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Wilshire Consulting

2018 Asset Allocation
Return and Risk Assumptions

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INTRODUCTION

This report is Wilshire Consulting's annual study on asset allocation for institutional portfolios. As the asset allocation decision drives more than 90% of a portfolio's return variance, it serves as a critical process that can assist fiduciaries in managing the key risks facing institutional investors. These risks include governance and behavioral risks, shortfall risk, drawdown, inflation and liquidity risks. The asset allocation process is comprised of four steps. The initial step requires forecasting asset class returns, risks and correlations. The second step is client specific and involves a review of a fund's unique financial commitments. Next, using inputs from the first two steps, an efficient frontier of diversified portfolios is constructed. The portfolios residing on this frontier are specific to each client's commitments, or spending objectives, and represent varying tradeoffs between expected risk and funding cost or expected risk and real return. The final step is to select an asset mix from the efficient frontier that matches the institution's attitude toward risk. The research presented here aids in completing the first step of the asset allocation process.

Wilshire Consulting works with funds individually to complete the remaining steps and to select the optimal portfolio that best reflects the risk tolerance and environment for that institution. Within these other steps we often introduce additional inputs to manage other important portfolio priorities, such as insights on asset class sensitivity to economic factors and liquidity profiles, for example. Unless otherwise noted, all return assumptions contained within this report represent median geometric returns based on a log-normal distribution.

2017 Market Environment & Expected Future Returns

Wilshire has been formulating long-term return, risk and correlation assumptions for decades and now updates these asset class forecasts on a quarterly basis. As it relates to our standard asset class forecasts used in asset-liability studies, we define "long-term" as estimates that span at least the next ten years. This extended time horizon is consistent with the benefit/spending obligations of most institutional investors. In addition to our standard long-term assumptions, Wilshire maintains a suite of ultra-long-term (ULT) asset class assumptions that are intended to serve as estimates of the equilibrium level of returns available through various investment classes. These ULT assumptions can be blended with Wilshire's standard asset class forecasts to project portfolio returns for periods greater than ten years. Unless otherwise noted, all future references made to long-term assumptions within this report reflect Wilshire's standard ten-year forecast horizon.

Wilshire's forecasting methodologies, which are illustrated in exhibits throughout the paper, have generally shown accuracy over ten-year intervals and we believe are superior to short-term estimates. As a result of this long-term forecasting horizon, Wilshire's assumptions typically experience only a moderate level of change from quarter to quarter or year to year. However, during volatile or transformative market environments one can expect more significant forecasting adjustments to our standard ten-year assumptions.

Assumption changes to the various asset classes reflect changes in underlying economic and market conditions. The U.S. economy strengthened as real gross domestic product (GDP) expanded at an estimated seasonally-adjusted annual rate of 2.6% for the four quarters ending September 2017. Inflation maintained the previous year's pace as the consumer price index (CPI) advanced 2.1% in seasonally-adjusted terms during 2017. The Treasury curve flattened as short to intermediate term rates rose while longer term rates fell. The ten-year breakeven inflation rate was unchanged at 1.95%.

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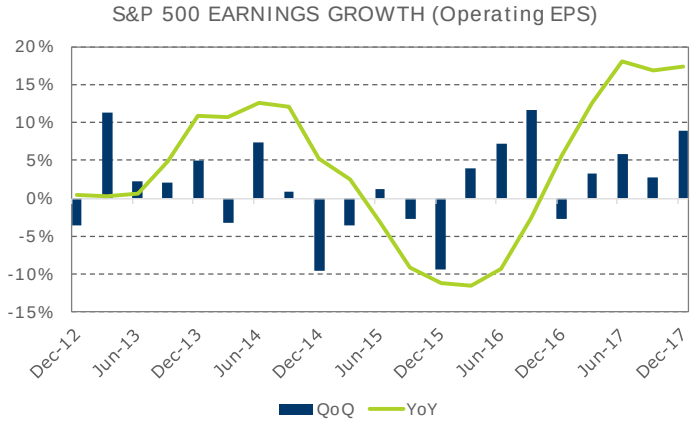
As can be seen in Exhibit 1, growth in operating earnings on the S&P 500 Index remained strong throughout 2017, rising 17.6% for the year (based on Q4 estimates as of early January).

Exhibit 1

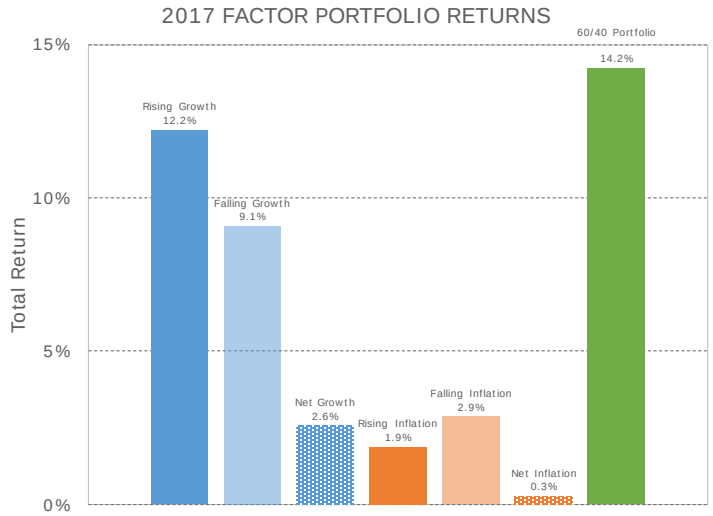


Data Source: S&P Dow Jones Indices

U.S. equities responded with a double digit gain for the year (Wilshire 5000 Total Market Index +21.0%) while non-U.S. equities also were positive (MSCI EAFE Index +25.0% and MSCI EM Index +37.3%). The global economy accelerated during the year while a decline in the U.S. dollar provided a boost to U.S. investors holding foreign securities. As described in Wilshire's "Economic Factor Portfolios: A Macro Lens for Understanding Market Behavior" research paper (August 2016), we find it helpful to examine market behavior through the broader lens of economic factors. Exhibit 2 displays the 2017 return drivers through Wilshire's two factor framework. In summary, we attempt to attach market performance to the underlying economic environment by computing returns across four targeted factor portfolios:

1. Rising Growth: Assets that generally perform well when growth exceeds expectations
2. Falling Growth: Assets that generally perform well when growth falls short of expectations
3. Rising Inflation: Assets that generally perform well when inflation exceeds expectations
4. Falling Inflation: Assets that generally perform well when inflation falls short of expectations

Exhibit 2



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Taken together, these factor portfolios can often reveal underlying return drivers more clearly than can observations based solely on individual asset classes. Results in 2017 were interesting, with strong performance to both the rising growth and falling growth asset classes, though in net terms sensitivity to rising growth led the way. These comparable year-to-date figures mask some of the material divergences that occurred between the rising versus falling portfolios during the year.

Long-term return forecasts play an important role in the institutional investment process. Actuarial interest rate assumptions, which are essentially portfolio return forecasts, are intensively scrutinized because of their potential impact on plan contributions. Wilshire has been forecasting asset class returns using forward looking assumptions since 1981 with a strong record of success for ten-year periods. We believe that the methods used in this report are intuitive, robust and provide sufficient flexibility to adapt to a rapidly changing landscape. Exhibit 3 presents Wilshire's December 2017 return forecasts and contrasts them with our December 2016 assumptions, while Exhibit 4 displays our current projections in graphical form.

Exhibit 3
Wilshire's December 2017 Expected Return and Risk Assumptions

	TOTAL RETURN			RISK		
	DEC. 2016	**DEC. 2017**	CHANGE	DEC. 2016	**DEC. 2017**	CHANGE
INVESTMENT CATEGORIES						
US STOCK	6.50 %	**6.25 %**	-0.25 %	17.00 %	**17.00 %**	0.00 %
DEV EX-US STOCK (USD)	6.50	**6.25**	-0.25	18.00	**18.00**	0.00
EMERGING MARKET STOCK	6.50	**6.25**	-0.25	26.00	**26.00**	0.00
GLOBAL STOCK	6.70	**6.45**	-0.25	17.15	**17.15**	0.00
PRIVATE EQUITY *	9.30	**8.75**	-0.55	27.50	**28.00**	0.50
CASH EQUIVALENTS	1.55	**1.75**	0.20	1.25	**1.25**	0.00
CORE BOND	3.65	**3.55**	-0.10	5.15	**5.15**	0.00
LT CORE BOND	4.10	**3.60**	-0.50	9.85	**9.85**	0.00
US TIPS	2.95	**2.95**	0.00	6.00	**6.00**	0.00
HIGH YIELD BOND	5.35	**4.95**	-0.40	10.00	**10.00**	0.00
NON-US BOND (HDG)	1.35	**1.30**	-0.05	3.50	**3.50**	0.00
US RE SECURITIES	5.40	**5.40**	0.00	17.00	**17.00**	0.00
PRIVATE REAL ESTATE *	7.15	**6.90**	-0.25	14.00	**14.00**	0.00
COMMODITIES	3.50	**3.70**	0.20	15.00	**15.00**	0.00
REAL ASSET BASKET *	6.50	**6.60**	0.10	8.40	**8.40**	0.00
INFLATION	1.95	**1.95**	0.00	1.75	**1.75**	0.00
TOTAL RETURNS MINUS INFLATION						
U.S. STOCKS	4.55	**4.30**	-0.25			
U.S. BONDS	1.70	**1.60**	-0.10			
CASH EQUIVALENTS	-0.40	**-0.20**	0.20			
STOCKS MINUS BONDS	2.85	**2.70**	-0.15			
BONDS MINUS CASH	2.10	**1.80**	-0.30			

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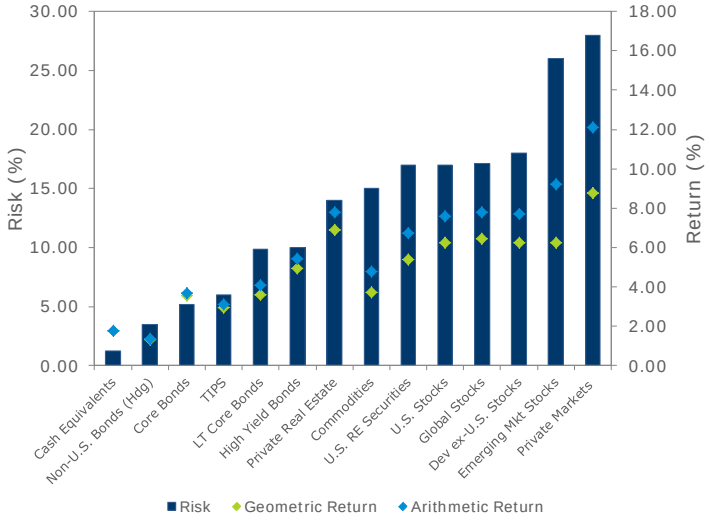
Exhibit 4
December 2017 Return and Risk Assumptions



Historical Returns

A key check on the reasonableness of asset class assumptions is their relationship to historical returns. Exhibit 5 contrasts Wilshire's return assumptions with historical returns over various periods of time and market regimes.

Exhibit 5
Historical Returns[1] vs. Wilshire Forward-Looking Assumptions

	HISTORICAL RETURNS (%)					WILSHIRE DEC. 2017 Asset Class Forecasts	
	1802 - 2017 *	1926 - 2017	Inflationary 1970-1979	Bull Market 1980-1999	Lost Decade 2000-2009	10-Year	30-Year
TOTAL RETURNS							
STOCKS	8.2	10.2	5.9	17.8	-1.0	6.3	7.5
BONDS	4.9	5.5	7.2	10.0	6.3	3.6	4.7
T-BILLS	4.1	3.4	6.4	7.2	3.0	1.8	2.8
INFLATION	1.5	2.9	7.4	4.0	2.5	2.0	2.3
RETURNS MINUS INFLATION							
STOCKS	6.8	7.3	-1.5	13.8	-3.5	4.3	5.2
BONDS	3.4	2.6	-0.2	6.0	3.8	1.6	2.4
T-BILLS	2.6	0.6	-1.0	3.1	0.5	-0.2	0.5
STOCKS MINUS BONDS	3.4	4.7	-1.3	7.8	-7.3	2.7	2.8

There are several notable relationships, in both absolute and relative terms.

[1] The source of historical returns presented in this report is Wilshire Compass[SM] unless otherwise noted.

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- Reflective of the current low yield / low return environment, Wilshire's U.S. stock and bond return forecasts, 6.3% and 3.6%, respectively, are below the actual returns achieved during the 216- and 92-year periods ending 2017.
- Although Wilshire's December 2017 inflation estimate of 2.0% is only 0.9% below the 92-year historical inflation rate of 2.9%, our return estimates for stocks and bonds relative to inflation of 4.3% and 1.6%, respectively, are notably lower than the historical spreads of 7.3% for stocks and 2.6% for bonds.
- Wilshire's implied return forecast for stocks relative to bonds of 2.7% is 0.6% below the 3.4% spread over the 216-year period and falls, more notably, 2.0% short of the 4.7% realized equity risk premium over the 92-year historical period.
- Despite a 75 basis-points increase in cash yields during 2017, the current 1.3% level continues to result in Wilshire's return assumption for cash relative to inflation to remain negative at 0.2%. This is significantly lower than the 2.6% and 0.6% historical spreads over the 216- and 92-year periods, respectively.
- Wilshire also maintains forecasts for an equilibrium state of investing, i.e. a "normal" time period, which can be utilized to derive longer-term return forecasts. However, the 30-year forecasts included in Exhibit 5 are still below the historical results, hampered by the low expected return environment in the next ten years.

INFLATION

Wilshire's long-term inflation forecast is 1.95%, which is equal to last year's assumption. Our practice since 2003 has been to derive our inflation forecast by observing the market's breakeven inflation rate – the spread between the yield on a 10-year Treasury and the real yield on a similar maturity Treasury Inflation Protected Security (TIPS). During periods of market stress, TIPS pricing may be affected by liquidity demands or a high level of inflation uncertainty, as was the case in 2008. However, with the benefit of several years of experience with these indicators, combined with a review of relevant macroeconomic data, Wilshire believes that the market's current implied estimate of future inflation serves as a reasonable forecasting signal. Therefore, the observed breakeven inflation rate of 1.95% appears to be an appropriate inflation assumption.

The current inflation forecast is based on data as of December 31, 2017. The ten-year constant maturity Treasury yield at year-end was 2.40% while the real yield on the constant maturity ten-year TIPS was 0.44%. The 1.96% difference in yields is the bond market's estimate for inflation for the next ten years, or the ten-year breakeven inflation rate. Exhibit 6 provides a summary of Wilshire's historical inflation forecast and the actual result for the following ten-year period.

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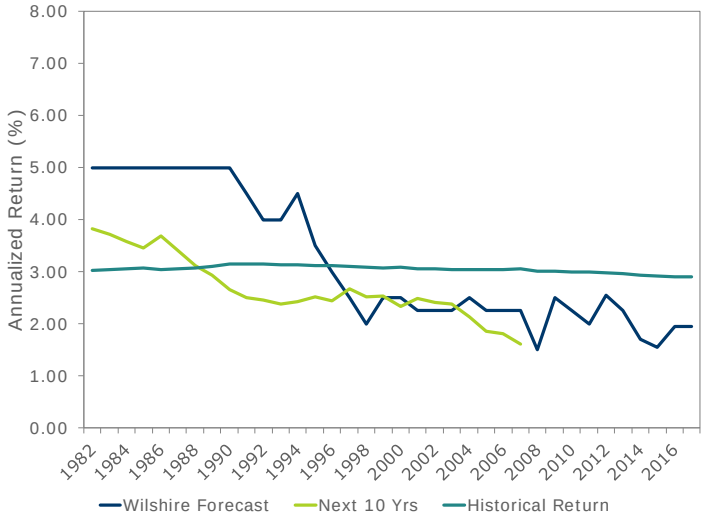
Exhibit 6
Wilshire's Inflation Forecast and Historical CPI



EQUITY

U.S. Stocks

The U.S. stock market, represented by the Wilshire 5000 Total Market IndexSM ("Wilshire 5000®), was up 20.99% during 2017. This marks the ninth consecutive year of positive gains for the broad U.S. equity market. What made the past year particularly impressive was the relative lack of volatility. The Wilshire 5000's largest drawdown for the year was -2.75% and there were only 4 trading days where the market was down 1% or more, making 2017 one of the least volatile years in nearly four decades. Several factors contributed to this success including a rebound in global economic growth and continued strength domestically. Investors also responded positively to the largest overhaul of the U.S. tax system in 30 years.

Wilshire employs two distinct models in deriving our long-term stock forecasts; a dividend-discount model ("DDM"), which we have used for several decades, and an Income-Growth-Valuation ("IGV") component model, which we formally introduced during the global financial crisis. We see complementary value in both models and, therefore, consider both signals when deriving our equity forecasts.

Wilshire's base IGV model begins by utilizing the market's current dividend yield for income, a real earnings growth rate for growth (which combines with our inflation assumption to form a nominal growth estimate) and a valuation component that assumes a market price in ten years that leads to a historical average dividend yield. As of the end of 2017, the IGV model suggests a long-term return for U.S. stocks of 5.30%. This signal compounds up from component contributions of approximately 1.95% from income, 4.00% from growth (2.00% real growth above Wilshire's 1.95% inflation assumption) and 0.65% from valuation change.

Turning to Wilshire's dividend discount model, we incorporate the following inputs as of December 2017:

- A year-end 2017 S&P 500 Index price of 2,674;

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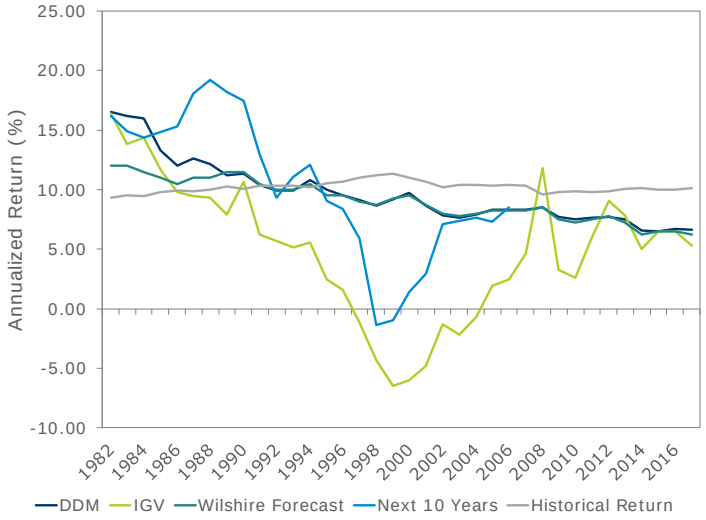
- A base earnings level of $125 per share;
- Earnings-per-share growth of 7.5% during the next five years, dropping incrementally to 4.0% from years six through 15;
- A 50% dividend payout ratio over the next five years.

Wilshire's current DDM forecast, which builds from the inputs listed above, points to a 6.65% long-term stock assumption. While we continue to value the DDM result, Wilshire believes that the IGV model can offer valuable market insights, particularly during market regimes that present a significant challenge to a DDM framework. For example, the DDM failed to anticipate the depth of the negative equity environment experienced in recent long-term returns (i.e. those beginning around the turn of the century). Wilshire's IGV model, however, correctly forecasted negative ten-year returns, although to a greater degree than what was realized. Recent results reveal the potential value of this signal; particularly the direction and size of the model's valuation ("V") component during periods of large fluctuation in price multiples. Our process incorporates these and other considerations when weighing the value of each model's signal against the current economic environment.

Wilshire's current long-term U.S. Stock assumption is 6.25%, which falls between the IGV and DDM model signals. Exhibit 7 details the history of Wilshire's stock return forecast together with the dividend-discount and IGV models' return forecasts, historical returns and the rolling returns for the ten-year period following each estimate.[2]

Exhibit 7
Wilshire U.S. Stock Forecast and Historical Equity Returns



Developed ex-U.S. Market Stocks

Wilshire has historically assumed the same expected return for the stocks of non-U.S. developed markets as it does for U.S. stocks. This view has gained wider acceptance among institutional advisors in recent years and, as demonstrated in Exhibit 8, the historical record is quite supportive of return

[2] Historical signals for the IGV model reflect its current structure (i.e. nominal growth built from long-term real earnings growth plus Wilshire's inflation estimate, etc.)

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parity between the two markets in the long run. However, we do monitor relative valuation levels across regional markets to serve as a possible signal to add/deduct a return premium/discount to our non-U.S. equity forecasts. While we expect to have potential informational value at extreme market levels where significant deviations from the norm appear, we anticipate departures from return parity to be quite rare. Currently, based on metrics such as relative price-to-earnings and yield levels, Wilshire does not believe that a different forecast for non-U.S. developed markets is warranted. From both a yield and earnings perspective, the developed ex-U.S. market is very close to a historical median observation, relative to U.S. equity. The relative P/B suggests that developed ex-U.S. markets are somewhat inexpensive versus history but not to such an extreme that would suggest an expected return premium, particularly given the other valuation signals. Therefore, our long-term forecast for developed non-U.S. stocks is the same 6.25% as discussed above for U.S. stocks.

Exhibit 8
Historical Equity Returns: 1970 – 2017

1970 - 2017 ANNUAL	U.S. DOLLAR RETURN	U.S. DOLLAR RISK	LOCAL CURRENCY RETURN	LOCAL CURRENCY RISK
S&P 500 INDEX	10.5 %	15.1 %	10.5 %	15.1 %
MSCI EAFE INDEX	8.9	16.8	7.7	14.2
EUROPE	9.2	17.3	9.0	15.0
PACIFIC	9.1	19.6	7.0	16.8

Reliable returns for non-U.S. stocks are available beginning in 1970. Since that time U.S. stocks, as represented by the S&P 500 Index, have returned 10.5% per year, versus 8.9% for developed market ex-U.S. stocks as measured by the MSCI EAFE Index in U.S. dollars. On a rolling basis, however, there have been several periods where the developed markets index has significantly outperformed U.S. stocks for prolonged periods of time. Given this long-term performance record, similar risk levels and common financial attitudes toward risk-taking, it would seem reasonable to anchor the return forecasts of non-U.S. developed market stocks to long-term expectations for U.S. stocks, barring significant relative valuation levels.

Emerging Market Stocks

Consistent with the discussion of developed ex-U.S. stocks above, we incorporate a relative valuation component to our modeling of emerging market stocks. Wilshire continues to examine the relationships between the U.S. and emerging markets and believes that the rationale for starting with a consistent return expectation from U.S. to developed markets stocks applies to emerging markets. Some investors have long supported the view that emerging market stocks should produce returns above those of developed markets given their far higher growth projections in terms of GDP. While growth rates can be in the high single digits, they are also far more volatile than in developed markets – and emerging markets equity returns generally follow that risk profile. It is important to note that the historical record on emerging market performance shows mixed results. The rolling 5- and 10-year relative return lines

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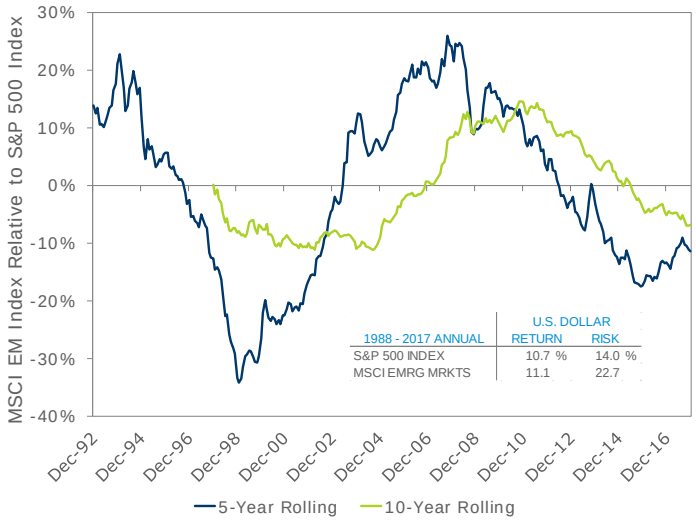
in Exhibit 9 demonstrate the questionability of anticipating a sustainable return premium for emerging stocks over the long-term and serves as a reminder to global investors of how the segment's risk can result in periods of significant underperformance. These results give us little confidence in forecasting a return premium to emerging markets above our return forecast for the developed stock markets. Instead, we believe an approach of applying a premium or discount to our U.S. forecast when relative valuations reveal meaningful departures from historical ranges provides the best opportunity to capture future return divergences. As with developed stocks, current relative valuations do not provide support for an expected return premium or discount, leading to a 6.25% return assumption for emerging markets stocks.

Exhibit 9
Emerging Market Returns: 1988 – 2017



Even in our base case of geometric return parity with developed equity markets, Wilshire's research shows that efficient portfolios include a meaningful allocation to the emerging markets, consistent with a market-weighting. For example, an efficient frontier constructed from Wilshire's underlying assumptions for U.S., non-U.S. developed market and emerging market stocks suggests an allocation of approximately 12% to emerging markets at a 17.15% risk level, which is representative of our expected risk for global stocks. This allocation is slightly above the emerging markets' market weight within the global equity opportunity set, reflecting a market-commensurate attraction to emerging market stocks despite their elevated risk level. We believe that, aside from periods of significant relative valuation levels, this provides strong support for our outlook of geometric return parity between the developed and emerging markets.

Global and Global ex-U.S. Market Stocks

Despite creating separate forecasts for the developed and emerging markets as discussed above, Wilshire's asset allocation work – unless otherwise directed by client circumstances – will implicitly assume a market weighted combination of our non-U.S. developed and emerging market components in a single non-U.S. equity asset class (currently with relative weights of 76% and 24%, respectively). This approach is consistent with Wilshire's treatment of the U.S. stock market where we do not separate stocks by size or style in the asset allocation process.

We can move the process one step further for clients that view the entire global equity market as a single asset class; thus seeking to completely eliminate any home-country bias within equity portfolios.

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Within this context, we currently construct the global market-weighted portfolio with allocations of 53% to U.S. stocks and 47% to the Global ex-U.S. market, resulting in a 6.45% return forecast at 17.15% estimated risk.

FIXED INCOME

Fixed Income Forecast Model

Wilshire's fixed income forecasting model has since its inception incorporated the contemporaneous yields-to-maturity of key sectors of the bond market as a key contributor to its return projection. Yields tend to be very strong predictors of bond returns, as demonstrated in the following graph that compares Wilshire's past bond return assumptions with historical returns, yields and rolling returns for the ten-year period following each forecast.

Exhibit 10
Wilshire Bond Forecast and Historical Fixed Income Statistics

Data Source: Bloomberg Index Services Limited

Our return forecast model for fixed income has three broad components:

1. Current and historical yield levels;
2. Roll projections based on current and forecast yield curves; and
3. Current and historical spreads for key bond sectors.

Our model begins with current market conditions, including inflation, and projects a gradual normalization of real yields as well as market spreads such that the historical equilibrium of maturity premiums and credit premiums are re-established. This will be discussed in more detail below.

In 2014, Wilshire introduced a separate forecast model for global developed market ex-U.S. fixed income. Our model utilizes the same framework as our U.S. fixed income forecast model while fully recognizing the fundamental differences between these bond markets. We also have formalized a separate but similar forecast model for the inflation-linked bond market outside of the U.S. The salient details of the global ex-U.S. fixed income forecast model are discussed below.

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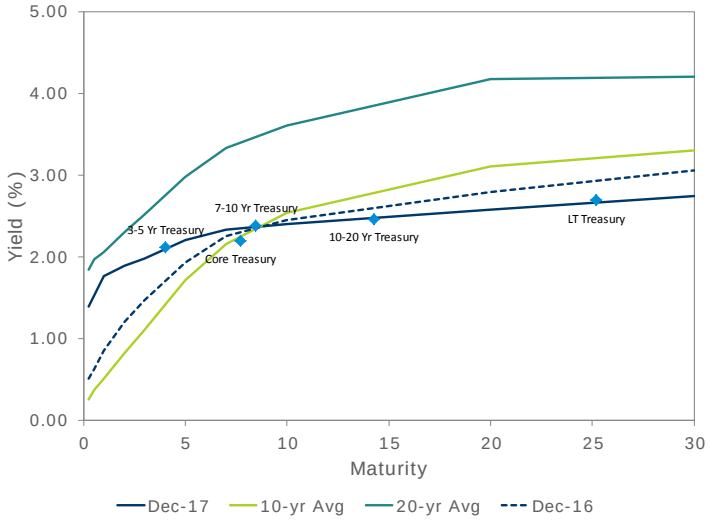
The U.S. Treasury Yield Environment

The U.S. yield curve ended 2017 with yields on short to intermediate term Treasuries rising while long-term rates fell. Long-term yields were down 21 basis points (at the 20-year maturity) and yields in the short one-to-two year band rose approximately 70-90 basis points. Exhibit 11 illustrates the yield curve shift and compares the current curve to the historical 10 and 20-year averages. Current yields are still relatively low across the term structure, although years of a low yield environment have brought the 10-year average curve down. The current spread between the ten- and two-year yields is 0.51% versus 1.72% for the ten-year average and 1.31% for 20-years. The current spread between the thirty- and ten-year yields is 0.34% versus 0.76% and 0.59% for the ten- and twenty-year averages, respectively. As will be explained in the discussion of U.S. TIPS, the Bloomberg Barclays 7-10 Year Treasury Index shown in Exhibit 11 provides the supporting data for our TIPS forecast.

Exhibit 11
Treasury Yield Curve Environment



Data Source: Bloomberg Index Services Limited, U.S. Department of Treasury

U.S. Treasury Bonds: Market and Long-Term

The Federal Reserve raised the Fed-funds rate by a combined 0.75% during 2017 to a range of 1.25-1.50%. The moves were made by 25 basis point increments during three separate meetings in March, June and December. The Fed has been cautious and steady with the benchmark overnight rate since it effectively reached zero at the end of 2008. Beyond the implications that higher yields have on investors, a higher overnight rate gives the Federal Reserve another monetary loosening tool should it be needed. Wilshire's fixed income forecasting model assumes that bond market yields will normalize during the next ten years and that the yield on the Treasury Index will reach a 0.85% spread above inflation (based on historical spreads as well as current ten-year forward rates on Treasuries), or 2.80% based on our December 2017 inflation assumption of 1.95%. Rising rates will affect a current investment in Treasuries in two ways: 1) the principal value will decline as rates rise and 2) the reinvestment rate will increase, boosting interest income. Based on the December 31, 2017 yield-to-maturity of 2.19% for the Bloomberg Barclays Treasury Index and its duration, Wilshire's model indicates that, despite a drop in principal value from rising rates, the improving reinvestment rate during the next ten years will provide a boost to the overall return of the Treasury Index. A simulated investment in Treasuries under this environment would yield a return of 2.85%. The same model applied to the Long Term Treasury Index reveals that the higher reinvestment rate fails to fully offset the principal loss projected for long Treasuries during the forecast period. Based on the Bloomberg

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Barclays Long Term Treasury Index year-end yield-to-maturity of 2.69% and its duration, a simulated investment would return 2.65%.

U.S. Bonds

The core bond market is represented by the Bloomberg Barclays U.S. Aggregate Bond Index and is comprised of four major segments: Treasuries, Government-related, Corporate and Securitized. Our approach has been to model each segment based on an environment of rising Treasury rates but also normalizing spreads versus a historical average. Current spreads for investment grade U.S. non-Treasury market segments are generally tighter than historic averages, so our credit model incorporates a slight widening of spreads for these sectors during the projection horizon. The performance of a market-duration core bond index (currently 5.98 years) would benefit as the yield curve normalizes, offsetting the principal hit from widening spreads to Treasuries. Our model suggests that the net effect is an overall boost in return for the core market with an expected return of 3.55% versus the index's year-end yield-to-maturity of 2.71%.

Cash Equivalents

Wilshire's approach to forecasting a cash return, which can be thought of as a return on 3-month Treasury bills or something similar, is to observe a number of market signals as an estimate of short-term yields in ten years. Historical relationships between cash and both inflation and longer-term Treasuries can be measured and then applied to our ten-year expectation for each to get a sense of what that implies about future cash returns. The market signals that we observe include:

- Historical yield difference between the broad Treasury market and cash
- Historical real yield on cash, or the difference between cash returns and inflation
- Current ten-year forward yield curve for expected short-term yields

Our ten-year cash yield forecast can then be utilized within our fixed income model to simulate what an investment in cash would return. Our assumptions for year-end 2017 result in a cash forecast of 1.75% versus the year-end yield on 3-month Treasuries of 1.36%. Exhibit 12 compares our historical cash return forecast to the yield curve signal, inflation signal and the actual cash return, ten-years forward. Focusing on the green line depicting the Wilshire forecast and the dark red line depicting the Treasury bill rolling ten-year return, our assumption matched very closely with actual cash returns during the early periods of the chart. However, more recently, the negative real yield environment that the U.S. has been experiencing has resulted in wider deviations.

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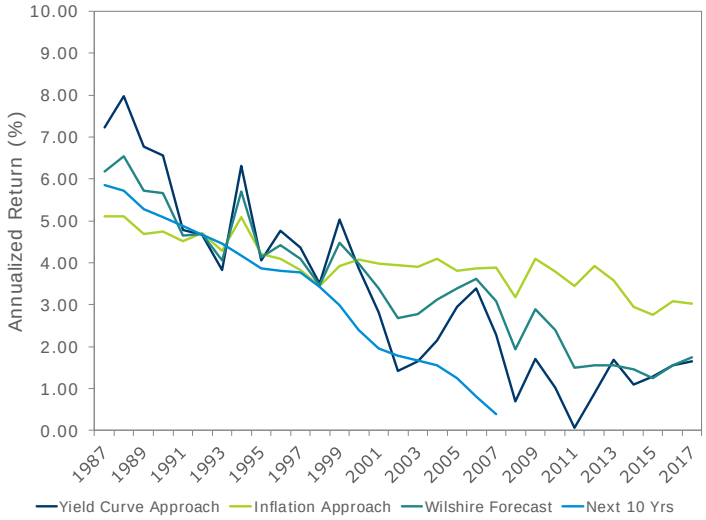
Exhibit 12
Wilshire's Cash Equivalents Forecast vs. Actual 10-Year Return



Non-U.S. Bonds

Investment theory suggests that non-U.S. bond yields will be equivalent to core U.S. bond yields when currency adjustments are taken into account. This would imply using the same 3.55% core U.S. bond return forecast for non-U.S. bonds. Wilshire's research and experience, however, have shown that custodial costs, taxes, transaction fees and a higher credit quality versus the U.S. bond market, due to the large proportion of government debt in non-U.S. bond indexes, all combine to reduce the performance of non-U.S. bonds in local currency terms relative to U.S. dollar-denominated bonds. Exhibit 13 compares historical core U.S. bond return and risk values[3] with hedged and unhedged values of the Citigroup Non-U.S. Government Bond Index.

Exhibit 13
U.S. vs. Non-U.S. Bond Returns: 1985 – 2017

	U.S. DOLLAR		LOCAL CURRENCY	
1985 - 2017 ANNUAL	RETURN	RISK	RETURN	RISK
CORE U.S. BONDS	7.0%	4.5%	7.0%	4.5%
CITIGROUP NON-U.S. GOVT.	7.6%	11.0%	6.5%	3.9%

Unhedged non-U.S. bonds offered better returns over the 33-year period due to a net fall in the dollar, in aggregate, for the entire time period. Hedged non-U.S. bond returns take out expected and unexpected currency movements and have exhibited returns 0.5% below core U.S. bonds at less risk. A long-term forecast for non-U.S. bonds should not include a currency return, positive or negative, and should rely upon historical hedged returns. Risk forecasts, however, should come from the experience of the unhedged indexes unless a hedged strategy is employed.

As mentioned earlier, Wilshire's Global Ex-U.S. Fixed Income forecast model explicitly reflects the fundamental and structural characteristics of this market. The framework for our return assumption forecasting is the same as that used for U.S. bonds:

[3] Wilshire uses the Bloomberg Barclays U.S. Aggregate Index as the principal benchmark for core bonds.

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1. Current and historical yield levels;
2. Roll projections based on current and forecast yield curves; and
3. Current and historical spreads for key bond sectors.

Due to the non-U.S. bond markets' elevated exposure to local-market Treasury securities and a lower yield environment outside of the U.S., our current return assumption for dollar-hedged global ex-U.S. core bonds is 1.30%; this reflects a 10-bps reduction to our unhedged global ex-U.S. core bond forecast return of 1.40%.

Treasury Inflation Protected Securities (TIPS)

Wilshire typically recommends using an expected return for Treasury Inflation Protected Securities (TIPS) equal to the expected return for nominal Treasury bonds of similar maturity. As with other fixed income asset classes, we have modeled the Treasury segment closest in maturity to TIPS including our forecast for the interest rate environment during the next ten years. The average maturity for the Bloomberg Barclays U.S. TIPS Index was 8.27 years at year-end. The index with the closest average maturity is the U.S. Treasury 7-10 Year Index, at 8.47 years. The modeled return assumption for this index is 2.96%, resulting in a U.S. TIPS assumption rounded to 2.95%.

Long-Term Bonds

Wilshire's return assumption for long-term bonds is derived from the yield-to-maturity on the Bloomberg Barclays Long Term Government/Credit Index. This index consists of Treasuries, government-related and corporate securities with a minimum maturity of ten years. As with the core bond market, we modeled the various sectors within the index reflecting our custom return forecast for long-term Treasuries. Despite the rising rate environment, the higher reinvestment rate during the period offsets the projected principal loss for the broad long-term market. Our return forecast for long-term core bonds is 3.60% versus an index yield of 3.49% at year-end.

High Yield Bonds and Emerging Market Debt

Wilshire's return forecast for high yield bonds is 4.95%, 40 basis points lower than last year's assumption. Our return forecast is based upon our high yield bond model that accounts for the dynamic nature of credit yield spreads, defaults and recoveries. The current forecast incorporates the following assumptions:

- An initial yield spread of 3.64%, tighter than the 4.42% spread of one year prior;
- An annual default rate of 4.10% during the forecast period, reflecting the 20-year average default rate of speculative-grade U.S. debt;
- A ten-year cumulative default rate of 34%;
- An annual recovery rate of 40%, again reflecting the long-run average rate;
- A ten-year cumulative annual loss rate – defaults less recoveries – equal to 22%.

In Exhibit 14 we graph Wilshire's expected future default rates against all historical cumulative default rates from 1970 through 2016. Each line represents the historical cumulative default rates for high yield bonds issued in a single vintage year. The black dotted line is Wilshire's forward-looking default rate that is used in our expected return model for high yield bonds. Wilshire's default forecast line represents default expectations for a market portfolio holding bonds issued across various years. While it differs in nature from the vintage year default lines, which represent cumulative default rates specific

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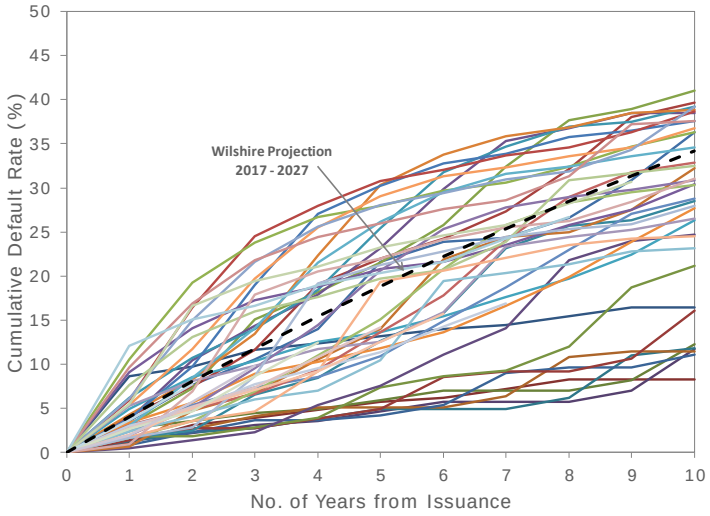
to each single year of issue, the chart is useful in comparing our projection to historical default rate paths.

Exhibit 14
Historical Cumulative Default Paths: 1970 – 2016



Data Source: Moody's Investor Service, Wilshire Consulting

Emerging market debt (EMD) has rapidly evolved into a unique segment of the fixed income universe. Until fairly recently, EMD was typically viewed as simply a spread product among other high yield fixed income components, providing exposure to credit spread risk as well as country-specific risk. Investors nowadays have multiple options to gain exposure to emerging market debt; they can invest in bonds denominated in hard currencies such as U.S. dollars or euros, as well as local currency denominated paper that may or may not be hedged into base currencies. Management of currency risk as a result becomes an important consideration with EMD investment. Local-currency EMD managed on an unhedged basis unsurprisingly introduces currency-related risk; however, even hard-currency EMD exposes investors to embedded currency risk, since issuers must convert earnings collected in local currency to hard currency to service bond debt[4]. Wilshire incorporates the mechanics of the high yield model described above in deriving our core hard-currency emerging market debt forecast of 4.55%. Wilshire assumes identical return forecasts for hard currency EMD and unhedged local-currency EMD; our hedged local-currency EMD forecast of 4.40% deducts 15 bps for the explicit and implicit costs of hedging emerging-economy currencies. Note that risk forecasts for hard-currency EMD and unhedged local-currency EMD are higher than those for hedged local-currency EMD due to currency risk.

PRIVATE MARKET INVESTMENTS

Private equity fundraising continues to trend higher despite an occasional drop in commitments. Global fundraising has averaged $111 billion per quarter during the year ending September 2017 versus only $102 billion, on average, for the four quarters ending September 2016. The number of funds closing, however, has dropped slightly during that time from an average of 275 to 242. Global private equity

[4] Wilshire Associates Incorporated (2013). *Recent Developments in Emerging Markets Debt*: Walker.

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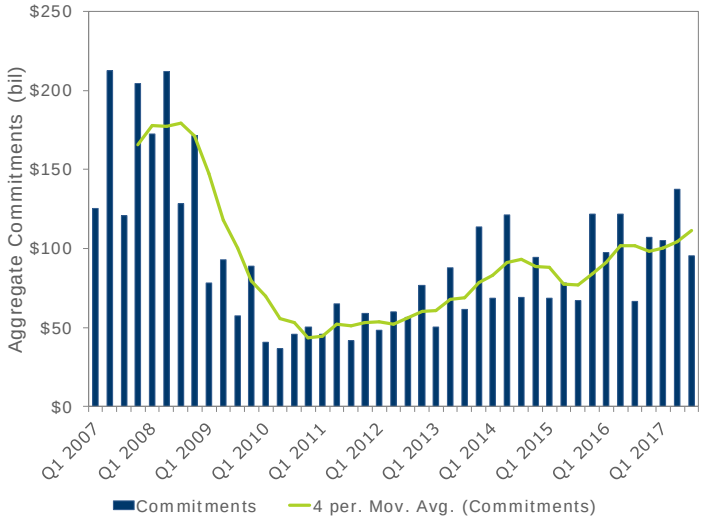
fundraising is displayed in Exhibit 15, including the $338 billion raised during the first three quarters of 2017.

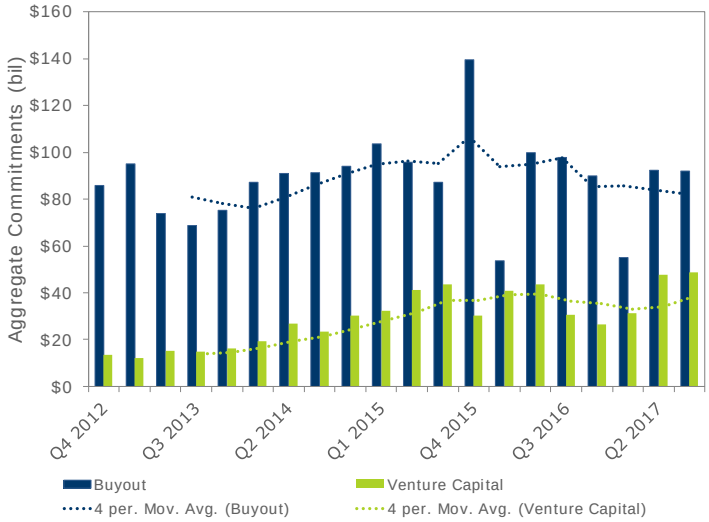
Exhibit 15
Global Private Equity Fundraising



Data Source: Preqin

Exhibit 16 shows quarterly equity investments in buyout and venture capital-backed deals during the past five years. Buyout commitments decreased 16% for the four quarters ending September, 2017 versus the preceding four quarters while venture capital has increased 6% during the same periods. Through the first nine months of 2017, buyout commitments totaled $240 billion while venture capital equals $128 billion.

Exhibit 16
Buyout and Venture Capital Commitments



Data Source: Preqin

Wilshire's return and risk assumptions for individual private market asset classes are contained in Appendix B. Our private market return expectations are derived by drawing parallels to the public

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markets where appropriate, along with using private market data if available. Since there is not a passive, beta-only option when placing capital in the private markets, these investments necessitate an important element of active management, whose results can vary dramatically. As such, Wilshire's return methodology embeds an assumption that investors are able to identify and access managers that can deliver above-median returns. This underscores the importance of implementation decisions, as, absent the ability to deploy capital with skillful managers, one would likely not find private market returns compelling.

Risk estimates pose a unique challenge because infrequent private market investment valuations preclude the calculation of short-term periodic returns. As a result, projections of risk based on accounting data consistently understate risk. However, our return methodology offers a sense of what the true risk levels might be if the public markets were adjusted for commensurate leverage exposure or greater business risk. In general, Wilshire views the use of private equity as a type of leveraged equity return rather than a diversification tool. The linkage between these markets is quite intuitive, as private equity returns are subject to the receptiveness of the capital markets to generate potential outsized returns.

Buyouts and Venture Capital

Wilshire follows an identical modeling structure to forecast buyout and venture capital private equity returns but with tailored inputs that are representative of each market segment's unique characteristics. Our methodology attempts to identify and account for all key factors that contribute to an investment's realized return. The model includes five primary return components (the table below displays how these components contribute to our current buyout and venture capital forecasts):

- Beta and relative valuation: Sensitivity to systematic risk (i.e. public market equity), adjusting for possible relative pricing differences. Our current beta assumptions for buyouts and venture capital are 1.10 and 1.25, respectively.
- Financial leverage: Adjustments for differences in leverage between public and private markets, including public market proxies for senior and subordinated debt within the private markets. Our total debt assumption for buyouts is 65% (i.e. a 2.9x leverage ratio) and for venture capital it is 0%.
- Illiquidity premium: Compensation for lack of access to invested capital.
- Operational premium: Based on the historical results of successful managers.
- Fee: Base and incentive fees paid to general partners based on a typical structure.

Exhibit 17 contains all of the year-end buyout (including non-U.S.) and venture capital inputs. Our expected risk assumption is included for completeness sake.

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Exhibit 17
Private Equity: Return Assumption Inputs

	BUYOUTS	NON-U.S. BUYOUTS	VENTURE CAPITAL
Market Return	6.25%	6.25%	6.25%
Beta/Leverage Impact	-0.10%	-0.10%	0.75%
Net Return	6.15%	6.15%	7.00%
Illiquidity Premium	0.50%	0.50%	0.50%
Operational Premium	3.00%	3.00%	4.00%
Fee (Base/Perf.)	-2.35%	-2.35%	-2.70%
Expected Return	7.30%	7.30%	8.80%
Expected Risk	30.00%	32.00%	44.00%

The initial step essentially expresses our forecast for public equity in terms of its implications within private equity. The beta adjustment accounts for the greater sensitivity that private markets have to equity returns, generally, and the leverage impact is derived from differences in debt utilization within both the public and private markets. The remaining inputs are applied after those adjustments. For additional detail regarding our methodology, please see our 2017 paper on private equity forecasting[5].

Private Market Debt: Mezzanine and Distressed

Private market debt instruments offer investors fixed income-like private securities but at higher expected risk than public market bonds. Wilshire views mezzanine debt like a convertible bond. However, unlike publicly traded convertibles with characteristics combining stocks and bonds, mezzanine debt possesses characteristics combining buyouts and high yield bonds. Consequently, we expect their return and risk measures to lie somewhere between buyouts and high yield bonds. Therefore, the 6.70% return and 20.0% risk forecast for mezzanine debt in Appendix B is based upon a blend of our buyout and high yield assumptions. Distressed debt is an issue that is in default and should provide for a slightly higher expected return than mezzanine debt. Our return forecast for distressed debt is 6.95% with a 20.0% risk expectation.

Private Markets Portfolio

The return and risk forecast for a diversified private markets portfolio is provided in Appendix B. The makeup of the private markets portfolio is as follows:

U.S. Buyouts	50%
Non-U.S. Buyouts	20%
Venture Capital	20%
Distressed Debt	5%
Mezzanine Debt	5%

When the components are geometrically calculated with a lognormal assumption, the forecast return for a diversified private markets portfolio is 8.75%, which is 2.50% above Wilshire's 6.25% expected return for U.S. stocks. The expected risk for the diversified private markets portfolio is 28.0%, which is slightly more than 1.6x the forecasted risk of U.S. stocks.

[5] Wilshire Associates Incorporated (2017). *Forecasting Private Equity Returns: Building Return Assumptions in Private Markets*: Foresti and Rush.

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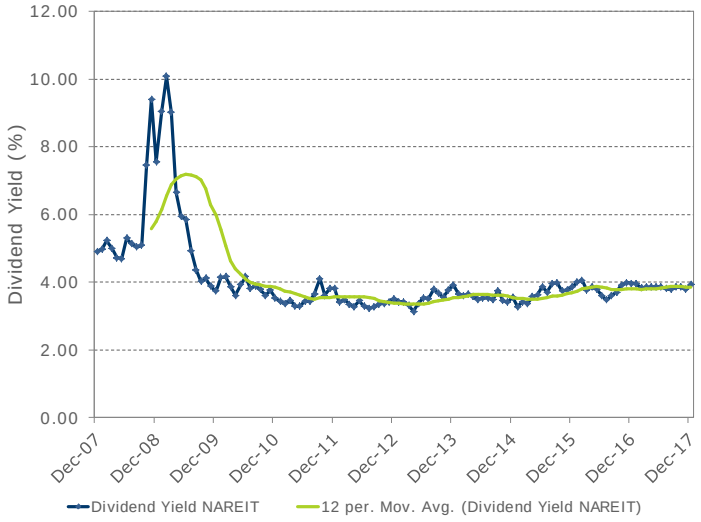
REAL ASSETS

Asset correlation, or the degree to which asset prices move in tandem, results from a common sensitivity to underlying economic forces (i.e. growth, inflation, etc.). Real assets, in particular, share a common sensitivity to inflation and therefore can partially protect real asset investment values against inflationary environments. This connection with inflation typically generates a relatively low correlation with other traditional assets. Therefore, Wilshire groups together the discussion of several asset classes into a Real Assets[6] section – Real Estate, Infrastructure, Timberland, Commodity Futures, Oil and Gas and Master Limited Partnerships (MLPs). While we consider TIPS a member of the real asset class, they are absent from this section as a discussion of our TIPS methodology was included in the Fixed Income section above.

U.S. Real Estate Securities

Wilshire currently forecasts an expected return of 5.40% for U.S. real estate securities, which is equal to our December 2016 assumption. Wilshire derives its forecast by combining the current dividend yield environment of Equity REITs with an expected dividend growth rate equal to three-quarters of long-run inflation.[7] Periods of market turbulence, such as in 2009, are the most challenging times to forecast return. Fortunately, the yield environment has been relatively steady during the past several years. Exhibit 17 contains the historical REIT dividend yield along with a one-year moving average.

Exhibit 18
Equity REIT Dividend Yields



Data Source: FTSE Group and the National Association of Real Estate Investments Trusts

Non-U.S. Real Estate Securities

Wilshire's usual practice is to assume comparable non-U.S. and U.S. returns within a global asset class containing regional components. Within this context we often employ a market or model based

[6] Wilshire Associates Incorporated (2007). *Real Asset Investments*: Browning.
[7] Examining REIT dividend growth historically, Wilshire found that REITs were able to pass through about three-quarters of long-run inflation through rent and dividend increases.

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approach to forecasting the U.S. component return, which we then build into a non-U.S. component assumption. However, as mentioned in the Developed ex-U.S. Market section, we also consider relative valuation signals among regional markets to identify periods of relative valuation mismatch. In looking at yields on global public real estate securities, we do not currently see justification for instituting a premium or discount to our U.S. Real Estate Securities forecast for our non-U.S. assumption. A consistent or permanent return premium for either U.S. or non-U.S. securities is not supported by the historical record of total returns. Therefore, our approach leads to the same 5.40% long-term return forecast for non-U.S. real estate securities.

Private Real Estate

Wilshire's expected return assumption for Private Real Estate is 6.90% with an expected risk of 14.0%. The forecast is measured as a basket or portfolio of the three major real estate segments: 70% core, 15% value-add and 15% opportunistic real estate. Core real estate includes stable properties with high occupancy rates while the realized return that an investor earns is mostly income-based. Formulating an expected return begins with the available yield, or capitalization rate, in the core private market. The National Council of Real Estate Investment Fiduciaries (NCREIF) Property Index is comprised of thousands of properties acquired on behalf of tax-exempt institutions. NCREIF reports market data on the index on the properties themselves, meaning that any financial leverage that is employed by asset owners is not included. Wilshire's forecasting methodology begins with the most recent yield at the index level as being representative of the broad market generally. We also include an income growth rate as rents on core properties are expected to increase during our forecasting period. The growth rate is based on expected inflation, as owners may capture a portion of an economy's rising prices in increased rents, and is equal to 75% of our current inflation assumption. Beyond this "market return," our methodology focuses on four other potential drivers of return, some of which are informed by the public markets:

- Financial leverage: Debt equal to 20% of total capital, including floating and fixed rate debt
- Illiquidity premium: Core real estate funds offer regular redemptions, so zero in this case
- Operational premium: Based on the historical results of successful managers
- Fees: Average fee on a core real estate fund is 1%

Exhibit 19 contains all of the year-end core private real estate inputs, along with the final assumption.

Exhibit 19
Core Private Real Estate: Return Assumption Inputs

	MARKET RETURN		CORE REAL ESTATE
Capitalization Rate +	4.40%	Market Return	5.85%
(Inflation Capture *	75%	Leverage Contribution	0.30%
Expected Inflation)	1.95%	Illiquidity Premium	0.00%
		Operational Premium	0.50%
		Fee (Base/Perf.)	-1.00%
Market Return	5.85%	Net Successful Return	5.65%

Value-add and opportunistic real estate are very different investment types from core, and Wilshire's approach to forecasting returns in each segment is similarly different. Such properties require substantial investment to develop or even repurpose a site before earning a meaningful return, which comes mostly in the form of price appreciation. Active managers in this space deploy significant debt, often in excess of 50% of total capital, and the illiquidity profile of a fund is similar to what is common within the private equity market. Therefore, Wilshire's approach to forecasting returns within value-add and opportunistic real estate is to observe what managers within these two market segments have

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been able to earn above core real estate managers. The available data are sufficiently robust to make such observations, with 20 to 30 years of data from multiple sources. Value-add funds have been able to outperform by somewhat less than 2%, at the minimum, but as much as nearly 4% during other periods. The assumption utilized within our methodology is currently 3%, for an 8.65% net successful return assumption. For the opportunistic segment, we based our assumption on relative performance versus value-add real estate. When considering the previous 30 years of data, opportunistic funds have not performed particularly well on a relative basis. However, the recent history is more promising. Opportunistic funds have outperformed value-add by an average of 2% on a rolling ten-year basis since 2008. The assumption utilized within our methodology is currently 1%, for a 9.65% net successful return assumption for opportunistic private real estate. For additional detail regarding our methodology, please see our 2018 paper on private real estate forecasting[8].

Infrastructure

Direct infrastructure investments cover a broad range of asset types, ranging from stabilized, income producing assets ("brownfield infrastructure") to new and unproven development projects ("greenfield infrastructure"). These physical assets are further differentiated by geographic location, sector, financing and other characteristics. Similar to real estate properties, infrastructure returns are primarily generated by owning and operating physical assets; and like real estate, operating income is often linked directly or indirectly to long-term inflation trends. As such, Wilshire utilizes private real estate as an infrastructure proxy in asset liability studies. Recognizing the imperfections that exist in this methodology, Wilshire believes there are few better corollaries than private real estate with relation to inflation capture and physical asset cost structure. Further, the properties of core real estate can be representative of the factors driving brownfield infrastructure while opportunistic real estate investments can be a suitable proxy for development of greenfield infrastructure. Leverage adjustments may be necessary, however, as there is a wide range of financial leverage that can be deployed within infrastructure investments. On a project basis, customized assumptions can be developed to model the unique characteristics of specific infrastructure investments.

Timberland

Timberland investment returns are driven by four primary components: biological growth, the market price for timber, the market price for land and the skill of active management. Wilshire's return assumption for the timber asset class is 6.95% and is based on a return attribution of 5.00% annual biological growth and a 1.95% increase in timber market prices. The timber market price component is consistent with our inflation forecast and reflects the ability of timberland products to capitalize expected and unexpected inflation over long time periods. The holding period return to land is assumed to be negligible, and thus estimated to have no addition to return unless successful management is employed. For a more detailed discussion on our forecast methodology, please refer to Wilshire's research paper "Timberland Investments – Does the Return Fall Far From the Tree?"

Commodity Futures

The returns for commodities differ from other asset classes because commodities do not represent compensation for the risk associated with future cash flow uncertainty. Instead, investors in commodity futures can be compensated for providing insurance to producers, thus insulating the business

[8] Wilshire Associates Incorporated (2018). *Forecasting Private Real Estate Returns: Building Return Assumptions in Private Markets*: Foresti and Rush.

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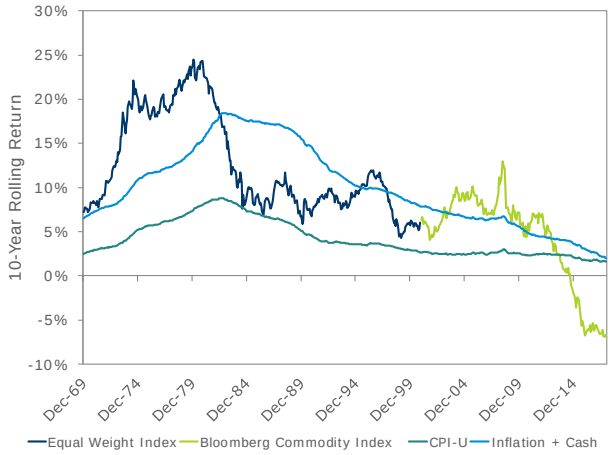
operations of these commodity producers from short-term commodity price fluctuations. In other words, a majority of a commodity future investor's exposure is to short-term economic conditions.

Wilshire's approach to forecasting a return for a basket of commodity futures focuses on the three components of the asset class's total return: changes in spot prices, collateral yield and contract roll yield. The first two inputs are rather straightforward. Our 'spot price' return is represented by our inflation assumption and the collateral yield is equal to our forecast on cash. Our assumption for roll yield is currently zero. Prior to the early 2000's, roll yield was positive within the commodities market. However, for the past decade or so, roll yield has actually been negative. Given these mixed results, we currently find it prudent to assume a 0% return from roll, rather than essentially picking one of the historical trends. We will continue to monitor this component going forward. Therefore, currently our commodities assumption is inflation (1.95%) plus cash (1.75%), equal to 3.70%. Exhibit 20 contains a return history for the Bloomberg Commodity Index, an equal weight index, CPI-U and the sum of actual inflation plus the return on cash through time.

Exhibit 20
Historical Commodity Index Returns



Data Source: Gorton and Rouwenhorst "Facts and Fantasies about Commodity Futures"

Wilshire's forecasted risk for commodity futures is 15% based on the composition of the Bloomberg Commodity Index. It is important to note that other indexes differ in composition from the Bloomberg index and may be substantially more or less risky.

The low measured correlation of commodity returns with more traditional assets, such as stocks and bonds, stems from their price sensitivity to current economic supply and demand forces. In contrast, stock and bond valuations are more heavily driven by forward-looking expectations. Historically, these factors have caused traditional assets and commodities to have lower correlations. A complete list of correlations for commodities versus other asset classes can be found in Appendix A.

Master Limited Partnerships (MLPs)

A Master Limited Partnership (MLP) is a public partnership that is traded on a stock exchange. It is a legal structure that combines individual limited partnerships into one large entity to make the ownership interests more marketable, with a general partner operating the business. The majority of energy MLPs engage primarily in the midstream portion of the energy chain – i.e. pipelines, storage terminals, gathering, processing. However, MLP businesses have expanded to include the exploration and production of oil and natural gas, coal leasing and mining and shipping. Tax implications of investing in

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MLPs are quite complicated and institutional investors should seek guidance from tax advisors before investing. For a more detailed analysis of the asset class, please refer to Wilshire's 2011 research paper "Investing in MLPs."

As MLPs are predominately a yield-returning asset class, Wilshire looks to both the current yield and potential for yield increases in the future to formulate a return assumption. Our starting point is the current yield environment for MLPs, which is similar to our REIT methodology. Determining future income growth can be an opaque process as a federal regulatory body is involved and can either increase or decrease the amount operators can charge, and the changes themselves can vary. The basic formula is equal to the expected Producer Price Index (PPI), which is historically 85% of CPI, plus the regulated spread. Therefore, rather than growth essentially equaling CPI less a deduction (for PPI) and then increased by an unstable spread, we assume that growth in MLP distributions is simply equal to CPI.

Our current MLP return assumption is 9.60%; equal to the Alerian MLP Index's 7.64% yield plus our inflation forecast of 1.95%. Wilshire's risk forecast for MLPs is based on historical observations, much like with other asset classes. The observed risk on the Alerian index has moved since inception between 13% and 21%, increasing through time. Our analysis currently suggests an assumed risk on the asset class of 17%.

Oil and Gas

Wilshire's Oil and Gas assumption focuses on private energy investments and utilizes the MLP index as a starting point in forecasting returns. There are two major differences, however, between the two asset classes. The first is the amount of leverage utilized, with MLPs employing a higher level of borrowing. Secondly, private energy funds typically invest in more "upstream," or extraction, projects. This fact results in two adjustments within our forecasting methodology. Exploration projects will have a greater exposure to energy prices than midstream transportation, which we capture by utilizing the risks embedded within our Commodity assumptions. The other adjustment is to allow for value-added possibilities through upstream investments. The net result is a current long-term return forecast of 9.35% with an expected annual volatility of 16.25%. It is worth noting that the risk assumption is lower than for MLPs and is a reflection of the lower amount of leverage typically employed within the asset class.

Real Asset Basket

In an effort to assist institutions who take a holistic approach to inflation linked investing, Wilshire develops forecasts for a broadly diversified Real Asset Basket. In that approach, we construct a 50/50 combination of underlying public and private real asset portfolios. The underlying sub-component asset classes are approximately risk weighted within the public and private real asset baskets to efficiently gain exposure to the inflation capture of the individual underlying investments. The approach weights the sub-components as follows:

- Public Real Asset Basket

U.S. TIPS	50%
Commodity Futures	20%
Global REITs	15%
MLPs	15%

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- Private Real Asset Basket

Private Real Estate	35% (includes infrastructure)
Timberland	35%
Oil & Gas	30%

The aggregate Real Asset Basket with risk weighted sub-components is expected to return 6.60% and is included in the standard annual asset class matrix (Appendix A). Furthermore, the individual real asset basket component classes along with the private and public combinations can be found in Appendix B.

HEDGE FUNDS

While Wilshire primarily views hedge funds as implementation vehicles, rather than as a separate asset class, we do maintain return, risk and correlation assumptions to support their use within asset allocation studies. We maintain forecasts for five major styles or strategy groupings that are common within the hedge fund industry. For each of these strategies, Wilshire uses a building block approach with the following three components: a risk free rate (i.e. a cash equivalent return), a systematic market component (i.e. beta) and an active component (i.e. alpha). It is important to note that the inclusion of an alpha or skill-based component makes our expectations for hedge funds unique to many other forecasts in this report, whose return expectations are beta-only. Using regression analysis to identify beta factors to different asset classes, Wilshire is able to create synthetic hedge fund style returns that demonstrate reasonable tracking against actual hedge fund style indexes. We are then able to utilize the information contained in our underlying asset class forecasts to model the implied returns of the five hedge fund styles. Below we summarize the results for December 2017 along with a forecast for a diversified basket of hedge fund strategies. A more detailed discussion of the methodology can be found in Wilshire's Hedge Fund assumptions research note[9].

Strategy	Basket Weight	Expected Return (%)	Expected Risk (%)
Equity Market Neutral	10%	3.85	4.50
Event Driven	25%	5.55	7.00
Equity Long/Short	35%	6.10	9.75
Global Macro	5%	5.80	6.75
Relative Value	25%	4.85	5.75
Hedge Fund Basket		5.50	6.60

WILSHIRE'S HISTORICAL FORECASTS

Exhibit 21 shows how Wilshire's annual return forecasts have changed over the past 36 years. Notice the relative relationship between asset classes and how, when the assumptions change, they generally move together. This co-movement in assumptions is the result of common economic drivers, such as the level of growth, inflation and interest rates, which contribute to all asset class valuations, thereby linking various investments to each other in, at minimum, an indirect way.

[9] Wilshire Associates Incorporated (2013). *Hedge Fund Style Assumptions*: Foresti.

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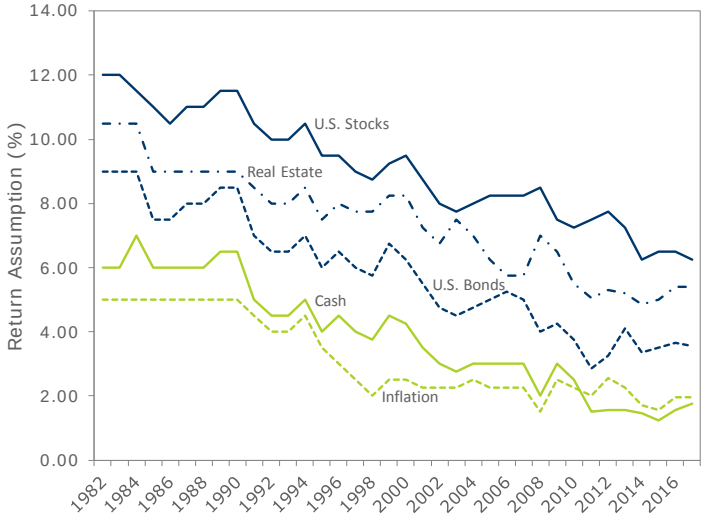
Exhibit 21
Historical Returns



RISK AND CORRELATION

Wilshire's approach to forecasting long-term risk and correlation is largely based on observed historical asset class behavior and an understanding of the discounting properties of individual asset classes to changes in economic factors. Generally, past relationships across market cycles serve as reasonable predictors of future long-term risk and correlation, as they provide statistical evidence of the commonality of asset class reactions to underlying economic conditions. In practice, Wilshire applies financial theory and judgment to the interpretation and analysis of historical results. The role of judgment ("art") versus measured statistics ("science") is more pronounced for investment categories with less historical data or that have experienced material structural changes. In general, Wilshire places much more confidence in the predictive accuracy of past relationships for asset classes with longer and more robust historical data. In this report we rely upon historical measurements of risk and correlation through 2017 to estimate future risk and correlation. To maximize the quality of our estimates, we observe this historical behavior over various time horizons (i.e. five years, ten years, full history, etc.). Wilshire does not use a preset or static rolling time period to derive these forecasts, as such an approach could result in forward numbers reacting too quickly to what may prove to be short-term relationships or event driven anomalies between markets.

One of the greatest challenges in constructing well-diversified portfolios is the instability of correlation relationships between various asset classes. Having access to longer track records does not resolve this complication; in fact, a longer historical record can sometimes serve as greater evidence of unstable correlations through time. However, many of these unstable relationships can be better understood when observing the more predictable relationship of asset class returns versus underlying economic factors. In 2014, Wilshire published two related research reports on factor-based asset allocation, including one that presented a practical approach to utilizing such factors. In that research,

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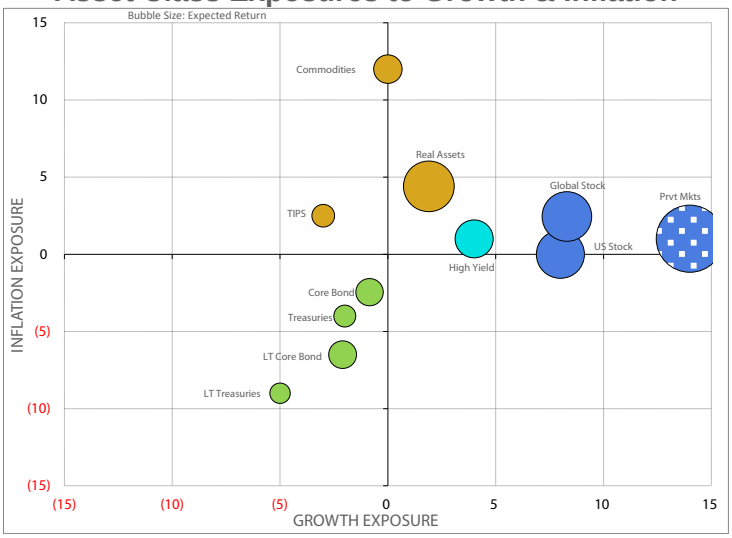
we presented a two-factor framework to assist in understanding the more predictable relationship between asset returns and the common economic factors of inflation and growth.[10]

In Exhibit 22 below, we present several of the major asset classes along these dimensions to provide a sense of the common factor exposures that contribute to either the stability or instability of correlation relationships. Assets with similar exposure to both factors are more likely to show stable relationships across market regimes, while those with common exposure to just one factor are likely to reveal correlation instability; with high correlations when returns are driven by the factor to which they share similar exposure and divergent returns in periods where the factor to which they have dissimilar exposures is driving returns. As discussed in the aforementioned research report, incorporating these factor exposures within an asset-liability study can assist in protecting against the unpredictability that is the consequence of unstable asset class correlations.

Exhibit 22
Asset Class Exposures to Growth & Inflation



Finally, and as is the case every year, we did make minor modifications to several risk and correlation assumptions primarily as the result of relative moves in sub-asset class component weights. We view these changes as minor and insignificant rather than indicative of a more meaningful shift in our view of asset class relationships.

A full listing of Wilshire's risk and diversification assumptions for all asset classes can be found in Appendix A.

[10] Wilshire Associates Incorporated (2014). *A Practical Approach to Factor-Based Asset Allocation*: Foresti, Rush, Walker.

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APPENDIX A: WILSHIRE DECEMBER 2017 CORRELATION MATRIX

	EQUITY						FIXED INCOME						REAL ASSETS					
													REAL ESTATE					
	US STOCK	DEV EX-US STOCK	EMG MRKT STOCK	GLOBAL EX-US STOCK	GLOBAL STOCK	PRIVATE EQUITY	CASH	CORE BOND	LT CORE BOND	US TIPS	HIGH YIELD	NON-US BOND (HDG)	US RES	GLOBAL RES	PRIVATE RE	CMDTY	REAL ASSETS	US CPI
EXPECTED COMPOUND RETURN (%)	6.25	6.25	6.25	6.45	6.45	8.75	1.75	3.55	3.60	2.95	4.95	1.30	5.40	5.60	6.90	3.70	6.60	1.95
EXPECTED ARITHMETIC RETURN (%)	7.55	7.70	9.20	8.05	7.80	12.10	1.75	3.70	4.05	3.10	5.40	1.35	6.75	6.75	7.80	4.75	6.95	1.95
EXPECTED RISK (%)	17.00	18.00	26.00	18.75	17.15	28.00	1.25	5.15	9.85	6.00	10.00	3.50	17.00	15.80	14.00	15.00	8.40	1.75
CASH YIELD (%)	2.00	3.00	2.00	2.75	2.35	0.00	1.75	3.55	4.75	3.05	8.15	1.65	3.95	3.95	2.65	1.75	2.85	0.00
CORRELATIONS																		
US STOCK	1.00																	
DEV EX-US STOCK (USD)	0.81	1.00																
EMERGING MARKET STOCK	0.74	0.74	1.00															
GLOBAL EX-US STOCK	0.83	0.96	0.86	1.00														
GLOBAL STOCK	0.94	0.92	0.82	0.94	1.00													
PRIVATE EQUITY	0.74	0.64	0.62	0.67	0.74	1.00												
CASH EQUIVALENTS	-0.05	-0.09	-0.05	-0.08	-0.07	0.00	1.00											
CORE BOND	0.28	0.13	0.00	0.09	0.20	0.31	0.19	1.00										
LT CORE BOND	0.31	0.16	0.01	0.12	0.23	0.32	0.11	0.93	1.00									
US TIPS	-0.05	0.00	0.15	0.05	0.00	-0.03	0.20	0.60	0.47	1.00								
HIGH YIELD BOND	0.54	0.39	0.49	0.45	0.51	0.34	-0.10	0.25	0.32	0.05	1.00							
NON-US BOND (HDG)	0.16	0.25	-0.01	0.18	0.18	0.26	0.10	0.67	0.64	0.39	0.26	1.00						
US RE SECURITIES	0.59	0.47	0.44	0.49	0.56	0.50	-0.05	0.17	0.23	0.10	0.56	0.05	1.00					
GLOBAL RE SECURITIES	0.65	0.59	0.56	0.62	0.66	0.58	-0.05	0.17	0.22	0.11	0.62	0.03	0.94	1.00				
PRIVATE REAL ESTATE	0.54	0.44	0.44	0.47	0.52	0.51	-0.05	0.19	0.25	0.09	0.57	0.05	0.77	0.76	1.00			
COMMODITIES	0.25	0.34	0.39	0.38	0.32	0.27	0.00	-0.02	-0.02	0.25	0.29	-0.10	0.25	0.28	0.25	1.00		
REAL ASSET BASKET	0.42	0.43	0.50	0.48	0.47	0.43	0.01	0.24	0.25	0.41	0.53	0.06	0.65	0.69	0.69	0.59	1.00	
INFLATION (CPI)	-0.10	-0.15	-0.13	-0.15	-0.13	-0.10	0.10	-0.12	-0.12	0.15	-0.08	-0.08	0.05	0.03	0.05	0.44	0.26	1.00

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APPENDIX B: WILSHIRE DECEMBER 2017 ALTERNATIVE INVESTMENT ASSUMPTIONS

	BASKET WEIGHT	EXPECTED RETURN (%)	EXPECTED RISK (%)
PRIVATE EQUITY			
BUYOUTS	50%	7.30	30.00
VENTURE CAPITAL	20%	8.80	44.00
DISTRESSED DEBT	5%	6.95	20.00
MEZZANINE DEBT	5%	6.70	20.00
NON-US BUYOUTS	20%	7.30	32.00
PRIVATE EQUITY BASKET		8.75	28.00
PRIVATE REAL ESTATE			
CORE	70%	5.65	12.00
VALUE ADDED	15%	8.65	17.50
OPPORTUNISITC	15%	9.65	25.00
PRIVATE REAL ESTATE BASKET		6.90	14.00
PUBLIC REAL ASSETS			
GLOBAL REAL ESTATE	15%	5.60	15.80
U.S. TIPS	50%	2.95	6.00
COMMODITIES	20%	3.70	15.00
MLPs	15%	9.60	17.00
PUBLIC REAL ASSETS BASKET		4.90	7.40
PRIVATE REAL ASSETS			
PRIVATE REAL ESTATE	35%	6.90	14.00
TIMBER	35%	6.95	15.00
OIL & GAS	30%	9.35	16.25
PRIVATE REAL ASSETS BASKET		8.15	10.90
HEDGE FUNDS			
EQUITY MARKET NEUTR	10%	3.85	4.50
EVENT DRIVEN	25%	5.55	7.00
EQUITY LONG/SHORT	35%	6.10	9.75
GLOBAL MACRO	5%	5.80	6.75
RELATIVE VALUE	25%	4.85	5.75
HEDGE FUND BASKET		5.50	6.60

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APPENDIX C: HISTORICAL 1, 5 & 10-YEAR ROLLING RETURNS (1926 TO 2017)

1-Year Returns

YEAR	S&P 500 INDEX	BOND INDEX	T-BILLS	CPI	YEAR	S&P 500 INDEX	BOND INDEX	T-BILLS	CPI
1926	11.6	7.4	3.3	-1.5	1972	19.0	7.3	3.8	3.5
1927	37.5	7.4	3.1	-2.1	1973	-14.8	2.3	6.9	8.7
1928	43.6	2.8	3.5	-1.0	1974	-26.4	0.2	8.2	12.4
1929	-8.4	3.3	4.7	0.2	1975	37.2	12.3	5.8	7.0
1930	-24.9	8.0	2.4	-6.0	1976	24.1	15.6	5.0	4.9
1931	-43.4	-1.9	1.1	-9.5	1977	-7.3	3.0	5.4	6.7
1932	-8.2	10.8	1.0	-10.3	1978	6.4	1.4	7.5	9.0
1933	54.0	10.4	0.3	0.5	1979	18.5	1.9	10.3	13.3
1934	-1.4	13.8	0.2	2.0	1980	32.2	2.7	11.8	12.5
1935	47.7	9.6	0.1	3.0	1981	-4.9	6.3	14.5	8.9
1936	33.9	6.7	0.2	1.2	1982	21.1	32.6	11.1	3.8
1937	-35.0	2.8	0.3	3.1	1983	22.4	8.4	8.8	3.8
1938	31.1	6.1	0.0	-2.8	1984	6.1	15.2	9.9	4.0
1939	-0.4	4.0	0.0	-0.5	1985	32.1	22.1	7.7	3.8
1940	-9.8	3.4	0.0	1.0	1986	18.6	15.3	6.1	1.1
1941	-11.6	2.7	0.0	9.7	1987	5.2	2.8	5.4	4.4
1942	20.4	2.6	0.3	9.3	1988	16.8	7.9	6.7	4.4
1943	25.9	2.8	0.4	3.2	1989	31.5	14.5	9.0	4.6
1944	19.7	4.7	0.3	2.1	1990	-3.2	9.0	8.3	6.1
1945	36.4	4.1	0.3	2.3	1991	30.6	16.0	6.4	3.1
1946	-8.1	1.7	0.4	18.2	1992	7.7	7.4	3.9	2.9
1947	5.7	-2.3	0.5	9.0	1993	10.0	9.8	3.2	2.8
1948	5.5	4.1	0.8	2.7	1994	1.3	-2.9	4.2	2.7
1949	18.8	3.3	1.1	-1.8	1995	37.5	18.5	6.1	2.5
1950	31.7	2.1	1.2	5.8	1996	23.1	3.6	5.4	3.3
1951	24.0	-2.7	1.5	5.9	1997	33.3	9.7	5.5	1.7
1952	18.4	3.5	1.7	0.9	1998	28.8	8.7	5.4	1.6
1953	-1.0	3.4	1.8	0.6	1999	21.0	-0.8	4.6	2.7
1954	52.6	5.4	0.9	-0.5	2000	-9.1	11.6	6.2	3.4
1955	31.6	0.5	1.6	0.4	2001	-11.9	8.4	4.4	1.6
1956	6.6	-6.8	2.5	2.9	2002	-22.1	10.3	1.8	2.4
1957	-10.8	8.7	3.2	3.0	2003	28.7	4.1	1.2	1.9
1958	43.4	-2.2	1.5	1.8	2004	10.9	4.3	1.3	3.3
1959	12.0	-1.0	3.0	1.5	2005	4.9	2.4	3.1	3.4
1960	0.5	9.1	2.7	1.5	2006	15.8	4.3	4.8	2.5
1961	26.9	4.8	2.1	0.7	2007	5.5	7.0	5.0	4.1
1962	-8.7	8.0	2.7	1.2	2008	-37.0	5.2	2.0	0.1
1963	22.8	2.2	3.1	1.7	2009	26.5	5.9	0.2	2.7
1964	16.5	4.8	3.5	1.2	2010	15.1	6.5	0.1	1.5
1965	12.5	-0.5	3.9	1.9	2011	2.1	7.8	0.1	3.0
1966	-10.1	0.2	4.8	3.4	2012	16.0	4.2	0.1	1.7
1967	24.0	-5.0	4.2	3.0	2013	32.4	-2.0	0.1	1.5
1968	11.1	2.6	5.2	4.7	2014	13.7	6.0	0.0	0.8
1969	-8.5	-8.1	6.6	6.1	2015	1.4	0.6	0.1	0.7
1970	4.0	18.4	6.5	5.5	2016	12.0	2.7	0.3	2.1
1971	14.3	11.0	4.4	3.4	2017	21.8	3.5	0.9	2.1
					Winning Percentage:	**64.1%**	**23.9%**	**12.0%**	

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5-Year Returns

YEAR	S&P 500 INDEX	BOND INDEX	T-BILLS	CPI	YEAR	S&P 500 INDEX	BOND INDEX	T-BILLS	CPI
1926-30	8.7	5.8	3.4	-2.1	1970-74	-2.4	7.6	6.0	6.6
1927-31	-5.1	3.9	3.0	-3.7	1971-75	3.2	6.5	5.8	6.9
1928-32	-12.5	4.5	2.5	-5.4	1972-76	4.9	7.4	5.9	7.2
1929-33	-11.2	6.0	1.9	-5.1	1973-77	-0.2	6.5	6.3	7.9
1930-34	-9.9	8.1	1.0	-4.8	1974-78	4.3	6.3	6.4	8.0
1931-35	3.1	8.4	0.5	-3.0	1975-79	14.8	6.7	6.8	8.1
1932-36	22.5	10.3	0.3	-0.8	1976-80	13.9	4.8	8.0	9.2
1933-37	14.3	8.6	0.2	2.0	1977-81	8.0	3.1	9.9	10.1
1934-38	10.7	7.8	0.1	1.3	1978-82	13.9	8.4	11.0	9.5
1935-39	10.9	5.8	0.1	0.8	1979-83	17.2	9.8	11.3	8.4
1936-40	0.5	4.6	0.1	0.4	1980-84	14.6	12.6	11.2	6.5
1937-41	-7.5	3.8	0.1	2.0	1981-85	14.6	16.5	10.4	4.8
1938-42	4.6	3.8	0.1	3.2	1982-86	19.7	18.4	8.7	3.3
1939-43	3.8	3.1	0.1	4.5	1983-87	16.4	12.5	7.6	3.4
1940-44	7.7	3.3	0.2	5.0	1984-88	15.4	12.4	7.1	3.5
1941-45	17.0	3.4	0.3	5.3	1985-89	20.4	12.3	7.0	3.7
1942-46	17.9	3.2	0.3	6.8	1986-90	13.2	9.8	7.1	4.1
1943-47	14.8	2.2	0.4	6.8	1987-91	15.4	9.9	7.1	4.5
1944-48	10.9	2.4	0.5	6.7	1988-92	15.9	10.9	6.8	4.2
1945-49	10.7	2.2	0.6	5.8	1989-93	14.5	11.3	6.1	3.9
1946-50	9.9	1.8	0.8	6.6	1990-94	8.7	7.7	5.2	3.5
1947-51	16.7	0.9	1.0	4.3	1991-95	16.6	9.5	4.8	2.8
1948-52	19.4	2.0	1.3	2.7	1992-96	15.2	7.0	4.6	2.8
1949-53	17.9	1.9	1.5	2.2	1993-97	20.2	7.5	4.9	2.6
1950-54	23.9	2.3	1.4	2.5	1994-98	24.1	7.3	5.3	2.4
1951-55	23.9	2.0	1.5	1.4	1995-99	28.6	7.7	5.4	2.4
1952-56	20.2	1.1	1.7	0.8	1996-00	18.3	6.5	5.4	2.5
1953-57	13.6	2.1	2.0	1.3	1997-01	10.7	7.4	5.2	2.2
1954-58	22.3	1.0	1.9	1.5	1998-02	-0.6	7.5	4.5	2.3
1955-59	15.0	-0.3	2.3	1.9	1999-03	-0.6	6.6	3.6	2.4
1956-60	8.9	1.4	2.6	2.1	2000-04	-2.3	7.7	3.0	2.5
1957-61	12.8	3.8	2.5	1.7	2001-05	0.5	5.9	2.4	2.5
1958-62	13.3	3.6	2.4	1.3	2002-06	6.2	5.1	2.4	2.7
1959-63	9.8	4.5	2.7	1.3	2003-07	12.8	4.4	3.1	3.0
1960-64	10.7	5.7	2.8	1.2	2004-08	-2.2	4.6	3.2	2.7
1961-65	13.2	3.8	3.1	1.3	2005-09	0.4	5.0	3.0	2.6
1962-66	5.7	2.9	3.6	1.9	2006-10	2.3	5.8	2.4	2.2
1963-67	12.4	0.3	3.9	2.2	2007-11	-0.3	6.5	1.5	2.3
1964-68	10.2	0.4	4.3	2.8	2008-12	1.7	5.9	0.5	1.8
1965-69	5.0	-2.2	4.9	3.8	2009-13	17.9	4.4	0.1	2.1
1966-70	3.4	1.2	5.4	4.5	2010-14	15.4	4.5	0.1	1.7
1967-71	8.4	3.3	5.4	4.5	2011-15	12.6	3.2	0.1	1.5
1968-72	7.5	5.8	5.3	4.6	2012-16	14.7	2.2	0.1	1.4
1969-73	2.0	5.8	5.6	5.4	2013-17	15.8	2.1	0.3	1.4
					Winning Percentage:	**71.6%**	**25.0%**	**3.4%**	

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10-Year Returns

YEAR	S&P 500 INDEX	BOND INDEX	T-BILLS	CPI	YEAR	S&P 500 INDEX	BOND INDEX	T-BILLS	CPI
1926-35	5.9	7.1	2.0	-2.6	1968-77	3.6	6.2	5.8	6.2
1927-36	7.8	7.0	1.7	-2.3	1969-78	3.2	6.1	6.0	6.7
1928-37	0.0	6.5	1.4	-1.8	1970-79	5.9	7.2	6.4	7.4
1929-38	-0.9	6.9	1.0	-2.0	1971-80	8.4	5.6	6.9	8.1
1930-39	-0.1	6.9	0.6	-2.0	1972-81	6.4	5.2	7.9	8.6
1931-40	1.8	6.5	0.3	-1.3	1973-82	6.6	7.4	8.6	8.7
1932-41	6.4	7.0	0.2	0.6	1974-83	10.6	8.1	8.8	8.2
1933-42	9.4	6.2	0.1	2.6	1975-84	14.7	9.6	9.0	7.3
1934-43	7.2	5.4	0.1	2.9	1976-85	14.2	10.5	9.2	7.0
1935-44	9.3	4.5	0.2	2.9	1977-86	13.7	10.5	9.3	6.6
1936-45	8.4	4.0	0.2	2.8	1978-87	15.2	10.4	9.3	6.4
1937-46	4.4	3.5	0.2	4.4	1979-88	16.3	11.1	9.2	5.9
1938-47	9.6	3.0	0.2	5.0	1980-89	17.5	12.4	9.1	5.1
1939-48	7.3	2.8	0.3	5.6	1981-90	13.9	13.1	8.7	4.5
1940-49	9.2	2.7	0.4	5.4	1982-91	17.5	14.1	7.9	3.9
1941-50	13.4	2.6	0.5	5.9	1983-92	16.2	11.7	7.2	3.8
1942-51	17.3	2.0	0.7	5.5	1984-93	14.9	11.9	6.6	3.7
1943-52	17.1	2.1	0.8	4.7	1985-94	14.4	10.0	6.1	3.6
1944-53	14.3	2.2	1.0	4.4	1986-95	14.9	9.6	5.9	3.5
1945-54	17.1	2.2	1.0	4.2	1987-96	15.3	8.5	5.8	3.7
1946-55	16.7	1.9	1.1	4.0	1988-97	18.0	9.2	5.9	3.4
1947-56	18.4	1.0	1.3	2.5	1989-98	19.2	9.3	5.7	3.1
1948-57	16.4	2.1	1.6	2.0	1990-99	18.2	7.7	5.3	2.9
1949-58	20.1	1.4	1.7	1.9	1991-00	17.5	8.0	5.1	2.7
1950-59	19.4	1.0	1.9	2.2	1992-01	12.9	7.2	4.9	2.5
1951-60	16.2	1.7	2.0	1.8	1993-02	9.3	7.5	4.7	2.5
1952-61	16.4	2.4	2.1	1.3	1994-03	11.1	6.9	4.5	2.4
1953-62	13.4	2.9	2.2	1.3	1995-04	12.1	7.7	4.2	2.4
1954-63	15.9	2.7	2.3	1.4	1996-05	9.1	6.2	3.9	2.5
1955-64	12.8	2.7	2.6	1.6	1997-06	8.4	6.2	3.8	2.4
1956-65	11.1	2.6	2.8	1.7	1998-07	5.9	6.0	3.8	2.7
1957-66	9.2	3.3	3.0	1.8	1999-08	-1.4	5.6	3.4	2.5
1958-67	12.9	1.9	3.1	1.8	2000-09	-1.0	6.3	3.0	2.5
1959-68	10.0	2.4	3.5	2.1	2001-10	1.4	5.8	2.4	2.3
1960-69	7.8	1.7	3.9	2.5	2002-11	2.9	5.8	2.0	2.5
1961-70	8.2	2.5	4.3	2.9	2003-12	7.1	5.2	1.8	2.4
1962-71	7.1	3.1	4.5	3.2	2004-13	7.4	4.5	1.7	2.4
1963-72	9.9	3.0	4.6	3.4	2005-14	7.7	4.7	1.5	2.1
1964-73	6.0	3.0	5.0	4.1	2006-15	7.3	4.5	1.2	1.9
1965-74	1.2	2.6	5.4	5.2	2007-16	6.9	4.3	0.8	1.8
1966-75	3.3	3.8	5.6	5.7	2008-17	8.5	4.0	0.4	1.6
1967-76	6.7	5.3	5.7	5.9					
					Winning Percentage:	**78.3%**	**16.9%**	**4.8%**	

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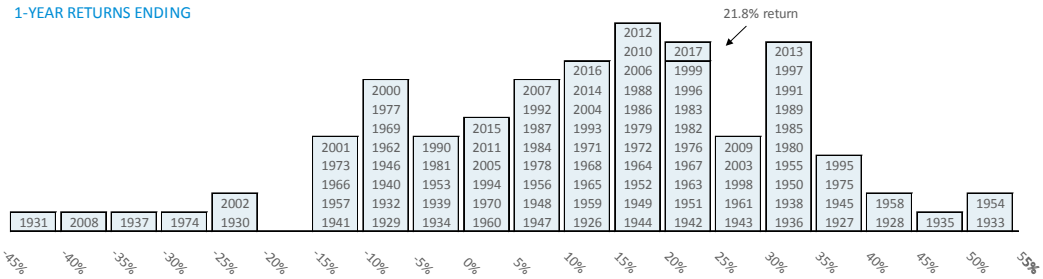
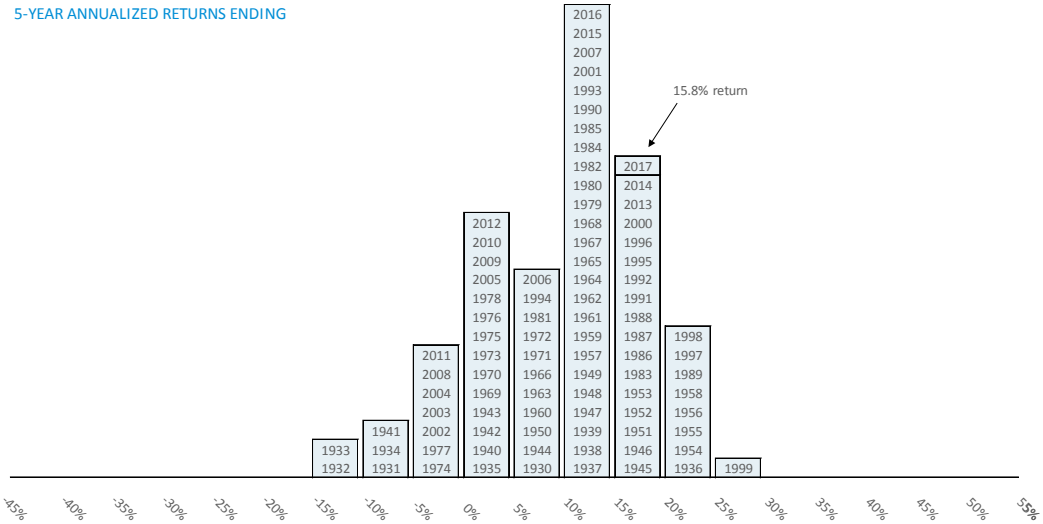
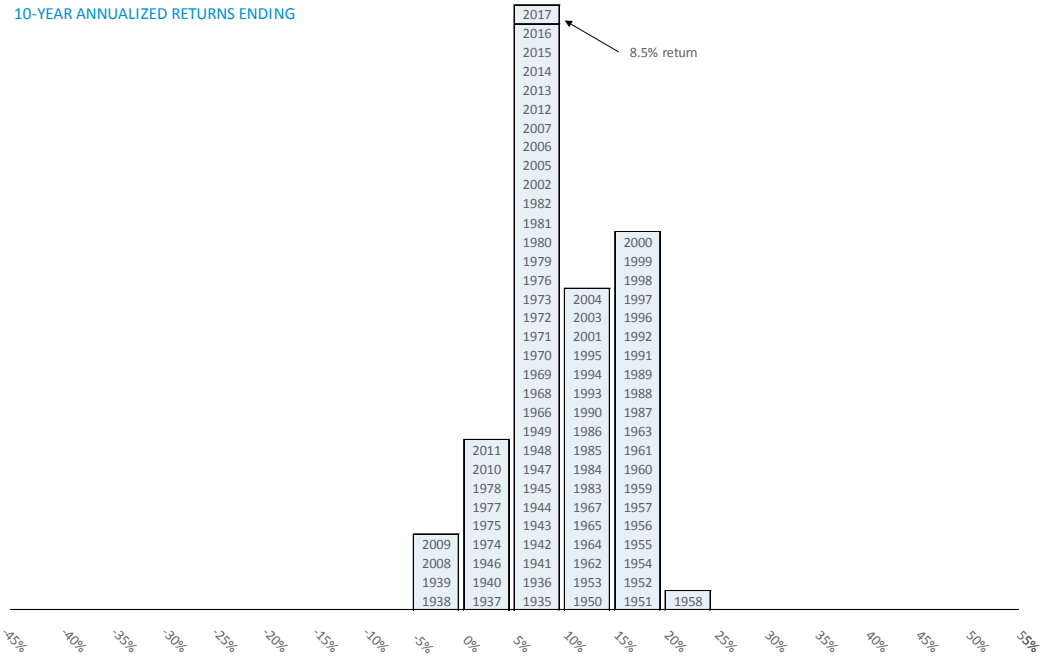
APPENDIX D: HISTOGRAM OF 1, 5 & 10-YEAR S&P 500 INDEX RETURNS







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