The Long-term Strategist

Bonds time diversify much better than you think

- **Time diversification requires mean reversion in periodic returns. Long run, we do find mild mean reversion in US equity returns and mean *aversion* in US Treasuries, which is the basis for the classic advice that young people should hold more equities than older ones.**
- **Equities time diversify better because both earnings growth and multiples mean revert over the long run, while real bond yields and inflation have not.**
- **We disagree, though, with the broad advice that long-term investors should have lower weights on bonds than short-term investors.**
- **For one, the risk on bonds 10-years out is much lower than indicated by historic volatility as the price/yield at which you buy bond funds significantly narrows the range of outcomes and thus risk relative to the broader range of historic returns.**
- **Equity return uncertainty 10 years out also falls once you take account of today's entry price, but less than for USTs. Beyond 10-years out, equity return risk does fall vs USTs.**
- **Time diversification is usually seen as a dichotomy between stocks and safer government bonds. This misses an important third asset -- high-yield corporate bonds – that fit in between stocks and USTs and that combine the best of both, making them tops for time diversification.**
- **HY bonds, both DM and EM, time diversify best as HY spreads and defaults mean revert more reliably and faster than equity returns do.**
- **Target date funds should include HY corporates, both DM and EM, instead of only equities and government bonds, and allocate steadily more to HY, in longer dated portfolios. Ideally, they should also regularly rebalance allocations based on the current yield of different asset classes.**

Long-term Strategy

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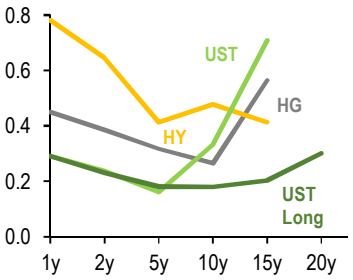
Ratios of annualized standard errors of regression against yield of USTs, HG and HY bonds to US equities, by holding period

Standard errors multiplied by square root of holding period. UST Long with 20yr period refers to history since 1876. Other ratios are for more recent histories as in Table 3.



Source: J.P. Morgan, S&P, Bloomberg Barclays, http://www.econ.yale.edu/~shiller/data.htm.

What is Time diversification?

Investors can reduce risk by diversifying their holdings across different types of assets that are not highly correlated to each other. Similarly, they can diversify portfolio risk over time by holding assets over longer periods **if** the periodic returns on their holdings are themselves negatively correlated over time. Thus **time diversification** holds if low returns in one year are followed by higher ones in another year, and vice versa.

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Evidence

Time diversification requires *negative* serial correlation in asset returns[1]. It manifests itself in holding-period return annualized volatility falling as assets are held over longer periods. To check this, we make use of two long time series for the US: equity and bond (UST) returns from the Robert Shiller database since 1876, and equity, UST, HG and HY bond returns over more recent periods, depending on availability.

Tables 1 (LHS) and 2 show that the **standard deviations of compound annual total returns on these asset class returns fall as holding period lengthens**[2]. However, this does not tell us that risk falls with holding period or that there is time diversification. A 1% risk on a 10-year annual compound return obviously creates more end-of-period wealth risk than that same 1% on a shorter period.

Table 1: Volatility of Compound US Returns by Holding Period, Outright and Annualized

%, annual, 1876-2014. Annualized vol is the standard deviation of the compound returns times the square root of the number of years in the holding period.

	Volatility		Annualized Vol	
Holding Period	Equities	USTs	Equities	USTs
20y	3.53	2.29	15.80	10.25
15y	4.21	2.41	16.31	9.34
10y	4.99	2.55	15.79	8.06
5y	7.56	2.93	16.90	6.56
2y	12.79	4.08	18.09	5.77
1y	17.42	5.96	17.42	5.96

Source: J.P. Morgan, http://www.econ.yale.edu/~shiller/data.htm. Last observation 2014.

The best way to detect time diversification is to convert the different period return volatilities to an annual basis through the **square root of time rule**. That is, if there is no serial correlation in annual returns, then the risk around the compound return over say 10 years is the same as that on one year when multiplied by the square root of time, 10. Without serial correlation, the probability of equities outperforming bonds does not change with holding period. Table 1 (RHS) and Table 3 show the results of this annualization. Figure 1 shows the same in graphical form.

Table 2: Volatility of compound US returns by holding period

% standard deviation, annual, start of series in parentheses

Holding Period	Equities (1951)	USTs (1972)	HG (1972)	HY (1983)
15y	4.01	2.45	2.32	1.54
10y	5.08	2.85	2.69	2.44
5y	7.12	3.53	3.89	4.35
2y	11.87	4.66	5.99	8.98
1y	17.13	6.31	8.58	14.56

Source: J.P. Morgan, S&P, Bloomberg Barclays. Last observation is 2019.

Table 3: Annualized volatility of compound US returns by holding period

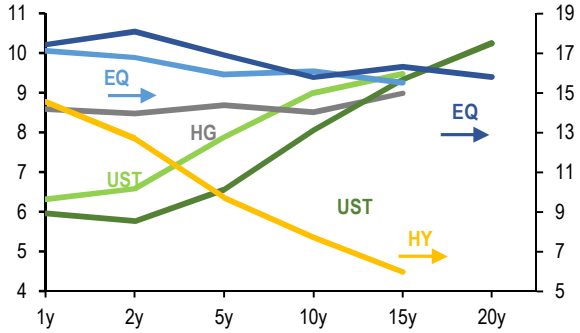
%, annual, start of series in parentheses. Annualized vol is the standard deviation of the compound returns times the square root of the number of years in the holding period.

Holding Period	Equities (1951)	USTs (1972)	HG (1972)	HY (1983)
15y	15.52	9.48	8.98	5.97
10y	16.08	9.00	8.51	7.73
5y	15.93	7.88	8.69	9.73
2y	16.78	6.58	8.47	12.70
1y	17.13	6.31	8.58	14.56

Source: J.P. Morgan, S&P, Bloomberg Barclays. Last observation is 2019.

Figure 1: Annualized volatilities of compound returns on different asset classes by holding period

%, EQ and UST lines with 20yr periods refer to history since 1876. Others are for more recent histories as shown in Table 3.



Source: J.P. Morgan, S&P, Bloomberg Barclays, http://www.econ.yale.edu/~shiller/data.htm.

We notice that equity return volatility on 10-year holding periods is about 1 % point lower than its 1-year volatility on both the last 70 and 140 years of history. That is, it is

[1] Low, but positive serial correlation is not enough to diversify risk across time. The theorem of market efficiency implies asset prices are random walks with trend, and returns are uncorrelated over time. If returns are serially uncorrelated, the efficient frontier does not change for different holding periods and time diversification does not work.

[2] We calculate returns and volatilities over all possible holding periods in our samples. It would be ideal to employ only non-overlapping periods, but we find that these give us virtually the same results.

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~1% lower than it would be if returns had been serially uncorrelated, thus showing slight time diversification.

With **US Treasuries, we find the opposite**, as annualized **volatility increases with holding period**. In the case of US HG corporate bonds, we find neither positive nor negative serial correlation and thus see no evidence here of time diversification. **HY bonds, in contrast, time diversify best.**

The results in Tables 2-3 including corporate bonds are not strictly comparable across asset classes as they are not each for the same period. Table 4 presents the same calculations for annualized volatility for only the shortest common history since 1983. It no longer shows time diversification for equities, reduces the mean aversion for bonds and now offers slight time diversification for HG corporate debt. The absolute levels of time diversification shift a bit, but the relative conclusions remain the same.

Table 4: Annualized volatility of compound US returns by holding period since 1983

%, annual, start of series in parentheses

Holding Period	EQ	USTs	HG	HY
15y	16.14	7.02	6.33	5.97
10y	17.60	7.03	6.31	7.73
5y	18.15	6.49	6.27	9.73
2y	17.08	6.22	6.68	12.70
1y	16.48	6.06	7.01	14.56

Source: J.P. Morgan, S&P, Bloomberg Barclays. Last observation is 2019.

And in real terms …

Much of the Finance literature analyses time diversification on real, inflation-adjusted returns, as there are more relevant for investors over the long run than nominal ones. Table 5 below repeats the Table 1 analysis of equity and UST returns since 1876 now for real returns by deducting CPI annual changes from nominal returns. We find little changed, except that UST volatility is a bit higher in real than in nominal terms.

Table 5: Volatility of compound real US returns by holding Period, outright and annualized

%, annual, nominal return minus 1-year % change in CPI,1876-2014.

	Volatility		Annualized Vol	
Holding Period	Equities	USTs	Equities	USTs
20y	3.31	2.48	14.81	11.08
15y	4.19	2.96	16.22	11.47
10y	5.29	3.49	16.71	11.03
5y	7.78	4.43	17.41	9.91
2y	12.91	6.49	18.25	9.18
1y	17.68	8.73	17.68	8.73

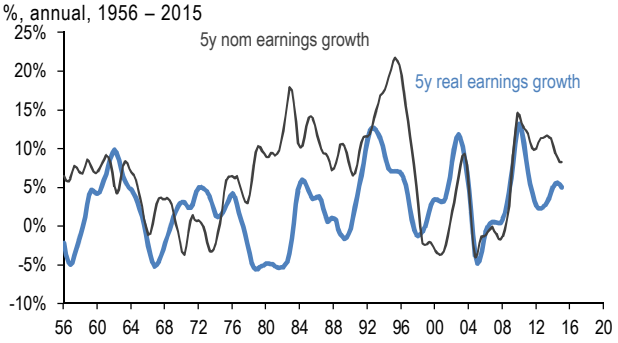
Source: J.P. Morgan, http://www.econ.yale.edu/~shiller/data.htm. Last observation 2014.

What makes time diversification work?

For time diversification to work, some of the components of return need to be negatively correlated over time. That is, they **need to mean revert**. We know from the empirical finance literature that at least in equities, returns are generally positive serially correlated (displaying momentum) from month to month and quarter to quarter, but tend to be negatively correlated, and thus mean revert, over a number of years[3]. Equity price movements consist by identity of changes in earnings and in price-earnings multiples. Figure 2-3 show the multiples and 5-year rolling earnings growth of S&P500 companies at the index level, displaying both shorter-term higher-frequency momentum and longer-term, lower-frequency mean reversion.

Figure 2: 5-year earnings growth S&P 500, real and nominal

%, annual, 1956 – 2015



Source: J.P. Morgan, S&P, last observation is 2020.

[3] See e.g., Empirical Asset Pricing. The Cross Section of stock Returns, Bali, Engle and Murray, Wiley, 2016, 494 pp. See also my What have I learned?, The JPMorgan View, Nov 10, 2017, where I summarize what I learned from decades as a tactical strategist and where I conclude that short term, momentum drives both fundamentals and asset prices.

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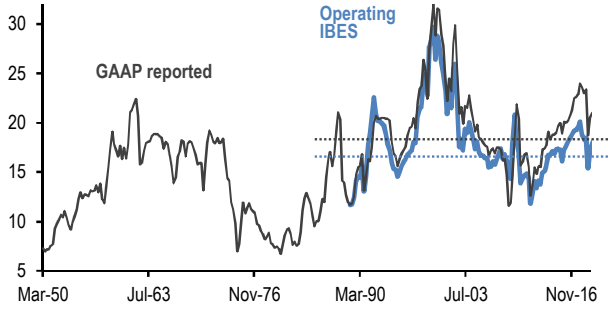
Figure 3: 12 Trailing PE S&P 500, reported vs operating

Quarterly, Q1 1950 – Q4 2019

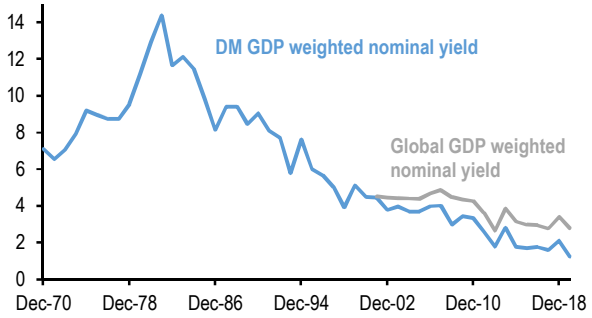


Source: J.P. Morgan, Thomson Reuters, Bloomberg, S&P. Last observation is 2019.

This mean reversion is not on display in the case of bonds. Figure 4-5 show both nominal and real bond yields at a global level since 1970-75, providing steady trending declines for more than 40 years now. This momentum over periods longer than 10 year is the likely cause of the expanding return volatility when bond portfolios are held over longer periods.

Figure 4: Global government bond yields

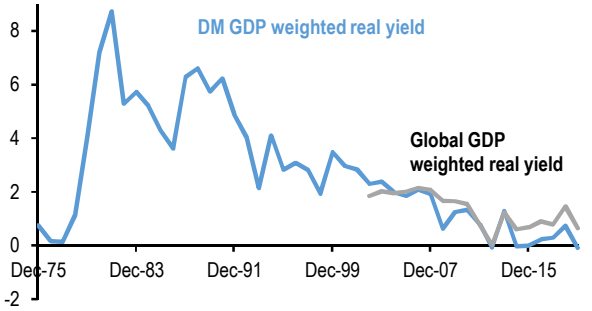
%, nominal, 10-year maturity, GDP weighted, 1970 – 2019. EM is measured through our GBI EM index.



Source: J.P. Morgan, OECD, last observation is Dec 2019.

Figure 5: Real global government bond yields

%, 10-year maturity minus 5-year rolling headline inflation, GDP weighted, 1970 – 2019. EM is measured through our GBI EM index.

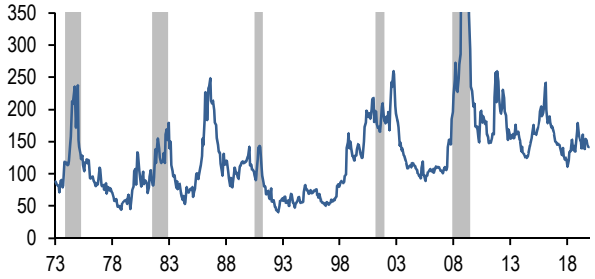


Source: J.P. Morgan, OECD, last observation is Dec 2019.

For corporate bonds, Figure 6-7 shows the clear mean reversion over business cycles in US HG spreads and HY credit spreads and defaults. Mean reversion in spreads was thus able to offset mean *aversion* in UST yields. In the case of HG, this brought time diversification to zero, but in the case of HY, where spreads are much larger and more volatile, spread mean reversion has dominated and made HY bonds the best for time diversification.

Figure 6: US High Grade credit spreads over USTs

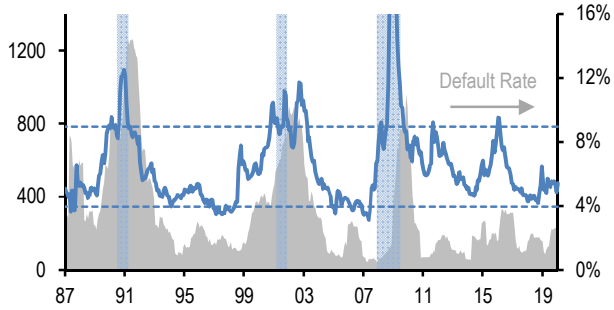
bp, monthly, 1973 – Oct 2019.



Source: J.P. Morgan, Bloomberg.

Figure 7: US High-Yield credit spreads over USTs

bp, monthly, Jan 1987 – Dec 2019.



Source: J.P. Morgan, Bloomberg.

Knowing where you start makes a difference

The above results are consistent with the consensus of the Finance literature on time diversification[4]. We do think, however, that there is an **important consideration missing from this literature that "unfairly" biases long-term investors against fixed income**.

The important consideration is that at the start of any period over which to judge asset returns and risks, **investors have important information that greatly narrows the scope of possible returns they can earn on these assets**. That information is the **price and IRR at which we buy the asset**. The above studies on time

[4] For an overview, see e.g., The Time Diversification puzzle: A Survey, Bianchi, drew and Walk, Financial Planning Research Journal, Sep 2016.

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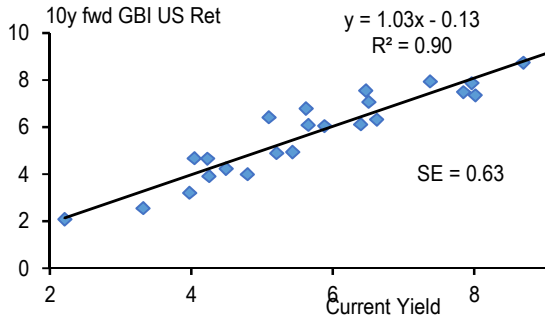
diversification implicitly assume that the next X years of returns are generated by random sampling from the population of past returns. This approach assumes the investor knows nothing more about the future than the historical returns and thus can only estimate risk from the range of historic returns.

As investors, though, we ***do know*** that the starting yield of an asset is important information to assess future returns. It is less well known that it also tells us something about how much risk we run around these return expectations. Consider Figure 8 that shows the 10-year rolling compound returns on our US Treasury index against the index yield at the start of each of these 10-year periods since index inception in 1986. The fit is very tight and the standard error of the regression is only 63bp. Figure 9 shows the 10-year rolling return on the S&P500 against Robert Shiller's cyclically adjusted PE ratio (CAPE) at the start of each period. The fit is much looser, but the standard error is still only 2.9% and a lot lower than the 5% standard deviation of 10-year compound returns over the past 70 and 140 years shown in Tables 1-2 for US equities.

Figure 8: 10-year rolling US Treasury compound returns against starting yield

%, annual, index yield at start of each 10-year period on x-axis, 1986- 2019



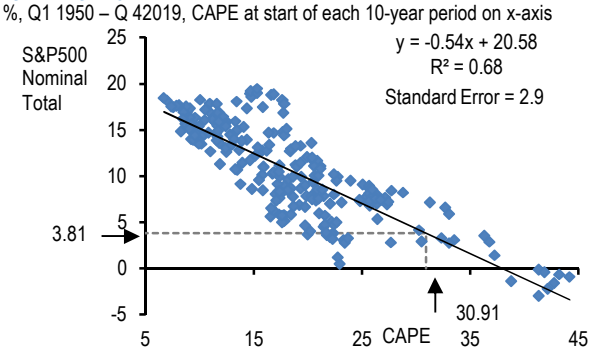
Source: J.P. Morgan, last observation is Dec 2019.

Why does knowing where you start make a difference?

In the case of equities, knowing the multiple at which you buy the index at the start of your holding period narrows the range of returns you could earn exactly because these multiples tend to mean revert over the medium to long term. It allows you to pinpoint with less uncertainty how multiples could change over time and what kind of returns you can earn. It thus could lower your risk of disappointment.

Figure 9: 10-year rolling SPX compound returns against starting cyclically adjusted PE (CAPE)

%, Q1 1950 – Q 42019, CAPE at start of each 10-year period on x-axis



Source: J.P. Morgan, http://www.econ.yale.edu/~shiller/data.htm.

In the case of bonds, the explanation is very different. Bond returns consist of income and price gains/losses. The latter, in the case of default-free bonds, are a direct function of duration times any change in yield that in turn determines future income. The annual return over T years can thus be written (approximately) as average income (mean of starting and ending yield Y) and price change, which equal the change in yield times duration DU, spread over T years, plus the annual slide[5] down the curve.

$$TR = (Y_0 + Y_T)/2 + (Y_T - Y_0)*DU/T + slide$$

$$TR = Y_0 \text{ if } (Y_T - Y_0)/2 = (Y_T - Y_0)*DU/T \quad \text{ignoring slide}$$

$$\Rightarrow T = 2*DU$$

Ignoring slide for the moment, the annual return over T years will thus equal the starting yield for a bond portfolio as long as the portfolio is held over a period that is twice the duration of the portfolio. With slide, we need to reduce this by about 1-2 years, depending on the average steepness of the curve. Most major bond indices have a modified duration not too far from 6 years. Our UST index duration has averaged 6.3 years over the past 5 years and 5.3 years since inception in 1986. With UST yields now near all time lows, duration has crept up to 7 years. With index duration only slowly changing over time, this implies that over the past few decades, the starting yield would have been a very good estimate of

[5] For those not into bond math, slide is part of bond returns when the curve is upward sloping. By definition, bonds eventually mature and each year lose 1 year in remaining maturity. If the yield curve is unchanged at the end of the year, but is upward sloping, then the yield of each bond will be lower and their price thus higher. Another way of looking at slide is that most bonds are issued at a longer maturity and thus higher yield/coupon than the index average we use for our shortcut approximation for return above. Adding slide is a way of adjusting for this income difference.

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what returns to expect over next 10 years. Hence, the close fit in Figure 8. The error, and thus the risk around using the current yield to project future returns would be higher for both shorter and longer holding periods than 10 years[6].

Beyond the above math, yield is a very good indicator of future return on default-free bonds over a 10 year horizon because any changes in yield that create price volatility in the short term will eventually be offset by changes in coupons on newly issued bonds entering the index. Consider a bear market with steady rises in yields and thus capital losses on bonds. As these bonds gradually mature and are replaced by newly issued bonds, the higher coupons on this new debt eventually offset the earlier capital losses as long as we are considering a period of about twice the duration of the portfolio and duration is relatively stable.

Impact of starting yield on time diversification

Tables 6-7 replace our volatility measures of Tables 1-3 with the standard error of regressing 1 to 15- or 20-year returns on USTs, HG, HY and Equities against their relevant index yields at the start of each holding period. For HG and HY, we take the index yield, but deduct average annual losses due to downgrades into HY (for HG) and due to default (for HY). This only affects the intercept of the regression. For equities, we use the trailing 12-month earnings yield plus 5-year rolling annual inflation[7]. Figure 10 shows the same in graphical form.

We observe the following

1. **Return uncertainty declines across all asset classes** after we take account the starting yield. Knowledge reduces uncertainty. Accounting for the starting yield reduces return uncertainty, the further in time one looks.

2. The reduction in risk from holding assets over a longer period does not really come from any mean reversion in returns that lies at the core of the time diversification thesis, but from using value measures that are more telling about long-term return than about the next few years. Using current yield is valuable information to judge future returns and risks on our holdings, but its value and thus risk reduction improves the further in time we look.

Table 6: Standard error of compound US returns by holding period, outright and annualized, of regression of returns against start-of-period yield

%, annual, 1876-2014. Annualized vol is the standard deviation of the compound returns times the square root of the number of years in the holding period

	Standard Error (SE)		Annualized SE	
Holding Period	Equities	USTs	Equities	USTs
20y	3.09	0.93	11.98	3.61
15y	3.69	0.75	14.29	2.89
10y	4.11	0.74	13.01	2.33
5y	7.26	1.31	16.24	2.93
2y	12.74	2.93	18.02	4.15
1y	17.41	5.06	17.41	5.06

Source: J.P. Morgan, S&P, Bloomberg Barclays. Last observation is 2014.

Table 7: Standard error of compound US returns by holding period of regression of returns against start of period yield

%, annual, start of series in parentheses

Holding Period	Equities (1951)	USTs (1972)	HG (1972)	HY (1987)
15y	2.06	1.46	1.16	0.85
10y	3.71	1.23	0.98	1.77
5y	6.49	1.04	2.06	2.68
2y	11.67	2.77	4.50	7.54
1y	17.17	4.98	7.71	13.42

Source: J.P. Morgan, S&P, Bloomberg Barclays. Last observation is 2019.

Table 8: Annualized standard error of compound US returns by holding period of regression of returns against starting yield

%, annual, start of series in parentheses. Annualized vol is the standard deviation of the compound returns times the square root of the number of years in the holding period

Holding Period	Equities (1951)	USTs (1972)	HG (1972)	HY (1983)
15y	7.99	5.66	4.50	3.30
10y	11.73	3.90	3.11	5.59
5y	14.50	2.33	4.60	6.00
2y	16.51	3.92	6.36	10.66
1y	17.17	4.98	7.71	13.42

Source: J.P. Morgan, S&P, Bloomberg Barclays. Last observation is 2019.

[6] Risk is not zero, as duration does change over time due to changing issuance patterns and yield changes themselves changing the effective duration of the portfolio. Also, yields may not change in a smooth linear fashion as assumed in our return approximation.

[7] An earnings yield -- the reverse of the PE ratio -- is a real concept and we thus needed to add a measure of expected inflation to make them comparable with our nominal bond yield analysis. Using instead Robert Shiller's cyclically adjusted earnings yield did improve our ability to project 10-year out equity returns but not by much as we thus stay with the simpler trailing PE ratio.

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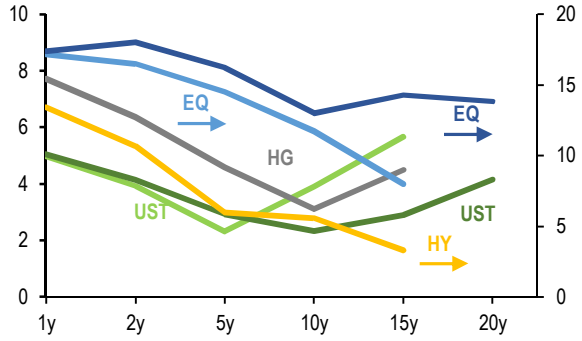
Figure 10: Annualized standard errors of compound returns of regressing different asset classes against starting yield by holding period

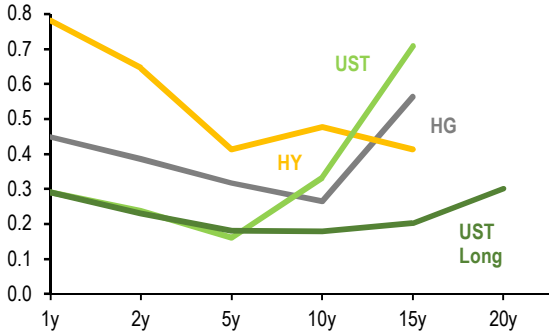
%, EQ and UST lines with 20yr periods refer to history since 1876. Others are for more recent histories shows in Table 8.



Source: J.P. Morgan, S&P, Bloomberg Barclays, http://www.econ.yale.edu/~shiller/data.htm.

Figure 11: Ratios of annualized standard errors of USTs, HG and HY bonds to US equities by holding period

Standard errors of regression multiplied by square root of holding period. UST Long refers to history since 1876. Other ratios are for more recent histories as shown in Table 3.



Source: J.P. Morgan, S&P, Bloomberg Barclays, http://www.econ.yale.edu/~shiller/data.htm.

3. **UST risk** falls enough to now show lower annualized risk at longer-holding periods. This can be interpreted as evidence for **time diversification**, as it must come from early period price changes being offset by later changes in income. But the real factor holding down return risk is knowing the starting yield of your bond portfolio.

4. Broadly consistent with the 2-times-duration rule discussed above, UST uncertainty starts rising again after 10 years on the longer history and 5 years out on our 1951 history. HG bond risk similarly rises after 10 years.

5. Changes in the relative risk of bonds versus equities as we lengthen the holding period no longer favor equities. In fact, at about 5-10 year holding periods, USTs time diversify better than equities. However, this starts reversing as we lengthen the holding periods beyond ten years. Figure 11 depicts the ratios of UST, HG and HY standard errors to those of equities at the same holding period.

6. HG time diversifies now even more dramatically than USTs, showing less risk than USTs at holding periods from 10 years on. **HY bonds remains the time diversification champion.**

Investment implications

1. **Pure time diversification** that relies on mean reversion of returns, ignoring entry points, does favor equities over government bonds, steepening the risk/return trade off line as we look at investment horizons from 5 years on, with the relative advantage for equities rising as the horizon lengthens.

2. The **advantage for equities** comes largely from real bond yields and inflation trending over long periods and thus not reverting to any mean within a decade.

3. Time diversification **does not lower outright risk.** End-of-period uncertainty on one's wealth still rises with time. Only the relative risk of equities falls versus government bonds.

4. There is more to bonds than USTs. The annualized risk on **HG** corporate bonds does not rise with time, while **HY** bonds, benefitting from mean reversion of spreads and default losses, see **more dramatic time diversification than equities.**

5. We argue that the **entry price/IRR at which you buy your assets** is more important for return uncertainty than statistical mean reversion. Starting yield affects strongly both return and risk on your investments. An asset's IRR is the best indication of what return to expect over the medium to long term, and in turn narrows the range of potential returns you could earn relative to the much wider range delivered in the past.

6. The value of taking your entry point into account to gauge future returns and risk grows the further you look into the future, but only up to a point. Bond

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uncertainty falls most up to 5-10 years out and then reverses for safer bonds while riskier assets such as equities and HY still see further falls in uncertainty.

7. Hence, **investors who only plan 5-10 years out have no reason to favor equities more than those who only look 1 year ahead**. It is only those investing for 15 years or more that should have more equities.

8. The exception is **HY bonds**. **Whether ignoring your entry point and taking it into account, HY bonds time diversify better than equities and safer bonds**. For 5- to 15-year out horizons, HY bonds should have a higher strategic weight versus equities and safer bonds than to an investor with only a 1-2 year horizon. HY bonds do not offer a great return to risk on a year-to-year basis, but with greater mean reversion than equities can offer much improved returns to risk over long holding periods.

9. With only 37 years of return history for HY bonds, relative to some 150 year for USTs and equities, one should not draw strong conclusions on horizons over 20 years in the future. At the same time, the HY results have withstood the test of the x-sigma event of the GFC. Spreads and default losses have been very stationary over this period. We thus feel good about advising to keep higher allocations to HY in 20-year portfolios.

10. **What to do today**? Our contribution to the time diversification debate is to show that entry points matter and provide good guidance on what returns and risks to expect over the medium term. And we add that this debate has missed the best asset class for time diversification-- HY bonds. With most major bond indices, including HY, now trading near or at all time lows in yields, the question arises, though, whether the now historically low expected returns on bonds do not offset their low risk advantage versus equities on a 5-10 year horizon.

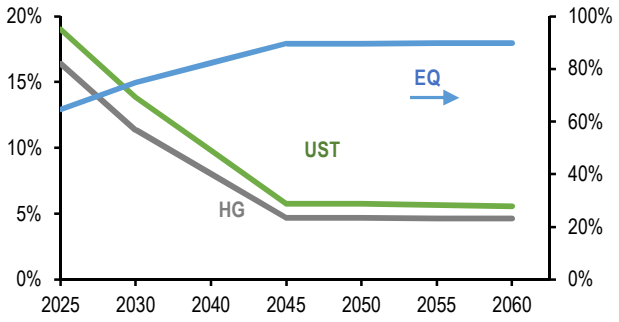
11. **Value considerations:** In the case of the **Euro area and Japan**, with government bond yields zero to negative and high grade bonds at around 50bp, there is low risk on these bonds 10 year out, in our view, but also no return. Hence, we believe an investor with a positive return target should heavily overweight equities on both the short and the medium term.

12. In the **US**, bond yields are also near all-time lows, but equity multiples and profit margins are also decently above historic means, with the S&P profit margin just below its all-time high. Based only on our IRR based regressions, the expected 10 year-out return on UST, HG, HY and SPX equities would be 2.8%, 3.1%, 5.6% and 7.2%, respectively. Using the shorter history from Fig. 10, deducting long-term credit losses for HG and HY and incorporating a view that US profit margins are likely to come down, we would come up with returns of 1.6%, 2.7%, 3.7% and 4.7% for these four asset classes[8]. The expected excess returns do not seem out of order with very long-term means and thus do not suggest that in the US, a long-term investor should favor equities over bonds more so than a short-term investor. If the investor has a minimum return target, we believe this does make the case for a higher equity weight, but that should not be a function of their investment horizon.

13. Do **target date funds** still make sense then? Target date funds are dynamic allocation funds that start with high equity weights for far-out dates and then automatically reduce in favor of bonds with each passing year. Target date funds are thus the supreme expression of the time diversification thesis.

14. Our results suggest that **target date funds should be allocating across three, not just two asset classes**: equities, safer bonds and riskier fixed income (HY and similarly risky bonds). Ideally, they should also regularly rebalance, say once a year, on the basis of the then current yield of these three asset classes. Fig 12 shows the allocation to equities, government bonds and HG corporates by the various target date funds that Vanguard offers in the US. From our point, it misses an allocation to HY as the asset class that time diversifies best.

Figure 12: Asset allocation of Vanguard target date funds



Source: J.P. Morgan, Vanguard, as of end 2019.

[8] A more extensive analysis of 10-15 year out expected returns has for a long time been produced by our colleagues in JPMorgan Asset Management, Long-term Capital Market Assumptions, 2020. It similarly offers low future returns, without a large excess return on equities.