Real Interest Rate Shocks and Portfolio Strategy

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Interest rates affect almost every aspect of economic activity. They not only mechanically impact the prices of fixed income securities, but also influence the market values of stocks, alternative assets, and long-term liabilities such as those of pension funds. *Shocks* to interest rates, unexpected changes in the rate, are important to analyze because they change asset and liability values in somewhat predictable ways, depending on the asset class under consideration and the reasons for the shock. In other words, portfolios can be prepared, in advance, to absorb those shocks.

Nominal and real interest rates

Interest rates and inflation are inextricably linked. Irving Fisher's famous equation,

$$\textit{Nominal interest rate} = \textit{real interest rate} + \textit{expected inflation} \qquad (1)$$

states that the nominal interest rate on a financial instrument equals the real (inflation-adjusted) interest rate, plus the inflation rate expected over the life of the instrument (Fisher 1930).[2]

Thus, nominal interest rates can change for either (or both) of two reasons:

- changes in real interest rates, and
- changes in inflation expectations.

In this article, we focus on real interest rates because, for most investment decisions, at both the corporate and the investor levels, the real cost of capital and the real expected return is what matters. We concentrate on fixed income assets and on liabilities, although we cover other asset classes as well, because real interest rates affect the discount rate and expected return on all assets, not just fixed income.

This article is pedagogical and integrative in nature. While we do not present original research, we bring together threads of existing knowledge and literature in what we believe is a manner that is clear and helpful to practitioners. On the way, we note the importance of history, including very old history, in preparing for the future.

The central role of liabilities

Essentially all asset pools have been gathered to pay some sort of liability. The liability can either be explicit and legally binding (as with a defined-benefit pension fund) or take the form of a stream of planned consumption (as with a defined-contribution plan or an individual's savings). An emphasis on liabilities and the coordinated management of assets and liabilities as a single portfolio is a central theme of this paper.

A liability typically resembles a fixed income asset held short. The "liability asset," the asset that would most closely resemble the liability if it were held short, can be nominal (like an ordinary bond) or real (with cash flows inflating as in an inflation-indexed bond). Because of this resemblance of most liabilities to fixed income assets, we cover liabilities in this paper as a kind of mirror image of the fixed income part of one's asset portfolio.

Robert Litterman, originator of the Black-Litterman asset allocation framework and a respected investment manager and scholar, has written:

> Pension liabilities typically contain a significant component of long-dated obligations that induces a large (*and, sadly, often unrecognized)* economic exposure to changes in the level of interest rates. Lower discount rates increase the present values of long-dated liabilities. Managing asset duration relative to liability duration is thus a first-order risk issue for pension funds.[3]

The same caveat applies to individual investing and to other types of funds, including those for which the liability is not legally defined or easily measured.

Principal findings

Before engaging in a more detailed analysis, we summarize our conclusions:

- Rapidly rising real rates pose the biggest risk to both fixed income and equities, and thus to the whole portfolio. The risk posed to fixed income is direct and mechanical. The risk posed to equities and alternative assets is complex and subtle.
- This risk is offset (to a greater or lesser degree depending on the real interest rate duration of the liability) by a decrease in liability valuation due to rising real rates.
- The risk of a decline in real interest rates comes from the opportunity cost of being out of a rising bond market. Many investors, leery of the potential for rising rates, have shortened the duration of their holdings and would not participate to a satisfactory extent in a bond rally due to falling rates.
- This risk is exacerbated by an increase in liability valuation due to falling rates.
- *It's the whole portfolio, and its sensitivity to real interest rate shocks, not just the fixed income part of the portfolio, that counts for asset allocation, asset-liability management, and long-range planning.*
- The "whole portfolio" that "counts" includes the liabilities as well as the assets. They should be managed as a unit. This principle has been recognized practically forever (see, for example, Koopmans [1942], Leibowitz [19xx, 19xx], and the very

helpful literature review in Ryan [2013]) but, to quote Shakespeare, is more honored in the breach than the observance.[1]

And individuals and their advisors should regard planned consumption, say in retirement, as just as "real" a liability, and just as subject to real interest rate and other shocks, as the formally defined liability of a pension plan.

Real interest rate shocks and the multi-asset portfolio

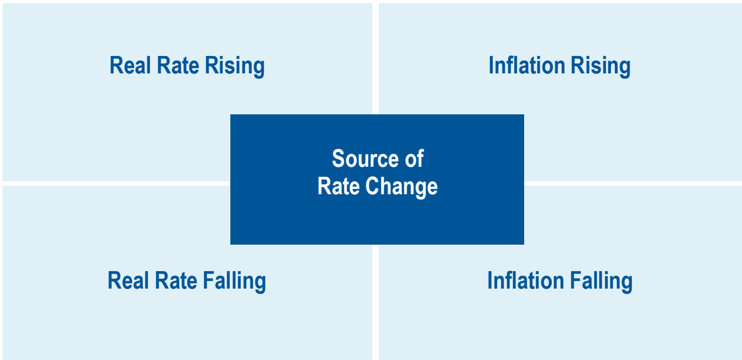
We've already noted that interest rate shocks affect the market values and returns of fixed-income assets in a mechanical way, although the separation of the effect into real rate and inflation components is perhaps underappreciated. But shocks to real interest rates also affect equities and alternative assets—in short, the whole portfolio—as well as the liability.

For this reason, any strategy prescription for the fixed income "silo" in a portfolio should be consistent with the goals and policies of the whole institution. Thus, if much of the portfolio is devoted to equities, which are by and large long-duration assets, it may provide meaningful diversification and protection to invest in bonds that are shorter in duration than one might otherwise hold. One should also keep in mind the equity-like character of credit instruments, lest the effective factor exposure to equities be larger than intended because of the credit allocation within the fixed income portfolio.[4]

The ideas we've expressed thus far motivate us to look at a *matrix* of interest-rate risks faced by investors, illustrated in Exhibit 1. Interest-rate shocks can be upward or downward, and caused by changes in the real rate or in expected inflation.[5]

Surprises in Inflation and Real Rates Drive Nominal Rates
Exhibit 1: Matrix of possible interest rate shocks

[1] Koopmans, Tjalling C. 1942. "The Risk of Interest Fluctuations in Life Insurance Companies." Philadelphia: Penn Mutual Life Insurance. Leibowitz, Martin L. 1992. *Investing: The Collected Works of Martin L. Leibowitz*. Edited by Frank J. Fabozzi. Chicago: Probus Publishing. Ryan, Ronald J. 2013. *The Evolution of Asset/Liability Management*. Charlottesville, VA: CFA Institute Research Foundation literature review (September), https://www.cfainstitute.org/en/research/foundation/2013/the-evolution-of-assetliability-management.



Our analysis begins with an explanation of the dual-duration nature of bonds. We then proceed to macroeconomic analysis and recommendations for the future using what we call a Very Simple Macro Model (VSMM). In the Appendix, we present a history of the bond market, focusing on the “bond mountain”—when yields rose and bond prices fell to levels unprecedented in peacetime over 1940–1981, then fell as dramatically as they had risen, ending in historically low rates at the present time.

Bonds have two durations

As we just briefly mentioned, bonds have *two* durations, a real interest rate duration and an inflation duration, expressing their sensitivity to each of these factors (see Siegel and Waring 2004).[6] For nominal bonds these two durations are identical, since the bond doesn’t care whether a change in nominal rates was due to a change in the real rate or the inflation component; it reacts in the same way to either shock.
But, for inflation-indexed bonds, the inflation duration is effectively zero; the reason is that changes in inflation flow through equally to the numerator, or coupon and principal payment, of the bond valuation equation, and to the discount rate in the denominator—so the price of the bond doesn’t change in response to changes in inflation. In contrast, the real interest rate duration of an inflation-indexed bond, that is, its price sensitivity to changes in the real interest rate—is similar to that of a nominal bond.

Other assets, such as equities and real estate, also have these two durations, but much less tightly estimated and less important relative to other factors. For these real or real-ish assets, the impact of inflation is more direct and that of real rates less direct.

The Very Simple Macro Model

Before presenting scenarios of the future, let’s pause and introduce a macro model that we believe is helpful in framing one’s thinking about markets in general and especially the fixed income markets on which we’re focusing in this paper. Here’s the model, in words only (no math):

- The macroeconomy is influenced by tension between two factors: (1) the real business cycle and (2) government responsibility for economic management.

    1. *Real business cycle*. The classical economists argued that business cycles occur because of shocks in the real economy. These shocks, for example a new form of transportation or a cheaper way to grow a crop, constitute a positive stimulus to supply and reverberate through the economy by increasing demand for all kinds of goods. Negative shocks can also occur, but for illustrative purposes let's focus on a positive one.

       Facing imperfect information about the future, businesses respond to increased demand by increasing supply further; and you get a generalized boom. Because information about the future is always incomplete, businesses respond to what they see in the present and over-extrapolate it. This, some classical economists argued, is the mechanism by which booms and busts occur.

       The boom ends when it has caused inputs to become so expensive that there are no economic (true) profits. A bust phase then ensues until input prices fall right through the equilibrium point and eventually become so cheap that investment becomes highly profitable and thus irresistible.

    2. *Government responsibility*. The real business cycle described above is, in round terms, what would happen if the money supply were on autopilot as Milton Friedman prescribed—that is, if all of the shocks came from the real economy and none from monetary policy. Now, enter the government, which in the postwar US and elsewhere secured a popular mandate to "manage" the economy, typically following the precepts of John Maynard Keynes. The primary goals of such management are to promote full employment as well as stable prices.

       There is an inherent tension or contradiction here. Try as they might, governments can rarely achieve both goals.[7] For example, we currently have a stable inflation rate around 2%, which the Fed currently regards as *price* stability. It isn't—at 2% inflation, prices double every 35 years, well within the planning horizon of many organizations and individuals—but it's much more stability than we experienced at various times in the past.

       By redefining its mandate for price stability as a mandate for a low and stable rate of inflation, the Fed has made an undoable job doable—at the expense of precision in language. Consumer prices have roughly doubled since 1989. While things could be and have been worse, I doubt if you'd be satisfied today with the purchasing power of your nominal 1989 paycheck. Some inflation seems to be a prerequisite for an adequately nimble Fed policy.

> But, in the 1960s and 1970s, inflation and interest rates soared to unprecedented levels as governments around the world tried to combat economic stagnation with monetary and fiscal stimulus. A major risk to the fixed income markets, and capital markets in general, is that this could happen again—even though it has not yet happened in the wake of the massive stimulus that followed the Global Financial Crisis, or the ongoing stimulus over the subsequent decade of gradual recovery.

Explaining real interest rates with the Very Simple Macro Model

With this framing, we can break up the history (and almost certainly the future) of nominal interest rates into their real interest rate and inflation components.

Applied to real interest rates, the *real business cycle* hypothesis states that the real interest rate is the price that equilibrates the supply and demand for capital. On the demand side, real rates are high when the economy is good, low when bad; on the supply side, real rates are high when savings are scarce, low when plentiful.

The *government responsibility for the economy hypothesis* says that the US Federal Reserve ("Fed") lowers nominal rates (and thus, usually, real rates indirectly) when it anticipates an economic slowdown or recession, and raises them when it anticipates inflation due to tight labor and goods markets. This is the process usually described in the popular press and to some extent also among investment professionals.

Inflation regimes: Government action
In the great bond bear market of 1940-1981, documented in the Appendix in Exhibit A-2, the US Treasury "defaulted" on its debt *in real terms* (not in nominal terms) to pay off war debts and to fund social programs in excess of what could be collected in taxes. (By "defaulted" we mean paying back bondholders in cheaper dollars than what they expected, causing losses on the bonds in real terms, although the promised nominal coupon and principal repayments were made.) These policies were inflationary, and reduced the debt/gross domestic product (GDP) ratio to very modest levels. The postwar low point of debt/GDP in the US was 31.7% in 1974, having reached 122% just after World War II.[8]

The restoration of sound money began in the 1979-1981 period with the appointment of Paul Volcker as Fed chair, in response to intense public dissatisfaction with the "stagflation" of the time. This "revenge of the monetarists" amounted to an intentional disinflationary policy. Exhibit A-3 in the Appendix documents the bond market recovery that began around that time.

This set of observations explains the inflation part. Now let's turn to the real rate part.

Real rate regimes: The real business cycle
Real interest rates have historically been positive on average, reflecting not only the time value of money but the fact that there has usually been a positive "real riskless

rate," or short-term rate as represented by US Treasury bills. However, this relationship has fluctuated widely over time.

Real rates were persistently negative in the 1970s because inflation increases were unexpected by the market, then positive in 1980s and 1990s because inflation *decreases*, too, were unexpected. (Bond markets tend to expect inflation to persist at its recent prior level.) But these fluctuations in the real rate reflected changing government policies, not the real business cycle. The weak economy in the 1970s and the stronger economy in the 1980s may have contributed to the flip-flop in real rates from negative to positive, but it wasn't the main factor.

The real business cycle kicked in as a powerful determinant of real rates in the Global Financial Crisis. Demand for capital was suddenly weak, causing the "natural" real rate to be low or negative. In other words, real rates probably would have been low even without quantitative easing and a zero interest-rate policy. But central-bank policies surely pushed rates down below their natural rate, the rate at which the supply of capital equals the demand for capital.

Looking forward, secular growth seemed to be picking up until the novel coronavirus panic of early 2020. (As of this writing, the market is in free fall, and we are reluctant to say much about the near future.) In the inevitable recovery, whether it is soon or far off, the demand for capital will be more robust. We saw some real interest rate increases because of the growth pickup before the panic, and we will see them again (someday).

This rise in real interest rates between 2012 and 2018 suggested stronger demand for capital. However, recent events have reversed this trend; record-low nominal rates, and near-record real (TIPS) rates, suggest instead a surfeit of capital relative to investment opportunities. Although we've put most of the historical data in the Appendix, it seems useful at this point to show the recent evolution of the real interest rate, so Exhibit 2 displays yields (real interest rates) for all TIPS bonds with maturities of 10 years or more, over most of the period that those bonds have existed.[9]

Low TIPS Yields Signal an Abundance of Capital and a Shortage of Opportunities
Exhibit 2: Yield (real interest rates) on 10-year TIPS bonds, 2003–2019

Source: FRED (St. Louis Fed). Data begin January 2003, the longest history for which FRED data are available. TIPS began to be traded in 1997.

Looking toward the future

But enough about the past. Investors should only make decisions based on what they expect to happen in the future.

Understanding persistently very low real rates
As we saw in Exhibit 2, real rates have been lower since about 2010 than before, and (although not shown in the exhibit) lower than at any time in modern history except for the stagflationary 1970s. What is behind this phenomenon, which has cost savers and fixed income investors so much money?

There is a possible real business cycle explanation and a government explanation.

Real business cycle. One possibility is that weak worldwide demand for capital has caused the low real rates. In this explanation, banks and other lenders, having few willing borrowers at conventional, higher real rates, have had to lower these rates to bargain-basement levels to attract business. Although sometimes heard in the press, this is not a particularly credible story, since governments are demanding capital as never before. Corporate debt is also large and growing. A more likely real-economy explanation for low real rates is a savings glut caused by very high savings rates in some fast-growing economies.

Government intervention. The governmental explanation for low real rates is well-known and obvious: the stimulus needed to relieve the Global Financial Crisis has a long tail. With quantitative easing just now being unwound, the real interest rate has been held artificially low, well below what it would be without the interventions. When this phenomenon occurred in the 1970s it was called "financial repression" by the economists Ronald McKinnon and Edward Shaw. The term is even more applicable now than it was then. The purpose of financial repression is Ricardian: generating revenue for the government through a hidden, but potentially very large, tax on savers and fixed income investors.

Long-term prospects for real rates
So, are low real rates a good forecast over the indefinite future? Are we in a "new era" of low returns and low capital costs, and resultant high exposures to the global economic growth factor (mostly through equities) in an attempt to improve returns?

Neither we nor anyone else can reliably forecast interest rates, so we won't try. However, we'd point out that both emerging-market demand for capital and the emerging-market supply of capital are massive. So is the demand for capital by developed-country governments with aging populations, to whom generous retirement and medical benefits have been promised. Thus, there are powerful forces in both directions, and we do not know which will prevail. As a result, fixed income investors, as well as multi-asset class investors, should be prepared for all the scenarios we identified in Exhibit 1: real rates rising or falling, and inflation rates rising or falling.

Real interest rate duration and portfolio management

At this point we want to characterize the sensitivity of each major class of asset and liability to changes in real interest rates. It is customary to do so using the measure called *duration*, the present-value-weighted average time to receipt of cash flows from an investment (or to payout of cash flows in the case of a liability).[10]

Exhibit 3 shows these real interest rate durations, tightly estimated for some asset classes (cash and bonds) and loosely for others (equity, real estate, and so forth):

Interest Rate Durations Vary Widely Among Asset Classes

Exhibit 3: Real interest rate durations of principal asset and liability classes

			Real Interest Rate Duration*
Assets	Fixed Income	Cash	0%
		10 Year Treasury Bonds	≈9%
		10 Year TIPS	≈10%
		10 Year Credit	≈8%
	Global Equities	Public	6 to 20%
		Private	even more uncertain than public
	Real Assets	Real Estate	14%
		Commodities	Unknown
		Infrastructure	High
Liabilities	DB Pensions with COLA		18%
	DB Pensions with no COLA		17%
	Individual Savings - 25-year horizon		25%
	Endowments and Foundations		32%
	Sovereign Wealth Funds		51%
Fully Duration Hedged Asset-Liability Portfolios			0%

Source: Estimates compiled by the authors: Underlying sources in notes.[11]
Note: Durations shown as percentage increase in value of asset or liability for 1 percentage point decrease in real interest rate.

Duration measures the sensitivity of each asset's or liability's price, or market value, to a unit (say 100 basis points, 1%) of movement in the real interest rate. Here, the real interest rate is proxied by the yield on a 10-year Treasury bond minus inflation expectations over the life of the bond or, alternatively, by the yield on a 10-year TIPS bond.

Exhibit 3 may be interpreted as follows: if the real rate, thus defined, rises by 100 basis points, the 10-year Treasury bond itself will fall by 9% and equity portfolios will fall by 6% to 20%; a defined-benefit pension liability will fall by 18%; and so forth. While the relationship between changes in real yields and changes in market prices is inverse (that is, a rise in one implies a fall in the other), it's customary to leave out the minus sign and we have followed that convention here. Just as long as you remember that the relationship is negative![12]

Obviously, for *declines* in real rates, the effect is an *increase* in market value, for both assets and liabilities.

For equities and alternative assets, duration is a much looser estimate of the asset's sensitivity to changes in the real rate (in technical terms, a lower R^2) than it is for fixed income and for liabilities. This is because equities and alternative assets have many factors besides duration that influence their price movements.

Implications for fixed income portfolios and for asset-liability management

There are three interest-rate scenarios: rising, stable, and falling. Asset-only portfolios (both fixed income and multi-asset) benefit from falling rates. In contrast, asset-liability portfolios benefit from rising rates if the duration of the liabilities is generally longer than that of the assets that are set against them (and it usually is).

This situation presents a dilemma for portfolio managers, expressed in Exhibit 4. The market value of assets is known every day and closely observed. The value of a liability is not: it's estimated periodically by actuaries and economists, using payout forecasts that can be challenged and discount rates that vary according to the type of pension fund, the methods used by a particular actuary, and external pressures facing the organization. Thus, a pension manager or individual investor is likely to pay much more attention to maximizing asset values and minimizing asset risk than she is to maximizing *surplus* (asset minus liability) values and minimizing *surplus* risk. (We call this differential number a surplus even if it's a deficit, that is, a negative surplus.)

Challenges of Managing Duration During Various Interest Rate Scenarios

Exhibit 4: Change in market value of bond portfolio, total assets (60/40), liability, and "surplus" with 100 basis point rise or fall in real interest rate (assuming $1 million liability)

					Real interest rate +100 bp		Real interest rate -100 bp	
	Duration assumption	Modified Duration	Weight	Starting value	Dollar change in value	% change in value	Dollar change in value	% change in value
Bond Portfolio (long duration)	9	8.82	40%	$320,000	($28,235)	-9%	$28,235	9%
Equity	13	12.75	60%	$480,000	($61,176)	-13%	$61,176	13%
Total Assets (60/40)	11.4	11.18		$800,000	($89,412)	-11%	$89,412	11%
Liabilities	18	17.65		$1,000,000	($176,471)	-18%	$176,471	18%
Surplus				($200,000)	$87,059		($87,059)	

Source: Calculations by Franklin Templeton Capital Market Insights Group based on scenarios constructed by authors. NEEDS MORE DETAIL

Note: "Surplus" is defined as assets minus liabilities with 80% funding ratio (i.e., surplus is actually a deficit).

Asset-only considerations

A manager concerned with minimizing fixed income asset risk can "shorten," that is, reduce the term-to-maturity and duration of his or her bonds. This means smaller losses if real interest rates rise. Shortening is a bet on rising rates; lengthening, a bet on falling rates. This is how most managers in the fixed income "silo" think about rates, and about risk.

Shortening also has the side effect of investing at a lower yield, if the yield curve is of typical shape (long-term rates higher than short-term ones). However, with today's relatively flat yield curve, that effect is minor if it exists at all. Over the longer term, the yield differential across the yield curve can be significant.

Asset-liability considerations

But a total asset duration shorter than that of the liability, which is almost always the case, is a leveraged bet on rising rates. The bet is leveraged because the liability is a debt owed to the beneficiaries, so one can think of the assets being financed with debt (the liability). The leverage ratio can be thought of as the inverse of the funded ratio.

Taking a fixed income duration position even shorter than the typical or benchmark position, because one is concerned about rising real rates, thus *increases* the mismatch between asset duration and the (very long) liability duration. That's fine if your rising-rate forecast is correct—you win on the assets (which fall less than if you hadn't shortened) and you win on the liabilities (which fall a lot).

But you could be wrong! Until fairly recently, widespread opinion supported a forecast of rising nominal and real rates but was repeatedly defeated by market realities. So, like Harry Markowitz, you should "care about risk as well as return." And the risk you should care about is surplus risk, the variation in the difference between asset values and (economically correctly calculated) liability values. Minimizing surplus risk is a worthy goal for asset-liability managers, and is pursued by minimizing the duration gap between assets and liabilities.

The ongoing pension funding struggles over the last two decades are the result of, among other factors, this structural bet on rising rates being maintained in the face of falling rates: assets have done well, but liability valuations have risen much faster because of their long durations.[13] Basically, pension managers turned out to be lousy interest rate forecasters. Aren't we all?

As a last thought on this question, let's look back at the last line of Exhibit 3. A theoretical fully duration-matched asset-liability portfolio has no real interest rate risk and is thus, from that viewpoint, the Holy Grail of investment management in the face of a liability. Yet such portfolios basically do not exist in practice. Why? The much more attractive returns of equities and alternative assets have forced pension and endowment managers out of fixed income and into "risk assets." This move has not worked out particularly well. "Stocks for the long run," the Wharton professor Jeremy Siegel's mantra, is empirically a good idea but *bonds are also good for the long run*.

Implications for other asset classes

Equities
Equities tend to fall when real interest rates rise, making their duration negative (like that of a bond, it's portrayed using a positive number). Our equity real interest rate duration estimates of 6% to 20%, as shown in Exhibit 3, are very wide and reflect these issues:

- The real interest rate duration of equities fluctuates over time
- It cannot be derived mathematically as it can be for a bond, because no one knows what the cash flows from a stock will be, so...
- It is inherently hard to estimate

Researchers differ widely on what this duration is, or can be expected to be in the future, thus the wide range shown in the exhibit. Leibowitz and Kogelman [1993] write:

> Basing theoretical stock price on a standard dividend discount model (DDM) results in a duration for equity of 20 to 50 years...[b]ut DDM durations such as these are grossly inconsistent with the observed behavior of equities. Empirical studies show that equities generally have low durations—on the order of two to six years.[14]

They are talking about nominal durations, which mix the real-rate duration and the inflation duration (which is near zero for equities). Thus, to compress the range of estimates a bit, we take the high end of their empirical measure as our low end.[15]

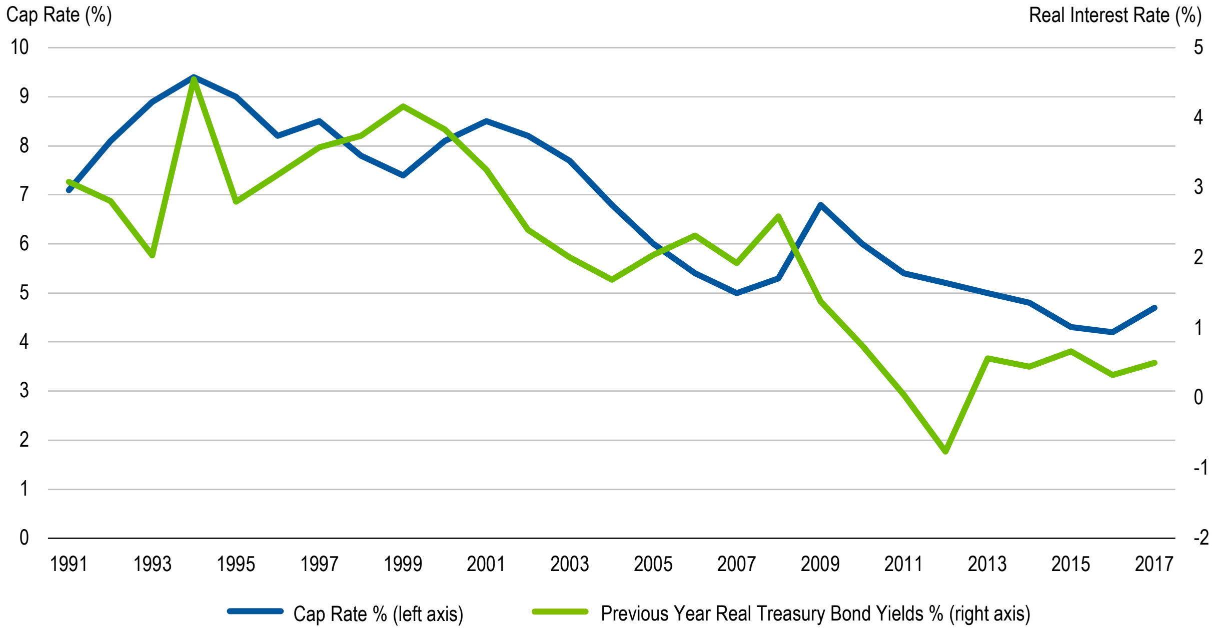
To establish a high end, we note that Waring [2004] finds a real interest rate duration of equities as large as 20, but reminds us that the R^2 of the relationship between real interest rates and equity returns is low—meaning, as noted earlier, that factors other than duration explain most of the movement of equities.[16] Thus, Waring argues, we cannot use the long durations of equities to hedge long-duration liabilities without taking on a lot of non-duration risk. These considerations explain our wide range of 6% to 20% in the exhibit.

Real assets

Real assets are an important component of many portfolios and an important inflation hedge. Real estate is often held in leveraged form (that is, it is the equity that's held). Some investors also hold commodities as an inflation hedge.

Real estate. While real asset valuations almost always react positively to inflation shocks, they react negatively for real interest rate shocks (for the same reason as equities—they promise a stream of cash flows that are discounted to present value at the real rate). Exhibit 5, taken from a report by CBRE Group, a leading real estate manager, shows that "cap rates" (a proxy for expected real returns) for real estate in the US were fairly closely correlated with real interest rates over 1991–2017, with the correlation being tighter over longer time frames.

Real Estate Valuations Correlate Highly with Real Interest Rates
Exhibit 5: US real estate capitalization rates and real interest rates, 1991–2017



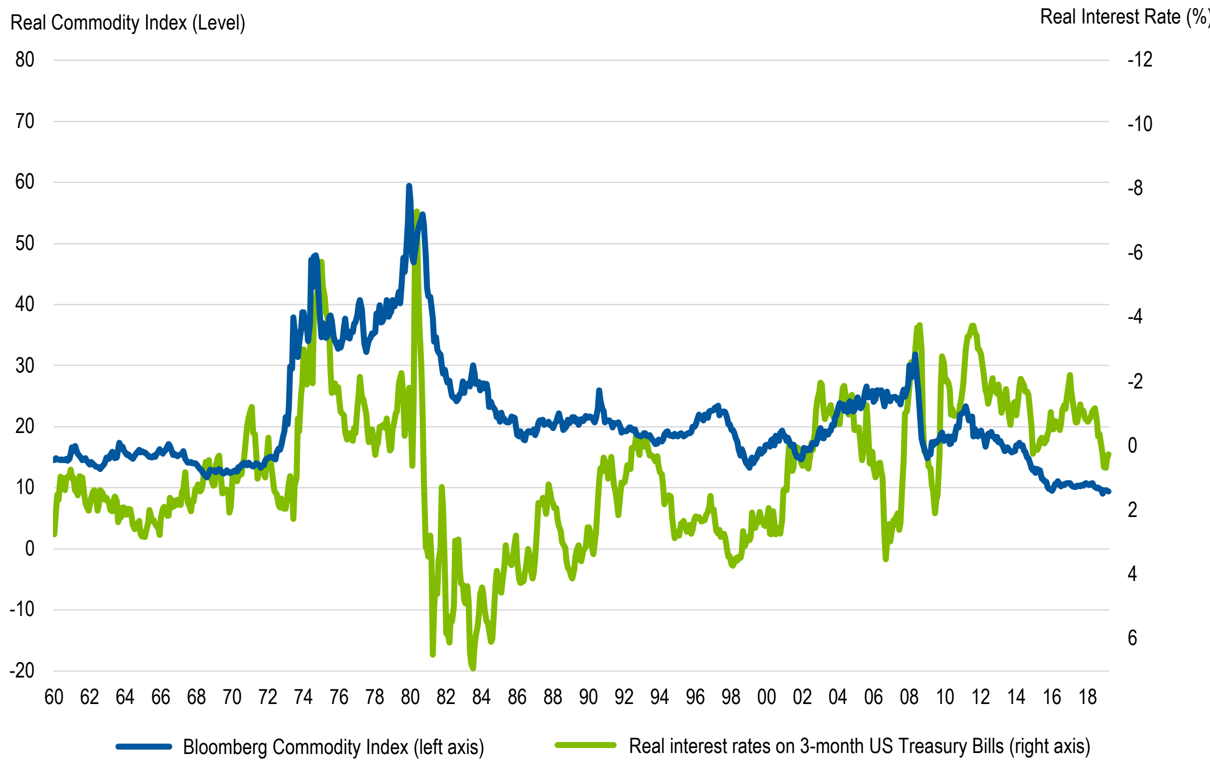
Source: Franklin Templeton Capital Markets Insights Group, CBRE Group, December 2017.

You can't derive a duration from a correlation. However, it is clear from the diagram that the real estate positions studied in the CBRE report, while presumably equity-like in their formal structure, have bond-like return characteristics, and thus reasonably long durations. Hartzell *et al.* [1988], studying real-rate and inflation durations separately—a very advanced technique at the time—found that the equity component of real estate with long leases has a real interest rate duration of 14.3%, an astonishingly high (but we think correct) number given that the then-prevailing view was that the duration of core real estate was low or even possibly negative.[17]

Thus, equity real estate holdings offer a potentially effective duration match to long-dated liabilities. The rub is that, if you expect real rates to rise, real estate equity will behave like a very long bond—it will decline in value. (If rates fall, real estate equity should do very well.) Thus, real estate is one possible way of protecting the portfolio from falling real rates, but not from rising real rates. In other words, it is a very imperfect way of hedging the liability.

Commodities are a classic inflation hedge and real-asset holding, and are found in some institutional portfolios (fewer individual ones). The broad-based Bloomberg commodity price index, used in Exhibit 6, includes energy, agricultural commodities, metals, and other items.

Commodity prices vary inversely with real interest rates, but weakly
Exhibit 6: Real interest rates and commodity prices, 1960-2019
As of April 30, 2019



Source: Franklin Templeton Capital Markets Insights Group, Macrobond, Bloomberg

Exhibit 6 shows that *real* commodity prices were weakly related to real interest rates, especially in the first part of the period. (Note that the right-hand y axis, showing the real interest rate, is inverted; commodity prices are high when real interest rates are low, like a bond). Again, you can't derive a duration from this information, but commodities are somewhat TIPS-like, with effectively no inflation duration (because they move with inflation, being themselves a component of inflation) and what is probably a high real interest rate duration.

To sum up, while real assets are an effective hedge against inflation, they are not likely to be an effective hedge against shocks to the real interest rate.

International issues

Up to this point, we have been primarily concerned with shocks caused to US investors by changes in US real interest rates. But investors in other countries are affected by similar forces. Most non-US investors hold assets in multiple countries (because most non-US markets are smaller than the US market and thus less diversified), and experience currency fluctuations as well as the other factors we've discussed. For example, high real interest rates can mean a strong currency and low real interest rates a weak one, although the effect is not mechanical and is subject to wide variation. Non-US investors participating in their own domestic markets need to consider the real interest rate effects we described, where the relevant real rate is their domestic rate.

Changes in real interest rates beyond one's national borders can also have an impact on the investor's liabilities, which are not always owed only in the investor's home currency. (For example, many companies have multinational labor forces to whom pensions are owed.) Thus, real interest rate fluctuations outside one's home country could pose some degree of asset-liability mismatch risk (sometimes called spread risk) for an investor.[18]

Conclusion: Considerations for investors

A framework for thinking about risk and return in asset-liability portfolios
One thread in finance theory says that asset pools exist to pay liabilities and that risk is minimized when the assets and liabilities have the same (thus offsetting) risk characteristics, primarily duration but also beta. Since most liabilities have a beta near zero, the best way to minimize surplus (asset minus liability) risk is an LDI-like strategy wherein the asset manager holds bonds and TIPS with a duration similar to that of the liability. This minimizes counterparty risk for the liability claimants, a worthy goal.

Another, equally important, thread says that risk is rewarded—at least certain kinds of risk are. The risk of holding a broad equity benchmark, in particular, is rewarded—on average over time—by a higher rate of return. Asset managers can reduce the cost of providing benefits for their clients by taking measured amounts of this risk, not limited to equities *per se* but also equity-like investments such as real estate and certain alternative assets. And the opportunity set for any such investment should be global, not home biased.

All of investment management is about resolving the tension between these principles or, more generally, the desire to avoid risk and the hope of achieving gain. In this setting, the tension can be expressed as: How much duration mismatch risk (between the assets and the liabilities) should I take—and why? And, how much equity-beta mismatch risk (between the assets and the liabilities) should I take in pursuit of higher return?

Borrowing a framing from defined benefit plans, then, investment management is all about the surplus. The surplus is the only thing that matters; surplus risk, surplus return. Everything else is ancillary because it doesn't give you the full dimensionality of what you're trying to achieve—it just gives you half. This framing, first suggested by Leibowitz and Henriksson [1988] and Sharpe and Tint [1990], helps managers of non-DB assets too, because, as we said earlier, all asset pools were gathered to pay some sort of liability, obligation, or benefit.[19] We are all asset-liability managers.

Protecting the portfolio in all real interest rate scenarios
We have framed our discussion of real interest rates in the context of (1) not knowing the future path of interest rates, and (2) recognizing the importance of knowing the impact of "shocks" in interest rates on the surplus in any real-rate scenario. This applies to individuals saving to pay a retirement "consumption liability" too.

While many investors have responded to this challenge by taking very large positions in equities and equity-like investments, one should always keep in mind that such assets add to surplus risk rather than subtracting from it. They are driven by many factors more powerful than duration. Stocks can go down and stay down for long periods. Let's remember what we said earlier: stocks for the long run, but bonds are also good for the long run. Diversification is essential.[20]

The role of fixed income in the larger portfolio
We need fixed income in the portfolio because it reduces asset risk and potentially surplus risk. Fixed income assets can also be duration-matched closely to the liability if the funding and investment policies support that approach. Whether or not that is the path taken, we need a duration strategy for the fixed income allocation. Because equity-dominated portfolios are quite long in duration, a shorter-duration fixed income strategy may be consistent even with "no forecast" or a forecast that real interest rates will fluctuate around current levels; it's the total portfolio duration that matters, not the duration within each asset-class "silo."

Even if you have only 20% allocated to fixed income and your fund is focused on return maximization through risk-taking, you really need to be thoughtful about the role of that 20% in fixed income. Some funds that are seeking growth will take considerable risk in the fixed income portfolio as well as in the other assets. Instead, we believe such an approach risks clouding the more fundamental role of fixed income as an "anchor to windward," a liability hedge or prepayment, and a source of funds for rebalancing.

Last word
Changes in real interest rates affect every part of the portfolio. They impact the liabilities in a mechanistic way. They affect the fixed income assets mechanically too, but there's more nuance in the ways they affect equities, equity-like alternative assets, and other (non-equity) alternative assets. We need to be aware of these effects throughout the asset-liability portfolio, not just in fixed income where they are most obvious.

And we should seek to defend the portfolio against shocks in the real rate—in whatever direction—by managing the risk exposures of the assets and the liabilities as an integrated whole.

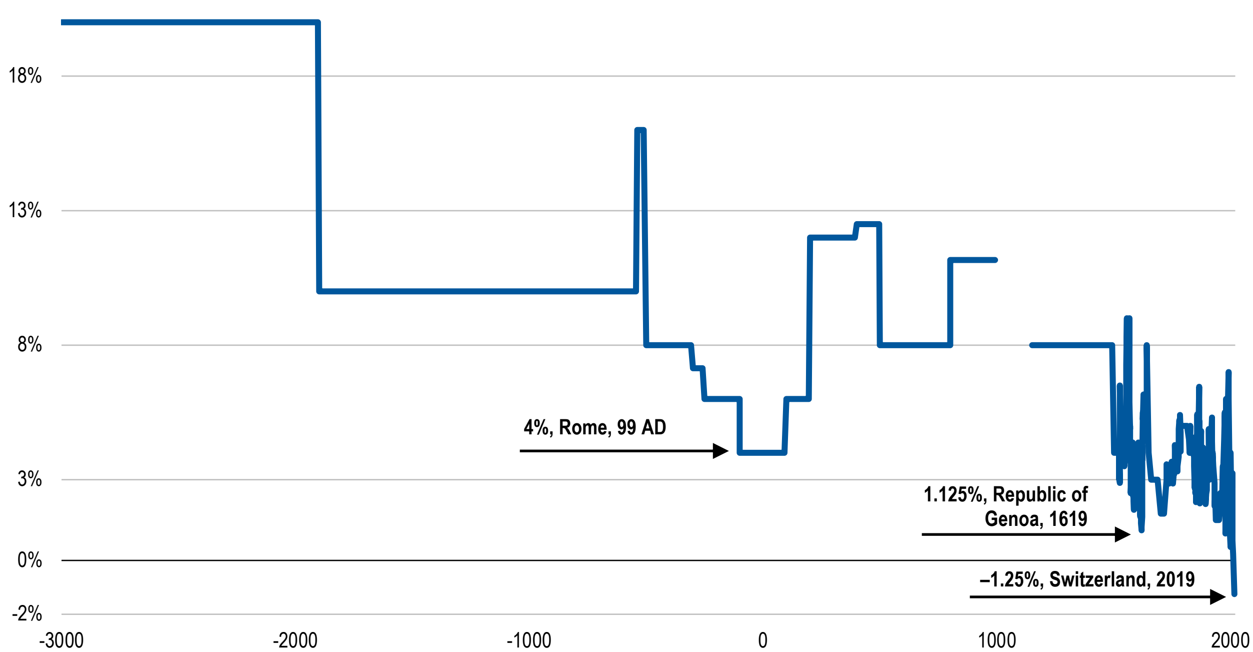
APPENDIX
A BRIEF HISTORY OF THE BOND MARKET

The market for loans and fixed-interest promises is as old as civilization itself (Goetzmann 2016).[21] Our history starts early (five thousand years ago), proceeds relatively quickly to modern times, and focuses on the Bond Mountain, the unprecedented (in peacetime) rise in interest rates from about 1940 to 1981 in most developed countries and the subsequent decline in rates to their current historically low levels.

Interest rates starting in the very distant past

The *very* long-term history of interest rates is one of improving credits—both sovereign and corporate, but we're mostly concerned with sovereign credit—and thus falling yields. Over most of the history of capitalism, the leading countries were on a gold standard so expected inflation was close to zero. Exhibit A-1, based on Sidney Homer and Richard Sylla's classic *History of Interest Rates*, with additional data from Wellershoff & Partners Ltd.'s Costa Vayenas, shows the general tendency of rates to decline over time as sovereign issuers become more financially responsible and probabilities of default decline, effectively to zero in the best cases. Rates even go negative right at the end (-1.25% in Switzerland in 2015).

The really, really long-term history of nominal interest rates (best credits or lowest rates, 3000 BCE–2019 CE)
Exhibit A-1: History of interest rates over last 5000 years.



Source: Costa Vayenas; Sidney Homer & Richard Sylla "A History of Interest Rates" (2005), IMF
Because Exhibit A-1 shows the *best* credits (lowest rates) at each point in time over the last 5000 years, not the *typical* credit, you can't see the "bond mountain," the

great rise and subsequent decline in bond yields that occurred in the US, the UK, and other advanced countries from roughly the beginning of World War II until recently. We'll get to that momentous episode soon enough.

But we should note that the rates in Exhibit A-1 are nominal, not real. That doesn't make much difference over most of the time period, since the best credits were generally in countries with zero or low inflation, but the Bond Mountain was due primarily to very high inflation, not high real rates, even in the most creditworthy countries—so if we had a 5000-year history of real rates it would show a very different picture toward the end. Fortunately, we do have real rates, or a rough proxy for them, over more recent historical periods so that's what we turn to in the next section.

It may seem a little silly to look back 5000 years—or even 500—to provide the background for an investigation of what could happen over a time frame that matters to today's investors. But the gradual maturation of credit markets over time, as reflected in declining rates, is a phenomenon worth understanding. It suggests that even lower rates are possible in the future, that there is nothing foreordained about rates rising significantly now that they've reached historically low levels.

In fact, one possible interpretation of Exhibit A-1 is that, as capital markets have developed, matured, and grown more efficient over the last 5000 years, the real cost of capital has declined to the point where, with technology, crowd funding, and internet-based aggregation of capital it could approach zero. We have already observed a zero real riskless rate during the economic dislocation of the last decade, but the zero rate could persist. There will still be a term premium because of duration (price fluctuation) risk, so that government interest rates might be expected to consist of the sum of inflation expectations and the term premium, with no "real riskless [short-term] rate of return."

However, there is no reason to expect the inflation part of nominal rates to be zero, or anything even close to zero. We'll examine inflation risk in the forthcoming companion paper.

Up the bond mountain: Inflation rears its ugly head; real rates go negative

We now look at the consequences of the great monetary experiment of the 20th century. The gradual abandonment of the gold standard in the US between 1933 and 1971 made *fiat money*, money that is money because the government says it is,[22] the only money available for saving and transacting in the United States.

Fiat money gives the monetary authority, or government, a call option on the real economic resources of the country. If the government runs a more or less balanced budget, only borrowing a limited amount and paying the debt back reliably over time, then there is little or no inflation, and the real value of savers' balances is safe.

However, if the government persistently spends more than it collects in taxes, someone has to make up the difference, and that "someone" is almost always the holder of nominal bonds, that is, the population of savers and fixed income investors. There simply isn't anywhere else for the money to come from.

This observation has deep economic roots, beginning with David Ricardo, who noted in 1817 that all government spending must be paid for by current taxation, borrowing (which implies future taxation to service or pay down the debt), or debasement of the currency (inflation, which reduces the real value of savings invested in bonds). Through this last method, a government can default on its debt in real terms while maintaining its commitments in nominal terms. This happened in slow motion in the US, UK, and most advanced economies during the period of the Great Inflation (roughly 1945–1981) and at a vastly accelerated pace in Germany in 1923 and Argentina, Zimbabwe, and Venezuela more recently.

Robert Barro, a near-Nobel economist whose name is batted about every year when the economics Nobel is given, formalized this principle and, in a classic 1974 paper, called it "Ricardian equivalence."[23] It is one of the most powerful observations in macroeconomics, and explains the Great Inflation of the last three-quarters of a century. A more recent take on the same idea is the "Fiscal Theory of the Price Level" propounded by John Cochrane and Eric Leeper.[24]

The Great Inflation

With fiscal and monetary policy accommodating the vast needs of government in fighting World War II and then simultaneously pursuing the Vietnam War and the Great Society, inflation grew from a meow to a roar, pushing nominal interest rates to levels never before seen in the US in peacetime. Exhibit A-2 shows the climb up the bond mountain, as shown by the real and nominal Treasury yields in the top panel, with real (inflation-adjusted) total returns on a portfolio of long-term Treasuries shown in the bottom panel along with real stock total returns for comparison.

Climbing Up the Bond Mountain…

Exhibit A-2 Top: US Long Term Treasury Bond Yields, January 1, 1940–September 30, 1981

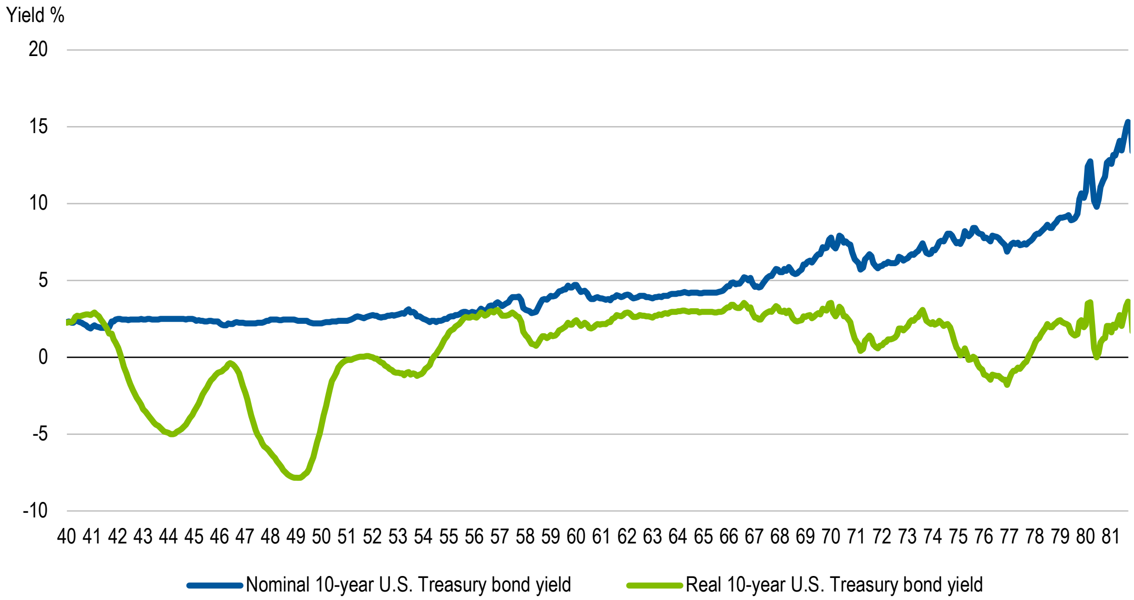
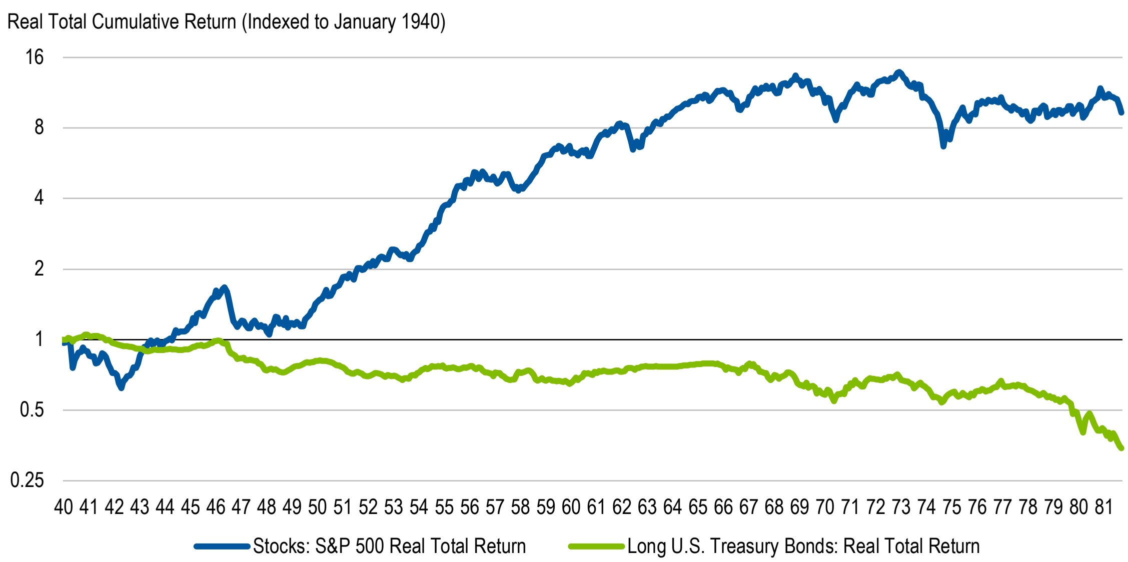


Exhibit A-2 Bottom: US Real Total Returns on Equities and Bonds, January 1, 1940–September 30,1981



Source: Franklin Templeton Capital Markets Insights Group, Ibbotson Group, Morningstar. Important data provider notices and terms available at www.franklintempletondatasources.com[25]

By 1981, everyone then active in the investment profession knew only one interest rate environment: rising nominal rates, mostly negative real rates, and plunging bond prices. In real (inflation-adjusted) terms, the Ibbotson total return index of long-term Treasury bonds, initialized at $100 in 1940, had fallen to $33. That's total return, with all interest reinvested! On a price-only basis, with interest consumed, $100 fell to $4.92 in real terms. Bonds of all kinds were sometimes called "certificates of confiscation."[26]

Down the bond mountain: Inflation crawls away, real rates rise

All this capital destruction ended on August 6, 1979, with a return to monetary sanity, although the effects would not be seen in market prices for a couple of years. What happened on that memorable day was that, acting against instinct but knowing the economy was in deep trouble, President Jimmy Carter appointed Paul Volcker, a hard-money man, to replace the weak outgoing Federal Reserve chair, G. William Miller. Volcker knew that he'd have to take drastic action to reverse the accelerating course of inflation.

An astonishingly restrictive monetary policy, with the Fed Funds rate eventually reaching 21.5%, brought about a recession that caused inflation rates to plunge from 13.5% in 1980 to 3.2% in 1983. In an economy addicted to easy money, as shown by the negative real rates, such a radical reversal of policy was the only way to end the Great Inflation. The disinflation of the Volcker era was even faster than the inflation acceleration that preceded it, and both fixed income and equity markets boomed. In the bond market, those bullish conditions prevailed for almost 40 years, and only recently has the secular decline in rates begun to falter.

Exhibit A-3 shows the results. Let's look at nominal yields first. The longest-term Treasury yields fell from over 15% in 1981 to just over 2% in 2016 (and only 1.35% on the more widely-held 10-year bond). Bonds became a fruitful investment once again, and stocks soared, with the S&P 500 returning a total of 5,500%, including dividends, starting in August 1982 and ending at the recent high before the crash of 2020. The grand bull market was not all Volcker's doing, of course; later Fed chairs, and the dynamism of the economy, broken up by several recessions and crises, supported the markets.

…And the Descent on the Other Side

Exhibit A-3 (Top): US Long Term Treasury Bond Yields (Nominal and Real), October 1, 1981–December 31, 2018

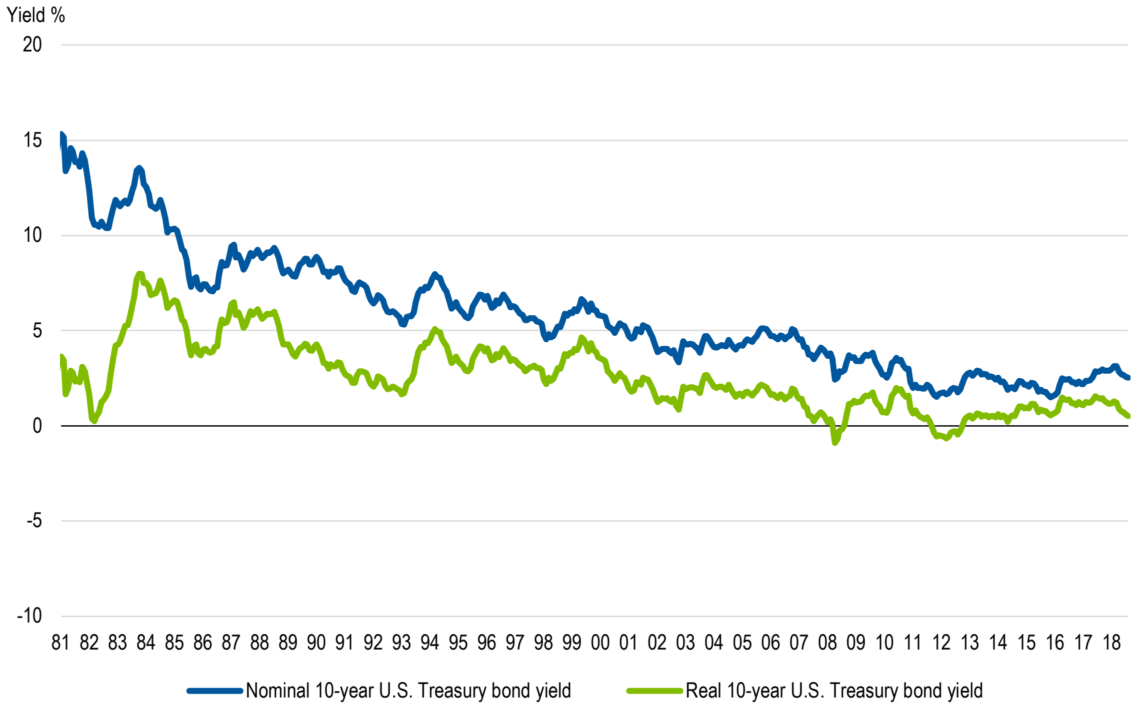
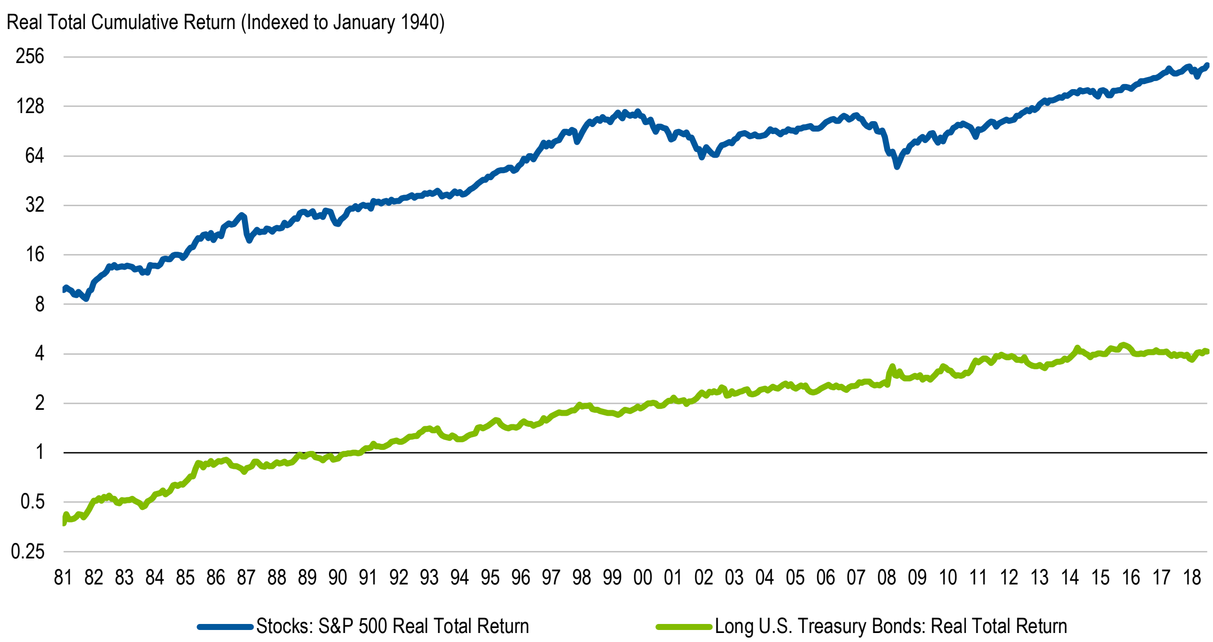


Exhibit A-3 Bottom: U.S Real Total Returns on Equities and Bonds, October 1, 1981–April 30, 2019



Source: Franklin Templeton Capital Markets Insights Group, Ibbotson Group, Morningstar. April 2019.

As a result, at the present time, most active financial practitioners can only remember one market environment: falling yields and rising bond prices. (Real rates have fluctuated all over the place.) This, in itself, presents a risk—the risk of not knowing the longer history. We hope we've helped to fill it in.

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[1] Bios and contact info tk. The authors thank Stephen Sexauer, CIO of the San Diego County Employees Retirement Association (SDCERA), for the Very Simple Macro Model (his idea, our name), a framing without which this paper would be considerably less worthwhile.

[2] Fisher, Irving. 1930. *The Theory of Interest*. Equation (1) is the linear approximation, good enough for most purposes at low interest rates and having the virtue of simplicity. The full (discrete time) form is $(1 + n) = (1 + r) \times (1 + i)$ where *n* is the nominal interest rate, *r* is the real interest rate, and *i* is the inflation rate.

[3] Litterman, Robert ("Bob"). 2005. "Equity duration – how viable?" Investment and Pensions Europe (February), https://www.ipe.com/equity-duration-how-viable/17520.article. We added the italics.

[4] Some purportedly advanced asset allocation approaches split the portfolio into a "liability hedged" or risk-averse portion and a "maximum Sharpe ratio" or risk-seeking portion, in the manner suggested by Sharpe's CAPM. They then typically shift between the two portfolios dynamically, perhaps taking less risk as the population of beneficiaries ages. This is not LDI (which would involve duration matching, as best one can accomplish that, over the whole portfolio), but it is not useless either, since some attempt is made to focus on the liability duration as an aspiration or goal. In such a setting, long duration bonds—and corporate bonds—may make sense as they have a duration similar to the economic liability of most plans (DB and DC)—and, not coincidentally, to the corporate bonds used to derive the discount rate for the liabilities of private sector DB plans.

[5] The inflation rate that is relevant for the Fisher equation (equation 1 above) is the inflation rate that is expected over the life of the bond being evaluated, not the current or recent past inflation rate.

[6] Siegel, Laurence B., and M. Barton Waring. 2004. "TIPS, the Dual Duration, and the Pension Plan." *Financial Analysts Journal*, Volume 60, Number 5 (September/October).

[7] See the section on Germany in Sexauer, Stephen C., and Laurence B. Siegel. 2016. "The Age of Experts: A Review of Marc Levinson's An Extraordinary Time," Business Economics (October 26), https://link.springer.com/article/10.1057%2Fs11369-017-0055-z (gated).

[8] Source: https://www.investopedia.com/terms/d/debtgdpratio.asp, based on data from the Bureau of the Public Debt.

[9] Some of the fluctuations in the real rate as revealed by TIPS yields are driven by supply/demand dynamics in the TIPS market, which is much smaller and less liquid than the nominal Treasury bond market. For example, when TIPS were first issued in 1997, they yielded about 4.3%, which makes no economic sense at all; why should a riskless asset yield 4.3 percentage points above inflation? (Of course, astute investors bought them at that time and enjoyed the high income as well as the capital gains as real yields receded to more normal levels.)

While TIPS have many "structural" buyers with inflation-indexed liabilities, nominal Treasuries are more typically free of weird market dynamics, and may provide a more accurate reflection of the real risk free rate if an independent assessment of inflation expectations can be accurately made. It is, nevertheless, conventional among economists to use TIPS yields as the measure of the real rate, as we have done, during time periods when those yields are available.

[10] It is also possible—and in some cases preferable—to express the relationship between real interest rates and asset prices or liability valuations using "bond betas," but duration is more customary so we use it here. The modified duration, not the Macaulay duration, is the relevant duration measure and is used throughout this discussion. See Fabozzi, Frank J. 1999. "The basics of duration and convexity," in Frank J. Fabozzi, ed., *Duration, Convexity, and Other Bond Risk Measures*, New Hope, PA: Frank J. Fabozzi Associates.

[11] All estimates rounded to the nearest integer to avoid illusion of precision.

Treasury bond: Calculated by the author using the standard modified duration formula (Fabozzi 1999) assuming a 2% coupon, 2% yield to maturity, and annual payments. A nominal bond's real interest rate duration is very close to its nominal duration.

TIPS bond: Calculated by the author assuming a 1% real coupon, 0% real yield to maturity, and annual payments.

Credit (Baa corporate bond): Calculated by the author assuming a 4% coupon and yield (Baa seasoned bond yield from FRED was 4.13% on May 1, 2020, https://fred.stlouisfed.org/series/BAA, rounded to 4%).

Equities:

Real estate: Hartzell et al. (1988).

Pensions with COLA and no COLA:

Individual savings: Varies by stage of life. Modeled as a single payment real liability arriving in 25 years, based on a 40 year old person planning to retire at 65. Modified duration of a 25 year zero-coupon bond (at any yield) is 25. Even at retirement, the real rate duration can be quite long.

Endowment or foundation with 5% payout: modeled as a growing perpetuity with an annual inflation rate of 2% and annual payout rate of 5%, thus net compound annual growth of -3%; modified duration of 32 calculated by the author.

Sovereign wealth fund: modeled as a growing perpetuity with 2% annual growth rate due to inflation; modified duration of 51 calculated by the author.

[12] It is theoretically possible for an asset to have a positive duration (so that a rise in yields implies a rise in the asset's market value), but in practice only short positions and put options have this characteristic (so almost all assets have negative durations, with the minus sign left out when discussing them).

[13] Among the other factors are one-way benefit increases (usually implemented after bull markets, and the increases cannot be retracted when the market subsequently declines); increases in life spans; and misstatement of discount rates by actuaries, leading to economically unjustifiable "contribution holidays" by plan sponsors.

[14] Leibowitz, Martin L., and Stanley Kogelman. 1993. "Resolving the Equity Duration Paradox." *Financial Analysts Journal*, Volume 49, Issue 1 (January/February), https://www.cfapubs.org/doi/pdf/10.2469/faj.v49.n1.51.

[15] The exact relationship among the three durations is given by the law of cosines, a complex mathematical construct that is beyond the scope of this paper.

[16] Waring, M. Barton. 2004. "Liability-Relative Investing." *Journal of Portfolio Management* (Summer). Additional information and opinions provided through personal communication.

[17] Hartzell, David G., David G. Shulman, Terence C. Langetieg and Martin L. Leibowitz. 1988. "A look at real estate duration." *Journal of Portfolio Management (*Fall), volume 15, number 1, pp. 16-24. As nominal interest rates rose in the 1970s and early 1980s, real estate values boomed, but not because real estate had a low or "negative" real interest rate duration. (I'm putting quotes around "negative" because I mean a positive number, real estate rises as the rate rises, expressed according to the convention described earlier that all such duration numbers are multiplied by -1 for the purpose of discussion.) The low nominal duration of real estate equity was due to the very strong (possibly leveraged or multiplicative) flow-through of inflation to real estate values, causing the inflation duration of real estate to be low or negative; when you combine that with a long real interest rate duration, you get an overall (nominal) duration that is low, consistent with the broader literature on real estate and REIT factor sensitivities. Most of the good work on duration was done in the 1980s, hence the use of old sources.

[18] This spread risk might be mitigated or eliminated for an investor that has both assets *and* liabilities denominated in non-US currencies, as long as the asset-liability management technique are specifically designed to address that issue.

[19] Leibowitz, Martin L., and Roy D. Henriksson. 1988. "Portfolio Optimization Within a Surplus Framework." Financial Analysts Journal, Volume 44, Issue 2 (March/April). Sharpe, William F., and Lawrence G. Tint. 1990. "Liabilities: A New Approach." Journal of Portfolio Management, Volume 16, number 2 (Winter).

[20] Moreover, any assets that involve leverage—say, real estate and private equity—are affected profoundly by the cost of funds.

[21] Goetzmann, William N. 2016. *Money Changes Everything: How Finance Made Civilization Possible*. Princeton, NJ: Princeton University Press.

[22] *Fiat* in Latin means "let it be."

[23] Barro, Robert J. 1974. "Are Government Bonds Net Wealth?" *Journal of Political Economy*, vol. 82, no. 6: pp. 1095–1117.

[24] See, for example, Cochrane, John H. 2019. "The Fiscal Theory of the Price Level." University of Chicago Booth School of Business working paper (February 5), https://faculty.chicagobooth.edu/john.cochrane/research/papers/fiscal_theory_book.pdf

[25] Bottom chart compares Yield on Long-Term United States Bonds for United States/10 Year Treasury (i.e., "Nominal") with 10 Year Treasury Yield less Year-over-Year 3 year trailing average US CPI Inflation Rate (i.e., "Real")

[26] This is also roughly the time when Modern Portfolio Theory began to actually be used in large institutional portfolios. The concepts of corpus (principal) and income, previously considered separately, melded into a single variable, total return (the sum of the two components). Reflecting the newfound view, influenced by MPT, that total return is the dominant or even sole investment objective. equities began to enter pension fund and endowment portfolios is a much more significant way around this time.

For example, at CalPERS the portfolio was almost entirely fixed income and earned the fund's discount rate—which peaked at around 8.5%—from the early 1960's until about 1983. As interest rates fell, equities grew in importance—due to both capital gains and intentionally increased allocations —to the point where fixed income is less than 30% of the portfolio today. Many institutional portfolios followed a similar trajectory. This trend has injected a level of volatility into liability funding that was basically unheard of before the mid 1980s.