency and must justify the time period used. In the historical context, "consistency" equates to demonstrating that the difference between the 10-year Treasury rate and the measure chosen for the average growth rate is stationary, or that it fluctuates around a stable mean. How this issue is best approached is beyond the scope of this paper, but it involves more than just performing a single statistical test and calling it quits. Similarly, justifying the choice of the time period used requires more than claiming to have captured several business cycles or just stating what period was used. It requires both knowledge of and an appreciation for changes in monetary policy and for changes in the macro economy.

VII **Conclusions**

The foregoing discussion has established that the bond-ladder approach fails because it cannot be expected to produce cash flows that are equal either to the projected losses being discounted to the present, or to the actual losses that will be experienced *ex post* by the plaintiff. Additionally, the bond-ladder approach incorrectly assumes that the plaintiff will invest an award in a dedicated portfolio at current rates. Because the plaintiff will almost certainly invest in a mix of risk-free and risky assets, and will likely face the need to sell securities in the portfolio and to reinvest in additional securities as time passes, the discount rate used should reflect not only current rates but also future unknown rates.

It is important to note that, even if the justification for use of a bond ladder does not rely on the claim that the portfolio will produce the projected or actual losses, or that the plaintiff can only invest at current rates, the method fails on its face. At its core, economics involves explaining and understanding how individual economic units make choices and decisions. Knowing that the plaintiff will not make a one-and-done investment decision by building a bond ladder, we cannot as economists assume that they will. That is, an economist cannot credibly ignore the fact that the fixed portfolio assumed by the bond-ladder approach is contrary to the expected behavior of the plaintiff. Instead of bond ladder, the discount rate should be based on the total return of a portfolio of U. S. Treasuries, or other suitable securities, whose mix of maturities is unknown.

Finally, the 10-year Treasury rate is a good proxy for the expected return on a portfolio of U.S. Treasury securities with a wide range of maturities that meets *Pfeifer's* constraint that the discount rate used should be free of default risk. Unless the loss period coincidentally equals 10 years, relying only on the current 10-year Treasury rate is insufficient. Because the plaintiff will likely have to sell individual holdings in the portfolio before their maturity, or reinvest excess cash in new holdings, the discount rate needs to reflect some estimate of the average 10-year rate over the loss period. Determination of this estimate cannot be done in a vacuum. The present value of the future losses clearly depends on both the interest rates used to discount future dollar amounts to the present and the growth rates used to project the dollar amounts into the future – the mathematics cannot be denied. At a minimum, the interest rates used for discounting needs to be consistent with the growth rates used to project the future losses. Basing the discount rate on a forecast of the 10-year rate, or on estimates derived from the current 10-, 20- and 30-year Treasury rates leaves the consistency issue unaddressed. However, use of a historical average interest rate translates the consistency requirement into the requirement to establish that the resulting net discount rate is stationary, a task involves more than just running a simple statistical test. Additionally, use of a historical average interest rate imposes the requirement to justify the choice of the time period used.

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Jones & Laughlin Steel Corp. v. Pfeifer (103 S. Ct. 2541, or 462 U.S. 523, 1983)

Figure 1 - The Portfolio Choice Decision

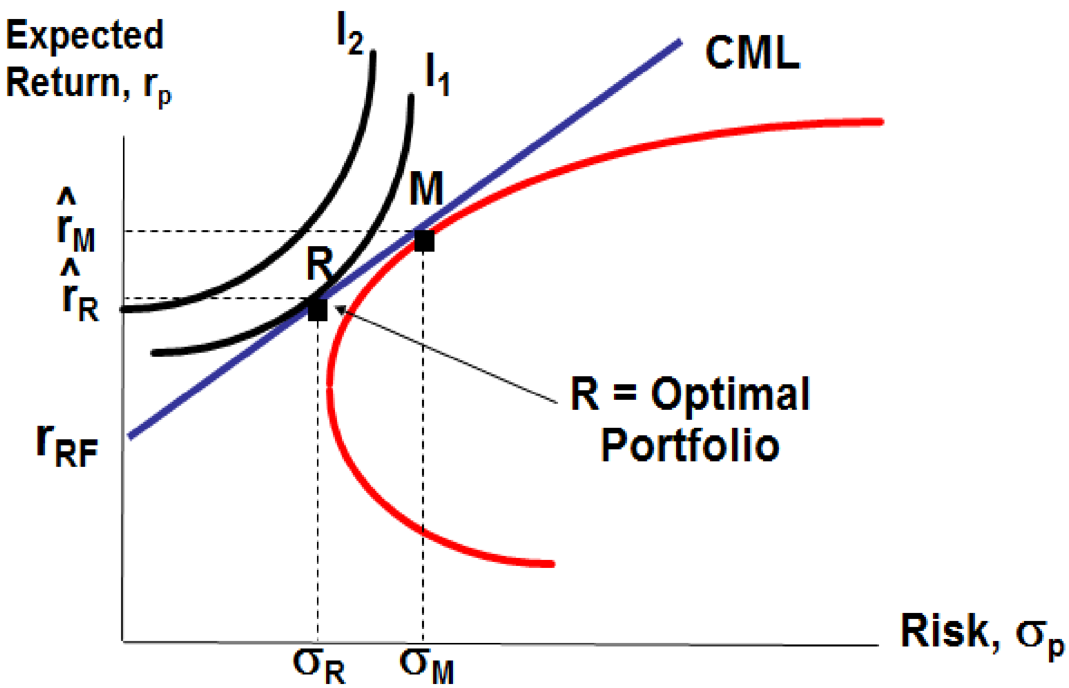


Figure 2 - Ibbotson's Bills, Intermediate & Long-Term Returns

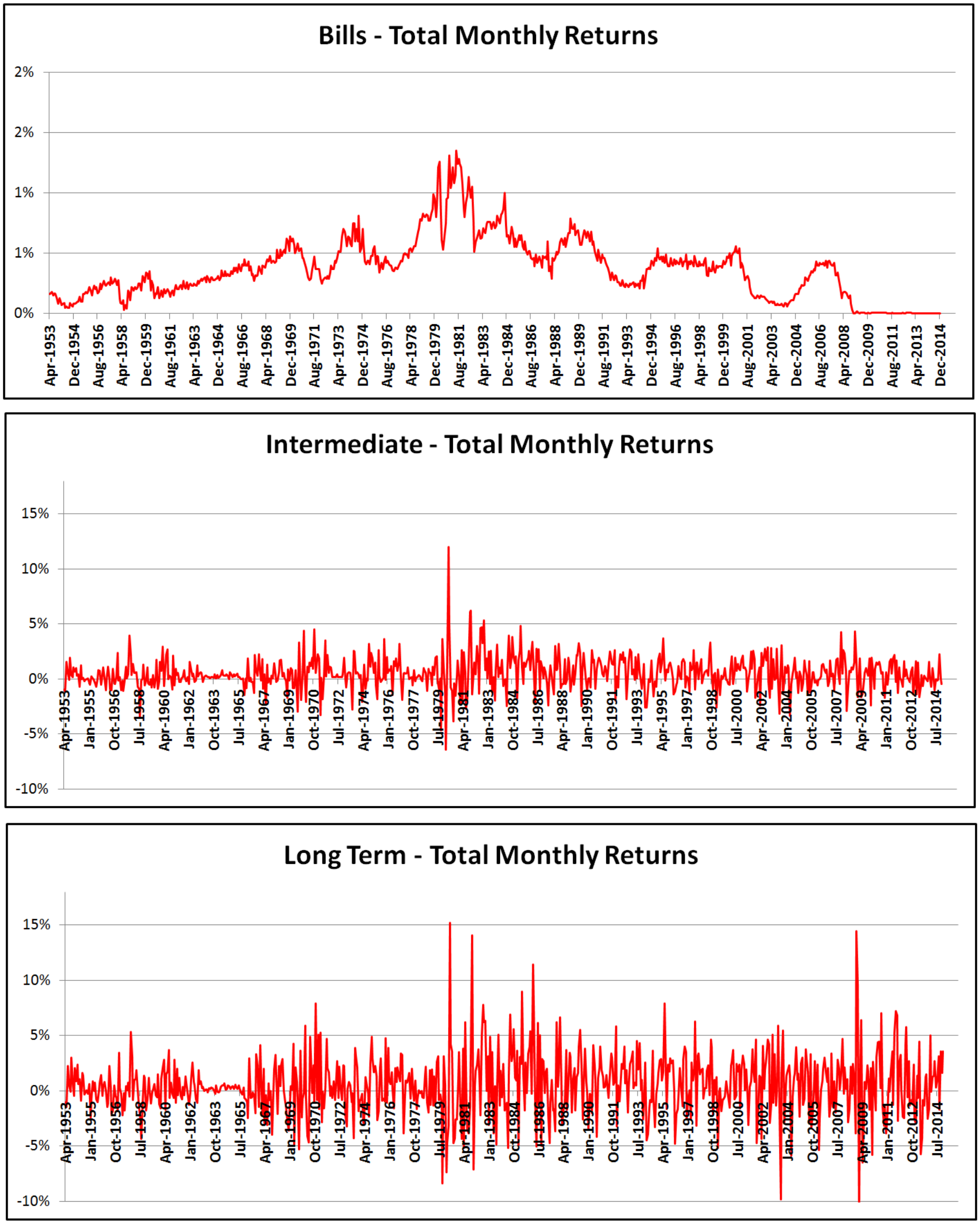
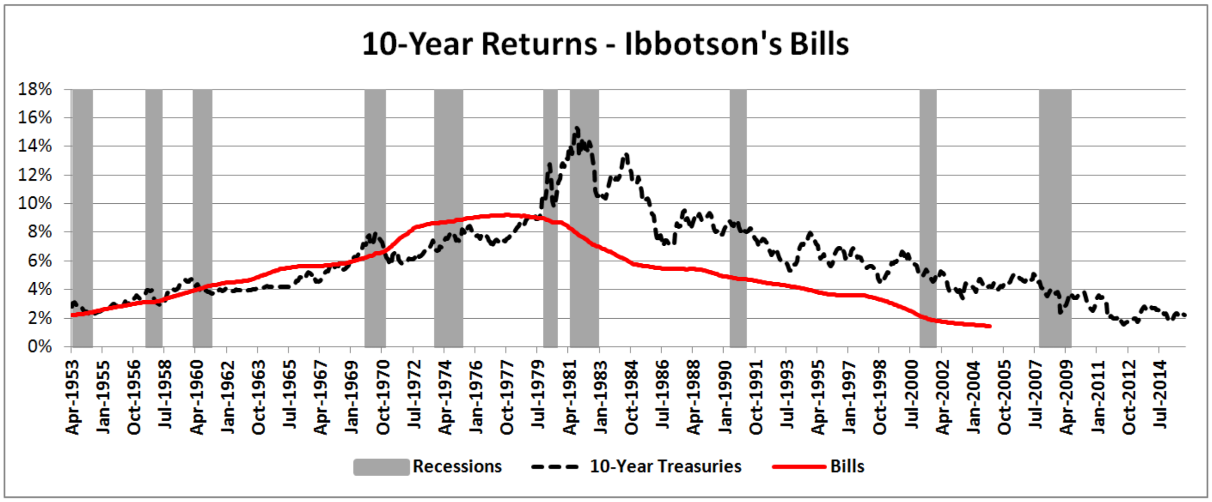
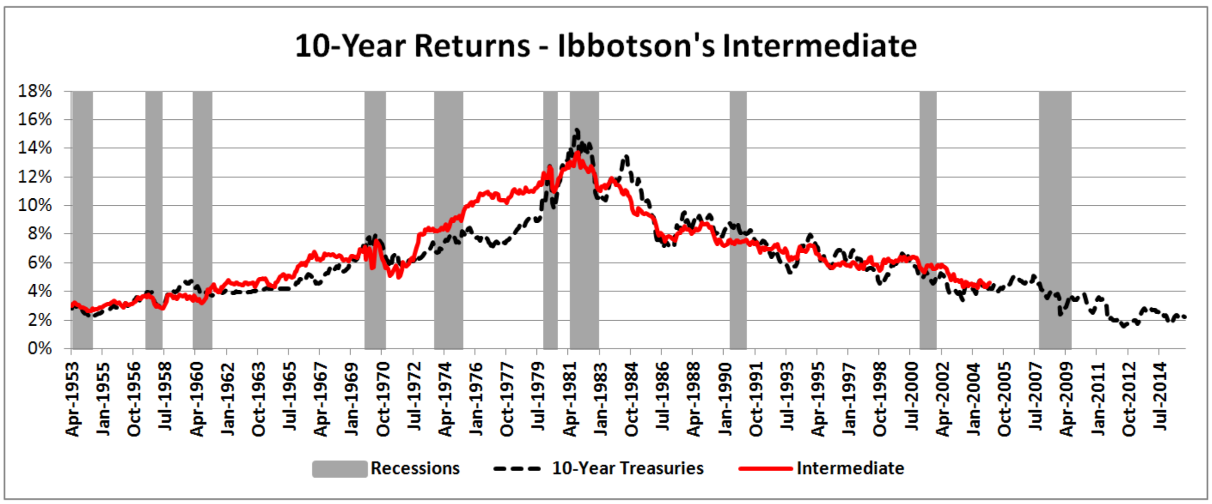


Figure 3 - Rolling 10-Year Returns





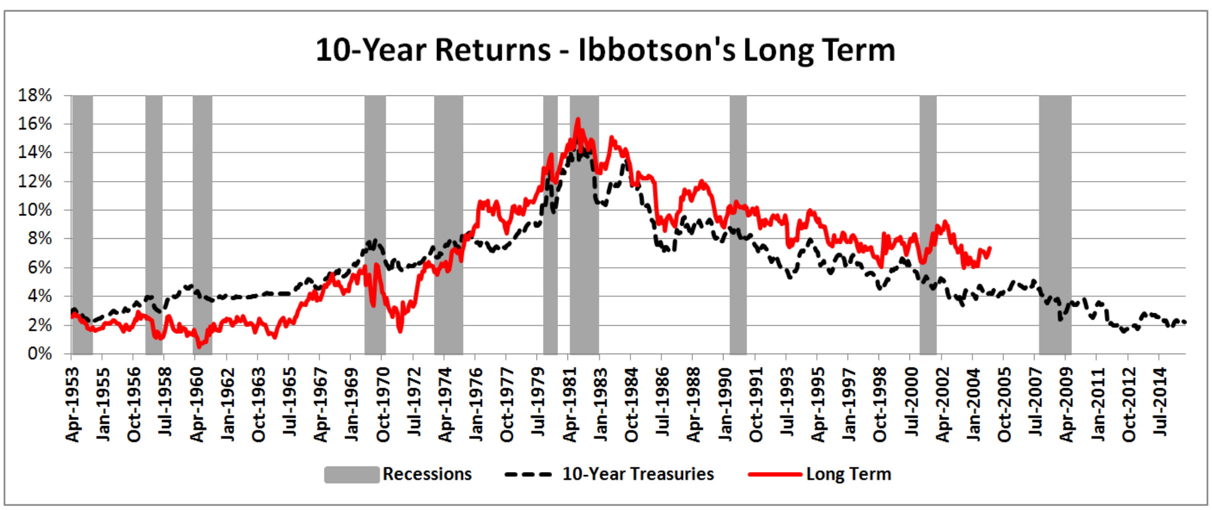


Figure 4 - Two Portfolios Based on Ibbotson's Bills, Intermediate & Long-Term Total Returns

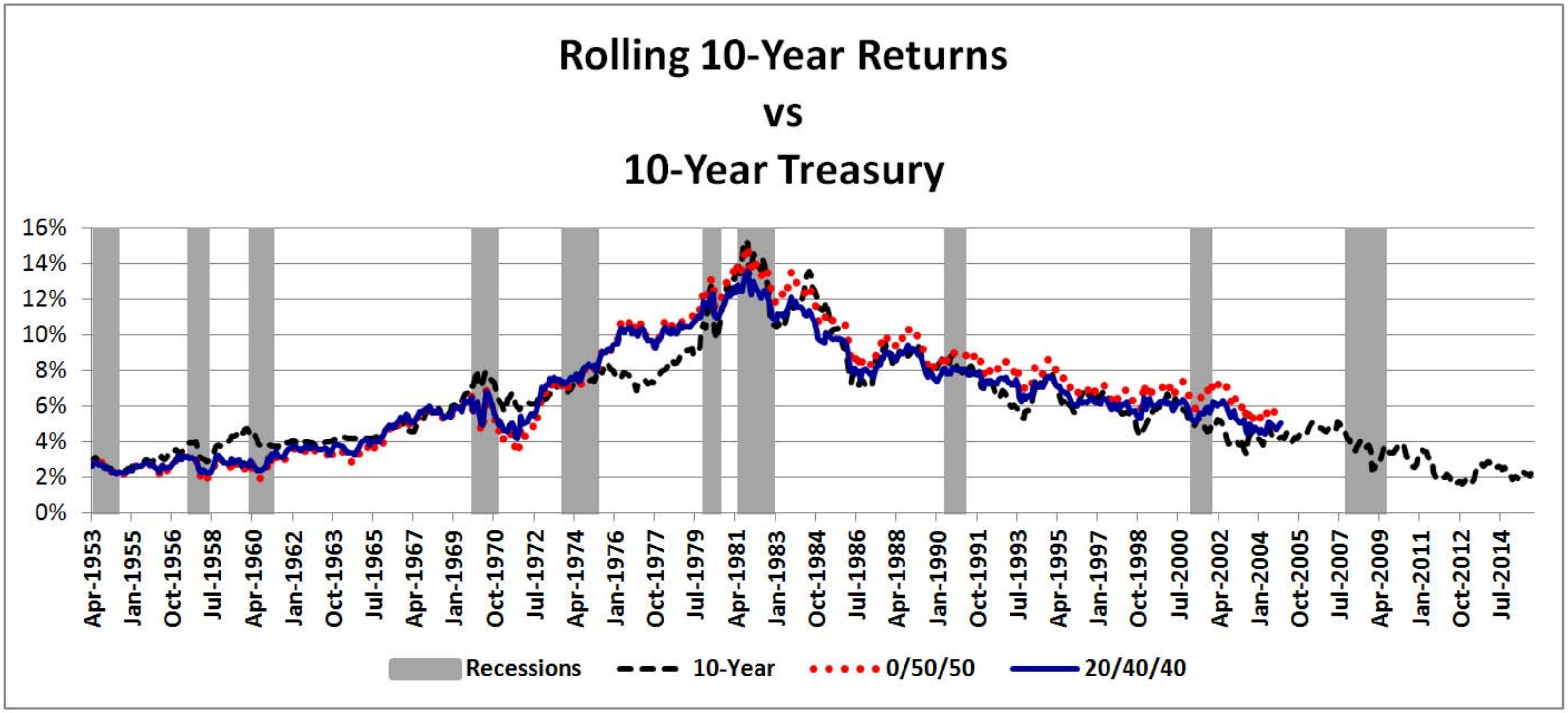


Table 1 – Correlation Between the 10-Year Treasury Yield and the Subsequent Total Return for Various Portfolio Mixes and Time Periods

	Portfolio Mix				
Bills	**0.00%**	**5.00%**	**10.00%**	**15.00%**	**20.00%**
Intermediate	**50.00%**	**47.50%**	**45.00%**	**42.50%**	**40.00%**
Long Term	**50.00%**	**47.50%**	**45.00%**	**42.50%**	**40.00%**
William McChesney Martin (April-1951 to Jan-1970)	0.8695	0.8772	0.8842	0.8905	0.8961
Arthur Burns and G. William Miller (Feb-1970 to July-1979)	0.8108	0.8081	0.8052	0.8018	0.7981
Paul Volcker (Aug-1979 to Aug-1987)	0.9166	0.9126	0.9076	0.9016	0.8944
Alan Greenspan (Sept-1987 on, through Dec-2004)	0.9137	0.9194	0.9246	0.9291	0.9330
Entire Period, through Dec-2004	0.9309	0.9343	0.9369	0.9387	0.9393

Table 2 – Average Difference Between the 10-Year Treasury Yield and the Subsequent Total Return for Various Portfolio Mixes and Time Periods

	Portfolio Mix				
Bills	**0.00%**	**5.00%**	**10.00%**	**15.00%**	**20.00%**
Intermediate	**50.00%**	**47.50%**	**45.00%**	**42.50%**	**40.00%**
Long Term	**50.00%**	**47.50%**	**45.00%**	**42.50%**	**40.00%**
William McChesney Martin (April-1951 to Jan-1970)	60.73	56.87	53.01	49.16	45.30
Arthur Burns and G. William Miller (Feb-1970 to July-1979)	(53.02)	(55.73)	(58.45)	(61.16)	(63.88)
Paul Volcker (Aug-1979 to Aug-1987)	(64.33)	(39.94)	(15.55)	8.84	33.23
Alan Greenspan (Sept-1987 on, through Dec-2004)	(108.14)	(88.38)	(68.62)	(48.87)	(29.11)
Entire Period, through Dec-2004	(36.25)	(27.57)	(18.90)	(10.23)	(1.55)

Note: Entries equal the average of the 10-year Treasury rate minus the subsequent total 10-year return for each time period and portfolio mix. Negative values indicate that the 10-year Treasury rate underestimated the actual return.

Endnotes

[1] Rather than selling a portfolio holding prior to its maturity, the plaintiff may fund the shortfall by borrowing at some unknown rate. Even so, the plaintiff's future losses will be underfunded.

[2] I regularly see reports in which the opposing economist bases his discount rates on a ladder of zero-coupon TIPS (Treasury Inflation Protected Securities). The rates are derived from the current yield curves for coupon-bearing Treasuries and regular TIPS, and on the heroic assumption the expected annual inflation over the next six months, 1, 2, 3 and 4 years will equal the average expected inflation over the next 5 years. Because only two maturities for such securities exist in the market, this gives rise to another, albeit local, fallacy: it is impossible for the plaintiff to purchase the securities upon which the discount rates and present value are based.

[3] Bell and Taub (1988) also discuss the construction of such a portfolio of regular coupon-bearing bonds, and propose a linear-programming approach to satisfy the constraint that the bonds are purchased in integer amounts.

[4] Similar situations exist with other types of losses. For example, the expenses in a life care plan may be extended with certainty through the plaintiff's remaining life expectancy, or they may be extended through the end of the life table and reduced in each year to account for the plaintiff's mortality risk. The important point here is that the cash flows being discounted to the present do not necessarily equal the *ex post* losses that will be experienced.

[5] Of course, if it were not the case that the future losses were reduced to account for such risks, the resulting loss estimates would over-compensate the plaintiff in an *a priori*, or before-the-fact, sense.

[6] With respect to life care plans in particular, forensic economists will generally use the midpoint of a range of values for each item in the plan, or prepare two present value calculations based on the high and low end of the range for each item. Regardless, the future expenses themselves are unknown and may be higher or lower than the values underlying the calculated present value.

[7] The "best and safest" language in *Pfeifer* is taken from *Chesapeake & Ohio R. Co. v. Kelly* (241 U.S. 485, 1916), which found: ". . . And the putting out of money at interest is at this day so common a matter that ordinarily it cannot be excluded from consideration in determining the present equivalent of future payments, since a reasonable man, even from selfish motives, would probably gain some money by way of interest upon the money recovered. Savings banks and other established financial institutions are in many cases accessible for the deposit of moderate sums at interest, without substantial danger of loss; the sale of annuities is not unknown; and, for larger sums, state and municipal bonds and other securities of almost equal standing are commonly available." Note that all of the listed securities have some degree of default risk, as do U.S. Treasury securities. Except for U.S. Treasuries, this risk can be diminished through diversification and by selecting only the most credit-worthy issuers.

[8] Final resolution of these last two issues is a topic beyond the scope of this paper. *Kelly* imposes stipulation that the discount rate not require "the exercise of financial experience and skill in the administration of the fund". I have seen opposing experts argue that a bond ladder can be easily constructed via Treasury Direct, or through a one-time call to a broker. If the investment decision were of the "one-and-done" variety, then many plaintiffs could easily build a bond ladder. While what may have constituted financial experience for the *Kelly* court has undoubtedly changed in today's world, given that the plaintiff will not invest in a dedicated portfolio and will regularly need to sell securities or reinvest excess funds, these claims run afoul of *Kelly's* restriction. It may be that it is more reasonable to estimate the present value on the basis of the return provided by a bond fund that is easily purchased through Vanguard, Fidelity or other major brokerage houses. Additionally, it is worth noting that the linkage between the discount rate and the assumptions underlying the projected future losses was recognized by *Pfeifer*. Specifically, it was found that: "In calculating an award for a longshoreman's lost earnings caused by the negligence of a vessel, the discount rate should be chosen on the basis of the factors that are used to estimate the lost stream of future earnings."

[9] Each solid line stops in December 2004 because that is the start of the 10-year period ending in December 2014.

[10] For example suppose that the current (nominal) 10-, 20- and 30-year Treasury rates were 1.95, 2.35 and 2.75 percent, respectively. Under this approach, the first 10 years of future losses would be discounted to the present using a 1.95 percent discount rate. Losses projected in the second 10-year interval would be discounted to the present using a 2.75 percent discount rate (1.0235^{20} divided by 1.0195^{10} to the one-tenth power minus 1 equals 2.75 percent). Losses projected in the third 10-year interval would be discounted to the present using a 3.55 percent discount rate (1.0275^{30} divided by 1.0235^{20} to the one-tenth power minus 1 equals 3.55 percent). Note that 1.0195^{10} times 1.0275^{10} taken to the one-twentieth power equals 1 plus the current 20-year rate. Similarly, 1.0195^{10} times 1.0275^{10} times 1.0355^{10} taken to the one-thirtieth power equals 1 plus the current 30-year rate. In other words, the three discount rates are consistent with the market expectations for the 10-year return in each successive 10-year period.

[11] This point is a fundamental result of the standard Keynsian IS-LM analysis or of David Romer's IS-MP model, and of the expectations theory of the term structure of interest rates. Though overlooked or dismissed by some forensic economists I encounter, it is widely recognized in the broader economics profession. See, for example, Bernanke (2013 and 2015), Summers (2014) and Rachel and Smith (2015).