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Alternative Investment Analyst Review

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Editor's Letter

Past Performance Can Help You Create a Winning Private Fund Portfolio

Introduction

Since 2000, less than 7% of active mutual funds have outperfomed their benchmarks for three years in a row and only a handful have shown outperformance over four years or longer. It does not seem to be a fruitful exercise to spend resources to identify mutual funds that could produce alpha. How about private funds that operate in the alternative assets space? Does it make sense for asset allocators to spend resources to identify potential top performers? Is there performance persistence among private funds, and can this persistence be used to create a winning portfolio?

Given the heterogeneity of alternative assets, it turns out that persistence of performance is not a characteristic shared by all funds in all strategies. Some display as little persistence as mutual funds while some show remarkable persistence over several years. It is important to point out that the analysis presented here along with a review of currently available academic studies show that performance persistence is rarely permanent. Even in the best cases, the persistence disappears after about five years. The lesson is that asset allocators must remain vigilant and ready to move on from underperforming managers as studies have shown that the persistence is present among poor performing funds as well. It is important to note that almost all academic studies that examine performance persistence rely only on past performance to identify managers that are likely to outperform their peers in the future. Consequently, asset allocators who have access to additional information about private funds should be able to do much better by identifying managers who are most likely to outperform their peers over longer periods of time.

As mentioned above, there is strong evidence that persistence is found among top and bottom performing managers. However, firing underperforming managers poses several challengers. There are both direct and indirect costs associated with firing a manager. The investor is likely to lose future access to the fired manager. Lockups may prevent the investor from firing the manager, which means selling a position in the secondary markets might be the only option. In this case, there are likely to be losses associated with the sale. Next, the withdrawn capital must be reallocated to a new manager, which will result in a costly due diligence process. Also, the investor may not be able to find a suitable manager right away, and therefore the capital remains idle. Still, there are significant benefits in withdrawing funds from a poor performing manager. There are substantial differences between the average performance of top quartile managers and bottom quartile managers. In the case of hedge funds, the difference could be around 500-600 basis points annually, while it is about twice as large for private equity and venture capital funds.

Hedge Funds

The analysis here is based on the CISDM-Morningstar[1] hedge fund database. To minimize the impact of survivorship bias, both live and dead funds have been used. One can measure performance persistence using several different methods. For instance, we can examine raw returns and count the number of funds that outperform the median return in 2, 3, 4, etc. consecutive periods. Alternatively, we can use some measure of risk adjusted returns to do the ranking. To keep matters simple, we will use the raw returns. Next, we need to determine if the number of funds that display persistence is not just driven by noise and that the results are significant. A variety of methods can be used to measure the statistical significance of persistence. We use a combination of cross product ratio and rank correlation to measure the significance.

Exhibit 1 shows the percentage of hedge funds that displayed significant persistence between 1996 and 2013. The sample size changes throughout the study with the average size being close to 3000. Note that persistence here covers both "winners" who end up being winners in the subsequent periods as well "losers" who end up being losers in subsequent periods. For example, close to 43% of those funds which performed better or worse than the median performed better or worse than the median in the next month. We can see that as we move to 36 months in the future, the percentage of funds displaying persistence declines significantly. By the way, more than 60% of persistence cases are due to those funds that perform poorly. In short, the sample of funds that consistently perform well is rather small. More importantly, persistence almost disappears after 36 months, which means that investors who want to take advantage of this property must be willing to turnover a significant portion of their hedge fund portfolio every 3-4 years. Another important point to remember is that the degree of persistence among funds of funds is roughly the same as that of hedge funds.

The above results do not appear to be very promising. However, as we show below, skilled managers' past performance appears to be a strong indicator of future performance once we control for strategy differences. That is, a skilled convertible fund manager is more likely to outperform its peers more frequently and consistently.

Exhibit 2 displays the results for several strategies. The first observation is that a higher percentage of funds display performance persistence. Second, the degree of persistence does not decline as rapidly as the one observed when all hedge funds were lumped together.

We can see that a few strategies display strong persistence and minimal drop off at different time horizons. For example, close to 40% of merger arbitrage managers display strong persistence for at least 36 months. The same applies to multi-strategy where about

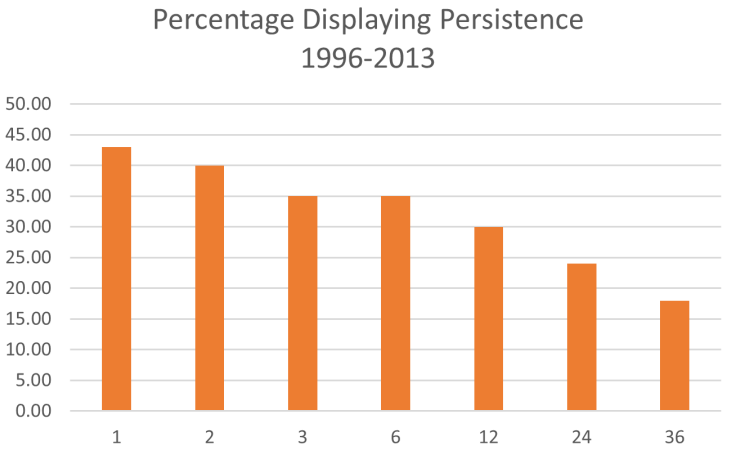

Exhibit 1: Percentage of hedge funds that display performance persistence.
Source: CISDM

30% of funds display strong persistence. On the other hand, some strategies display strong performance only at short horizons. Other studies have shown that fund managers that have a distinct approach to a given strategy are more likely to display persistence. For instance, a convertible arbitrage manager who employs a unique implementation of this strategy is more likely to display persistence – good or bad.

The lesson here is that asset allocators can create a portfolio of managers with great potential to outperform their peers, but they may have to give up the idea of having a diversified portfolio of hedge fund strategies unless they are willing and able to turn over a meaningful portion of their portfolio every 18-24 months, a rather impractical strategy. Those investors who are willing to accept a hedge portfolio that is not fully diversified among various strategies will have a better chance of creating a winning portfolio.

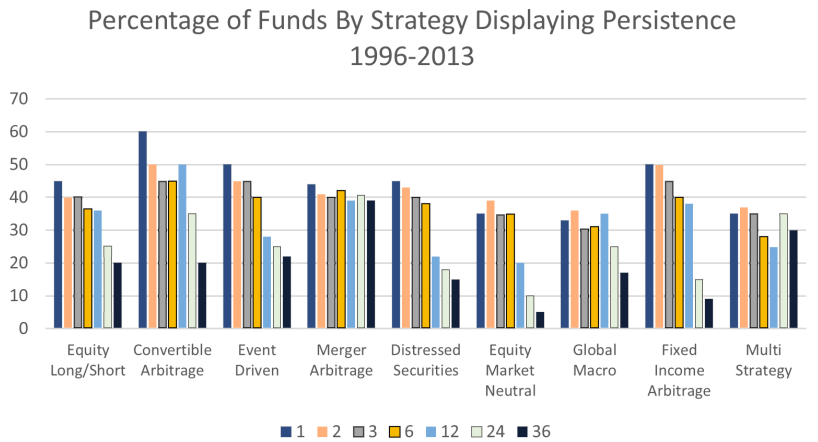

Exhibit 2: Percentage of Funds that Display Performance Persistence by Strategy.
Source: CIDM

Private Equity (PE), Buyout (BO), and Venture Capital (VC) Funds

A number of studies have examined performance persistence among PE, BO and VC funds. Since data is not as widely available in this area and funds may use different methods to report their performance, the issue of performance persistence is less settled in this area. Unlike hedge funds where one examines the performance persistence of a fund at various time horizons, for PE, VC and BO funds we must limit ourselves to follow-on funds. In addition, in order avoid any bias related to interim reported returns we must wait until a fund is liquidated to use the return realized by investors. This means that the most recent year that one can study is likely to be several years ago.

First, let's us consider the probability that a follow-on fund will be in the top quartile conditioned on the performance of the first fund. Exhibit 3 displays these conditional probabilities for BO funds. We can see, for instance, that there is about 37% chance that the first follow-on (FO1) of a BO fund that its previous fund was in top quartile will be in the first quartile as well. However, the probability that its second follow-on fund of the same buyout fund will end up in the top quartile is just above 20%. Interestingly, the second follow-on funds of BO funds that were not initially in the top quartile are more likely to end up in the top quartile. Clearly, there is some degree of mean-reversion at work here. The lesson from these results is that investors should strongly consider investing in the first follow-on funds of successful buyout funds. However, second and third follow-on funds should stand on their own, and historical performance of the GP is not a strong indicator of future performance.

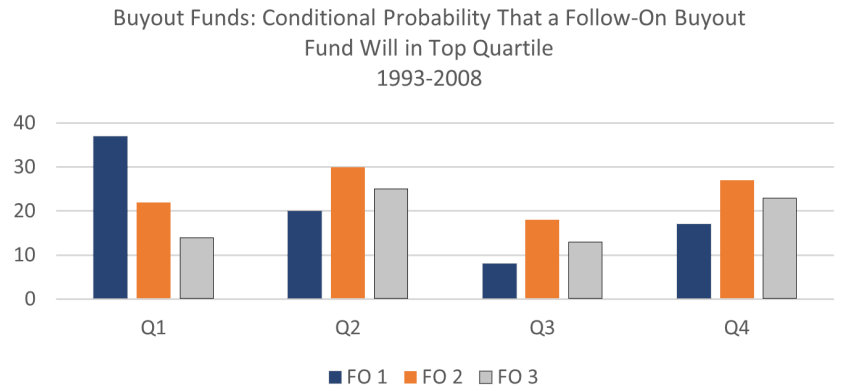

Exhibit 3: Percentage of Funds that Display Performance Persistence by Strategy.
Source: CIDM

The results for VC funds are presented in Exhibit 4. Unlike BO funds, there appears to be significant persistence among VC funds. For top quartile funds, first, second and even third follow-on funds have a good chance (30-35 percentage) of ending up in the top quartile. On the other hand, as far as VC funds are concerned, follow-on funds of bottom half require extra care and due diligence.

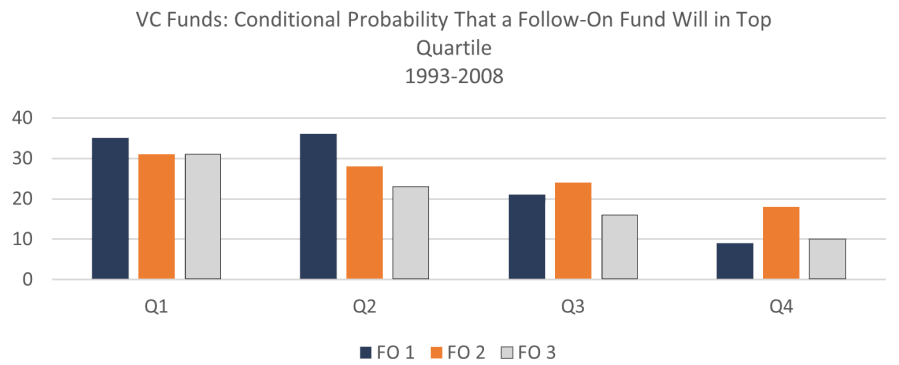

Exhibit 4: Conditional Probability for Follow-on Buyout Funds to Appear in the Top Quartile.
Source: Preqin[2] & J.W. Chung[3]

Studies of PE funds' performance can vary depending on the time period and the data source. For example, a recent paper by Harris et al, examines the performance persistence for follow-on funds for two periods – pre-2001 and post-2001. They show that since 2001 BO funds have not displayed any performance persistence. On the other hand, as shown in Exhibit 5, strong performance persistence continues to exist among VC funds. For instance, we can see that there is 48% of the first follow-on funds of top quartile VC funds have ended up being in the top quartile.

	First Follow-On VC Fund Post 2001			
	Q1	Q2	Q3	Q4
Q1	48%	20%	26%	6%
Q2	24%	43%	12%	22%
Q3	17%	23%	42%	19%
Q4	23%	14%	34%	29%

Exhibit 5: Post 2001 Conditional Probability for the First Follow-on VC Fund to Appear in the Top Quartile
Source: Harris et al[4]

As several studies have shown, the first follow-on funds of top performing VC funds have about 50% chance of landing in the top quartile. Also, we see that the follow-on funds of second quartile funds are most likely to land in the second quartile, still above average.

Private Real Estate

There are far fewer studies regarding performance persistence among private real estate funds. Also, similar to PE, VC and BO funds, one can only measure performance persistence by examining the follow-on funds. Exhibit 6 displays information about the importance of prior performance for private real estate funds.

	First Follow-On Fund			
	Q1	Q2	Q3	Q4
Q1	34%	23%	27%	16%
Q2	25%	36%	24%	15%
Q3	16%	29%	26%	28%
Q4	16%	22%	20%	42%

Exhibit 6: The Conditional Probability of a Follow-On Fund to Appear in Quartiles
Source: Preqin

According to Exhibit 6, there is 34% chance that the first follow-on fund of a top quartile manager to land in the top quartile. The same probability drops to just 16% for a bottom quartile fund. In other words, past performance of private real estate funds will matter and can be used to identify funds that are more likely to outperform their peers. Performance persistence is present among both US and non-US private equity real estate funds. However, the evidence is weaker for non-US funds. Also, depending on how outperformance is measured, the degree of persistence could change. In particular, persistence is much stronger if one defines winners as those funds that had above median performance. On the other hand, if winners are defined as those funds that were in the top quartile, then persistence is weaker.

Conclusion

Past performance is an important indicator of future performance among certain private fund strategies. In case of hedge funds, the persistence becomes weaker as one looks at performance 3-4 years out, and while past performance seems to be a good indicator of the potential relative performance of the first follow-on fund for private equity funds, the rankings of subsequent funds appear to be entirely random.

Using past performance as the only guide for selecting managers is, of course, not a wise strategy. However, ignoring past performance is equally unwise. A number of studies have examined characteristics of funds that display strong persistence. In case of hedge funds, we observe the strongest persistence among smaller and younger funds and those funds that are not strongly correlated with their peers. Also, hedge funds that have performed relatively well during periods of increased market stress, tend to perform well when markets recover, and their outperformance appears to persist. It seems that funds with strong risk management and control systems are more likely to repeat as winners.

Among private equity funds, larger funds tend to display stronger performance persistence when it comes to their first follow-on funds. The advantage disappears with subsequent funds. In addition, private equity funds with industry focus tend to display stronger performance persistence if the first follow-on fund focuses on the same industry.

Endnotes

1. CISDM is a research center association with Isenberg School of Management, University of Massachusetts, Amherst.

2. https://www.preqin.com/

3. Chung, Ji-Woong, Performance Persistence in Private Equity Funds (March 1, 2012). Available at SSRN: https://ssrn.com/abstract=1686112 or http://dx.doi.org/10.2139/ssrn.1686112

4. Harris, Robert S. and Jenkinson, Tim and Kaplan, Steven N. and Stucke, Rüdiger, Has Persistence Persisted in Private Equity? Evidence from Buyout and Venture Capital Funds (February 28, 2014). Darden Business School Working Paper No. 2304808; Fama-Miller Working Paper. Available at SSRN: https://ssrn.com/abstract=2304808 or http://dx.doi.org/10.2139/ssrn.2304808

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Investing Like the Harvard and Yale Endowment Funds

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Introduction

The US University Endowment Funds ("US Endowment Funds"), such as Harvard and Yale, have been leaders in diversified multi-asset class investing for over two decades. Through this approach to investing and with a large exposure to alternative asset classes, they have consistently achieved attractive annual returns with moderate risk. This paper explores whether investors can benefit by applying these investment principles to their own portfolios.

The rationale for investing across multiple asset classes is supported by Modern Portfolio Theory. This theory, developed by Nobel Prize winner Harry Markowitz, demonstrates that the risk-adjusted returns of a portfolio can be improved by diversification across assets with varied correlations. Modern Portfolio Theory is at the heart of the investment philosophy of the Harvard and Yale University Endowment Funds, and is the foundation upon which their portfolios are constructed.

In their seminal study into the importance of asset allocation, Brinson, Hood & Beebower (1986)[1] and Ibbotson et al. (2000)[2] determined that the vast majority of the variability of a portfolio's returns emanated from the long-term or strategic asset allocation of the portfolio (Table 1). Therefore, an investor constructing an indexed portfolio with a similar asset allocation to the top performing Endowments should, in theory, achieve similar return/risk characteristics to these successful investors.

The US Endowment Funds are exceptionally well resourced and have access to the best fund managers and private equity programs, which contributes significantly to their investment success. However, in this paper we demonstrate that by adopting similar asset allocation principles, it is possible for smaller investors to obtain high levels of risk-adjusted returns for their own portfolios; superior to that of traditional equity/ bond portfolios and to most balanced investment funds.

Research	Brinson (1986)	Brinson (1991)	Ibbotson (1999)	Ibbotson (2000)
Percentage	94%	92%	81%	88%
Active Return	-1.1%	-0.1%	-0.3%	-0.4%

Table 1: Percentage of Return Explained by Asset Allocation[1,2]

	Alternative Allocation (%)	10 Year Return (A)	15 Year Return (A)	20 Year Return (A)
Global Equity/Bond Portfolio (60:40)	0%	4.9%	5.3%	6.0%
Average US Endowment Fund (NACUBO)	30%	5.0%	5.2%	6.8%
Endowment Funds > $1bn	39%	5.7%	6.5%	7.8%
Endowment Funds Top 5	44%	6.9%	8.8%	11.2%
Super Endowments (Harvard/Yale)	45%	6.9%	9.2%	11.5%

Table 2: US Endowment Funds relative to a Traditional Portfolio (to June 2016)[5,6,7]

Overview

University Endowment funds are non-taxable vehicles established to contribute towards the future funding requirements of colleges and universities. Their funding comes from a combination of legacies, gifts and investment returns. They employ an investment philosophy focused around diversification whilst taking advantage of a long term investment time horizon which allows them to invest a portion of capital in less liquid assets whilst also being tolerant of market volatility. This in turn ensures the pursuit of long term investment objectives as opposed to reacting to shorter term market movements.

In the US in 2016, there were 805 Endowments which represented $515 billion in combined endowment assets; the largest fund being Harvard University with $35.7 billion under management.[3]

Oxford and Cambridge[4]

In the UK, University Endowment funds are smaller in size. The Cambridge and Oxford University Endowment funds manage approximately £2.5 billion. Similar to the US endowment funds, the two UK endowment funds have a broad asset allocation which does not change by a large amount each year. However, Cambridge and Oxford have an allocation to equities of approximately 70% in contrast to an average allocation of approximately 50% to equities (public and private) for most US Endowment Funds.

Why study the US Endowment Funds

Examining the strategies of the US Endowment Funds is of relevance to investors for the following reasons:

- US Endowment Funds have consistently achieved superior investment returns. This is especially the case for the "Super Endowments" of Harvard and Yale. They have achieved an average 20 year annualised return of 11.5 per cent, 5.4 per cent greater than the returns of a traditional 60/40 global equity/ bond portfolio[5] (Table 2).
- US Endowment Funds have diverse portfolios with exposure to multiple asset classes including significant exposure to alternative asset classes. This emphasis on diversification provides inspiration for smaller investors looking to meet their own personal long-term investment objectives at a time when many investors are looking at ways to diversify from large bond holdings into alternative asset classes (Chart 1).
- US Endowment Funds typically have long-term investment horizons and stable, strategic asset allocations over time; asset allocations that rely less on market timing for generating returns with lower trading costs.

This paper will focus on US Endowment Funds, assessing their current asset allocation as well as the relationship between investment performance, fund size and relative allocations to alternative asset classes. Following this, we will evaluate the performance of a set of Endowment Index Portfolios, created by applying the average annual asset allocation of the five largest Endowment funds to a selection of indices. This will provide a robust means of assessing the merits of adopting an "endowment style" investment strategy as well as providing insight into the importance of strategic asset allocation as a driver of portfolio returns and risk.

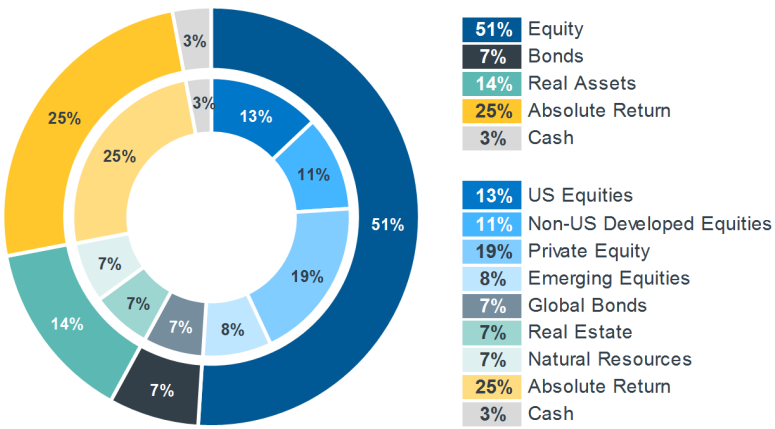


Chart 1: Asset Allocation of the top US Endowment Funds > $ 1billion 2016[6]

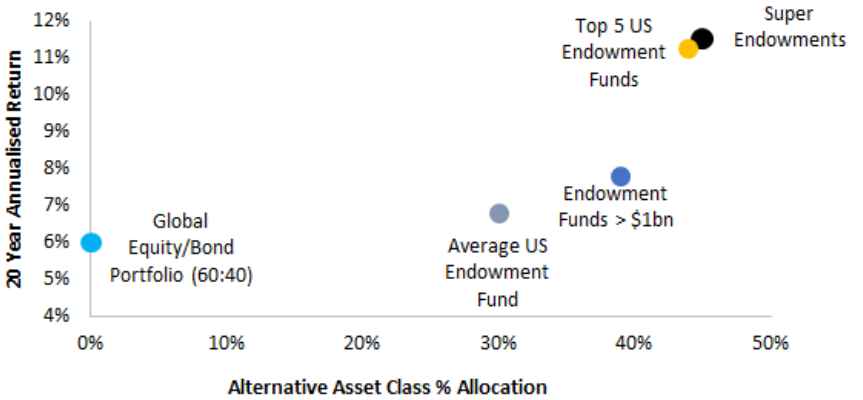


Chart 2: 20 Year Returns and Alternative % Allocations[3,5,6,7]

Endowment Asset Allocation

The average US endowment fund held roughly 70 per cent in traditional asset classes (public and private equity, bonds and cash) with the remaining 30 per cent invested in alternative assets. Comparatively, the Largest 20 Endowments and the Super Endowments (in reference to their size) of Harvard and Yale held 55 per cent in traditional asset classes with the remaining 45 per cent allocated to alternatives.[4] This additional diversification employed by the larger US Endowment Funds is one of the reasons for their superior long-term investment performance. In particular, the larger Endowments have sizeable allocations to alternative asset classes such as real estate, commodities, natural resources and absolute return strategies which can be seen to be positively correlated with long term performance (Chart 2).

The Top Five Endowments

Frontier places particular emphasis on the asset allocation methodology of the largest five endowment funds "Top Five Endowments" which include Harvard and Yale. These funds have consistently been five of the better performing US Endowments with annual returns placing them in the top 10 of over 800 US Endowments in a majority of years. For the 20 years to June 2016 the annualised returns for the Top Five was 11.2%, greater than the vast majority of their peers and those of a traditional portfolio at 6.0% (Table 3).

The Harvard Endowment Fund is the largest at $35.7 billion whilst the Yale Endowment Fund is the second largest at $25.4 billion and the Top Five account for $132 billion which represents 26% of the 805 Endowment funds' assets. These funds have been pioneers in multi-asset investing.

Like US Endowment Funds in general, the asset allocations of the Top Five Endowments has been very stable over-time, changing by an average of only 5% per year over the past fifteen years. A large part of this annual change is due to asset class price movements since the "target allocations" of these investors are stable, long-term and strategic.

These stable allocations reflect their long-term investment horizon and willingness to remain invested throughout economic cycles. They generally do not seek to tactically time the markets.

Index Investing Using the Asset Allocations of the Top Five Endowments

The superior returns, long-term investment horizons, and stable asset allocations of the Top 5 Funds make benchmarking to their asset allocations attractive. Academic research by Gary Brinson and Robert Ibbotson et al have confirmed that the strategic asset allocation of a portfolio is the dominant driver of both return and risk (Table 1).

In this paper, we create an Endowment Index Portfolio ("EIP") that applies the Top 5 asset allocation to a set of indices. This will allow us to determine whether a multi-asset portfolio is able to deliver superior risk- adjusted returns relative to that of a traditional portfolio. In addition, it will provide insight into the importance of strategic asset allocation and also the amount of "alpha" generated by the Top 5 Endowments. We also create a second endowment index portfolio that substitutes the Cambridge Associates Private Equity Index (non-investable) with an investable proxy index that offers investors daily liquidity, in line with the rest of the Endowment Index Portfolio.

	Harvard	Yale	Top 5 Endowments	60:40 Equity/Bond
Size ($ billion)	35.7	25.4	132.1	N/A
Annual Return 2015/16	-2.0%	3.4%	1.2%	0.8%
10 Yr Ann. Returns	7.6%	10.0%	6.9%	4.9%
15 Yr Ann. Returns	8.3%	10.2%	8.8%	5.3%
20 Yr Ann. Returns	11.8%	13.7%	11.2%	6.0%
Manager	Narv Narvekar	David Swenson	-	-
Investment Style	Multi-Asset	Multi-Asset	Multi-Asset	Equity/Bond

Table 3: Top Five Endowment Funds as at June 2016[5,6,7]

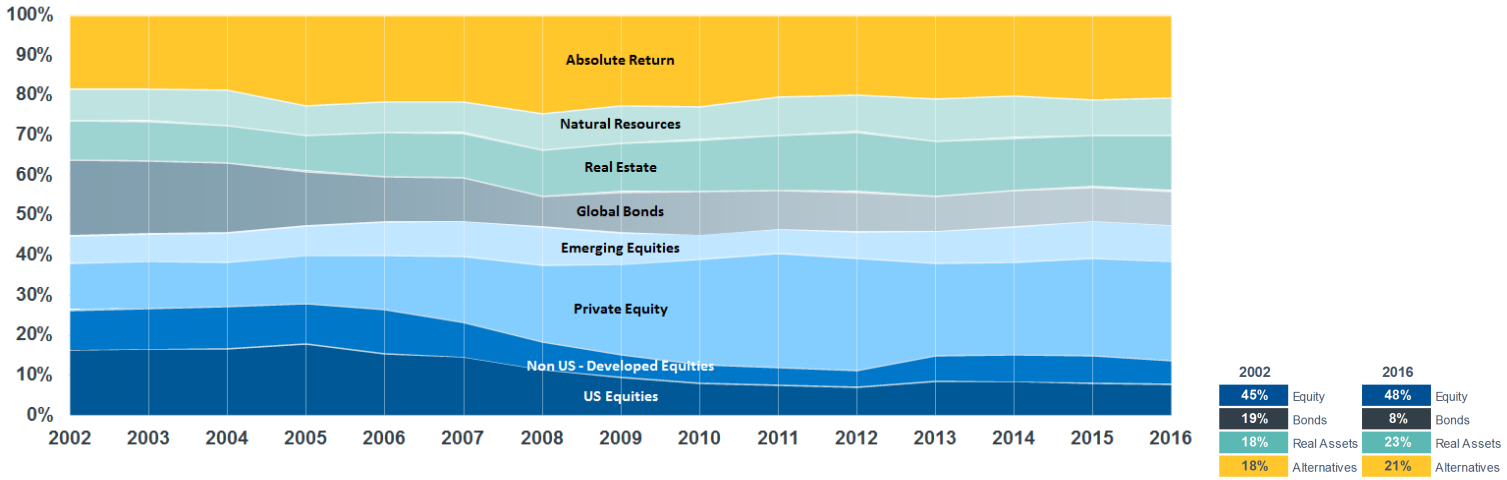


Chart 3: Top Five Endowments Asset Allocation over time[6]

Methodology

The first step was to take the average annual asset allocation of the five largest US Endowments funds at yearly intervals from July 1996 to June 2016. The only asset allocation adjustments made were to reallocate Cash so that the portfolio could be directly comparable to a fully invested portfolio. Further analysis of the underlying exposures allowed us to divide the Equity allocation into "US Domestic," "International," and "Emerging" components. A major benchmark index was selected to represent the returns from each asset class. (See Appendix A) For Private Equity we use the Cambridge Associates Private Equity Index and as a liquid Private Equity proxy, the LPX 50 Index. The asset allocation for 2016 is presented in Chart 4 and places 56 per cent of the portfolio in equity/bond asset classes with the remaining 44% allocated to alternative asset classes.

Portfolio returns were calculated by multiplying asset class weights by index returns in USD from July 1996 to June 2016 (20 years) and rebalanced annually every 30th June.

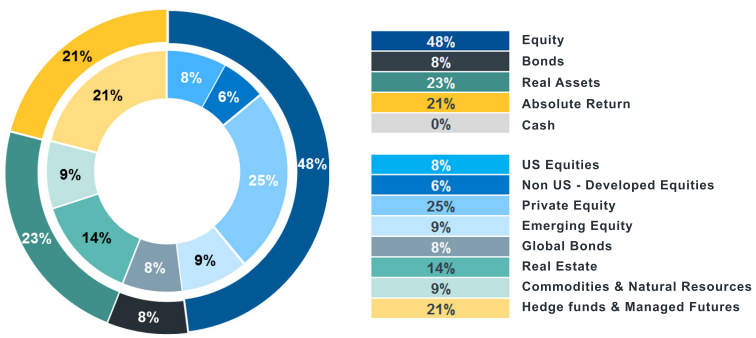


Chart 4: Endowment Index Portfolio 2016 Asset Allocation

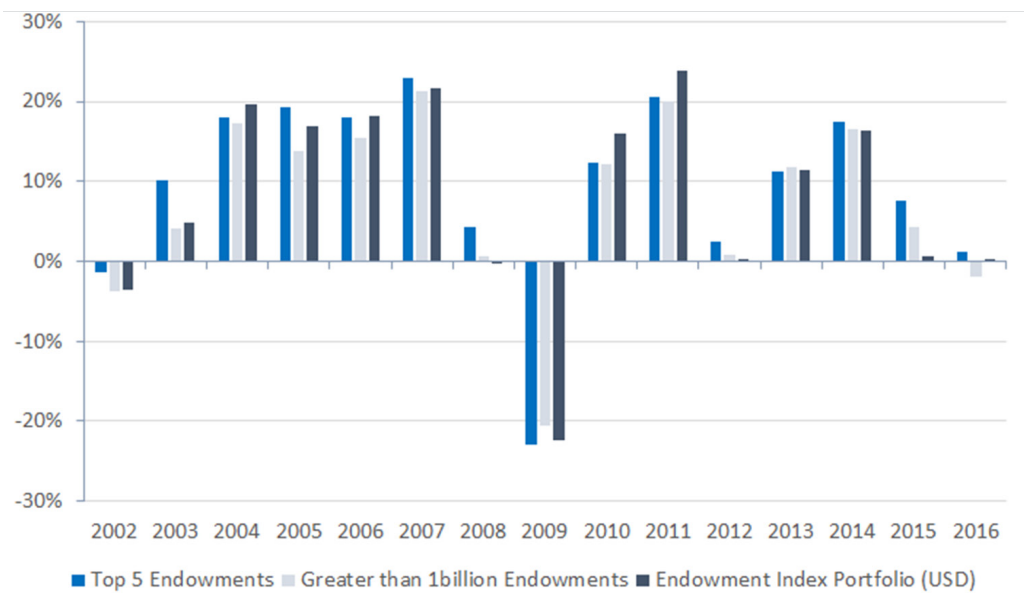


Chart 5: Top 5 vs Endowment Index Portfolios Fiscal Year Returns[6]

	15Y Return (Annual Data)	20Y Return (Annual Data)	20Y Volatility (Annual Data)	20Y Return / Volatility Ratio *	15/20 Yr. Avg EIP % of Return Captured
Top 5 US Endowment Funds by Assets	8.8%	11.2%	11.4%	1.0	
Top 5 US Endowment Funds by Assets (GBP)	9.7%	12.0%	12.5%	1.0	
Endowment Funds > $1bn (94 Institutions)	6.5%	7.8%	10.9%	0.7	
Average US Endowment Fund (805 Institutions)	5.2%	6.8%	10.1%	0.7	
Endowment Index Portfolio (USD)	**7.5%**	**8.4%**	**11.5%**	**0.7**	**81%**
Endowment Index Portfolio (Liquid Private Equity USD)	6.5%	7.3%	13.7%	0.5	69%
US Equities (S&P 500 TR)	5.8%	7.9%	17.0%	0.5	
Global Equity/Bond Portfolio (60:40)	5.3%	6.0%	9.5%	0.6	
Endowment Index Portfolio (GBP)	**8.3%**	**9.2%**	**12.1%**	**0.8**	
Endowment Index Portfolio (Liquid Private Equity GBP)	7.3%	8.1%	14.2%	0.6	
UK Equities (MSCI UK TR)	4.6%	6.2%	13.9%	0.4	
Global Equity/Bond Portfolio (60:40 GBP)	6.1%	6.9%	10.0%	0.7	
IA Mixed Investment 40-85% Shares Sector	4.5%	5.4%	9.9%	0.5	

Table 4: Relative Performance of Endowment Index Portfolio (July 2001 to June 2016)[3,5,6,7,8]

For comparison purposes, an Endowment Index Portfolio hedged into GBP was also calculated. All returns are shown gross of fees and access costs. The resulting performance of the Endowment Index Portfolio is shown in Table 4 above and the annual returns are shown in Chart 5.

The Endowment Index Portfolio ('EIP') generated a 20 year annualised return of 8.4% (9.2% hedged into GBP) since July 1996, relative to 6.0% for a Global Equity/Bond portfolio and 6.8% for the average Endowment Fund.

Comparatively, the EIP utilizing a liquid private equity proxy index generated an annualised return of 7.3% (8.1% hedged into GBP) with only slightly greater volatility, highlighting the attractive returns that can be still be obtained without sacrificing liquidity.

The Endowment Index Portfolio generated a 15 year annualized return of 7.5% which was less than the Top 5 Endowments but still captured 85% of their return with similar levels of volatility and substantially outperformed a traditional equity/bond portfolio which generated 5.3%.

Over the 20 year period and using annual return data, the EIP has a correlation of 94% to the Top 5 Endowment funds with an R squared of 88% indicating that the EIP is a good "fit" (T-Stat =2.13).

Out-performance versus Global Equity/Bond portfolios over long periods of time illustrates the benefits of a globally diversified asset allocation with significant allocations to alternative asset classes. Relative to an Equity/Bond portfolio, the Endowment Index Portfolio increased the 20 year annualized return by 38%. In addition, Equity/Bond portfolios have experienced a twenty year period of declining interest rates that have been a key driver of bond returns. Going forward, bonds have a low probability of generating these high historical returns.

While the EIP performance is not as strong as the Top 5, it still manages to capture 81% of their return thereby supporting Brinson/Ibbotson's et al findings that strategic asset allocation drives the majority of the variability of portfolio returns. It also confirms that the top performing and elite Endowment Funds generate alpha of 1.3% to 2.8% per year, which is consistent with other academic research on Endowments. (See Appendix B)

Summary

The Top 5 Endowment Funds have consistently achieved attractive investment returns with moderate volatility due to their multi-asset approach to investing, their strategic approach to asset allocation, and their significant exposure to alternative asset classes. Whilst the financial crisis of 2008 negatively impacted the performance of the US Endowment Funds, their long term investment strategy has prevailed to the extent that long term total and risk-adjusted returns remain superior to those of traditional portfolios.

Whilst most investors do not have access to the superior resources of the larger Endowment funds, this research note demonstrates that by applying their multi-asset principles to an investable index based portfolio, there is considerable scope for achieving risk-adjusted returns that have historically been superior to those of more traditional portfolios.

Appendix A

Benchmark Indices Used

Each asset class referred to in this note is represented by a relevant market index which is used to construct the Endowment Index Portfolio "EIP." All indices are total return. Asset class index returns used are gross and have not been adjusted for management fees and access costs.

Important Notes and Source Data

This material is for information purposes only and is not a solicitation for investment.

The contents of this document are based upon sources of information believed to be reliable. Frontier has taken reasonable care to ensure the information stated is factually true. However, Frontier makes no representation, guarantee or warranty that it is wholly accurate and complete.

The "Endowment Index Portfolio" is a hypothetical portfolio that has been created by Frontier to calculate the historical investment performance achieved over a twenty year period through applying the average annual asset allocations of the Top 5 Endowment

Asset Class	Benchmark
US Equities	S&P 500 TR Index
Non US - Developed Equities	MSCI EAFE TR Index
Private Equity - Illiquid	Cambridge Associates Private Equity Buyout Index
Private Equity - Liquid	LPX50 TU Index
Emerging Equities	MSCI Emerging Markets TR Index
Global Bonds	Barclays Global Aggregate Bond Index
Real Estate	DJ Global Select REIT TR Index
Natural Resources	S&P Global Natural Resources TR Index
Hedge Funds and Managed Futures	Credit Suisse Hedge Fund Index
Global Equities	MSCI World TR Index

Funds to a set of broad market indices (selected from Appendix A) with rebalancing on 30 June of each year, gross of all fees and expenses. The Endowment Index Portfolio does not constitute an investment vehicle available to purchase by an investor. Therefore, the performance presented does not represent the performance of a real portfolio and may be subject to biases making it an unreliable indicator of performance. Past performance is no guarantee of future results and no assurance can be provided that any portfolio described herein would yield favorable investment results in the future. These performance tables and results are hypothetical in nature and do not represent trading in actual accounts.

PAST PERFORMANCE IS NOT INDICATIVE OF FUTURE PERFORMANCE

Appendix B: Academic Research on Endowments

"Do (Some) University Endowments Earn Alpha?"

Barber, Brad M. and Wang, Guojun, *Financial Analysts Journal*, (May 7, 2013).

In this research paper, Barber and Wang aim to determine if the average Endowment fund earns an abnormal return (alpha) relative to standard benchmarks. Using a three and five factor model, they find that 95% and 99% respectively of the returns of the average Endowment can be explained by the performance of the underlying asset classes.

Some important quotes from the paper are below:

"The fact that the average allocations to asset classes explain the returns for top-performing and elite institutions provides insights into the mechanism used to generate the strong returns earned by these endowments. Specifically, these results suggest that manager selection and dynamic (or tactical) asset allocation do not generate alpha for top-performing and elite institutions. Rather, large strategic allocations to alternative investments explain much of the documented cross sectional variation in performance."

"In summary, the average endowment earns a mean return very close to average benchmark returns, and virtually all the time-series variation in endowment returns can be explained by these benchmark returns. Thus the average Endowment could easily match the returns earned on its investments by indexing."

"There is intriguing evidence of performance persistence. Elite institutions and top-performing endowments earn reliably positive alphas relative to simple public stock and bond benchmarks of about 1.7% to 3.8% per year." (driven by allocations to hedge funds and private equity)

This academic research is further evidence that indexing the asset allocation of top performing and elite endowment funds has merit. Part of Frontier's process involves examining the asset allocation of the top twenty Endowment funds but in particular, we look at the asset allocation of the top five endowments including Harvard and Yale.

Footnotes and References

1. Gary P. Brinson, L Randolph Hood and Gilbert l. Beebower, "Determinants of a Portfolio Performance", *The Financial Analysts Journal*, July/August 1986.

2. Roger G. Ibbotson and Paul D. Kaplan, "Does Asset Allocation Policy Explain 40%, 90% or 100% of Performance?", *The Financial Analysts Journal*, January/February 2000.

3. National Association of College and University Business Officers Report ("NACUBO") (2016).

4. Cambridge and Oxford University Annual reports 2015.

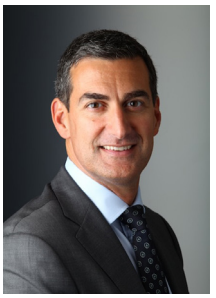
5. Equity/Bond Portfolio calculated by Frontier applies a 60% weighting to the MSCI World Total Return Index and a 40% weighting to the Barclays Global Aggregate Bond Index rebalanced annually 30th June. Portfolio is gross of fees.

6. US University Endowment Annual Reports.

7. 10, 15 and 20 year annualized returns for the Top 20 US Endowment Funds by Assets and the Top 5 Endowments are calculated by Frontier from multiple data sources including the annual report of each Endowment Fund. 15 Year annualized returns for the Average US Endowment Fund and Endowment Funds > $1bn is calculated by Frontier.

8. Bloomberg, Investment Association Monthly data.

Authors' Bios



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Michael Azlen has a total of 27 years experience spanning the entire spectrum of asset management including proprietary trading, hedge funds and multi asset investing. Michael founded Frontier Investment Management in London in 2004 growing the business to more than $700 million in AUM and successfully sold the firm in 2013. Michael now works with select clients to advise them on the creation and management of low cost "Endowment Style" multi asset portfolios.

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Offshore Property Investing - Thoughts on the Investment Process

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Frontier Advisors

Investment offshore is an established component of most Australian institutional investor portfolios, and has been for some time. However, investing in offshore direct property has not featured heavily due to the more challenging nature of this asset class.

In this article, we discuss some of the key aspects associated with investing in direct property overseas, along with a few of the more interesting and important structural differences between key offshore property markets and the Australian market.

The offshore property opportunity

Why broaden the property investment set?

A common misconception is that investors ought to receive a premium for investing globally. In fact, real estate fundamentals are universal and unaffected by borders. Like other financial instruments (e.g. bonds and equities), it is generally accepted that the benefit of international investing outweighs the risk associated with offshore markets. We believe this thesis also applies to real estate, with due consideration to tax and liquidity issues.

Frontier identifies four key reasons for extending a property portfolio configuration to include investment in international property markets. These are highlighted here.

A vastly expanded market size and opportunity set

Published estimates place the institutional global property market at in excess of US$25 trillion. This creates an enormous opportunity to strategically position property portfolios in accordance with desired objectives via the larger set of options in markets and sectors, and the wider set of skilled local investment managers.

Improved investment performance characteristics

Offshore property returns in the key core sectors are broadly comparable to domestic

core property returns, but subject to different cycles and influences, and hence can dampen the sometimes more volatile return profile in Australian direct property. It should be noted, however, that, globally, there is a far wider dispersion of returns compared to a pure domestic property portfolio. This divergence of return profiles between markets does, though, allow prudent investors to enhance portfolio performance over the longer term.

Diversification benefits

All real estate markets are reliant on the influences of local supply and demand factors (as well as that of the broader capital market) and, hence, return correlations are generally a lot less between offshore markets than they are within domestic markets. This creates significant scope to reduce the overall volatility of returns through a diversified portfolio.

Management of overall risk adjusted returns

Generally, real estate performance is correlated to the economic growth of the country and, over time, GDP growth should improve occupier demand and, in turn, drive higher rents. This is a key reason why country selection influences the ideal property portfolio configuration. There also needs to be a focus on how risky the separate markets are in isolation, and on how they interrelate. Higher returns are generally, but not always, associated with higher risks, and an optimised global property allocation can offer a higher return per unit of risk than that of any individual country.

Strategy and configuration areas of focus

Key areas of focus and assessment in developing a global property strategy and configuration include the following.

The availability and value of top-down and bottom-up research from local experts

Property markets operate in dynamic and cyclical environments, requiring regular research, meticulous monitoring and often revision of the decision-making systems and processes themselves. Better investment decisions offer the surest way to achieve higher investment returns while managing investment risks.

The relatively inefficient real estate marketplace is often described as the last bastion of entrepreneurship

Investors can alter the nature of investment returns and risks, by changing the nature of their involvement in real estate investment. The best investment managers make judicious use of available research, use appropriate tax shelter provisions, choose the best locations within markets, and manage assets in a highly professional and experienced manner, leading to consistent strong performance.

Consideration of the key risks

This can include: local market real estate fundamentals and specifics; economic environment driving tenant demand; leverage and the capital markets; the local legal system, including controls over highest and best use of land and constraints over supply levels; political issues impacting development and tenant demand; currency overlays and hedging; tax implications and efficient structures; liquidity driven by depth and size of markets; market transparency and knowledge of nuances; and the nature and structure of investment vehicles for accessing direct property.

A particular focus by global investors has been on the challenges associated with foreign tax regimes with respect to direct property. Investing globally is likely to mean that returns on real estate available to local investors are not always available to offshore investors, including Australian. Whilst investment vehicles can be structured to achieve efficient income and tax pass-through, this may not always be possible, particularly where investing via established pooled funds which may well have embedded sub-optimal tax structures.

The goal is to implement a tax efficient structure that allows the Australian investor to achieve their required after-tax return. Whilst an added complexity and risk, there are now examples currently of Australian funds investing offshore, both directly and in pooled vehicles, which provide an efficient after tax outcome.

Approaches of global institutional investors

Frontier has met with a number of major domestic and international, cross border property investors over the past 18 months to understand and compare the approach taken to ensuring the best decision outcomes for international/cross-border investing. The key offshore investors met with include: Ontario Teachers' Pension Plan; Caisse de Dépôt et Placement du Québec; Canada Pension Plan Investment Board; PGGM; Pensioenfonds ABP; and Blue Sky Group. Key take outs from the discussions (and with some of our major local investors) are as follows.

- The key commonality with these groups is that they are willing to commit the necessary resources, both people and financial, spending time in offshore property markets to ensure that decisions are made on the basis of being very informed and of a high conviction.
- One critical issue is the misconception that investors should require a premium for investing globally. Among the group of investors above, it is generally accepted the benefit of international investing outweighs the risk associated with offshore markets.
- Issues faced historically by global investors were similar to those experienced by Australian funds and their global property allocations, particularly those entered into at the height of the 2006/07 property market. These include the use of overly complex and expensive fund of fund structures, an excessive use of leverage, a lack of skilled local market operators, unacceptable fee leakage and poor market timing. They learnt that there is no requirement to behave differently than you would at home when building a sensible, domestic property core portfolio. The approach should be the same, just using the international opportunity set as the universe for investment.
- The pension funds met with all have the pre-condition of a formal analysis of real estate managers, which proceeds in a logical and rational fashion. Successful long-term investing involves the development of a clear investment strategy and deep analysis of investment opportunities, providing the necessary information with which to make

sound decisions. Completed investments are then closely monitored to provide feedback, allowing for correction in strategies where required and ensuring suitable future investment performance.

- Many of the international investors Frontier met with, and that Frontier has observed, view real estate investment as akin to buying a new business, with each property having a distinct set of physical, market, legal and financial characteristics. They see that a detailed and thorough understanding of this complex set of attributes, and how they translate into investment returns and risks, is far more likely to lead to successful long-term investment decisions. Moreover, they effectively and proactively manage the investment process.

Investment process fundamentals

The decision making framework

Analysing real estate investments involves a diverse group of interrelated activities such as market analysis, financial analysis, capital structure analysis, review of decision making and tax strategies. Ongoing investment decisions require an evaluation of the risk and return profile of the alternatives relative to an investor's strategy. In making decisions over a time horizon that includes both short and long-term considerations, short-term success is important in order to succeed over the long-term. Although the majority of decisions are generally "go" or "no go" investment choices, investing ought to focus on maximising the value of the overall portfolio.

To build out an offshore property portfolio as one portfolio, rather than as individual investments, decisions should be made on the basis of an overall real estate investment strategy. Investors must develop a strategy that defines the nature and measurement of the returns and risks that are acceptable to the investor. Each new investment that is made can then be evaluated in the light of its impact on the current portfolio, its relationship to other assets in the portfolio and the combined impacts to the overall investment plan.

Due diligence

Due diligence is about considering the elements of a proposed offshore property investment that will influence its future investment performance in an absolute and relative sense. Specifically, primary due diligence assesses the important aspects of a fund and its investment program, the investment manager that has oversight of the program and is representing the investor's interest, and also each of the key property specific, and portfolio specific, issues.

Determining an appropriate level of manager and market due diligence cannot be prescribed by formula; it is instead determined by the investment structure, property type and level of market knowledge of the individual conducting the process.

The due diligence process does not necessarily only involve a decision or a recommendation; rather, at a minimum, it confirms that requisite tasks have been performed, pertinent issues addressed and critical information has been identified and disclosed. It should also confirm that designated standards, including acquisition policies and criteria, as well as legal and regulatory guidelines, are being complied with and that the decision processes have been appropriately adhered to.

A comprehensive due diligence process involves consideration of issues at multiple levels: that of the investment manager, the fund or program; that of the actual professional managing the fund or program; and that of the particular or proposed properties that comprise the portfolio. The assessment of a particular investment fund or program will therefore normally consider and review seven critical elements.

1. Management.
2. Property quality.
3. Alignment and compensation.
4. Investment criteria.
5. Current and future portfolio composition.
6. Rights, responsibilities and decision-making processes.
7. Liquidity and exit strategies.

A comprehensive due diligence would normally necessitate a review and inspection of physical assets, or a representative cross section, and a review of geographical and locational attributes of the significant exposures. This due diligence validates that the manager's strategy is replicated by its actions, and the investment plan is consistent with the outcomes.

Other more property specific issues that should be considered, include: the local economy; supply demand balances; the property's competitive position within the respective markets; general condition of building improvements and building age; planned and needed capital expenditure; the nature of the lease tenure and credit worthiness of cash flows; taxation factors; historical investment performance; reasonableness of assumptions in the underlying financial analysis; validity of the cash flow modelling; physical environmental risks; regulatory compliance; and a review of the key senior management and decision making processes.

Beyond the physical attributes of the properties within the portfolio it is also important to gain an understanding of: the various neighbourhood and local sub-regional influences; market size; sources of demand; competitive market supply; aspects of financing and ownership structures; the tenant market; typical lease arrangements; typical property operations; typical approaches to management; historical financial performance; ESG; and local legal and planning issues.

Having an understanding of the above approach provides an understanding of the likely outcomes associated with an offshore property investment. In today's world, real estate due diligence is improved from decades past but the wide dispersion of rigour and professionalism remains. The current trend in institutional property investment noted above applies greater emphasis on assessing not only a managers' capabilities, adaptability and investor focus, but on asset selection and the merits or otherwise of markets, submarkets, sectors and subsectors.

Selecting markets to allocate to

International real estate investment has been growing substantially post the GFC, however it does present sizable

decision making, organisational and managerial challenges above and beyond the challenges involved at a local investment level. Many of these challenges are indeed inherent in the choice of real estate as an investment medium in any case, but they are accentuated for Australian investors by the time-distance gap, and the different socio-economic and cultural nuances associated with national and regional markets.

An additional time and cost commitment is required in the initial decision to examine the feasibility and opportunities of where to invest an international real estate commitment. Frontier believes the best approach is to look at country and local market variables, being conceived of as macro and micro issues. The macro issues conceptually relate to reducing systematic risks for portfolio allocation across particular international markets. By extension, international diversification should reduce portfolio systematic risk, especially if the portfolio was previously composed of assets principally with a home market bias. Micro issues are more orientated towards those factors that determine systematic risk.

Having developed a view of a limited number of macroeconomic or political variables and selecting some, somewhat arbitrary, performance cut-off benchmarks, a list of target country markets can be achieved. Having reduced the investment universe to anywhere from 10 to 30 regions, the urban market selection process begins, following a similar methodology but matched with greater emphasis on actual performance expectations.

In our view, the best international investment approach is to view the world as one large economic system, wherein major metropolitan areas constitute significant regional economies. National political changes and bureaucratic regulations are then simply different rules in the local game, which can be dealt with through appropriate tax and legal advice. Crucial to this process is the reliance on the best and most experienced local expertise available. The focus then becomes on fundamental analysis of the urban economy and the broader local real estate market trends.

The manager interface

Australian institutional investors should expect the organisations that advise, consult and represent them, and the managers that they invest through, to walk-the-talk of commitment to a prudent real estate investment process. This means adopting the appropriate strategic approach, combined with the prudent acquisition, operation and disposition of property investments. Given the heterogeneous nature of real estate, and the confidence and belief that many in the real estate industry possess, there is a need for the investor's advisor (as well as the investor) to fully understand the nature of the investment they are making and the similarities and differences between the numerous options and opportunities.

Without effective due diligence prior to an investment, no amount of strategic insight and/or operational/dispositional brilliance can overcome the debilitating risk associated with a marginal (or worse) property investment, or the consequences of overlooking a major weakness in the property, market, manager or investment structure. We should expect to have implicit trust in the manager and then we need complete assurance and confirmation that, everything that is supposed to be done, is in fact done. Trust is a necessary, but by no means a sufficient, precondition for institutional real estate investing. Finally, perspicuous substance must back up the absolute confidence of the manager-investor relationship.

Lessons from the GFC

A number of international property investments made prior to the GFC have subsequently performed poorly. This was primarily due to unprecedented and largely unanticipated market declines, however, the issue was exacerbated by some gaps in manager and market due diligence. Indeed, in many cases, self-promoting managers were successful in pitching their deal making capabilities as the primary assessment criteria relative to the traditional analysis criteria. This skew can lead to a lesser understanding of the proposed market's risk exposures and a reduced examination of the representations made by the manager.

As noted, Frontier's approach to property research and due diligence is that it is fundamentally a means to confirm whether an investor's expectations are likely to be achieved. The importance of this due diligence process is set out above, and the important flow on from the GFC on this issue is that investors require greater confidence that their expectations, on which they make their financial commitments, will be realised.

Therefore, an approach to market, manager and property investigation centred on increasing the likelihood that realised results will be consistent with expectations is critical. Future shortfalls should not be attributable to a lack of insight and understanding of the initial investment case and parameters. Post GFC, Frontier has implemented a "deep-dive" due diligence approach that we believe is a crucial part of the investment process, irrespective of the investment strategy being pursued. Our approach seeks to minimise reasons for underperformance, reasons that should be discovered through a professional, careful and thorough assessment prior to the decision being made to go forward with the investment.

Implementing due diligence

The greater the degree to which an investors' investment policies, strategy, portfolio composition and property investment criteria are clearly articulated, the better the implementation of the research and due diligence. For research not in the context of a particular investment, the due diligence assessment necessarily needs to be more general than precise. However, the greater the granularity of objectives for a portfolio's configuration, the more precise the investment investigation should be, with the depth and parameters expressly articulated.

The practicalities of completing an offshore direct property due diligence requires strong cooperation between the various parties to the idea proposed, including direct access to senior management within the investment management community, access to a large and diverse collection of researched documentation, and physical access to properties and markets, in addition to significant pre-planning and preparation to identify what information is needed, in what format and during what time frame.

In conclusion, it is worth noting that the comprehensiveness of research, due diligence and investigation required for offshore direct property investment is still evolving; there is no standard imposed by regulation, endorsed by professional associations or generally accepted by the advisor community. What might

be considered adequate by one institutional investor, could be considered totally insufficient by another. Regardless, the research, due diligence and investment process needs to question and confirm critical assumptions and information, and be a comprehensive investigation of those factors that will likely influence an investment program, and an offshore property investment's probable investment performance.

Offshore property - some local market differences

Offshore direct property investing has, in general, much more of a local aspect to it than any of the other major investment sectors. Indeed, offshore property markets tend to have many local market peculiarities and traditions, much more so than other international investment sectors that domestic institutions have successfully invested in in the past

Hence, in closing, we thought we would outline some of the more interesting and relevant local market differences, vis a vis Australia, for developed direct property markets of the US, UK, France, Germany and Portugal.

- In Germany, when a commercial transaction is agreed and about to be completed, representatives from both the buyer and seller must provide a full set of contract documentation to a notary. The notary is required to read every word of the contract whilst both parties are in attendance. Complex contracts can indeed take up to a couple of days to complete this process.
- In France, most commercial leases are indexed to a CPI annual rent review. If, throughout the duration of the lease, the rent climbs above 25% over the initial rent, and the CPI reviewed rent is greater than market rent, the new rent must revert back down to market rent. This is despite any conditions and terms within the lease to the contrary. The typical commercial office lease generally has a term of three, six or nine years. In the six and nine year lease, the tenant has a statutory imposed right to break the lease term, through a break option, after three years. Whilst under certain circumstances this can be negotiated out of the lease, it changes the long-term certainty associated with the cash flow.
- In Portugal, the courts take a rather borrower friendly approach to any action taken by lenders for enforcement of covenants such as loan to value ratio. If a lender is in breach of the covenants, and the bank wants to take enforcement action, the courts take the view that, as long as the borrower is paying the interest, then the covenants outside interest being paid are not enforceable.
- In the US, the most obvious example of a difference in the commercial marketplace is the availability of long-term fixed rate debt of 10 to 15 years. This compares with that available in Australia of up to five years. The sources of debt are dramatically broader, with 6,000 banks, numerous life insurance companies, agencies such as Freddie Mac, a CMBS markets and numerous debt funds. The debt market is the deepest, widest and most flexible in the world. In fact, the "right customer" can generally borrow on the basis of non-recourse, unsecured, interest only loans.
- Another US nuance is where the transaction of an asset has a loan in place. Because of the long term and fixed rate nature of loans and the associated large prepayment costs, transactions on assets are completed on the basis that loans "flow with the asset" from vendors to purchaser. The loans generally have transfer rights; these are critical to ensure that the asset can be transferred and not encumbered by unusual terms or conditions. The right of transfer is generally transferable to future downstream transactions. This makes the type of financing decision very important.
- The US has many state based regulations and taxes that are unique to the individual states, and there are elements like mortgage-recording taxes on the debt which, for example, in the city of New York is 2.5%. There is a vast variation in transfer taxes (state stamp duties) and there are also numerous local customs and laws required to be aware of and understood. Indeed, in some US states, the local custom is that the seller pays the stamp duty and not the buyer.
- In the US, leasing terms and conditions vary across the country, from triple net leases to full-service leases and everything in between. We note that, in the shopping centre market, it is highly unusual for landlords to be able to roll out a standard specialty shop lease, with most tenants, particularly national tenants, looking to impose their own specific terms and conditions. This slows the process down immeasurably.
- Finally, in the US it is pretty much standard procedure, by virtually all commercial office tenants, to have leasing reps/tenant advisors acting on their behalf in leasing negotiations with landlords.

The final word...

The concept of cross border investing should be developed on the theme of a single look through portfolio approach, which identifies the different sectors and markets that will provide varying returns at different periods of the cycle, increasing the benefit and scope of providing better risk adjusted returns. In taking an international approach, an ideal portfolio construction will be focussed on multiple markets, properties and property types in light of the heterogeneous nature of the international market. The low correlation of returns likely to be achieved implies there is scope for significant risk reduction through pursuing an international, cross border strategy.

The focus for an international investment strategy is that it is supported by long-term trends, such as the growing importance of large gateway cities, environmentally sustainable economic growth and technology driving e-commerce, trade logistics and work/leisure environments. Given the target markets that are identified in both Australia, US and pan-European markets, it will be important to maintain a disciplined approach and not be enticed into acquiring lower quality, non-core assets when it seems that it will be safe and returns will be sound.

Secondary asset return premiums may not necessarily compensate, over the long term, for the heightened risks taken. It is crucial to appoint managers that are experts in the chosen grades and sectors, and not align to managers without the necessary skills, experience and proven track record.

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Patience Premium

Igor Yelnik
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Discussing How the Concept of Ambiguity Aversion Leads to a Patience Premium

Introduction

We introduce the notion of a patience premium, which is based on the concept of ambiguity aversion and is an ambiguity premium. We identify three reasons for the existence of the patience premium:

- Certainty preferences: perceived confidence in the expected performance;
- Comparison with peers: desire to outperform the competition drives the focus towards short-term outcomes;
- Loss aversion: intolerance to negative performance leads to the use of sub-optimal trading strategies.

These reasons are driven by the behavior of market participants and are interconnected.

The phenomenon of the patience premium helps explain why the performance of investment strategies may benefit from having longer holding periods.

Is a Long Term View Good?

From our everyday experience, we know that performance uncertainty is often lower over the long-term than over the short-term. Simple intuition helps explain why this may be the case – even if we know exactly how a process will develop in general, i.e. we know the probability distribution, some random events or unexpected influences may lead to significant fluctuations along the way. For example, we can be comfortable with saying that the US stock market will almost certainly deliver a positive return over the next 50 years, but not so by whether it will be up tomorrow or over the next week.

This effect is immediately explained by the well-known fact that expected return is proportional

to time while its standard deviation is proportional to square root of time (under the assumption that the returns are independent and identically distributed). Hence, the ratio of accumulated returns to their standard deviation should increase for longer horizons.

For example, consider an investment with a mean expected annualised return of 10% and a standard deviation of 20%. In one year the ratio of expected return to standard deviation is: 10% / 20% = 0.5. In ten years, however, it will be: (10% * 10) / (20% * 10^0.5) ≈ 1.58, more than three times higher.

This implies that having a reliable forecast for the mean expected return the investor will be better off by investing over the long-term and absorbing volatility around that mean. In other words, the patient investor will earn a patience premium.

Now let us discuss reasons for its existence in more detail.

Certainty Preference: Finding a Rational Reason for Behaving Irrationally

The investor will never know with absolute certainty whether the expected return of a strategy will be positive. More generally speaking, the investor acts under ambiguity, as they can estimate but will not know for certain the probability distribution associated with an asset or an investment strategy. The problem of portfolio choice under ambiguity has been studied in the academic literature for a long time, see, for example, literature reviews in Tobelem-Foldvari (2010), Izhakain (2012) and Izhakain (2015).

In practice, investors' real-world utility functions are not only about return optimisation over the long term but are also influenced by other concerns and constraints specific to their situation. One example is that a typical investor's perception of losses and gains is asymmetric and they will often be judged over a time frame which is shorter than the one needed to statistically prove a concept. Following on from this, out of two equally volatile investments with equal estimates of expected returns and different levels of confidence in them, a typical investor will naturally choose the investment with a higher confidence. In other words, a higher certainty about expected return is preferred, all else being equal.

Thinking more generally, a higher certainty about the probability distribution is preferred (see, for example, Ellsberg (1961)). According to Easley and O'Hara (2009), this effect known as ambiguity aversion, causes limited market participation and impacts risk premia and in particular the equity premium. In a similar vein, lower participation in slower strategies causes the patience premium.

Put differently, out of two investors with equal ambiguity aversion, one with better knowledge of the expected distribution can afford greater patience, and out of two investors with equal knowledge of the expected distribution, the one with the greater patience should be able to collect the premium due to non-participation of the other investor. Shleifer, Vishny (1997) use the glamour/value anomaly as an example of high uncertainty that prevents many investors from taking advantage of it. They make an important general conclusion that market anomalies must have a high degree of uncertainty to persist over the long term.

Even though the literature mainly deals with the concept of ambiguity about the probability distribution in general, it is sufficient for our purposes to only focus on the ambiguity about the expected mean of the distribution, which we will refer to as uncertainty. The more general use of the term "ambiguity" allows one to account for preferences related to higher moments or joint distributions but we leave these generalisations to the reader.

Considering the uncertainty graphically in Exhibit 1, we show a volatility/mean return plane, which is traditionally used to show the trade-off between risk and expected gain, as a shear of a three-dimensional space in which the third axis shows uncertainty. Moreover, this shear is a very particular one as it assumes no uncertainty around estimated mean of the returns distribution.

If we fix volatility at a certain level, we can consider the mean return/uncertainty characteristics of strategies which will be seen as points on this plane which is orthogonal to the mean return/volatility plane.

The difference between volatility and uncertainty is fundamental for the understanding of risk; *volatility* shows variability of performance around the mean return while *uncertainty* indicates how trustworthy the estimate of the mean return is. An investor who knows the true expected return should only be interested in the volatility. However, in the real world this is rarely the case, which is why investors should take a much more meaningful look at the uncertainty.

Where does this fit in with our concept of the patience premium? It is well known that statistical significance of the mean return estimate depends on the sample size; the larger the sample, the lower the uncertainty, all else being equal. However, it is not the nominal sample size, e.g. the number of days in the sample, that

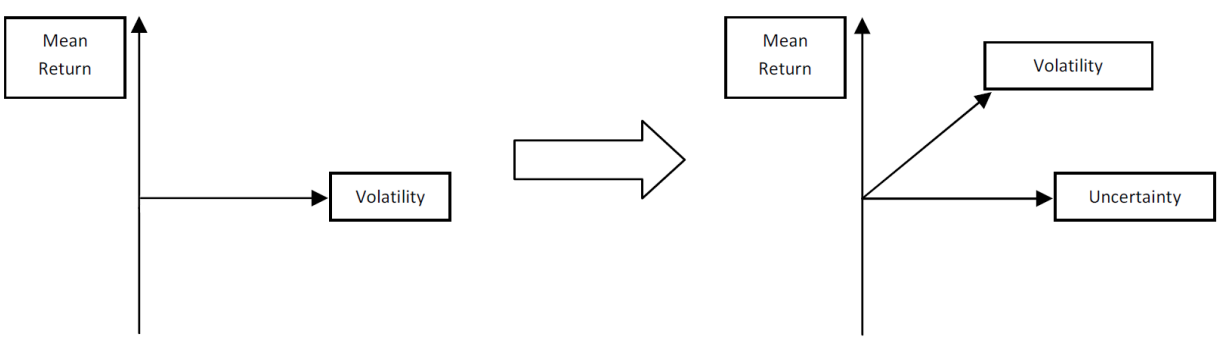

Exhibit 1: The Return / Volatility plane vs Return / Uncertainty / Volatility Space

matters. One needs to use a measure of the effective sample size that reflects the portfolio diversity over time. Faster strategies usually have a larger effective sample size versus slower strategies, all else being equal (see, for example, Gnedenko, Yelnik (2016)). As investors search for lower uncertainty, they are drawn towards faster strategies.

Unfortunately, most statistical tools do not tell us all about uncertainty and many of these tools or approaches assume that the markets are stationary while we know that they change over time.

Additionally, there's an argument to be made that (successful/ profitable) faster strategies play a role in markets being non-stationary. Such strategies are often based on lower capacity anomalies that are identified and traded on by a growing number of managers until they are no longer persistent and can no longer be exploited. At first, investors discover a market anomaly or a risk premium which appears to be statistically significant under the stationarity assumption, then they try to exploit it, and by exploiting it they eliminate the effect they are chasing.

Fast vs Slow: The Future Was Different in the Past

As more investors lean towards faster strategies, they select strategies with lower realised uncertainties and higher realised expected returns, i.e. the returns that were expected in the past. If the market remained stationary, they would be clear winners. However, as we touched on earlier, and as Yogi Berra famously said, "The future ain't what it used to be." As more people identify and chase the same effects, the expected uncertainty grows above the realised uncertainty and the expected return falls below the realised expected return.

Slower strategies are not that lucrative as far as their statistical confidence is concerned. Therefore, the degree of degradation of their expected returns shall not be as significant as that of faster strategies. Unfortunately, higher statistical confidence comes with the trade-off of faster expected performance degradation. In other words, the expected performance degradation should occur slower for strategies with a longer trade horizon for at least two reasons:

1. Higher uncertainty means there are fewer participants utilising slower strategies;
2. Slower strategies are typically less capacity constrained and thus need many more participants to be degraded compared with their faster peers.

A Noisy World: An Effect of Competition

"Half the money I spend on advertising is wasted; the trouble is I don't know which half."
John Wanamaker (1838-1922)

Almost all businesses operate in a competitive environment and this is no different for investors and the asset management industry. As in business, some investors will be more aggressive in exploring and trying to identify new sources of return. Some recent examples include social networks, machine learning and artificial intelligence. Investment companies have a strong financial incentive to be ahead of the curve and introduce novel

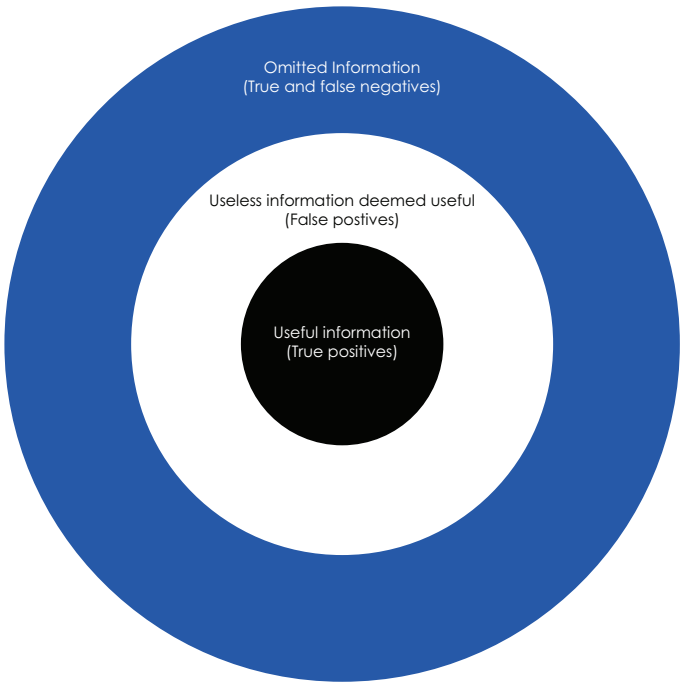

Exhibit 2: Information sets of an Investor

ideas before their competitors. Even if they are not the first to look in a new direction, they may at some point decide that the risk of not joining the crowd is too high. In either case driven by the competition they eventually start expanding the information set used in their decision making in an attempt to get better.

The pinnacle for an investor is to incorporate all useful information into their decisions. Since this task is practically insolvable each identifies a subset that is individual to them instead. This is shown in Exhibit 2 with the blue area indicating information omitted from the decision-making process (which is deemed noise) and the black and white areas indicating included information (deemed useful). The division between the union of black and white areas and the blue ring is subjective and unique to each investor; information omitted by one may be exploited by another.

Explaining exhibit 2 in more detail:

- The outer blue ring shows information omitted by an investor, including both information that is intentionally ignored and that is outside their knowledge, which will contain both true and false negatives or type II errors.
- The white ring shows information that is included (deemed useful) but is objectively useless for an investor so produces false positives or type I errors.
- The black circle represents information that is included and is useful for decision making and is what investors strive to increase.

As mentioned, the combination of the black circle and the white ring shows the full subset of information that the investor includes in their process, both useful (true positives) and useless (false positives). In practice, no investor knows with certainty which information in his subset is black or white so the border between them is blurred. Therefore, a more appropriate representation would be a grey circle scaling from black in the

centre (indicating a higher certainty) to white towards the borders (indicating a higher uncertainty).

As a result, an investor can only know for a fact that he expands the union of the black and the white and hope that the black will expand more. The presence of some unknown amount of false positives in any investor's information subset is inevitable.

For example, price information and some technical data like volume, open interest, etc. populate the black and white areas of a trend-following investor, though there is no way to tell whether a particular type of information lies in the black or white area.

Competition encourages investors to expand the subset of information that they use, moving the boundary of the blue ring since it will contain some useful information (false negatives or type II errors). This expansion of the subset leads the investors to take the risk that they identify more false positives or type I errors that may bring them no investment profits and not lead to higher positive expected returns.

Furthermore, for any given investor, there may exist a faster investor. That faster investor will try to use information the slower investor will omit. Therefore, the faster investor will use more information per unit time, which may increase statistical confidence in his realised expected returns and supposedly give him a competitive advantage. This drives many investors towards higher frequency. This in turn leads to the herding effect and to a lower predictability of usefulness of information or, in other words, to the lack of ability to tell whether information belongs in the black or the white area. As a result, the share of the false positives in the investors' used information subset may swell and the uncertainty of expected returns, increase. Speaking more formally, while the ambiguity about the realised distribution may decrease as the speed increases, the same may not necessarily be true about the expected distribution.

The reciprocal effect is rather weak and mainly driven by the loss of agility by investors growing too big for their markets in practice. The low, especially, the ultra-low frequency space has not been a magnet for investors. Even if it were, capacity of slower strategies is typically higher. As a result, slower strategies are characterised by a more stable predictability of usefulness of information due to less herding. The share of false positives in the slower investors' used information subset does not increase at a fast pace. (Note: It may be argued that in the general case, using low latency data does not necessarily force an investor to trade more frequently. For example, one may collect tick market data in real time, aggregate it and place one trade a month. However, in practice correlation between latency of data used and (a reciprocal of) frequency of trades is high enough for us to ignore the difference between the two for the purpose of this paper)

Pain Threshold: How Patient Can We Be and How Much Noise Can We Tolerate?

The Buddhist concept of dukha can be loosely translated as suffering or unsatisfactoriness. From the Buddhist point of view, dukha is an inherent part of life, which is difficult and imperfect. Dukha is not necessarily physical suffering such as pain, illness or dying but also ordinary, everyday difficulties. For example, the frustration of not getting what one wants may be considered dukha. Buddhism teaches that clinging to the pleasurable and aversion to the unpleasurable eventually results in dissatisfaction.

We don't have to be Buddhists to recognise some truths in the above. Applying this more directly to investing, if positive returns may be associated with the pleasurable and the negative returns with the unpleasurable, loss aversion should result in inferior returns, with all else being equal or in the absence of an informational advantage or harvesting shorter-term premia.

Investors are often tempted to act on noise even though it can't deliver positive expected returns. This happens because of the failure to recognise and acknowledge that one deals with noise. In other words, they are driven or persuaded by a desire to act, which is more likely to be based on instincts and feelings than on new useful information.

These instincts and feelings may be summarised as a concern that the investor's return forecast is not that reliable. Sometimes this concern leads to relying on information that ought to be classified as noise and thus belong in the blue ring but is instead erroneously classified as a useful one and thus appears in the white ring.

Moreover, the loss aversion and the certainty preference often force investors to take actions that result in negative expected returns. A classic example would be stop-loss rules applied in a strategy with negative autocorrelation of returns.

In other words, investors do not only avoid strategies with higher uncertainty, but in the foray to reduce uncertainty they reduce expected returns.

Eventually, there is a human investor behind all, even the most automated, investment strategies, be it a one-off bet against a currency, buy-and-hold exposure to the stock market or a high frequency strategy. The conviction of that investor or the extent of their certainty about the investment strategy is an integral part of the process. However, the majority of investors feel compelled to act too soon or train their strategies to act too soon as losses are unpleasurable. This adds a cognitive element to the otherwise financially and economically supported logic.

An investor who has implicit trust in longer-term return forecasts, patiently waits and lets the information he possesses work for him will avoid trading on noise and enlarging his personal white ring.

Concluding Remarks

The core reason for the existence of the patience premium is investors' aversion to ambiguity (or uncertainty). In other words, the patience premium is an ambiguity premium.

Due to certainty preferences, the average investor may have been drifting into an area of increasing information processing speed and shorter holding periods. This move has involved the use of information never used before. For such strategies, making assumptions about expected performance and its uncertainty may be even more challenging than for more traditionally exploited slower signals, in particular because of the ever-increasing competition in the area. This competition calls stationarity and hence forecastability of the return distribution into question.

Some of this high frequency information may be useful but other sets may not. Then the matter of expedience of shortening holding

periods will boil down to answering a question: does the benefit of using the extra set of useful information exceed the price to be paid for using other sets of information which are irrelevant at best?

Premia exploited in slower strategies should suffer less due to their high capacity nature and because the competition is much more severe in lower holding period strategies, which mainly target different effects and lack the patience of a slow and conservative approach.

However, patience has to build on confidence. Since statistical tools are less helpful in identifying slow investment strategies with positive expected return, discretion of a human investor plays an important role in forming the ultimate evaluation of certainty of such strategies.

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Igor Yelnik joined ADG Capital Management LLP in 2013. Prior to that he spent 9 years at IPM Informed Portfolio Management AB (Sweden) where he was a Partner and Head of Portfolio Management and Research. Prior to this, Igor co-founded St.Petersburg Capital, an asset management firm that specialised in the Russian securities market, and later Unibase Invest, a managed futures business based in Tel Aviv. Igor graduated from Leningrad Polytechnic Institute in 1986 where he obtained a Master's degree in Computer Science (diploma with distinction).

The Rise of Unicorn Funds – Examining the Supply of Private Growth Capital

Rohit R. Kulkarni
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In our recent reports, we highlighted key trends and factors leading up to the proliferation of "Unicorns" and emergence of the new "Private Technology Growth" asset class. As a next step to analyze the market forces that could drive further proliferation of Unicorns coupled with greater investor allocations towards the new Private Technology Growth asset class which contains them, we explore answers to the following questions: 1) How would you characterize the capital raising environment for the traditional venture capitalists and the other investors participating in the asset class since 2009? 2) Are traditional LPs allocating a greater or smaller proportion of their capital to the new asset class? 3) How much committed capital or "dry powder" do these funds currently have available to invest into the asset class? and 4) What do recent fundraising trends tell us about the health of the asset class and capital raising prospects for its companies?

Key highlights from our findings include the following:

Roughly $220B in funds raised for Private Technology Growth asset class since '09: Partially driven by a post-recession recovery tailwind, the annual run-rate of capital raised by US-headquartered, tech-focused venture capital and private technology growth investors has increased roughly 4X – from $11B in '09 to $41B in '15, exceeding pre-recession peaks (around $32-33B per year from '06 through '08), translating to a healthy 25% year-on-year 6-yr CAGR. On a YTD basis, these investors have raised $28B, and appear to be on track to exceed $50B in total new funds. Coincidentally, as highlighted in our recent report, "Birth of an Asset Class," there has been a growing demand for capital as private tech companies have raised, in the aggregate, more than $200B over the past six and a half years. The annual run-rate demand for capital from private tech companies has grown 5x from 2009 to 2015.

Clearly, the supply and demand curves for private capital have shifted as entrepreneurs' desire to stay private and raise private capital has continued to rise since the Great Recession.

Mega $1B+ funds account for 60% of incremental capital raised since early '14: Largely mirroring the trends observed in capital deployed into private technology companies, we noticed two distinct, three-year private fundraising paradigms since the end of the Great Recession in 2008. From 2009-12, capital raised by Private Technology Growth oriented funds more than doubled from $10-12B per year to $24-26B per year. Funds across all stages and sizes likely experienced a post-recession tailwind leading to a "reversion to mean" fundraising environment. Since 2013, annual run-rate capital raising has again almost doubled, from $25B in 2013, driven by a 4X increased in dollars committed to $1B+ funds. Roughly $10B out of $16B in incremental capital commitments (i.e. the delta between $25B in total fundraising activity in 2013 and $41B in 2015) have come via $1B+ mega funds, contributing to 60% of incremental dollars raised since early 2014.

Leading investors in today's Unicorns growing share of capital commitments: We estimate that the 20 most well-known private tech investment firms in the asset class today have raised roughly $83B over the past six and a half years, with more than $41B funds raised in the past two and a half years alone. And, 32 out of the 38 recent billion-dollar private technology growth oriented funds can be attributed to these firms. Such fundraising activity has led to a major shift in the market share of these funds among LPs - the share of capital raised has steadily increased from 25% in 2013 to over 40% of capital raised on a trailing twelve months (TTM) basis. In our first report, we highlighted that VC batting average has been remarkably consistent despite exponential growth in both size and number of "home run" outcomes. Effectively, we think we have seen a virtuous cycle evolve between the growth of Unicorn companies, the expected rate of return from Unicorn investments and the LP/investor allocation of capital to the fund's backing Unicorns.

Significant amount of dry powder available to support existing unicorns and mint new ones: We believe that private technology growth funds are like start-ups that unfold in slow motion. While a start-up tends to raise funds every 12-24 months, we estimate private growth funds tend to fundraise every 3 to 4 years. While investors in a start-up typically have an investment horizon of 6-10 years, investors in a VC fund usually have an investment horizon of 10-15 years. So, the fundraising activity over the past 4-5 years is likely going to fuel the asset class for the next 10 years or so. According to Preqin, a data aggregation platform for alternative assets industry, global VC investors were sitting on more than $200B in cumulative dry powder at the end of 2015, a record high in past 10 years. Based on data from Pitchbook and our own analysis, we believe roughly $30-40B in dry powder is available to leading 20 private technology growth investors, essentially to maintain the existing crop of Unicorns as well as invest in the next cohort of Unicorns over the next 5+ years.

Note About Profiling Fund Types Investing in Private Technology Growth Companies

Categorizing the firms investing in the new Private Technology Growth asset class can be challenging because many of the usual labels overlap and mean different things to different people. The challenge is compounded by the fact that firms are migrating into the asset class from adjacent asset classes. Traditional VCs are raising later-stage funds, public market investors are "swimming upstream," sovereign wealth funds and investment divisions within large corporations are opportunistically making large direct investments. For ease of reference, we have grouped investors in this report as follows:

1. We refer to "Traditional VCs" as pools of capital raised for the primary purpose of investing in the equity of startup companies. This group includes traditional venture capital investors such as Union Square Ventures, Kleiner Perkins, Sequoia Capital, Benchmark, etc.;
2. We refer to "Private Growth" capital as the funds raised by any institution with the primary intent to invest in private technology companies and that have invested in at least one Unicorn. Generally, such funds are identified as "growth equity funds" or "growth stage funds", and tend to be classified as private equity funds by data

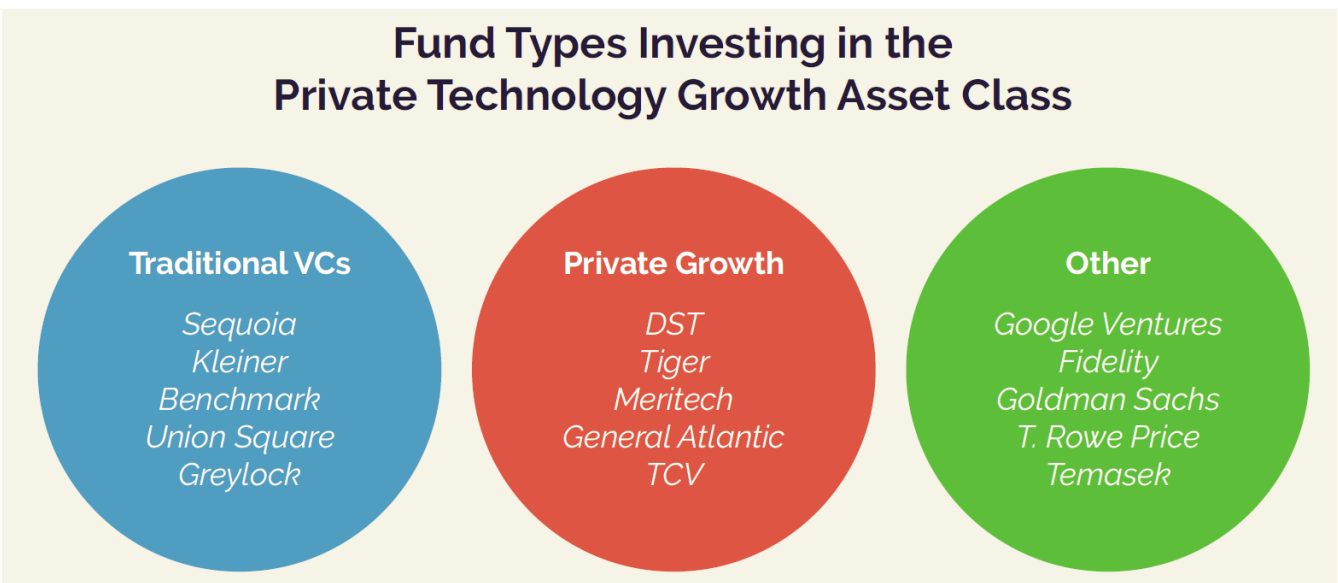


Exhibit 1: Profiling Fund Types Investing in Private Technology Growth Companies
Source: Sharespost Research

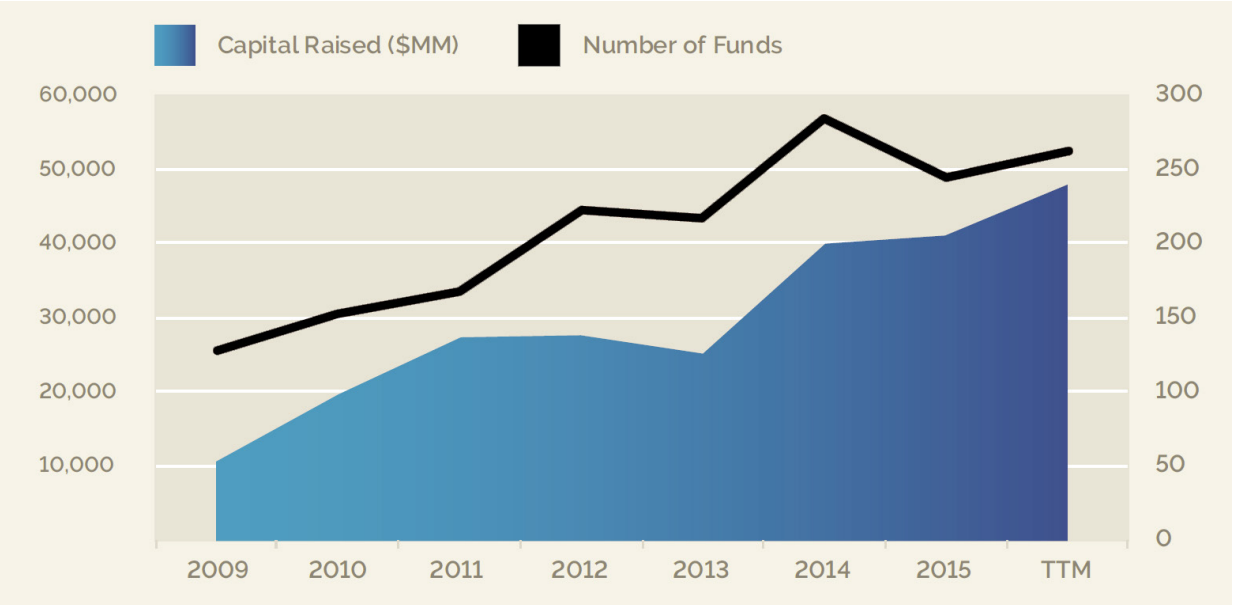


Exhibit 2: Traditional VC & Private Technology Growth Fund Raising Trends Since 2009
Source: Pitchbook, Sharespost Research; $ in millions

aggregators such as Pitchbook and Preqin. We note that we have not included private equity funds that primarily invest in buyouts or real estate or via mezzanine capital. We have included funds raised by only those traditional private equity investors that have a stated purpose to invest in tech companies, with a focus on growth, and that have invested in at least one Unicorn;

3. Lastly, we lump corporate venture investors, sovereign wealth funds, asset management divisions within large financial institutions (e.g., investment bank sponsored funds), and mutual funds into an "Other" group. We highlight that we have not included the funds raised by this group of investors in the analysis presented in this report. While these investors have played an important role in the ongoing proliferation of Unicorns, we believe such funds tend to comingle with other large pools of money managed by these institutions. Hence, separating funds dedicated towards private technology growth companies could become an exercise requiring significant number of assumptions and caveats. And, excluding this potentially large base of capital makes the overarching conclusions in the report even more compelling.

Roughly $220B in funds raised for Private Technology Growth asset class since '09

Since the dot-com crash in 2008(?), commitments to the traditional U.S. venture capital industry and the larger private growth capital asset class have grown, although this growth has not been uniform. Instead we have seen peaks in fundraising followed by major retrenchments. While a variety of factors affect the level of commitments to private growth as an asset class, we believe changes in the amount of demand for capital (or, entrepreneur's desire to raise private capital) and the LP/investor confidence on the expected rate of return from investments are among the most important factors affecting the supply of private growth capital funds.

Our recent reports on Unicorn creation and funding highlight the following factors likely led to growing supply of private growth capital: 1) Since 1995, the batting average of traditional venture capital and private growth investors has been remarkably consistent despite exponential growth in both size and number of "home run" outcomes. We think this has resulted in growing LP/investor confidence in Private Growth Capital as an asset class; 2) Private tech companies have raised more than $200B since the end of the Great Recession. On an annual run rate basis, the demand for capital from private tech companies has grown 5x from 2009 to 2015. We believe this has translated into a growing demand for private growth capital as entrepreneurs' desire to stay private and raise private capital has continued to rise since the Great Recession.

In order to dig deeper into the underlying trends affecting the supply of venture capital, as a first step, we collated quarterly data on VC fundraising trends across stages of company development, sliced by size of individual funds, and with a stated investor focus on Private Technology companies. We relied on data sourced from Pitchbook, Dow Jones Venture Source, and National Venture Capital Association (Thomson Reuters) since the beginning of 2009. In this report, we provide a series of data points and analyses illustrating the underlying trends and drivers affecting VC fundraising patterns. **The simple headline is that partially driven by a post-recession recovery tailwind, annual run-rate capital raised by US-headquartered Technology-focused traditional Venture Capital and Private Growth investors has increased ~4x from $11B in '09 to $41B in '15, exceeding pre-Recession peaks (around $32-33B per year from '06 thru '08).** Capital commitments to Private Growth Capital as an asset class have effectively increased at a healthy 25% per year 6-year CAGR.

Number of funds raised slowing down, but committed dollars rising

Since the Great Recession, there has been a general upward trend in the number of traditional VC and private growth funds launched per year as well as the amount of capital allocated by LPs

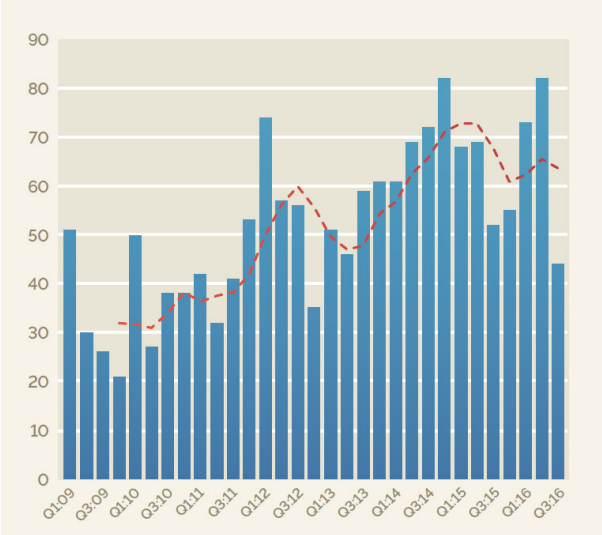


Exhibit 3: Number Of Funds Raised Per Quarter By Traditional VC & Private Growth Funds

Source: Pitchbook, Sharespost Research; chart shows number of traditional VC and private growth funds raised per quarter

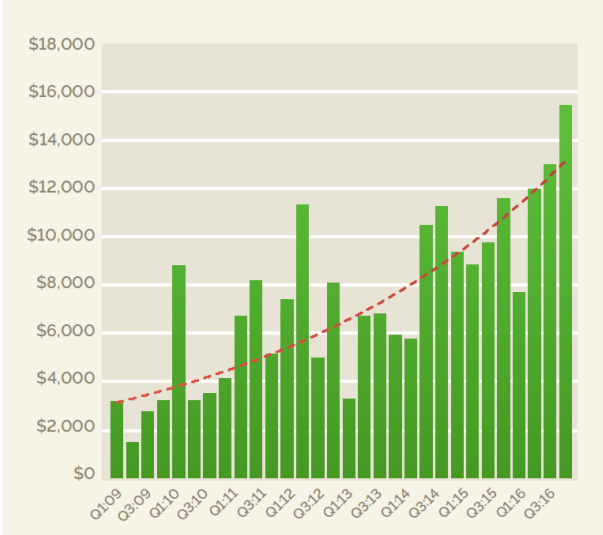


Exhibit 4: $MM Capital Raised Per Quarter By Traditional VC & Private Growth Funds

Source: Pitchbook, Sharespost Research; chart shows number of traditional VC and private growth funds raised per quarter

to this asset class. We believe these trends have largely been an outcome of the several macro-level trends coinciding over the past 5-6 years: 1) Growing volatility in public market fundamentals; 2) Lower costs to start a tech business given cloud computing proliferation; 3) Growing end-market opportunities given secular shift toward Internet and Mobile computing; 4) Rising costs to succeed or scale given blurring lines across traditional technology sub-sectors leading to rising competition among large tech stalwarts (e.g., large technology companies such Google, Apple, Microsoft, Amazon, and Facebook increasingly compete on the margins and growth opportunities); and 5) Growing confidence among LP investors of anticipated returns from existing VC investments due to the emergence and proliferation of "Unicorns."

We illustrate the big picture trends in the charts. Summary takeaways are as follows:

Annual run-rate of number of funds raised has increased 2x since '09: Over the past 6 years, the number of net new traditional VC and private growth funds launched has roughly doubled, from approximately 100-150 per year from 2009 to 2011, to over 250 net new traditional VC & private growth funds launched per year since 2014. When observed at a granular lever the number of funds raised per quarter ranged between 25 and 50 funds during 2009 and 2010. This quarterly run rate increased to a range between 35 and 70 during 2011 and 2012. And, since 2013, quarterly run rate has ranged from 50 to 80 funds raised. (We note that we are here referring to traditional VC and private growth funds that have a stated focus on "Information Technology" companies).

Annual run-rate of number of funds raised likely peaked in 1H:15, coincident with the number of sub-$100MM funds: As illustrated in the chart with a TTM trend of number of new funds raised, the annual run-rate of number of funds raised increased from 120-130 funds per year in 2009 to 250-ish funds raised during 2014. In 1H:15, the annual run rate approached 300 funds per year. Over the past four quarters, this annual run rate has gradually ticked lower to roughly 250 funds per year. We note that this sequential decline has been largely driven by funds with committed capital below $100MM.

Annual run-rate of dollar capital raised has increased 4x since '09: While the number of new traditional VC and private growth funds launched has doubled, the gross amount of dollars allocated or committed to traditional VC and private growth funds has been rising at a faster clip. From 2009 through 2015, VC fund allocations have roughly tripled from approximately $10-15B in annually in 2009 and 2010 (or $30B raised in total during 2 years) to more than $45B in annual capital commitments since 2015. And, on a YTD basis, 2016 VC fundraising trends imply another record-breaking year as far raising new funds is concerned. When observed at a granular level, the gross dollar amount of capital committed per quarter ranged between $3B to $4B during 2009 and 2010. This quarterly run rate increased to a range between $5 and $8B during 2011 and 2012, followed by another step-up to a range of between $7 and 10B during 2013-2014. And, since Q1 '15, quarterly run-rate has exceeded $10B, effectively quadrupling from the 2009-2010 levels

Roughly 55-60% of annual traditional VC & private growth funds are typically raised in 1H: It appears there is a bit of seasonality in VC fundraising activity as 1H committed dollars have exceeded 2H investment dollars during six out of the past seven years. And, drawing this out further, we'd expect the gross capital committed in traditional VC and private growth funds in 2016 to approach new post-recession record highs, likely approaching $50B, given the $25B+ raised so far in 1H:16. This finding largely ties in with our conclusion around VC investment seasonality. As highlighted in our previous report, VCs tend to invest more in 2H of any given calendar year, likely playing catch-up to meet capital thresholds or completing due diligence on existing deals.

1H:2016 committed capital levels imply continued rise in dollars raised: On a TTM basis, we estimate roughly $48B in capital has been committed to traditional venture capital and private technology growth funds based in US. This compares to an estimated $40B in 2014 and $41B in 2015. On a YTD

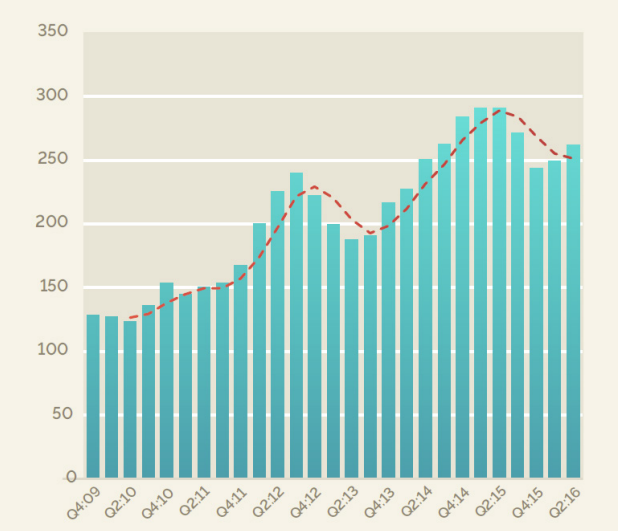


Exhibit 5: Number Of Funds Raised On A TTM basis
Source: Pitchbook, Sharespost Research

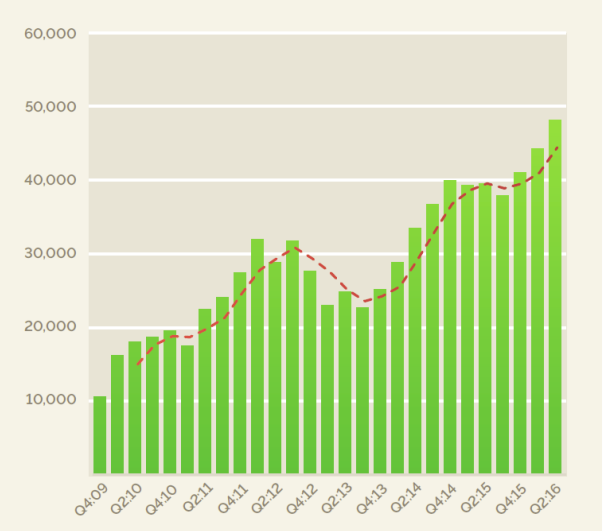


Exhibit 6: $MM Capital Raised On A TTM basis
Source: Pitchbook, Sharespost Research; $ in millions

basis, traditional venture capital and private technology growth investors have raised $28B in capital. And, assuming a roughly 60-40 split across 1H/2H fundraising activity, we guesstimate approximately $48-53B in capital will be raised in 2016, clearly exceeding annual capital commitments observed since the dot-com boom levels (in an inflation unadjusted manner).

Mega funds ($1B+) account for 60% of incremental capital since '09

Next, we looked under the hood to determine key factors leading up to the growth in capital commitments in US-based traditional venture capital and private technology growth funds. To provide a better frame of reference for the recent growth in capital commitments to traditional venture capital and private technology growth funds, we illustrate below a long-term trend in dollars committed by investors towards VCs and PE investment firms. Recall that the modern VC industry likely began in the 1940s and grew gradually until early 1980s. In the early 1980s, new sources of capital from pension funds led to accelerated growth, which resumed in the mid-1990s. Rapid growth in capital commitments to traditional VC & private growth funds in late 1990s ended in the dot-com crash in 2000. Between 1997 and 2001, there was a doubling or near doubling of the total number of traditional VC & private growth funds, the total number of VC firms, and the size (capital divided by funds or firms) of these traditional VC & private growth funds and VC firms. The size of the industry hit a plateau in 2001 and stayed steady between 2002 and 2006. However, the overall VC industry started to contract in 2007 which ended in 2009. However, despite year-on-year declines since 2007, according to NVCA, the capital under management is still higher than the 1999 levels. As highlighted in the charts below, VC firms have raised a sum total of $627B since 1995. Capital under management, calculated using a rolling eight years of fundraising, by those firms at the end of 2015 was $165B.

We note that due to the differences in the data collection methods and sample selection, the committed-capital amounts in Exhibit 1 are not directly comparable to the investment totals given in

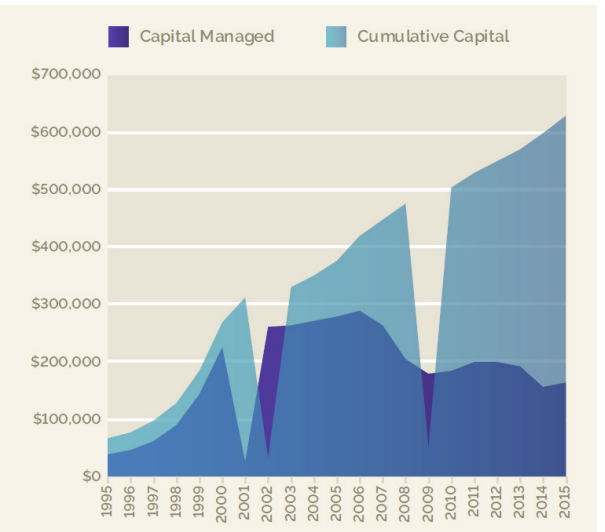


Exhibit 7: Gross Capital Managed Per Year Vs. Cumulative Capital Raised
Source: NVCA (Thomson Reuters); Sharespost Research; $ in millions; Capital managed based on rolling 8-year fundraising trends

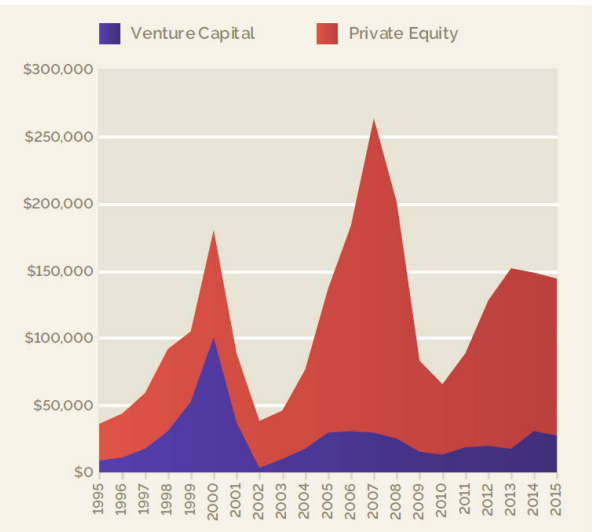


Exhibit 8: Gross Committed Capital Per Year Since 1995 By VC & PE Funds
Source: NVCA (Thomson Reuters); Sharespost Research; $ in millions; Private Equity committed capital includes Buyouts & Mezzanine Funds as well

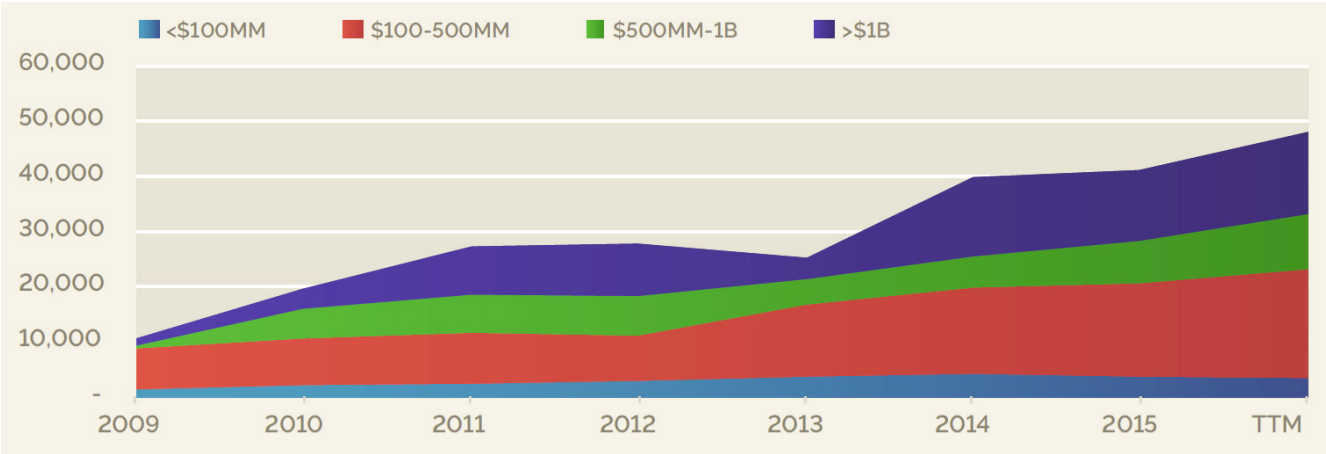


Exhibit 9: Gross $MM Raised Per Year By Traditional VC and Private Growth Funds
Source: Pitchbook; Sharespost Research; $ in millons

Exhibit 7 and Exhibit 8. Nevertheless, the general trends are similar. According to the NVCA 2015 Yearbook, the growth equity asset class really emerged from the private equity asset class (which includes venture capital, buyouts and mezzanine activity) after the 1999/2000 dot-com tech bubble. We believe the lines have increasingly blurred around the boundaries of traditional venture capital and growth equity investments in private technology companies since the end of Great Recession. In the rest of the report, we have relied upon curated Pitchbook data for trends in traditional venture capital and private growth fundraising trends. Our objective has largely been to identify the fundraising trends of key Unicorn investors, among other things, and we believe curated Pitchbook data by fundraising activity of individual investors allows us to include/exclude funds based on past investments.

Per Pitchbook, overall VC fundraising activity peaked in 1H:14, consistently exceeding $10B per quarter and, since then, we have witnessed $10B or greater fundraising during four out of the past eight quarters. **Small Funds (<$100MM in capital)** account for approximately 50-55% of traditional VC and private growth funds raised each year and 6-8% of capital. Per Pitchbook data, number of sub-$100MM traditional VC and private growth funds as well gross capital raised via sub-$100MM funds peaked around 2H:2014. Since then, both number of, and gross capital raised via, sub-$100MM deals has declined on a Q/Q basis. **Mid-Size Funds ($100-500MM in capital)** account for approximately 35-40% of traditional VC and private growth funds raised and 40-45% of VC invested dollars. Unlike the slowdown witnessed in early-stage VC investments, both the number of and gross dollar capital invested via mid-size VC investments have stayed above a fairly high watermark since early 2014; **Large Funds ($500MM or more in capital)** account for 6-8% of traditional VC and private growth funds raised and more than 50% of funds raised by private tech investors. Fundraising activity for large $500MM+ funds has been fairly cyclical over the past 5-6 years, with peaks every couple of years – around mid-2012, mid-2014, and current trends implying another peak fundraising period, largely driven by mega "Unicorn" funds.

While there has been a steady, consistent, and perhaps remarkable increase in the dollar amount raised by traditional venture capital and private technology growth investors since the Great Recession, we noticed two distinct, three-year private tech fundraising paradigms since the end of the Great Recession. This trend largely mirrors the trends observed in Private Tech

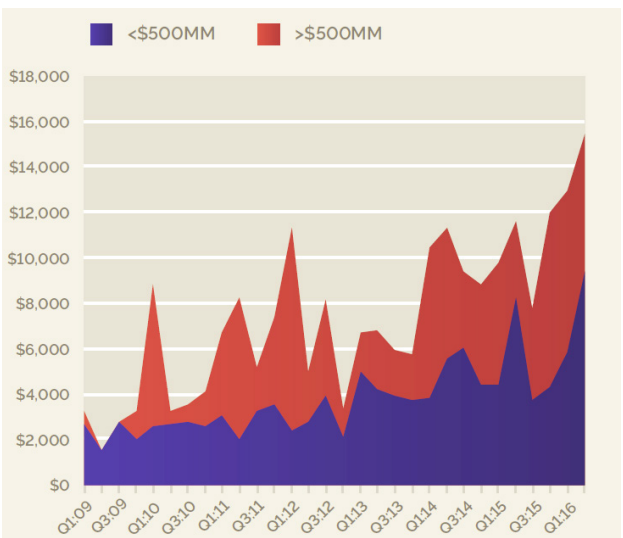


Exhibit 10: Gross $MM Raised Per Year By Traditional VC and Private Growth Funds
Source: Pitchbook; Sharespost Research; $ in millions

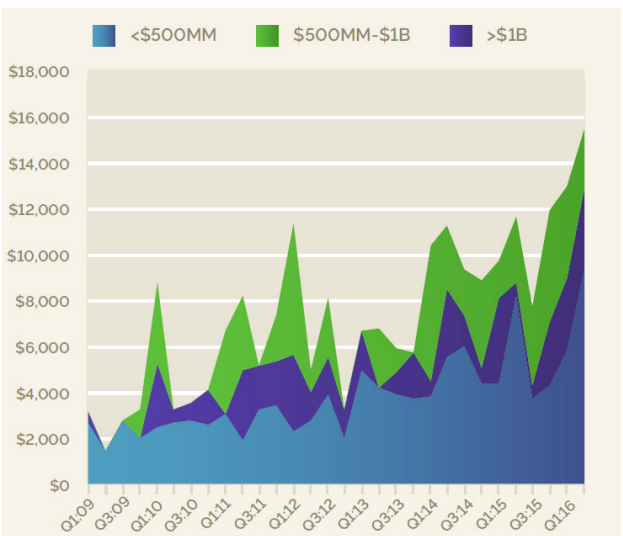


Exhibit 11: Gross $MM Raised Per Year By Traditional VC and Private Growth Funds
Source: Pitchbook; Sharespost Research; $ in millions

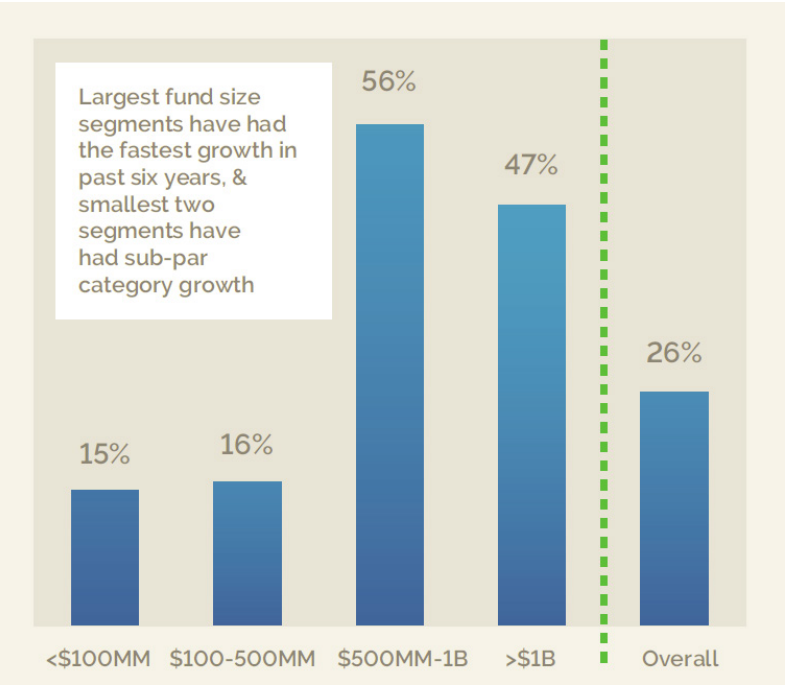


Exhibit 12: Comparing 6-Year Fundraising CAGRs Across Fund Sizes
Source: PwC/NVCA MoneyTree™ Report, Data: Thomson Reuters; Sharespost Research

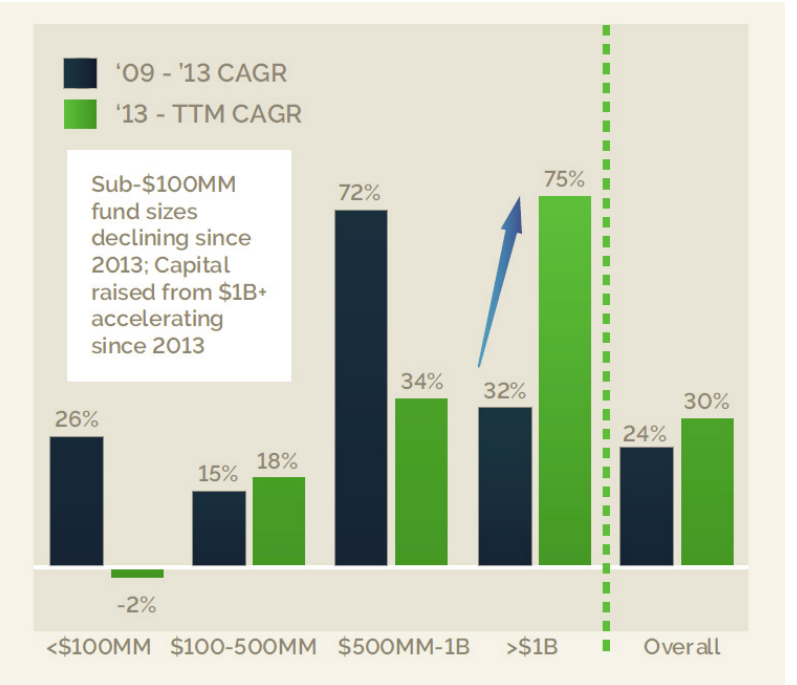


Exhibit 13: Comparing 6-Year Fundraising CAGRs Across Fund Sizes
Source: Pitchbook; Sharespost Research

investments over the past six years. From 2009-12, VC capital commitments more than doubled from $10-12B per year to $24-26B per year. Funds across all stages and levels of capital commitments likely experienced a post-recession tailwind leading to a "reversion to mean" funding levels. Since 2013, annual run-rate capital commitments to traditional VC and Private Growth investors have almost doubled, largely driven by a 4x increase in dollars committed to mega billion-dollar funds. And, roughly $10B out of $16B in incremental capital commitments (i.e., the delta between $25B in traditional venture capital and private technology growth fundraising activity in 2013 and $41B in 2015) have come via Mega funds ($1B+), contributing to more than 60% of incremental dollars raised by traditional venture capital and private technology growth investors since early 2014.

Leading Unicorn investors gaining share of capital commitments

Finally, we looked at fundraising trends of leading "Unicorn" investors. And, in particular, we were looking for answers to the following questions: How much committed capital or dry powder

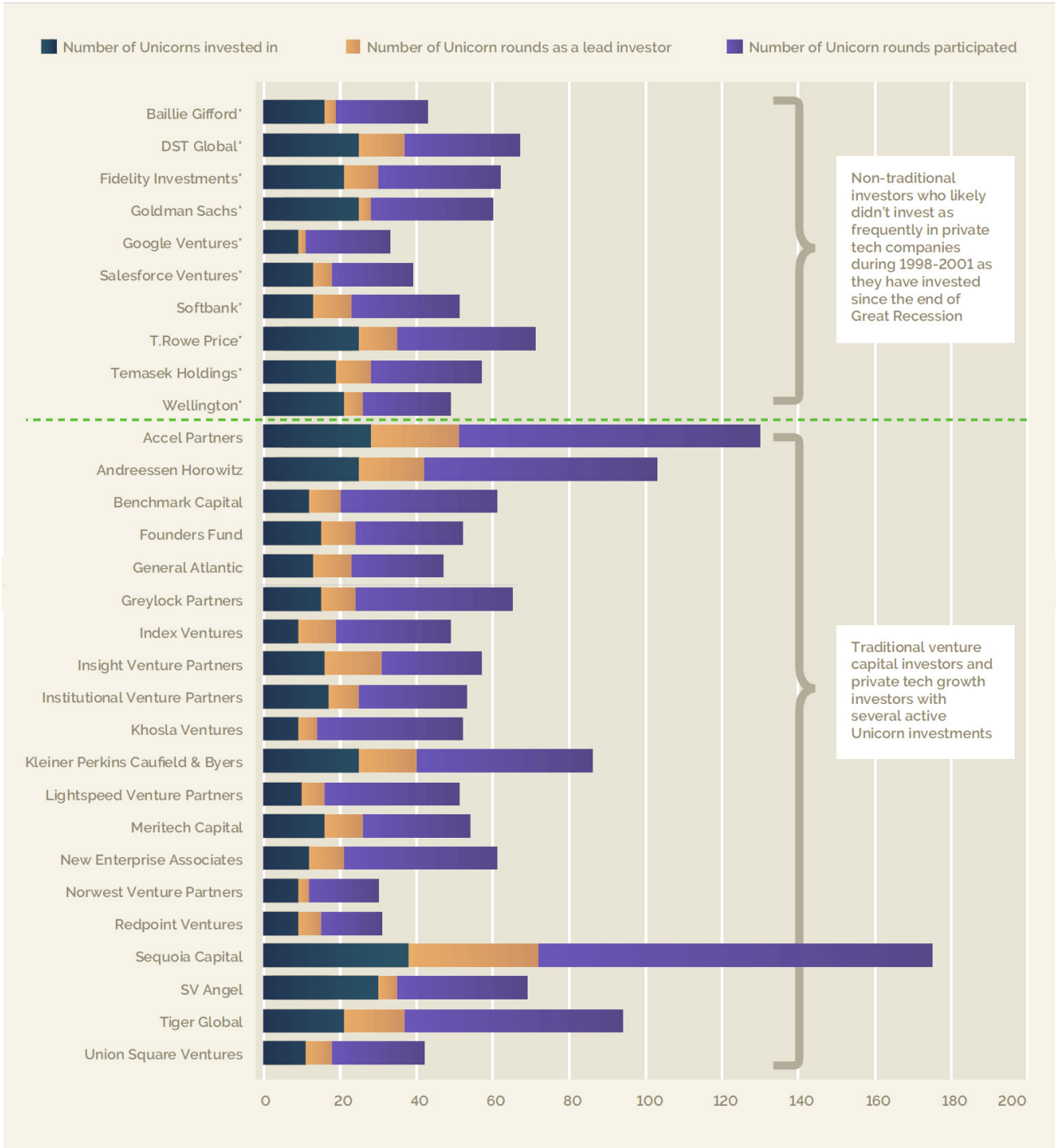


Exhibit 14: Leading "Unicorn" Investors incl. traditional VC, Private technology growth and "Other" investors

Source: Pitchbook; Sharespost Research estimates; Crunchbase; chart sorted alphabetically and grouped by investor types; Funds raised by Investors with an asterisk (*) have been excluded from the analysis presented in this section and the subsequent dry powder analysis

do leading investors in today's Unicorns have available? What do recent fundraising trends tell us about satisfying Unicorn capital requirements over the next three to five years?

The headline takeaway is that we estimate that the most successful and prolific traditional private tech investors in today's Paper Unicorns have raised roughly $83B in capital in the six and a half years since 2009, with more than $41B funds raised in the past 2.5 years. Furthermore, traditional venture capital and private growth investors who are also leading Unicorn investors have been busy raising larger funds. We estimate 32 out of 38 recent billion-dollar mega funds can be attributed to these prolific Unicorn investors.

Effectively, there appears to be an ongoing market share shift of capital towards such Unicorn investors as their share of capital raised has steadily increased from 25% in 2013 to over 40% of capital raised on a TTMs basis.

We think that the emergence and proliferation of Unicorns over the past three to four years has resulted in rising LP/ investor confidence on the expected rate of return from venture investments. We believe that traditional VC & private growth funds are start-ups that unfold in slow motion. Or, in other words, fundraising activity over the past five years is likely going to have an effect over the next 10 years or so. Effectively,

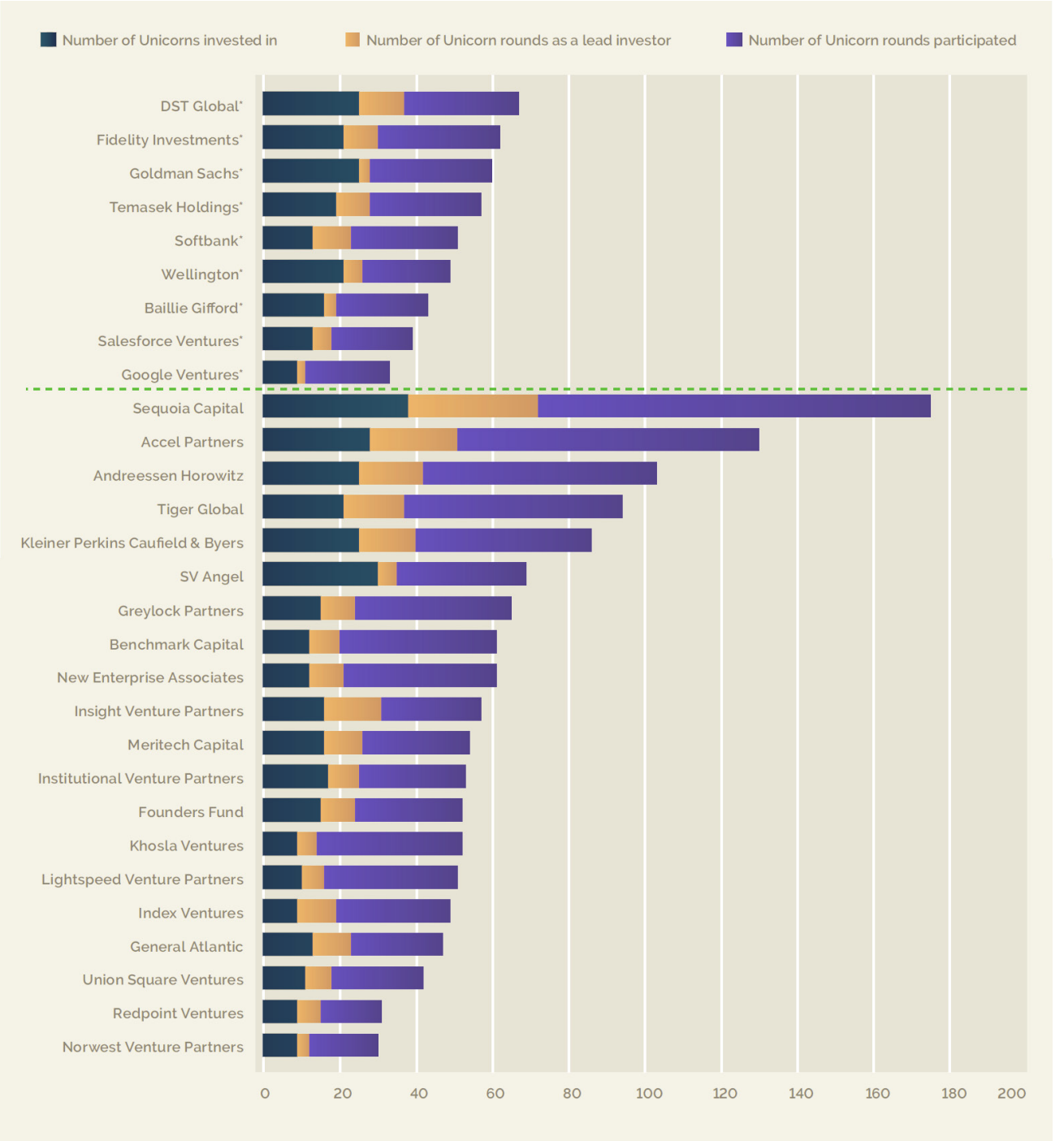


Exhibit 15: Leading "Unicorn" Investors incl. traditional VC, Private technology growth and "Other" investors

Source: Pitchbook; Sharespost Research estimates; Crunchbase; chart sorted based on sum total of overall activity by investors in Unicorns and grouped by investor category; Funds raised by Investors with an asterisk (*) have been excluded from the analysis presented in this section and the subsequent dry powder analysis

on a forward looking basis, recent fundraising activity by these leading traditional venture capital and private technology growth investors has resulted in significant amounts of dry powder available today to invest in the next cohort of "Unicorns" over the next 10 years.

As a starting point, we compiled a list of 20 leading and most prolific, traditional venture capital and private technology growth investors along with the 10 most active corporate venture capital arms, sovereign wealth funds, and traditional public equity/mutual fund investors. We relied on data compiled by TechCrunch and CB Insights, and filled in the holes using Pitchbook data on private tech investments. We provide the entire list of investors in the chart above (sorted alphabetically and sorted by the sum total of investment activity, as measured by the number of Unicorns invested in plus the number of Unicorn investment rounds participated in plus the number of Unicorn investment rounds participated as a lead investor).

As a next step, we looked at fundraising activity of leading (aforementioned) traditional venture capital and private growth focused tech investors since the end of the Great Recession. We compiled all the funds with vintages starting in 2009. We relied on Pitchbook as a primary source of data for compiling fundraising

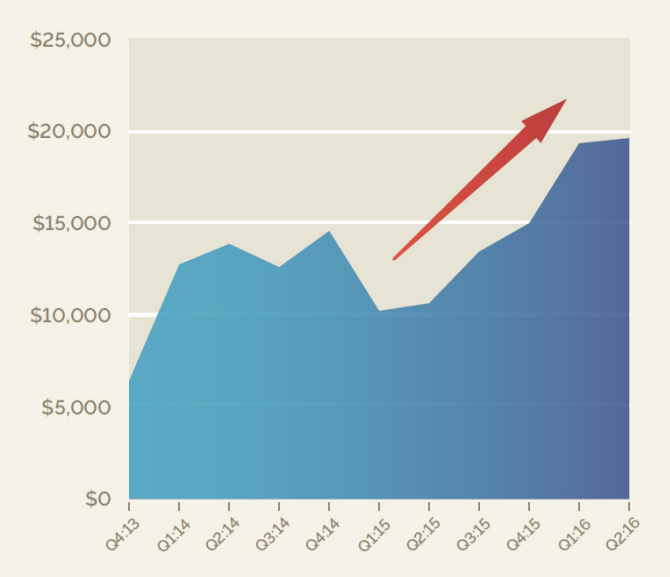


Exhibit 16: Capital Raised By Classic VC/Private Tech Investors Since 2013

Source: Pitchbook; Sharespost Research; Chart shows TTM committed capital to leading traditional VC and Private tech growth investors; $ in millions

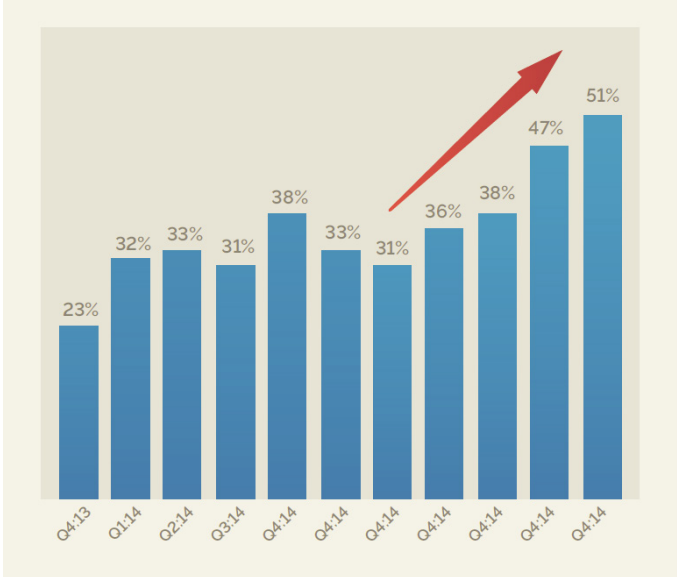


Exhibit 17: Proportion of Capital Raised By "Classic" Private Tech Investors Since 2009

Source: Pitchbook; Sharespost Research; Chart indicates proportion of capital raised by top-20 Unicorn investors as a percentage of total on TTTM basis

data. Here are key headlines: 1) Leading Unicorn investors have raised roughly $83B in total capital across 110 funds since 2009; 2) Median committed capital per fund is roughly $550MM; 3) Out of the 110-ish funds raised by leading traditional venture capital and private technology growth investors, roughly 65 funds have $500MM or more committed capital, and 31 funds are $1B or larger; 4) Out of the $83B-ish committed capital or funds raised by these investors, roughly $50B in funds have been raised through large billion dollar funds – translating to 60% of total.

We believe that traditional venture capital firms raise new funds every 3-4 years, and LPs in such funds tend to wait 8-10 years until receiving distributions for their initial capital commitments. As the absolute amount of dollars invested by traditional VC & private growth funds has increased over the past 3-4 years, we think an increasing number of VC firms have felt the need to raise capital on an accelerated timetable. Effectively, we have witnessed a sustained and arguably accelerating trend among VCs raising mega-funds (or, as we coined, Unicorn VCs). As illustrated in the next chart, Unicorn VCs have garnered an increasing proportion of overall VC fundraising activity over the past five years. Recall that, the gross amount of dollars raised by all traditional VC and private growth funds has doubled from 2010 to 2015. And, during this period, Unicorn VCs have increased their relative share of wallet, essentially growing at a much faster pace than the overall market.

Significant dry powder available to support existing Unicorns and mint new ones

As a last step to gauge the supply of venture capital in next three to five years, we estimated the amount of dry powder or un-invested but committed capital accessible to VCs and Private Growth Tech investors. As a first step, we'd highlight that traditional VC & private growth funds tend to have a lifetime in the range of 10 to 15 years. This chart tracks the year in which a 10-year fund is dissolved. These later periods are referred to as "out years." Historically, after the 10th year, only a few companies that typically do not have huge upside potential remain in the portfolios. But the slow pace of exits in recent years has resulted in a number of good, mature companies remaining in portfolios well past the nominal 10-year mark. Per NVCA Yearbook, Life science funds tend to have lives two years longer than typical technology funds. And, according to research conducted by Adams Street partners (as illustrated above), the median life span of a fund in this analysis is 14.17 years.

As a second step (and as a simple gut check), we relied on global dry powder estimates published by Preqin and Bain & Company. According to Bain's 2016 Private Equity report, the pile of dry powder added in 2015 by private equity investors was roughly equal to about 25% of all new capital raised during the year, increasing the already sizable backlog of investible capital waiting to be put to work. Undeployed capital earmarked to finance venture capital and growth funds has seen the lion's share of the growth. At $460 billion, the total capital targeted for buyouts alone reached its highest level since 2009, followed by roughly $210 billion in dry powder in venture capital funds. We illustrate the 10-year trend in the chart above. Also, what's interesting to us is that VC dry powder has been growing at the fastest rate vs. other comparable asset classes.

Finally, based on Pitchbook data and Sharespost Research estimates, we estimated the amount of dry powder available to 20 leading traditional venture capital and private growth investors. Out of the $83B committed capital in the past 6.5 years, and given the roughly 10-15 years lifetime of a typical VC fund, we estimate approximately $30-40B in dry powder available in funds raised by leading Unicorn investors today. Given that VCs have record-levels of dry powder available to them, we think either of the following scenarios are likely to unfold over the next couple of years: (i) There may not be a dramatic uptick in the number of starving Unicorns, even if the ongoing IPO chill lasts longer than anticipated; and (ii) Despite the ongoing private valuation multiple reconciliation as well as the speculated pullback in activity of non-traditional private tech growth investors, there may continue to be a robust late-stage funding environment over

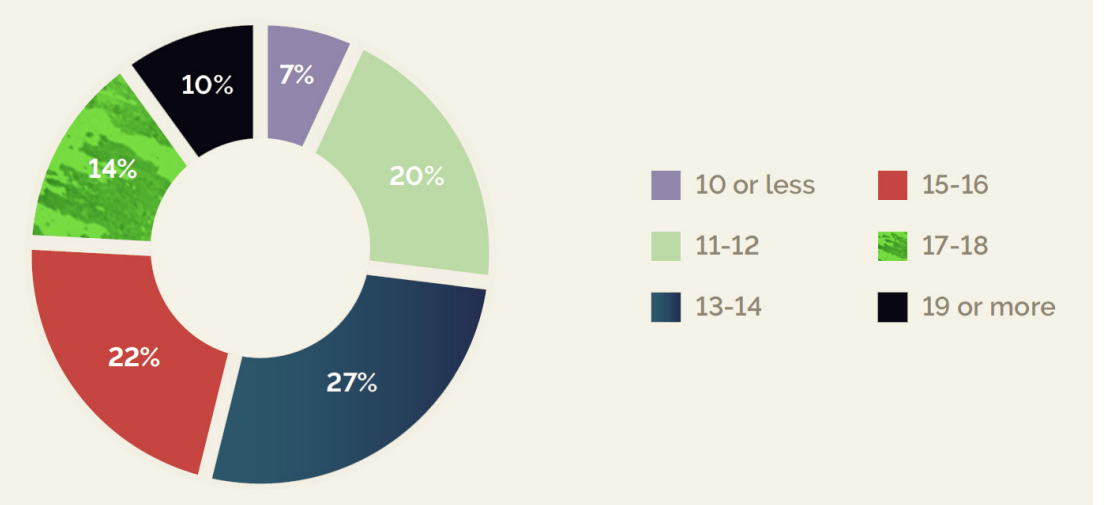


Exhibit 18: More than 70% of IT-Focused VC Funds Live More than 12 Years
Source: NVCA Yearbook; Sharespost Research; Adams Street Partners (2010 analysis); Chart indicates % of IT-focused traditional VC funds grouped by life in years

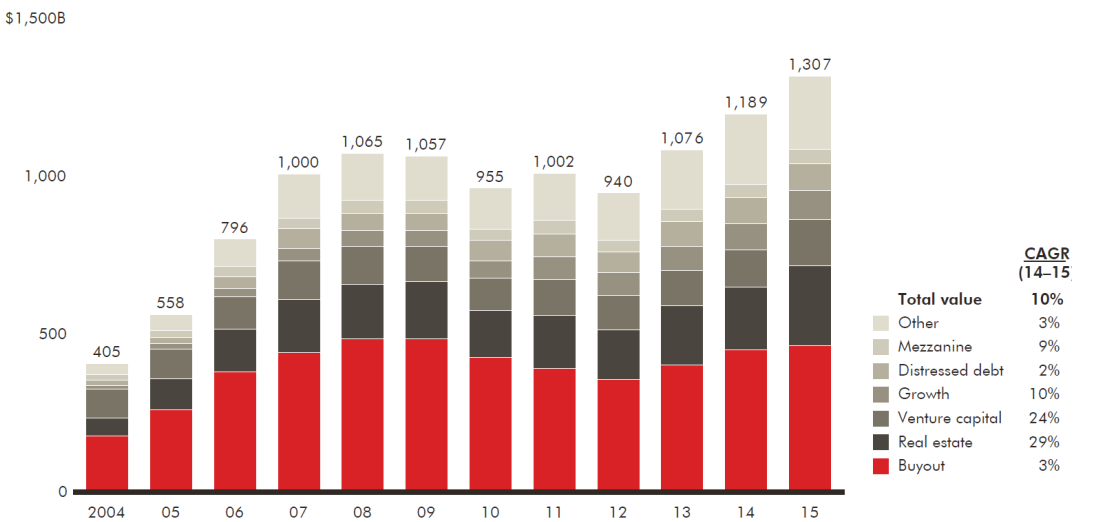


Exhibit 19: Uninvested dry powder hit record levels in 2015 for Private Equity Buyout & Venture Capital Funds
Source: Bain & Company 2016 Private Equity annual report; Preqin data; SharesPost Research; $ in billions

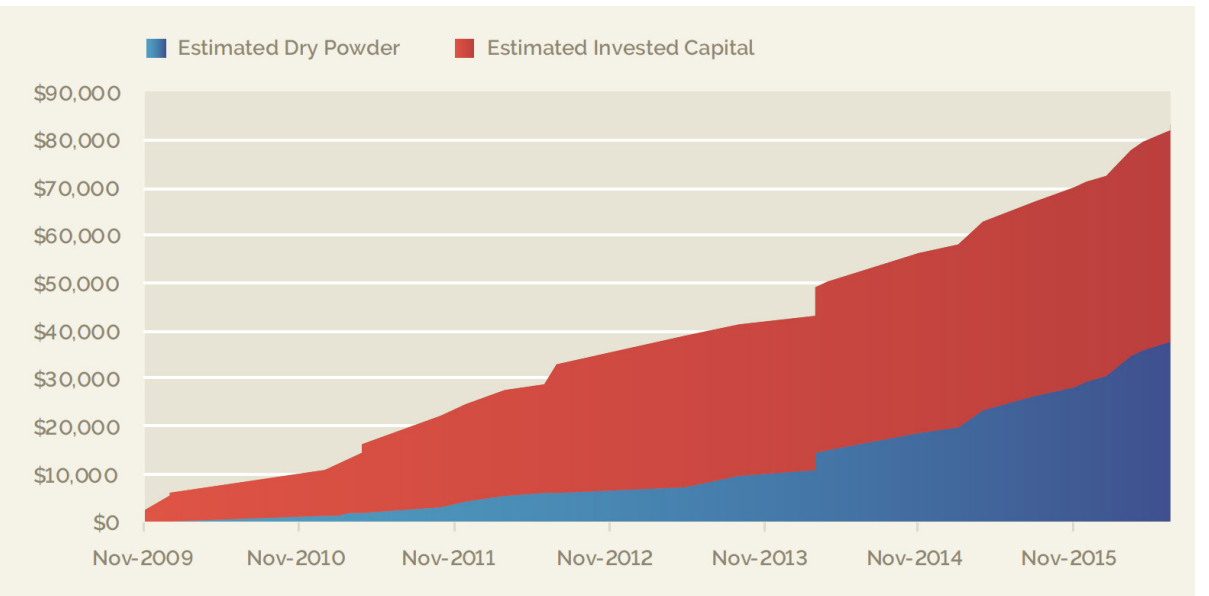
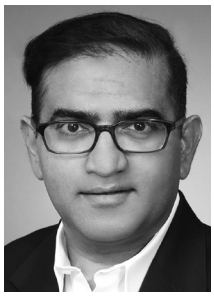


Exhibit 20: Roughly $30-40B in estimated dry powder out of $80-85B in committed capital
Source: Pitchbook data Sharespost Research; $ in millions

the next 24-36 months. And, this may lead to a steady uptick in Unicorn count as new Unicorns would continue to be minted and benefit from the fundraising activity among VC firms over the past 4-6 years. However, this analysis has a key caveat - if private tech growth investors face a liquidity crunch due to lack of Unicorn IPOs or M&A transactions, this may create a temporal "pig in a python" situation stunting the growth rate for new Unicorns. Put another way, private tech growth investors may not be able to "mint" new Unicorns with this fresh dry powder unless they realize returns from existing Unicorns. And, as highlighted in our recent report, excluding mega $500 billion dollar deals, VC investments have declined 10% year-on-year in 1H:16. In other words, all the raised capital, going by how investors have behaved so far in 2016 is not going anywhere in a hurry.

Author Bio



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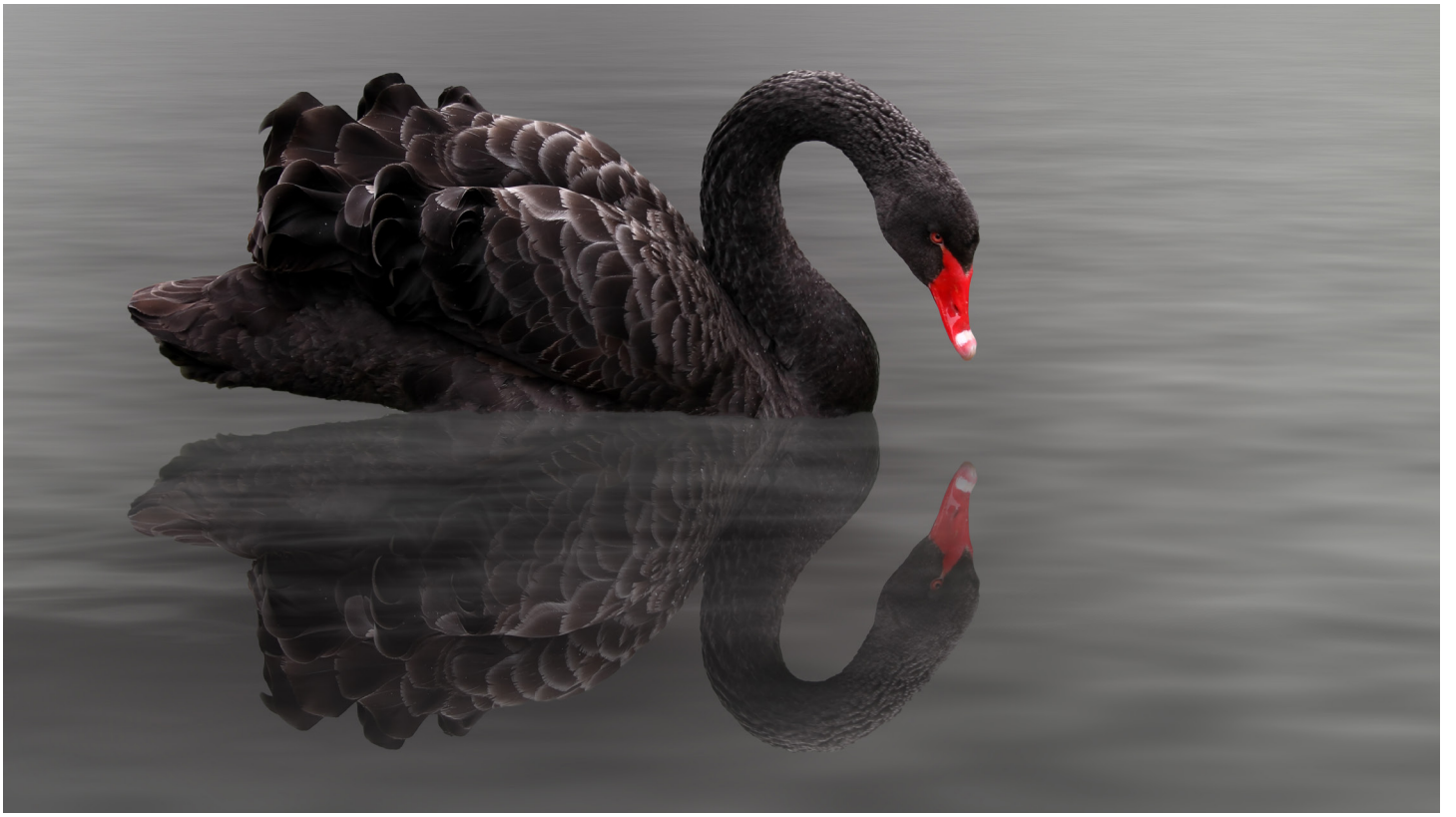
SharePost

Rohit is the head of research at SharesPost and manages all aspects of SharesPost platform's content, data, and analytics. Prior to SharesPost, Rohit was a Vice President, Senior Analyst at RBC Capital Markets, where he covered small and mid-cap stocks in the Internet sector and led the equity research efforts for several recent IPOs. Before that, Kulkarni was Equity Research Analyst, Internet and Interactive Entertainment, at Robert W. Baird & Co. Earlier in his career he worked for Citigroup, Houlihan Lokey and Oracle. Rohit received a 2015 Rising Star Award from Institutional Investor magazine for research in the Internet sector, and was a key member of top-ranked Internet research team in Citigroup (2008-2012).

Rohit received bachelor's & master's degrees in engineering from VJTI (University of Mumbai) and Rensselaer Polytechnic Institute, as well as an MBA in finance and strategy from The Wharton School. Rohit holds FINRA series 7, 63, 86 and 87 licenses.



Investing in an Overvalued Market and Tail-Risk Hedging

Michael Ning
PhaseCapital

Michael DePalma
PhaseCapital

The Case for Tail Hedging

Since the great recession officially ended in June 2009, risk has been rewarded and many risk assets have become very expensive in the process. The US central bank's vast financial engineering effort has created excessive liquidity in the banking system that, in turn, fueled asset bubbles. According to Citi, "eight years into the cycle—and one where QE has been the asset market driver—virtually every market appears rich" (Citi Research— Asset Allocation, 25 May 2017). Minutes from a Federal Reserve meeting indicate some members of the central bank opined that equity markets were significantly overvalued. When measured by the Shiller PE Ratio (also known as the Cyclically Adjusted PE (CAPE) Ratio), an indicator based on average inflation-adjusted earnings from the previous 10 years, current US equity market valuation is as high as pre-Great Depression 1929 and is exceeded only by the 2000 technology bubble. Despite some flaws, the Shiller PE Ratio is considered a better measurement of market valuation than typical formulations of the PE ratio because it eliminates ratio fluctuations that result from variations in profit margins during business cycles.

In Chart1 on the next page, we plot all the observations where the 3-year forward return on the S&P 500 is lower than 1-month T-Bill since 1934 against the starting level of the Shiller PE ratio when the downturn begins. The chart indicates that the maximum peak-to-trough loss of each bear market cycle is closely related to the level of market valuation.

A collapse of financial assets always threatens the real economy, its production, jobs, and price stability, and the ensuing ripple effects infer the existence of "tail risks." The notion of tail risk refers to the "tail" associated with a normal distribution of returns. Under normal market conditions, asset returns are clustered

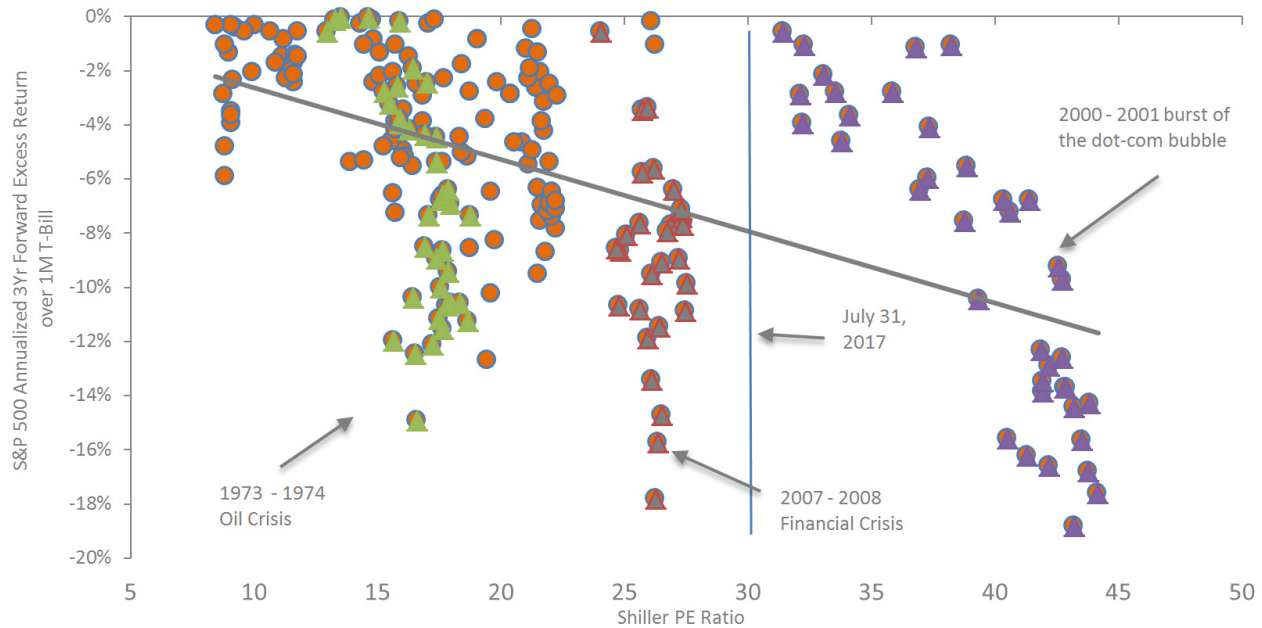


Chart 1: Maximum Drawdown Closely Related to Valuation
Shiller PE Ratio vs Historical 3Yr Drawdowns of S&P 500
Source: http://www.econ.yale.edu/~shiller, Bloomberg 1934.01-2017.07)

S&P 500 Daily Returns

	With losses exceeding	Predicted to occur once every	Actually occurred once every
2 SD Loss	-2.34%	44 days	40 days
3 SD Loss	-3.52%	741 days	113 days
4 SD Loss	-4.71%	31,574 days	254 days
5 SD Loss	-5.89%	3,488,556 days	531 days

Chart 2: Losses More Frequent Than Normally Assumed
Chart 2. Figures are calculated using daily data of the S&P 500 Total Return Index from January 2, 1928 to June 30, 2017.
Losses are tabulated as the mean minus the number of standard deviations. (Source: Bloomberg and PhaseCapital estimates)

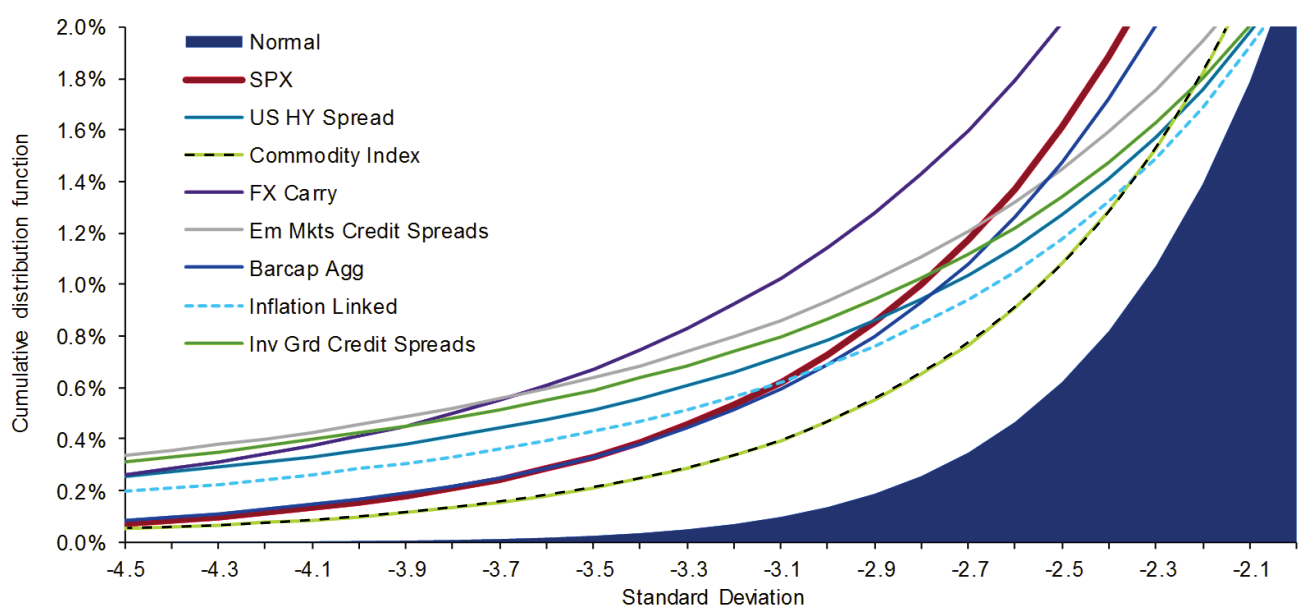


Chart 3: Fat Left Tails Not Limited to Stocks
Figures are calculated using index monthly data from Jan 1, 1992 to June 30, 2017.
Please see Appendix for index definitions. (Source: Bloomberg and PhaseCapital estimates)

around the average, and the chance that some fall well beyond the average follows statistical laws. Tail risk is a form of portfolio risk that arises when the possibility that an investment will move more than some extreme threshold, say three standard deviations from the mean, is greater than what is implied by a normal distribution. Tail risk defined this way includes both extreme positive and negative outcomes. In practice, risk should be viewed in the context of all outliers; however, for the balance of this paper we focus on negative outcomes, or left-tail events. The idea of buying protection against such a rare occurrence seems counter-intuitive, but history shows that real-world returns have not always behaved like a normal distribution. Left-tail events, with extreme drawdowns and volatility, occur more frequently than assumed using traditional models of risk and asset allocation. This is illustrated in Chart 2 by the pattern of daily returns for the S&P 500 since 1928. In a normal distribution, a three standard deviation loss should have occurred on about 28 days since 1928 (or once every 741 days). In reality, extremes losses occurred about seven times more often—on 198 days (approximately once every 113 days).

Not just limited to stocks, as can be seen in Chart 3, almost all asset classes exhibit fatter tails than implied by a normal distribution:

Large drawdowns impede compounding and can result in failure to achieve portfolio return targets. Since taking tail risk may not be compensated, tail risk is a "non-core" risk for most investors with limited ability to withstand market shock. In particular, this type of uncertainty is not welcomed by investors whose return path is critical, such as underfunded pensions. Given this backdrop and these fears, tail-risk hedging—or protecting investment portfolios against extreme negative moves in the market—has been a frequent topic of conversation among market participants in recent years.

Tail-Risk Hedging Strategies

There are many ways to approach tail-risk hedging, ranging from the orthodox purchasing of "insurance" via put options to constructing a portfolio of volatility-focused strategies.

A simple purchase of put options can span multiple asset classes, e.g. S&P 500 put, VIX call, receiver on US 10YR Rates, CDX Index payer, and put options on high beta currencies. While the buyer of an option gets a hedge, the seller requires a risk premium to compensate for the risk transfer. The value of an option is driven by price movements of the underlying asset and its volatility, among other things. A fall in asset prices or a rise in volatility would increase the value of the option; likewise, when volatility is low, options often trade at relatively lower prices.

Despite rich equity valuations, equity indices have reached repeated records since the US presidential election and volatility across a broad spectrum of asset classes is at or near the lowest levels in decades according to data compiled by Bloomberg (Chart 4). For example, one-month implied volatility on Treasuries (the MOVE Index) fell to the lowest level on record. In more pronounced fashion, the CBOE Volatility Index, or VIX, closed below 10 on ten straight sessions in July. Since its price history began in 1990, 17 of the 26 days on which the VIX Index closed below 10 occurred in 2017.

Today's overstretched asset prices and low volatility should mean historic opportunities to buy options. However, this traditional hedging strategy can still be expensive and may have limited benefit, even when tail events occur.

First, an option has a time-value component, becoming less valuable as it approaches expiration. This decay accelerates as the contract gets closer to expiration. Furthermore, options with different tenors often have different implied volatilities. While the spot VIX index hits record lows, VIX futures contracts expiring in 2018—a way to bet on where the VIX will be over the next

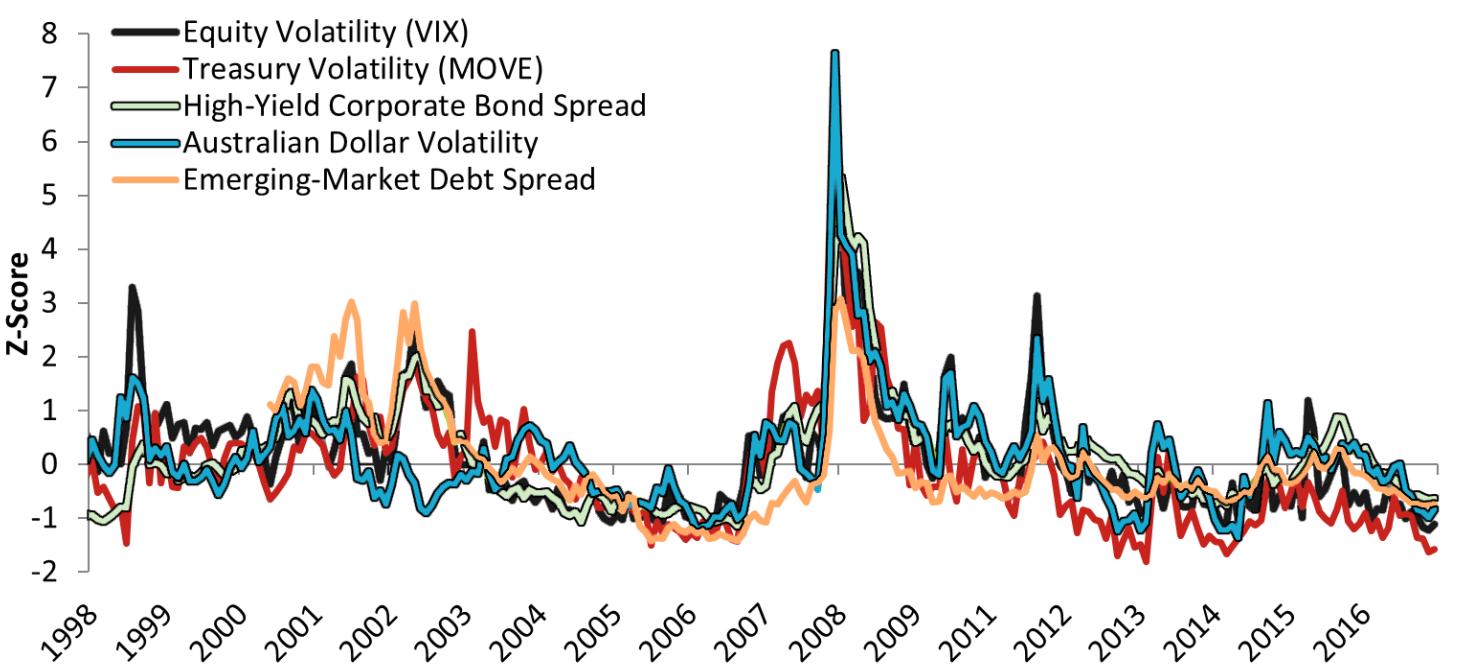


Chart 4: Volatility at Extreme Lows across
Figures are calculated using index monthly data from Jan 1, 1998 to June 30, 2017.
Please see Appendix for index definitions. (Source: Bloomberg and PhaseCapital estimates)

year—are at prices much closer to historically normal levels. When implied volatility curves are so steep—a condition known as being in "contango" where long-dated volatility is higher than short-dated volatility the decay in option value will proceed at an even higher rate.

Second, options with different "moneyness"—the difference between the strike price of the option and the current price of its underlying asset—are not priced uniformly. Since tail hedges specifically seek to achieve capital appreciation during periods of extreme market stress, at-the-money options are often too costly to fit into a hedging budget. While out-the-money options are cheap in nominal terms, their implied volatilities are usually higher, indicating that asset prices need to decline by more for the option to be profitable. The volatility skew is the difference in implied volatility between out-of-the-money options and at-the-money options (and sometimes, in-the-money options).

Both the slope of volatility curve and volatility skew are affected by sentiment and supply and demand, and they provide information on whether investors prefer to write calls or puts. At today's extreme levels it seems investors believe today's extraordinary calm won't last much longer. We may infer this because while implied volatilities are low across many asset classes, volatility skew is extremely high (Chart 5), indicating volatility curves are generally near their steepest levels.

As a result, many put options may not lead to effective tail protection, as illustrated by Chart 6.

As an example, let's assume one owned the S&P 500 stock index and purchased the S&P 500 put in the first line of Chart 6 as protection for one year. On July 26, 2017, a 1-year 9.55% OTM put trades at a premium of 2.55%. In 2008, the S&P 500 index experienced a loss of -38.49% (excluding dividends). Should a loss of similar magnitude happen again today, the equity portfolio would lose 38.49%, while the net gain on the put option would be 26.44% (38.49% - 9.55% - 2.55% = 26.44%). Therefore the put offers some protection but less than the decline in the market.

Buying options outright is a relatively inefficient way of achieving downside protection. To realize significant capital appreciation during periods of extreme market stress while minimizing the negative costs of tail hedges, a more nuanced active approach is needed, one that stems from identifying shared drivers of risk.

A Disciplined All Asset Approach to Tail Risk Hedging

All asset classes share exposure to a small set of common fundamental risk factors that explain their risk and return. Under normal circumstances, different asset classes are driven by a different set of factors, such as inflation and GDP growth, which can, and usually do, diversify each other. In a crisis, the

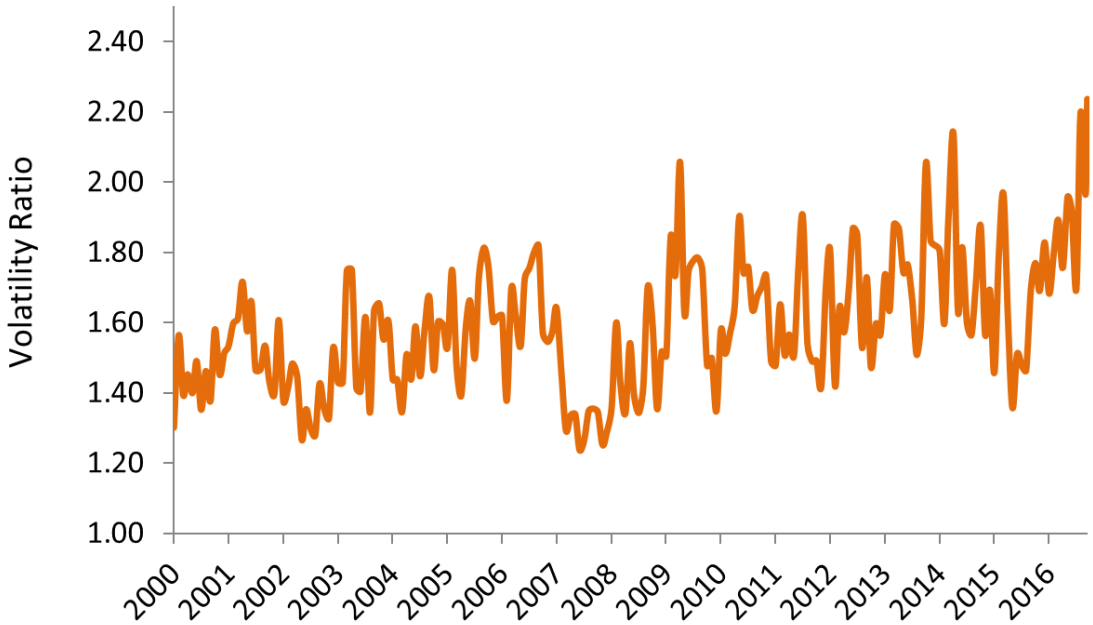


Chart 5: Steep Volatility Skew Implies Calm Markets May Not Last
Delta Put / 50 Delta Put Vol Ratio (Source: Bloomberg and PhaseCapital estimates)

1Yr Delta 25 Put/Call	Strike	Moneyness	Annual Cost	Annual Breakeven	2008 Gain	Gain/Cost
S&P 500 Put	2240	9.55%	2.55%	-12.1%	26.4%	10.2
VIX Call	35	25.9 pts	14.40%	+26.8 pts	37.7%	2.6
Receiver, US 10yr Rates	1.89	36 bps	0.87%	-45 bps	14.9%	17.1
Payer, CDX IG 5yr	110	54 bps	0.15%	+58 bps	2.3%	15.3
BRL Put	3.68	17.40%	2.66%	-20.00%	3.10%	1.2

Chart 6: Put Options Offer Limited Protection Today
Hedging Cost as of July 26, 2017 (Source: Bloomberg and PhaseCapital estimates)

usual drivers of performance may be superseded by a different set of factors that affect all asset classes in a similar way, such as volatility, correlation, and liquidity. These factors act as a common link between asset classes, and returns on different assets can be highly correlated in times of crisis. As a result of these relationships, left-tail events often expose many strategies as having a "short" position in volatility, correlation, or liquidity, each of which tend to suffer. Therefore, we believe one of the keys to the success of tail-risk hedging is to identify cost effective ways in which an investor can seek exposure to "long volatility," "long correlation," and "long liquidity":

- Long Volatility: positions that are expected to benefit from exposure to volatility. Volatility is highly correlated across asset classes and has historically spiked during tail events
- Long Correlation: positions that are expected to benefit from the tendency of cross-asset and intra-asset correlations increasing during tail events
- Long Liquidity: positions that are expected to increase in value due to dissipating liquidity during extreme market events (financing, ability to transact, bid/offer, high yield/investment grade spreads, etc.)

Markets do not always price risks across markets in a uniform manner. While different asset classes all tend to experience tail risk during times of extreme market stress, there can be wide dispersion under more normal market conditions. This implies that while all forms of tail-risk protection become expensive in a crisis, for the rest of time the cost of tail-risk hedging strategies can vary greatly, and some of the instruments that provide protection are more expensive than others. To implement tail-risk hedging strategies that are volatility-, correlation-, and liquidity-centric in an efficient manner, the tail hedge universe should span all assets and include derivatives in the global equity, credit, FX, rates, and commodities markets.

With the ability to employ all asset classes and instruments, an investor can construct trades based on what is the most efficient direct or indirect opportunity. Direct tail hedges typically involve assets that carry a risk premium, such as emerging market currencies or high-yield debt—we think of them as being "short-tail risk" because when volatility rises and/or liquidity dries up, they are likely to lose money. Examples of such strategies include:

- In equities, put options benefit when equity prices fall and volatility rises.
- Call options on equity volatility (such as futures on the VIX index) benefit when volatility rises.
- In currencies, options can be used to construct hedging strategies. One example is an "anti-carry" trade that takes a long position in low yield currencies like the Japanese yen and a short position in a high-yield currency like the Australian dollar. The idea is that higher yielding currencies typically underperform safe haven currencies when market participants become more risk averse.
- In fixed income, interest rate swaps can be used to take duration exposure so that the portfolio benefits when panic triggers a flight into US Treasuries or other safe havens, and yields fall.
- In credit, credit default swaps benefit if spreads on corporate bonds widen. Credit default swaps can also be purchased to insure against default of a basket of liquid corporate debt issuers.
- Indirect hedging strategies are derived from economic and empirical linkages across different assets, and seek to exploit underlying drivers of price movements. Indirect tail hedges sometimes offer superior hedge benefit potential per unit of cost than direct hedges. For example:
- Credit default swaps can be used to construct a spread duration neutral credit curve flattener—a short position in 3–5 year spreads and a long position in 5–10 year spreads. Credit curves tend to flatten in an economic crisis, with shorter maturities underperforming as default risk jumps.
- Volatility dispersion trading exploits relative value differences in implied volatilities between an index and a basket of its component stocks. The strategy typically involves a long option position on an index, against which short option positions are taken on a subset of index constituents. A dispersion trade is a type of a correlation trade as it usually losses money when the individual stocks are not strongly correlated (i.e., dispersion is high) and is profitable during stress periods when correlations rise (i.e., dispersion decreases) among the index members.

Tail hedges, direct or indirect, with higher unpriced macro or idiosyncratic upside potential may provide significant value. It takes in-depth research to identify pricing anomalies. Investors need to evaluate potential tail hedges based on the macro and idiosyncratic properties of the investment and instruments used to gain exposure. A screen can be designed to filter out the most attractive trade candidates, and rank opportunities that are highly price-sensitive with positive convexity to market movements. In Chart 7 on the following page, we analyze each trade based on three key metrics: z-score, correlation, and convexity. The z-score measures how cheap or expensive it is to enter the trade from a historical perspective. The correlation measures how the trade reacts to daily changes of the S&P 500 index over the past 90 days. Finally, the convexity, derived from differences in the trade's sensitivity to upside and downside movements of the market, measures its potential as a good tail hedge. The total rank is calculated as the combination of all three metrics. In addition to the ranking, we also examine the total cost of each trade by breaking down its carry and roll cost so that we can strike a balance between hedging cost and trade effectiveness.

Other factors worth taking into consideration include if a trade can be used to balance tail-risk exposures and allow for executable monetization of gains during calmer markets. More importantly, a tail hedge may only work in certain macro regimes. Many tail hedges are proxy hedges bearing macroeconomic or idiosyncratic risk and rarely surface with any consistency. For example, during the financial crisis, the long end of yield curve (10-year–30-year) had a tendency to flatten when VIX rose, with 30-year treasuries outperforming as growth and inflation expectations fell. In more recent periods, we often observe the opposite dynamic: when

Strategy	Trade Type	Rank	Total Cost	Carry	Roll	Z Score	Correlation	Beta	Beta +	Beta -	Convexity
CDX_HY_5	Long Protection	90%	510	321	189	0.9	-78%	-7.7%	-7.4%	-8.2%	0.77%
CDX_IG_5	Long Protection	86%	110	58	53	1.0	-79%	-1.8%	-1.8%	-1.8%	0.05%
CDX_IGHY_3X1	Decompression	85%	179	148	31	0.7	-51%	-2.3%	-2.0%	-2.6%	0.62%
CDX_IG_0510_DV01	Curve Flatte				44	1.1	-69%	-1.7%	-1.7%	-1.7%	0.04%
CDX_EM_5	Long Protection	83%	225	186	39	0.9	-53%	-3.6%	-3.6%	-3.7%	0.10%
CDX_IG_10	Long Protection	81%	154	105	49	0.8	-62%	-1.5%	-1.5%	-1.6%	0.05%
iTraxx_IG_5	Long Protection	70%	100	52	48	1.3	-52%	-1.3%	-1.7%	-0.9%	-0.85%
CDX_IGHY_4X1	Decompression	70%	69	91	-22	0.5	-13%	-0.5%	-0.2%	-0.8%	0.58%
NZD_S0305	Curve Flattener	69%	55	32	23	0.1	-24%	-0.5%	-0.3%	-0.6%	0.30%
ZAR_CDS_5	Long Protection	69%	306	178	128	0.2	-28%	-2.8%	-2.7%	-2.8%	0.13%

Most Attractive Trade

Chart 7: Screening for Opportunities
Screening for Opportunities (Source: PhaseCapital)

equity markets sell off, investors expect the Fed to maintain stimulus for longer, benefiting 5–10 year bonds more. Chart 8, below demonstrates this empirically.

Obtaining Tail Protection at a Reasonable Cost

Why would cost-effective tail-risk hedging trade opportunities exist? We believe in the existence of multiple market equilibria in markets dominated by hedgers (e.g. VIX) and by risk-takers (e.g. Emerging Market debt). As a result, we have researched and implemented strategies that allow investors to be long protection in a very cost-efficient manner.

One way to do this is by making an exchange in which one can trade off (sell) insurance against higher-frequency/low-impact events in order to fund the purchase of insurance against the much more damaging lower-frequency/high-impact events. This opportunity presents itself in many different markets. A classic example is one can sell protection on riskier credit tranches and buy protection on the least risky credit tranches in a structured Collateralized Debt Obligation (CDO). Protection on riskier tranches is expensive (and selling it is lucrative) because the market expects a few defaults even under normal conditions. Conversely, protection on the least risky tranches is cheaper because the market doesn't expect many defaults unless an extreme scenario unfolds. Put options on these "super senior" tranches become more valuable during times of market stress because investors start worrying about the potential for a much higher number of correlated defaults.

A simple analogy would be to automobile insurance premiums with a high deductible. The higher the deductible, the lower the annual premium charged by the insurance company. If you have a high deductible policy, you are willing to cover the costs of dents, scratches, and other minor incidents (high frequency/low impact) in order to have a lower premium for collision and other more costly accidents (low frequency/high impact).

Another approach is to seek active opportunities for tail hedging. Intrinsic factors, such as investor behavior and extrinsic factors, such as central bank policy, can cause dynamic variation in the pricing of tail risk and allow investors to be "long-tail risk" in a cost-efficient manner. Ex-ante, under appreciation and/

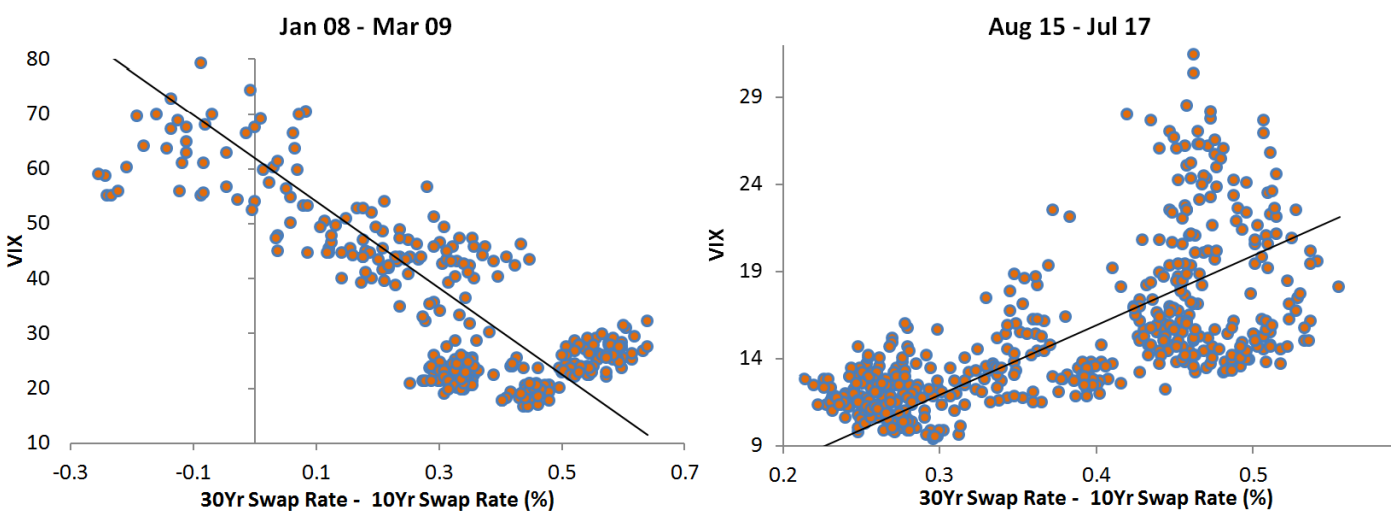


Chart 8: Hedge Performance May Vary with Macro Regime
VIX vs. 30Yr Swap Rate — 10Yr Swap Rate Left: Jan 08– Mar 09 Right: Aug 15– Jul 17 (Source: Bloomberg)

Chart 9: Potential Benefits of implementing a Tail Hedge Strategy
Potential Benefits of implementing a Tail-hedge strategy

or mispricing of these financial factors can potentially create attractive opportunities. These types of trades include exploiting the term structure of interest rates and credit markets discussed previously. For example, earlier we referred to both a yield curve and credit curve flattener. If curves are particularly steep, these positions can pay for themselves because long maturities compensate investors so well in the form of carry and roll return.

Conclusion

We have witnessed one of the longest expansions in modern US history. If conventional wisdom holds, we should expect an economic slowdown in the next 12–24 months, and stocks are likely to struggle in the years that follow. That being said, short-term market moves are impossible to forecast, and the starting point of those past downturns is uncorrelated with market valuation. Even Robert Shiller has admitted that his metric "is not suggesting, necessarily, any imminent disaster." With both aggregate credit growth and corporate earnings growth still accelerating, the current expansion has no end in sight. Accordingly, a reasonable conclusion for investors might be to remain invested, but to do so with fear.

An option investors should consider in order to remain invested with fear is to add a tail-risk hedging component to their portfolios. Since tail-risk hedging strategies should take the form of an active overlay program, investors can stay in the current investment strategy without incurring extra costs of managing any operational complexity. In addition, incorporating a tail hedge strategy allows for increased allocation to risk assets, among other benefits. Some of the potential benefits of including tail-risk hedging in a portfolio are displayed above in Chart 9.

We believe a successful tail-risk hedging strategy needs to cover the following aspects:

- A macro framework to identify the current macro regime, assets that benefited disproportionately, and the ability to evaluate the regime migration path and its impact on markets
- Seek opportunities across multiple asset classes
- Seek cost-effective strategies to reduce premium spend
- Disciplined rebalancing and monetization process

In an environment where valuations are high, volatility is low, and the performance of CTAs and other defensive strategies has been lackluster, tail-hedging strategies can help meet the needs of investors who seek to achieve return targets while preserving capital.

Authors' Bios

Michael Ning, *Ph.D, CFA*
PhaseCapital

Michael Ning joined PhaseCapital in November 2016 as the Chief Investment Officer. Previously, he was Senior Vice President and portfolio manager of First Eagle's Multi-Asset Absolute Return and Tail Hedge strategies. Prior to joining First Eagle in April 2013, Mr. Ning was Senior Vice President, Head of Credit Research, and portfolio manager for the Absolute Return Group at AllianceBernstein, managing 70 $bln Global Credit products, the Enhanced Alpha Global Macro Fund, Tail Hedge and Unconstrained Bond strategies. Before joining AllianceBernstein in 2004, Mr. Ning was a Senior Research Analyst at Citigroup. He has expertise in the research, development and management of trading strategies across global macro, equity, credit, rates and currencies. Mr. Ning received his PhD from Oxford University. He holds the Chartered Financial Analyst (CFA) designation.

Michael DePalma
PhaseCapital

Michael DePalma joined PhaseCapital in June 2016 as Chief Executive Officer. He previously worked at AB (formerly AllianceBernstein) where most recently Mr. DePalma was Senior Vice President and Chief Investment Officer for Quantitative Investment Strategies, AB's systematic multi-asset and alternatives business, as well as Director of Fixed Income Absolute Return. Prior to that, Mr. DePalma was Director of Fixed Income and FX quantitative research globally and portfolio manager for AB's quant-driven multi-strategy hedge fund. Early in his career, Mr. DePalma was part of the team that developed AB's Capital Markets Engine and Wealth Forecasting System, the technology at the core of all the asset allocation services delivered to clients. Mr. DePalma graduated with a B.S. from Northeastern University and a M.S. from New York University's Courant Institute of Mathematical Sciences.

Should DC Plan Sponsors Add Private Equity To Target-Date Funds?

Andres Reibel
Pantheon

Executive Summary

In this paper, we studied how the inclusion of Private Equity in custom Target-date Funds (TDFs) affects the return profile of TDFs – more specifically, our approach focused on including Private Equity in TDFs while keeping their risk profile unchanged. From a practical point of view, this analysis allowed us to research whether adding Private Equity to TDFs has the potential to enhance investors' retirement returns without assuming additional risk. Our results suggest that a pension plan member could potentially increase the total amount saved and distributable in year 45 by approximately 8.7%.[1]

There are two ways we could have performed this analysis, retrospectively using actual historical Private Equity returns or, as we have conducted it, prospectively using assumed forward returns for which we have used the J.P. Morgan Asset Management's 2016 Long-term Capital Market Assumptions.[2,3] We have taken this approach because it is more conservative than using historical returns as the J.P. Morgan forecast factors in declining excess private equity returns.

We based our analysis on the data of two financial institutions. We sourced the return, variance and correlation data from J.P. Morgan Asset Management's 2016 Long-term Capital Market Assumptions as mentioned above. This is an annual publication that represents one of the industry's most established and comprehensive sets of expectations for how risk, return, and correlations across asset classes may develop over the coming decades. Further, we sourced our TDF glide path data (i.e. TDF asset class weights) from Fidelity, a leading TDF provider. The TDFs we sourced from Fidelity had maturity dates between 2020 and 2060.[4,5] Since the maturity dates of the sourced TDFs lie in the future, the glide path data represents Fidelity's current expectations

of future asset allocations. We then used a well- established financial framework[6] that allowed us to quantitatively measure and demonstrate that adding Private Equity to a 45-year custom TDF had the potential to enhance expected returns, while keeping risk constant.

In particular, we were interested in determining whether we could increase the return potential of custom Target-date Funds ("TDFs") by changing the asset allocation mix to include assets with higher return potential, including Private Equity, whilst not changing the risk profile of the TDF. Our results show that we could improve the return potential of TDFs, while not increasing risk, which could potentially enhance investors' retirement income by 8.7%.

Key Findings

This study showed that investors may potentially increase expected returns over the 45-year life of a TDF by including Private Equity, while not increasing risk. We found that plan sponsors would need to have allocated 7.1% of their portfolio to Private Equity during the first 30 years (first six rebalancing periods) of the TDF and then reduce the allocation to Private Equity to 6.98%, 6% and 5.28% in years 30, 35 and 40, respectively. We found that we could indeed achieve potentially improved outcomes through changing the asset allocation mix. Depending on the annual contributions made by plan participants, the additional savings over the 45 year period vary. This is illustrated in the table to the right, "Additonal Savings over 45 years." Specifically, we found that a pension plan participant who invests $6,424 annually7 could potentially increase the total amount saved and distributable at maturity by approximately 8.7%, or in dollar terms, from $1,982,038 to $2,154,832 or by approximately $172,7948 .

We further found, through extension of the study, that higher allocations to Private Equity in the first 30 years of the TDF, could potentially increase the TDF's performance further still, while not significantly increasing risk9 . These results may be of particular interest to Plan Sponsors that are interested in committing higher allocations to Private Equity10. The key results of this extension can be found later in this paper.

Introduction

Over the last decade, custom TDFs have grown in popularity among DC Plan Sponsors and experienced strong inflows in assets – the persistence of this trend indicates that TDFs are likely to play an ever-increasing role in the future DC market.[11]

As discussed in the Executive Summary, Defined Contribution (DC) Plan Sponsors could, in our view, reassess their approach to strategic asset allocation by considering high-yielding asset classes such as Private Equity.

To derive intelligible conclusions, we asked ourselves two fundamental questions:

1. Could adding Private Equity to TDFs potentially improve the performance of TDFs?
2. Could this potentially be achieved without altering the risk profile of TDFs?

Additional Savings over 45 years

Annual Retirement	Additional Savings
$6,424	$172,794
$12,000	$322,779
$18,000	$484,168

In the analysis that follows, we described our scientifically rigorous approach to addressing these important questions in which we applied financial models that measured the effects on risk and expected returns of custom TDFs when adding Private Equity.[12]

Comparing Risk and Return of a TDF Including Private Equity to a TDF Excluding Private Equity

In our view, investors interested in adding Private Equity to their TDF would likely be seeking to increase expected returns without incurring additional expected risk.

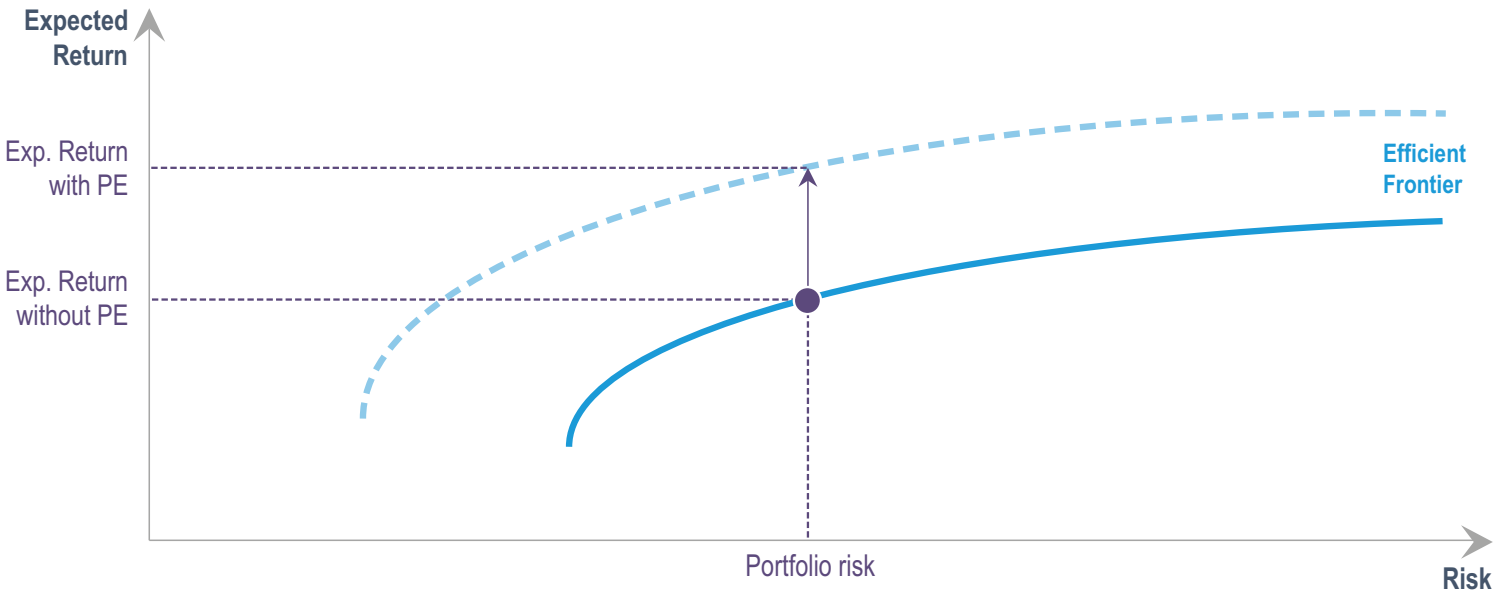
Therefore, we believe that the approach we chose would most likely be of particular relevance to these investors.

To conduct our analysis we used a well-established financial framework[13] that we applied to two datasets of financial institutions.[14,15] Our analysis quantitatively measured and demonstrated that adding Private Equity to a 45-year custom TDF, the typical glide path for a TDF, had the potential to enhance expected returns, while keeping expected risk constant.[16] To understand our approach we think it is insightful for the reader to consider the illustration below. The graph illustrates how adding Private Equity to a portfolio can potentially shift the efficient frontier to the upper left corner, essentially increasing investors' return potential, while keeping risk unchanged and therefore improving the portfolio's risk- return ratio (i.e. Sharpe ratio[17]):

In order to analyze how adding Private Equity to a TDF changes the risk and expected returns of the TDF, we compared a TDF including Private Equity to a TDF excluding Private Equity. We approached this comparison using the below three-stage procedure.

1. Measure the risk of the TDF excluding Private Equity.
2. Fix the risk of the TDF including Private Equity to that of the TDF excluding Private Equity and find the portfolio weights that optimize returns.[18]
3. Compare the returns of the TDF excluding Private Equity to that of the TDF including Private Equity.

First, we defined the core composition of our standard TDF; the standard TDF has a life span of 45-years with a glide path that rebalances in five-yearly periods and has no allocation to Private Equity.[19] In other words, our standard TDF presented the standard solution that is generally available to DC plan members



Graph 1: CAPM

and we therefore refer to it as the "standard TDF" throughout this paper. We measured the risk and expected returns that our standard TDF is expected to yield.

In the second step, we added Private Equity as an asset class that may be included in the TDF's glide path. Our financial framework decided the weight each asset class was assigned in a way that it produced the highest risk-return ratio.[20] Should Private Equity be able to enhance the risk-return profile of the standard TDF, then some of the weight of the standard TDF's glide path was reallocated to Private Equity. We followed this procedure for each of the nine rebalancing periods and so reallocated weights across all asset classes over the entire 45-years of our standard TDF. Since the risk of the TDF including Private Equity was kept equal to that of the standard TDF (excluding Private Equity), observing the change in returns allowed us to assess the benefits of adding Private Equity to a standard TDF.

Time-horizon Considerations

Note that this study's return, volatility, correlation data, and portfolio analysis used five-year time-horizons and as such the performance of the TDF should only to be judged over five-year horizons. We chose the five-year time horizon as it is aligned with the five-yearly rebalancing periods of the TDF.[21] It is important to note that the performance of the TDF for time periods of less than five-years may substantially differ from the five-year performance statistics.

This is important to understand as, for example, public markets tend to be more volatile than private markets over shorter time periods; therefore, while investors may experience substantial under or overperformance in Private Equity in any individual year due to volatility differences between asset classes, the excess performance potential of Private Equity investments should result in an outperformance over longer time periods. Note that we chose to express our results in terms of annualized numbers where appropriate.

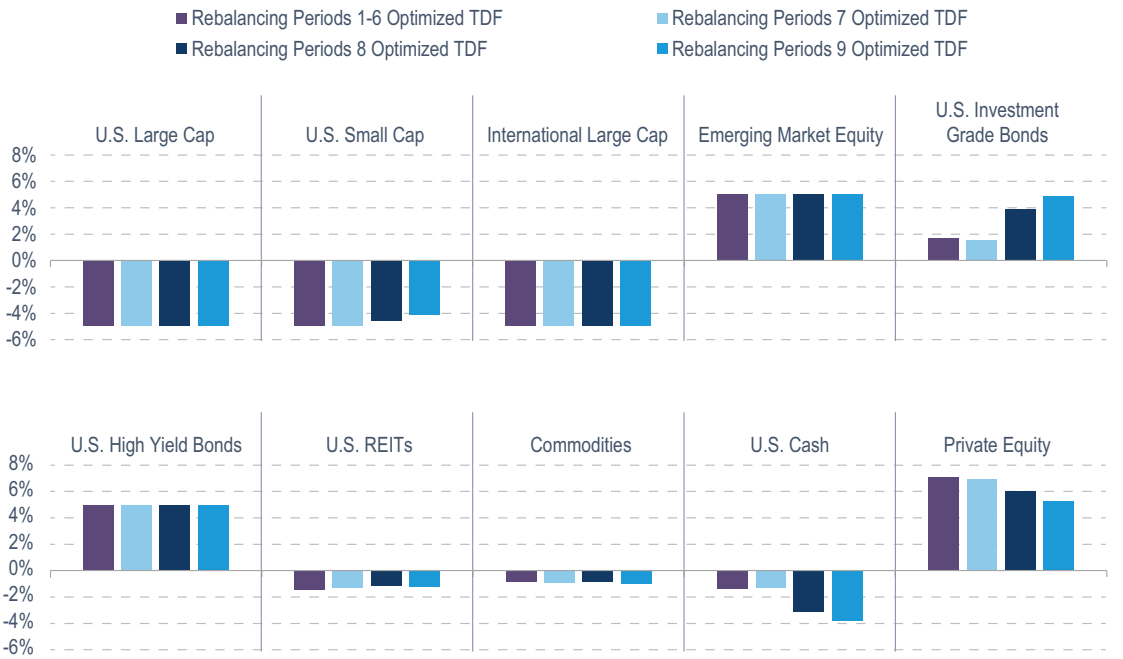
Results and Conclusion

What is the impact on the expected returns of the standard TDF if we fix its risk and add Private Equity as an investment option?

To answer this question, we were interested in understanding how the portfolio optimization affected the portfolio allocation (glide path) across rebalancing periods and performance of an optimized TDF when including Private Equity and fixing risk to that of a TDF excluding Private Equity.[22] We summarized the results of our analysis in Graph 2 and Graph 3 on the following pages. Having fixed the risk as a key parameter, the optimization selected the asset allocation that would maximize portfolio returns – an increase in allocation to higher-yielding asset classes, such as equities and a decrease in allocation to lower-yielding asset classes, such as investment grade bonds, was therefore also expected.

Below we set out the resulting change in the allocation and performance statistics across rebalancing periods and asset classes in more detail:

1. Importantly, the optimized TDF experienced a shift in weights in the first six rebalancing periods in favor of Emerging Market Equity (+5.0%), U.S. High Yield Bonds (+5.0%), and Private Equity (+7.1%).[23] Further, the optimized TDF experienced an increase in annualized expected return of 0.27% (i.e. the TDF's annualized expected return increased from 5.0% to 5.3%), while risk was kept constant by definition.
2. Further, the optimization of the TDF in the first six rebalancing periods resulted in a sharply reduced allocation to U.S. Large Cap (-5.0%), U.S. Small Cap (-5.0%), International Large Cap (-5.0%), while U.S. REITs (-1.5%), U.S. Cash (-1.4%) and Commodities (-0.9%) were moderately reduced. Interestingly, the allocation to U.S. Large Cap, U.S. Small Cap and International Large Cap decreased noticeably, even



Graph 2: Reallocation of Asset Class Weights When Adding Private Equity to the Standard TDF

Graph 2 shows, based on the study, the percentage change in portfolio weights across asset classes between a standard TDF excluding Private Equity and an optimized TDF including Private Equity. The optimized TDF maximizes returns, while keeping the same risk profile as a standard TDF excluding Private Equity.

though these asset classes tend to be relatively high-yielding; these results showed that for an optimized TDF including Private Equity, U.S. Large Cap, U.S. Small Cap and International Large Cap needed to be de-emphasized in order to achieve the highest possible risk-return ratio. These changes in asset allocation were fairly persistent throughout the life of the TDF; please see Graph 2 for details regarding rebalancing periods 7, 8, and 9.

3. In rebalancing period 7, the optimal portfolio allocated 6.98% to Private Equity and the TDF yielded a 0.26% higher expected return than the standard TDF. In rebalancing period 8 with a 6% Private Equity exposure, the TDF yielded a 0.27% higher expected return than the standard TDF. Finally, in rebalancing period 9 with a 5.28% Private Equity exposure, the TDF also yielded a 0.27% higher expected return than the standard TDF.

Key Conclusion

When optimizing the asset allocation of a TDF including Private Equity and fixing risk to that of a standard TDF excluding Private Equity during the first 30 years of the TDF, Private Equity obtained a 7.1% allocation; the return potential of the TDF may be improved by approximately 0.27% annually.

Further, optimizing the allocation to Private Equity while keeping the risk constant to that of the standard TDF in the last three rebalancing periods resulted in an allocation to Private Equity of 6.98%, 6.0%, and 5.28% in rebalancing periods 7, 8, and 9, respectively. The optimized TDF including a Private Equity allocation resulted in an increase in expected returns of 0.26%, 0.27%, and 0.27% in rebalancing periods 7, 8, and 9, respectively.

On average, the performance of the optimized TDF including Private Equity increased by 0.27% p.a. over its 45 year life. As explained in the Executive Summary, by compounding this additional return, a retiree's total amount saved potentially would have increased by approximately 8.7%.[24]

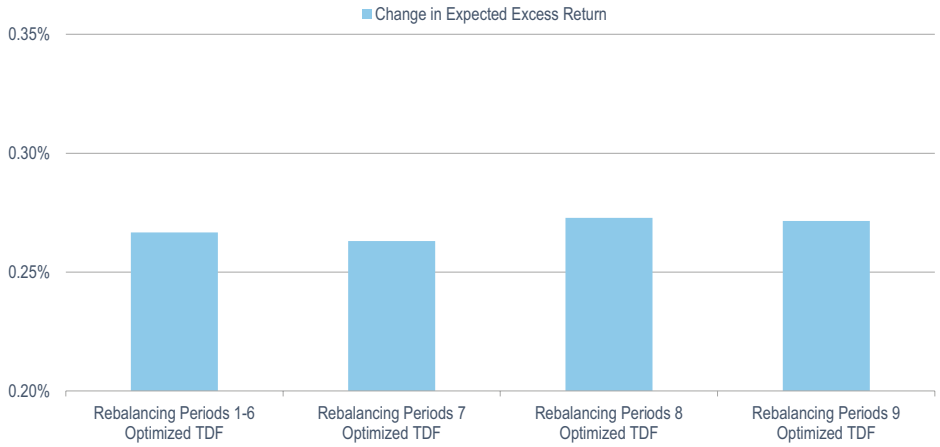
Study Extension – Higher Allocations to Private Equity in the First 30 Years

In this section of the study we analyzed how higher allocations to Private Equity may affect the performance of the TDF in the first 30 years of its life (first 6 rebalancing periods). To conduct our analysis, we first optimized the TDF's performance when including Private Equity and assuming that risk was fixed to that of the standard TDF. From the allocation of the optimized TDF with 7.1% exposure we then adjusted the allocation to non-Private Equity asset classes as we increased the allocation to Private Equity to 8%, 9.4% and 10%, respectively.[25]

We found that for Private Equity allocations of 8%, 9.4%, and 10% the expected return potential of the TDF when compared to the standard TDF improved by 0.28%, 0.3%, and 0.3% p.a. respectively.[26] Further, we found that despite the reallocation of asset class weights, we did not observe considerable increases in the TDF's risk profile. We therefore concluded that investors that seek exposure to Private Equity of up to 10% may potentially do so without incurring significantly higher risk, while substantially increasing their return potential, which ultimately resulted in an improvement of the TDF's risk-return profile when compared to the standard TDF.

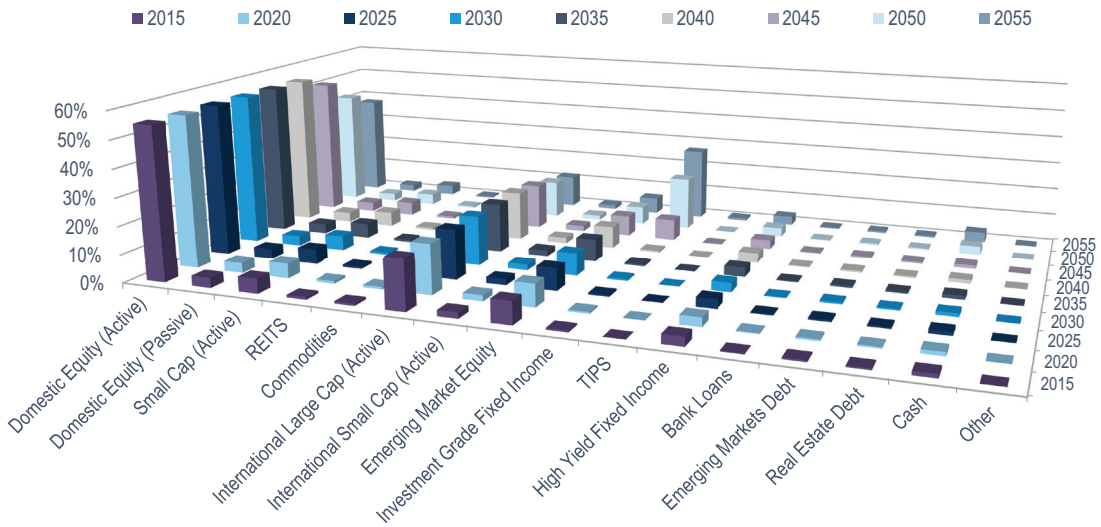
Data and Methodology

First, we required the glide path of a representative TDF. We obtained our glide path data from standard Fidelity TDFs with maturity dates between 2020 and 2060.[27] We derived the weights for our standard TDF's glide path from this data and so generated a TDF with inception in 2015 and the last rebalancing period in 2055. The glide path is rebalanced every five years and



Graph 3: Change in TDF Performance When Adding Private Equity (and Keeping Risk Constant)

Graph 3 depicts the difference in annualized excess returns between a TDF including Private Equity and a standard TDF. Our analysis showed that including Private Equity in a TDF has the potential to increase expected (excess) returns by approximately 0.3% – this increase can be achieved without assuming additional risk.



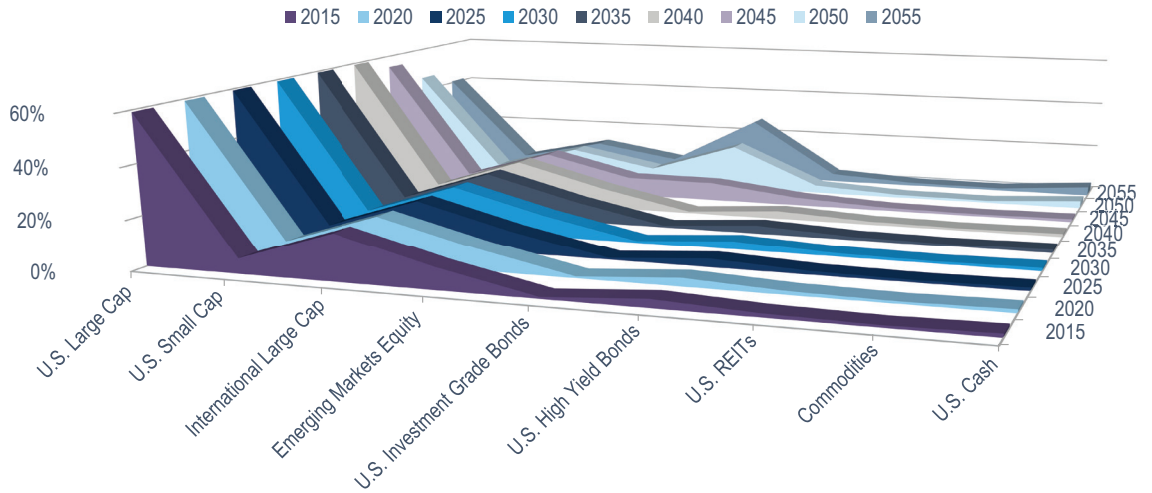
Graph 4: Original Fidelity Standard TDF Glide Path

Graph 4 depicts the allocation across asset classes in each of the nine rebalancing periods of the original TDF glide path data (Fidelity) that we used in this study. Since the maturity dates of the sourced TDFs lie in the future, the TDFs glide path data represents Fidelity's current expectations of future asset allocation.

de-risks over time by shifting weight toward less risky assets. Graph 4 represents the asset allocation according to the original Fidelity TDF. (See Table 2 in Appendix)

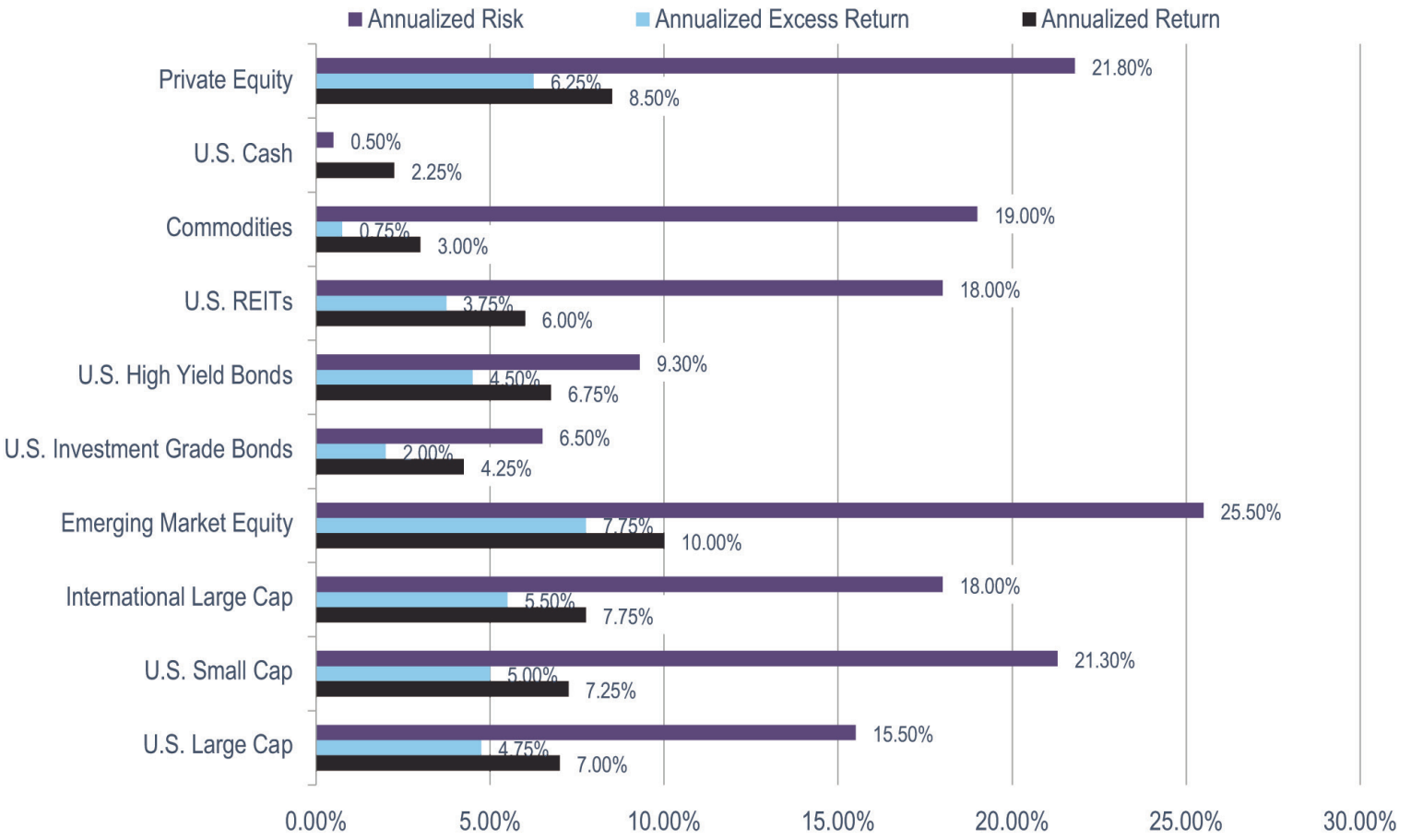
Second, we sourced the corresponding return and correlation data that we needed to conduct our analysis from J.P. Morgan Asset Management's 2016 Long-term Capital Market Assumptions.[28] J.P. Morgan's Long-term Capital Market Assumptions have been published for the last 20 years – this dataset provided the annual assessment of the long-term outlook across all major asset classes and markets. Note that we proxied for the risk-free asset using the return on U.S. Cash as provided in the J.P. Morgan dataset. The J.P. Morgan asset class definitions do not exactly match those of the Fidelity glide path and therefore we needed to make some simplifying assumptions in order to aggregate some of the asset classes described in the latter to match the former. For purposes of this study, we chose to reallocate weights as follows: we aggregated (U.S.) Domestic Equity (Passive) and (U.S.) Domestic Equity (Active) to U.S. Large Cap. We renamed (U.S.) Small Cap (Active) to U.S. Small Cap and International Large Cap (Active) to International Large Cap. Further, we reallocated International Small Cap (Active) equally to U.S. Large Cap, U.S. Small Cap, International Large Cap and Emerging Market Equity. We merged REITs with Real Estate Debt to cover both Equity REITs and Mortgage REITs and named this asset class U.S. REITs. TIPS, Bank Loans, Emerging Market Debt, and others were equally reallocated across all asset classes. In aggregate, the sum of the weights of all reallocated asset classes was less than 10% in any given rebalancing period. In Graph 5 we presented the reallocated TDF glide path that we used to conduct our analysis. Our analysis covered all nine rebalancing periods in the glide path represented in Graph 5; (See Table 3 in Appendix)however, due to the similarity of the asset allocation across the first six rebalancing periods, we used the 2015 rebalancing period to represent the rebalancing periods from 2015 to 2040 in a parsimonious way.

In Graph 6 below, we represent J.P. Morgan's return and risk estimates by asset class. We matched the J.P. Morgan data to the asset classes in our reallocated glide path by name; all names matched apart from International Large Cap, which corresponded to EAFE Equity and U.S. Investment Grade Bonds, which corresponded to U.S. Investment Grade Corporate Bonds in the J.P. Morgan data set.



Graph 5: Reallocated Fidelity Standard TDF Glide Path

Corresponding to Graph 4, Graph 5 depicts the allocation across asset classes in each of the nine rebalancing periods (or over the entire 45- year time span of the TDF) of the reallocated Fidelity TDF glide path data that we used in this study. Therefore, Graph 5 reflects the standard glide path used in this study. Since the maturity dates of the sourced TDFs lie in the future, the TDFs glide path data represents Fidelity's current expectations of future asset allocations.



Graph 6: J.P. Morgan Return and Risk Estimates[29]

Graph 6 depicts J.P. Morgan's annualized risk (standard deviation), annualized excess return and annualized return assumptions that we based our study on.[30] (see table 4 in Appendix) Note that excess returns were defined as expected returns minus the risk-free rate. The J.P. Morgan Asset Management's Long-term Capital Market Assumptions is an annual publication that represent one of the industry's most established and comprehensive sets of expectations for how risk, return, and correlations across asset classes may develop over the coming decades.

Appendix

Variance-covariance Matrix	U.S. Large Cap	U.S. Small Cap	International Large Cap	Emerging Market Equity	U.S. Investment Grade Bonds	U.S. High Yield Bonds	U.S. REITs	Commodities	U.S. Cash	Private Equity
U.S. Large Cap	1									
U.S. Small Cap	0.91	1								
International Large Cap	0.88	0.77	1							
Emerging Market Equity	0.76	0.7	0.88	1						
U.S. Investment Grade Bonds	0.26	0.17	0.38	0.37	1					
U.S. High Yield Bonds	0.69	0.66	0.72	0.69	0.56	1				
U.S. REITs	0.74	0.78	0.66	0.55	0.38	0.63	1			
Commodities	0.45	0.37	0.59	0.62	0.25	0.45	0.26	1		
U.S. Cash	-0.06	-0.07	0.04	0.09	-0.11	-0.13	-0.04	0.12	1	
Private Equity	0.87	0.95	0.76	0.69	0.19	0.69	0.7	0.4	-0.1	1

Table 1: J.P. Morgan 2016 Estimates – Correlation Matrix in USD

Table 1 depicts J.P. Morgan's correlation assumptions that we based our study on. The J.P. Morgan Asset Management's Long-term Capital Market Assumptions is an annual publication that represents one of the industry's most established and comprehensive sets of expectations for how risk, return, and correlations across asset classes may develop over the coming decades.[31] Please note that the table was converted to a variance-covariance matrix in order to conduct our analysis.

		Rebalancing period 1	Rebalancing period 2	Rebalancing period 3	Rebalancing period 4	Rebalancing period 5	Rebalancing period 6	Rebalancing period 7	Rebalancing period 8	Rebalancing period 9
US Large Cap Equity (Active)	**Ticker**	**Weight**	**Weight**	**Weight**	**Weight**	**Weight**	**Weight**	**Weight**	**Weight**	**Weight**
Fidelity Series Equity-Income Fund	FNKLX	9.75%	9.69%	9.65%	9.66%	9.64%	9.65%	8.90%	7.49%	6.59%
Fidelity Series Growth Company Fund	FCGSX	7.48%	8.20%	8.60%	8.53%	8.66%	8.58%	8.02%	6.71%	6.00%
Fidelity Series Growth and Income Fund	FGLGX	7.46%	7.43%	7.41%	7.41%	7.40%	7.41%	6.84%	5.74%	5.07%
Fidelity Series All Sector Equity Fund	FSAEX	7.32%	7.41%	7.40%	7.41%	7.39%	7.40%	6.82%	5.71%	5.02%
Fidelity Series Stock Selector Large Cap Value Fund	FBLEX	6.49%	6.43%	6.41%	6.41%	6.40%	6.41%	5.89%	4.95%	4.36%
Fidelity Series Blue Chip Growth fund	FSBDX	6.08%	5.82%	5.83%	5.84%	5.82%	5.83%	5.38%	4.51%	3.98%
Fidelity Series Intrinsic Opportunities Fund	FDMLX	5.42%	5.12%	5.00%	5.00%	4.99%	5.00%	4.61%	3.87%	3.41%
Fidelity Series Opportunistic Insights Fund	FVWSX	4.95%	4.91%	4.91%	4.91%	4.91%	4.91%	4.52%	3.79%	3.33%
Total		**54.95%**	**55.01%**	**55.21%**	**55.17%**	**55.21%**	**55.19%**	**50.98%**	**42.77%**	**37.76%**
US Large Cap Equity (Passive)										
Fidelity Series 100 Index Fund	FOHIX	2.32%	2.30%	2.28%	2.28%	2.27%	2.28%	2.11%	1.77%	1.55%
Fidelity Series 1000 Value Index Fund	FIOOX	1.30%	1.29%	1.27%	1.28%	1.27%	1.27%	1.18%	1.00%	0.87%
		3.62%	**3.59%**	**3.55%**	**3.56%**	**3.54%**	**3.55%**	**3.29%**	**2.77%**	**2.42%**
Small Cap US Equity (Active)										
Fidelity Series Small Cap Opportunities Fund	FSOPX	4.03%	3.99%	3.96%	3.97%	3.96%	3.96%	3.66%	3.07%	2.71%
Fidelity Series Small Cap Discovery Fund	FJACX	1.30%	1.29%	1.30%	1.30%	1.29%	1.30%	1.20%	1.02%	0.88%
Total		**5.33%**	**5.28%**	**5.26%**	**5.27%**	**5.25%**	**5.26%**	**4.86%**	**4.09%**	**3.59%**
REITS										
Fidelity Series Real Estate Equity Fund	FREDX	**0.88%**	**0.86%**	**0.81%**	**0.82%**	**0.80%**	**0.81%**	**0.75%**	**0.63%**	**0.54%**
Commodities										
Fidelity Series Commodity Strategy Fund	FCSSX	**0.78%**	**0.78%**	**0.79%**	**0.79%**	**0.79%**	**0.79%**	**0.89%**	**0.78%**	**0.80%**
International Large Cap Equity										
Fidelity Series International Growth Fund	FIGSX	8.96%	8.93%	8.94%	8.94%	8.94%	8.94%	8.22%	6.86%	5.94%
Fidelity Series International Value Fund	FINVX	8.89%	8.86%	8.87%	8.86%	8.86%	8.86%	8.14%	6.78%	5.88%
Total		**17.85%**	**17.79%**	**17.81%**	**17.80%**	**17.80%**	**17.80%**	**16.36%**	**13.64%**	**11.82%**
International Small cap Equity										
Fidelity Series International Small Cap Fund	FSTSX	**2.12%**	**2.10%**	**2.12%**	**2.11%**	**2.11%**	**2.11%**	**1.98%**	**1.64%**	**1.42%**
Emerging Markets Equity										
Fidelity Series Emerging Markets fund	FEMSX	**8.03%**	**8.06%**	**8.00%**	**8.01%**	**7.99%**	**8.00%**	**7.46%**	**6.56%**	**5.87%**
Investment Grade Fixed Income										
Fidelity Series Investment Grade Bond Fund	FSIGX	**5.70%**	**6.00%**	**6.00%**	**6.00%**	**5.80%**	**5.90%**	**7.70%**	**19.43%**	**26.66%**
TIPS										
Fidelity Series Inflation-Protected Bond Index Fund	FSIPX	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.01%**	**0.00%**	**0.83%**
High Yield Fixed Income										
Fidelity Series High Income Fund	FSHNX	**3.21%**	**3.23%**	**3.25%**	**3.25%**	**3.25%**	**3.25%**	**3.25%**	**3.23%**	**3.22%**
Bank Loans										
Fidelity Series Floating Rate High Income Fund	FFHCX	**0.25%**	**0.28%**	**0.28%**	**0.28%**	**0.28%**	**0.28%**	**0.28%**	**0.26%**	**0.28%**
Emerging Market Debt										
Fidelity Series Emerging Markets Debt Fund	FEDCX	**0.60%**	**0.61%**	**0.62%**	**0.62%**	**0.62%**	**0.62%**	**0.63%**	**0.62%**	**0.63%**
Real EstateDebt										
Fidelity Series Real Estate Income Fund	FSREX	**0.47%**	**0.47%**	**0.47%**	**0.47%**	**0.47%**	**0.47%**	**0.47%**	**0.47%**	**0.47%**
Cash										
Fidelity Institutional Money Market - Money	FNSXX	0.93%	0.89%	0.81%	0.83%	0.86%	0.85%	0.76%	2.07%	2.57%
Fidelity Series Short-Term Credit fund	FYBTX	0.39%	0.43%	0.40%	0.40%	0.43%	0.41%	0.40%	0.98%	1.05%
Total		**1.32%**	**1.32%**	**1.21%**	**1.23%**	**1.29%**	**1.26%**	**1.16%**	**3.05%**	**3.62%**
Other		**0.02%**	**0.02%**	**0.02%**	**0.02%**	**0.02%**	**0.02%**	**0.03%**	**0.06%**	**0.07%**

Table 2: Details of Original Fidelity TDF Glide Path

The information for the Fidelity glide path came from the following Fidelity-hosted website. The individual funds that make up the glide path came from the same source: http://fundresearch.fidelity.com/mutual-funds/category- performance-annual-total-returns/FREE. Link accessed on 8/19/2015. The weights in the below table are expressed in terms of percentages. Since the maturity dates of the sourced TDFs lie in the future, the TDFs' glide path data represents Fidelity's current expectations of future asset allocation. We show the breakdown of the individual Fidelity funds used in our analysis to provide transparency. Note that we used the glide path reported in Table 3 to conduct our analysis.

	Rebalancing period								
Asset Classes	1	2	3	4	5	6	7	8	9
U.S. Large Cap	59.20%	59.23%	59.39%	59.36%	59.38%	59.37%	54.87%	46.05%	40.74%
U.S. Small Cap	5.96%	5.91%	5.89%	5.90%	5.88%	5.89%	5.46%	4.60%	4.15%
International Large Cap	18.48%	18.42%	18.44%	18.43%	18.43%	18.43%	16.96%	14.15%	12.38%
Emerging Market Equity	8.66%	8.69%	8.63%	8.64%	8.62%	8.63%	8.06%	7.07%	6.43%
U.S. Investment Grade Bonds	0.67%	0.70%	0.70%	0.70%	0.68%	0.69%	7.81%	19.53%	26.86%
U.S. High Yield Bonds	3.31%	3.33%	3.35%	3.35%	3.35%	3.35%	3.36%	3.33%	3.42%
U.S. REITs	1.45%	1.43%	1.38%	1.39%	1.37%	1.38%	1.33%	1.20%	1.21%
Commodities	0.88%	0.88%	0.89%	0.89%	0.89%	0.89%	0.90%	0.88%	1.00%
U.S. Cash	1.42%	1.42%	1.31%	1.33%	1.39%	1.36%	1.27%	3.15%	3.82%

Table 3: Details of Reallocated Fidelity Standard TDF Glide Path[32]

Asset Classes	Annualized Return	Annualized Excess Return	Annualized Risk
U.S. Large Cap	7.00%	4.75%	15.50%
U.S. Small Cap	7.25%	5.00%	21.30%
International Large Cap	7.75%	5.50%	18.00%
Emerging Market Equity	10.00%	7.75%	25.50%
U.S. Investment Grade Bonds	4.25%	2.00%	6.50%
U.S. High Yield Bonds	6.75%	4.50%	9.30%
U.S. REITs	6.00%	3.75%	18.00%
Commodities	3.00%	0.75%	19.00%
U.S. Cash	2.25%	0.00%	0.50%
Private Equity	8.50%	6.25%	21.80%

Table 4: J.P. Morgan Risk, Return and Excess Return Assumptions

	Rebalancing Periods 1-6 Optimized TDF	Rebalancing Periods 1-6 Standard TDF	delta	Rebalancing Periods 7 Optimized TDF	Rebalancing Periods 7 Standard TDF	delta	Rebalancing Periods 8 Optimized TDF	Rebalancing Periods 8 Standard TDF	delta	Rebalancing Periods 9 Optimized TDF	Rebalancing Periods 9 Standard TDF	delta	Mean delta
U.S. Large Cap	54.20%	59.20%	-5.00%	49.87%	54.87%	-5.00%	41.05%	46.05%	-5.00%	35.74%	40.74%	-5.00%	-5.00%
U.S. Small Cap	0.96%	5.96%	-5.00%	0.46%	5.46%	-5.00%	0.00%	4.60%	-4.60%	0.00%	4.15%	-4.15%	-4.86%
International Large Cap	13.48%	18.48%	-5.00%	11.96%	16.96%	-5.00%	9.15%	14.15%	-5.00%	7.38%	12.38%	-5.00%	-5.00%
Emerging Market Equity	13.66%	8.66%	5.00%	13.06%	8.06%	5.00%	12.07%	7.07%	5.00%	11.43%	6.43%	5.00%	5.00%
U.S. Investment Grade Bonds	2.31%	0.67%	1.64%	9.31%	7.81%	1.51%	23.38%	19.53%	3.85%	31.76%	26.86%	4.90%	2.23%
U.S. High Yield Bonds	8.31%	3.31%	5.00%	8.36%	3.36%	5.00%	8.33%	3.33%	5.00%	8.42%	3.42%	5.00%	5.00%
U.S. REITs	0.00%	1.45%	-1.45%	0.00%	1.33%	-1.33%	0.00%	1.20%	-1.20%	0.00%	1.21%	-1.21%	-1.38%
Commodities	0.00%	0.88%	-0.88%	0.00%	0.90%	-0.90%	0.00%	0.88%	-0.88%	0.00%	1.00%	-1.00%	-0.89%
U.S. Cash	0.00%	1.42%	-1.42%	0.00%	1.27%	-1.27%	0.00%	3.15%	-3.15%	0.00%	3.82%	-3.82%	-1.86%
Private Equity	7.10%	0.00%	7.10%	6.98%	0.00%	6.98%	6.00%	0.00%	6.00%	5.28%	0.00%	5.28%	6.76%
Performance Stats													
5y Excess Return	29.53%	27.90%	1.63%	28.23%	26.63%	1.60%	25.60%	23.98%	1.63%	24.02%	22.41%	1.60%	1.62%
5y Variance	0.12	0.12	0.00	0.11	0.11	0.00	0.08	0.08	0.00	0.07	0.07	0.00	0.00
5y Standard Deviation	35.13%	35.13%	0.00%	32.90%	32.90%	0.00%	28.60%	28.60%	0.00%	26.13%	26.13%	0.00%	0.00%
5y Sharpe Ratio	0.84	0.79	0.05	0.86	0.81	0.05	0.90	0.84	0.06	0.92	0.86	0.06	0.05
Annualized Excess Return	5.31%	5.04%	0.27%	5.10%	4.84%	0.26%	4.66%	4.39%	0.27%	4.40%	4.13%	0.27%	0.27%
Annualized Variance	0.025	0.025	0.000	0.022	0.022	0.000	0.016	0.016	0.000	0.014	0.014	0.000	0.000
Annualized Standard Deviation	15.71%	15.71%	0.00%	14.71%	14.71%	0.00%	12.79%	12.79%	0.00%	11.69%	11.69%	0.00%	0.00%
Annualized Sharpe Ratio	0.3381	0.3211	0.0170	0.3465	0.3286	0.0179	0.3647	0.3434	0.0213	0.3764	0.3532	0.0232	0.0182

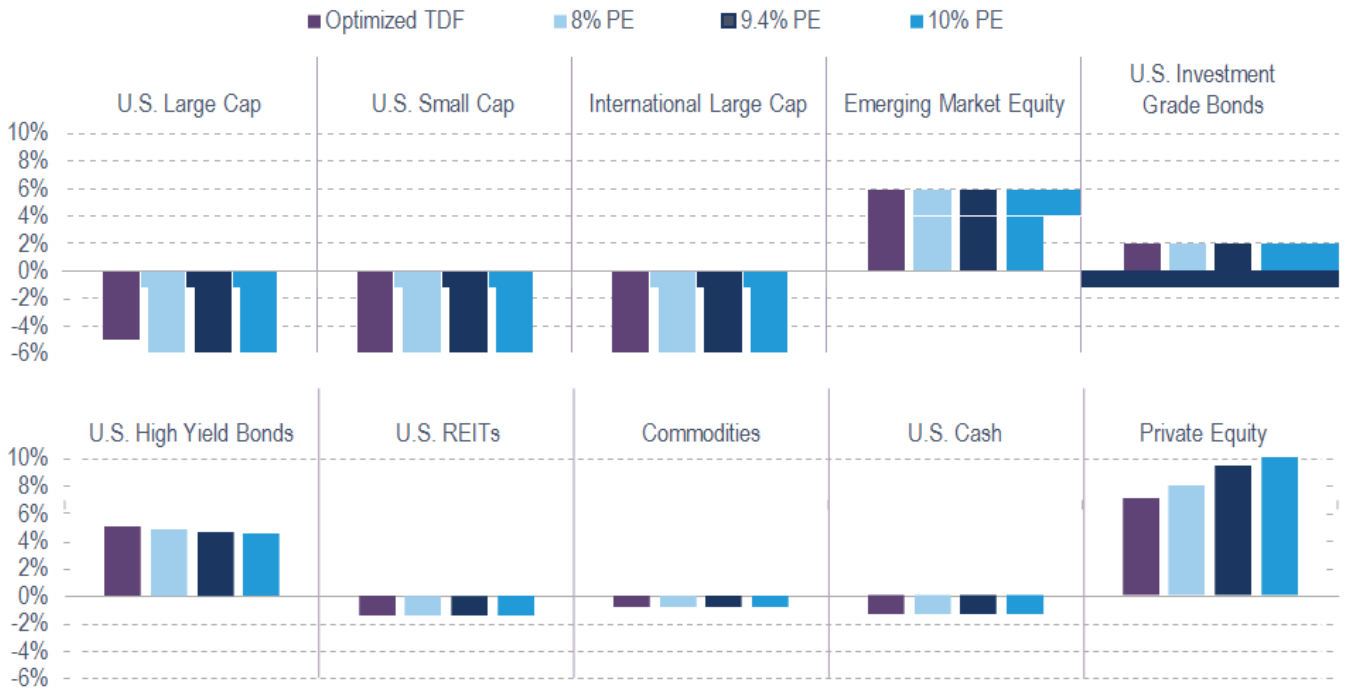
Table 5: Optimization of TDF Performance (and Keeping Risk Constant)

Table 5 shows, based on this study, the details to the portfolio reallocation and performance statistics when optimizing the TDF including Private Equity as compared to the standard TDF excluding Private Equity. In particular, the table shows these results for Private Equity exposures of 7.1%, 6.98%, 6% and 5.28% in rebalancing periods 1-6, 7, 8 and 9, respectively.

	Standard TDF	Optimal TDF	delta	TDF @ 8% PE	delta	TDF @ 9.4% PE	delta	TDF @ 10% PE	delta
U.S. Large Cap	59.20%	54.20%	-5.00%	54.05%	-5.15%	53.81%	-5.38%	53.71%	-5.48%
U.S. Small Cap	5.96%	0.96%	-5.00%	0.81%	-5.15%	0.57%	-5.38%	0.47%	-5.48%
International Large Cap	18.48%	13.48%	-5.00%	13.33%	-5.15%	13.09%	-5.38%	12.99%	-5.48%
Emerging Market Equity	8.66%	13.66%	5.00%	13.51%	4.85%	13.27%	4.62%	13.17%	4.52%
U.S. Investment Grade Bonds	0.67%	2.31%	1.64%	2.16%	1.49%	1.93%	1.26%	1.83%	1.16%
U.S. High Yield Bonds	3.31%	8.31%	5.00%	8.16%	4.85%	7.92%	4.62%	7.82%	4.52%
U.S. REITs	1.45%	0.00%	-1.45%	0.00%	-1.45%	0.00%	-1.45%	0.00%	-1.45%
Commodities	0.88%	0.00%	-0.88%	0.00%	-0.88%	0.00%	-0.88%	0.00%	-0.88%
U.S. Cash	1.42%	0.0 0%	-1.42%	0.00%	-1.42%	0.00%	-1.42%	0.00%	-1.42%
Private Equity	0.00%	7.10%	7.10%	8.00%	8.00%	9.40%	9.40%	10.00%	10.00%
Performance Stats									
5y Excess Return	27.90%	29.53%	1.63%	29.60%	1.70%	29.71%	1.81%	29.76%	1.86%
5y Variance	0.1230	0.1230	0.0000	0.1242	0.0012	0.1254	0.0024	0.1259	0.0029
5y Standard Deviation	35.13%	35.13%	0.00%	35.24%	0.11%	35.41%	0.28%	35.49%	0.36%
5y Sharpe Ratio	0.7940	0.8410	0.0470	0.8400	0.0460	0.8391	0.0451	0.8387	0.0447
Annualized Excess Return	5.04%	5.31%	0.27%	5.32%	0.28%	5.34%	0.30%	5.35%	0.30%
Annualized Variance	0.0246	0.0246	0.0000	0.0248	0.0002	0.0251	0.0005	0.0252	0.0006
Annualized Standard Deviation	15.71%	15.71%	0.00%	15.76%	0.05%	15.84%	0.13%	15.87%	0.16%
Annualized Sharpe Ratio	0.3211	0.3381	0.0170	0.3378	0.0167	0.3373	0.0162	0.3370	0.0159

Table 6: TDF Performance for Higher Private Equity Exposures in the First 30 years

Table 6 shows, based on this study, the details to the portfolio reallocation and performance statistics when optimizing the TDF including Private Equity as compared to the standard TDF excluding Private Equity. In particular, the table shows these results for Private Equity exposures for 7.1%, 8%, 9.4% and 10% in rebalancing periods 1-6.



Graph 7: Reallocation of Asset Class Weights for Higher Private Equity Exposures in First 30 Years

Graph 7 is analogous to Graph 2 – however, note that this graph only depicts the analysis for rebalancing periods 1-6 for higher exposures to Private Equity.

Graph 8: Change in Performance of TDF for Higher Private Equity Exposures in First 30 Years

Graph 8 is analogous to Graph 3 – however, note that this graph only depicts the analysis for rebalancing periods 1-6 for higher exposures to Private Equity.

Rebalancing period	Age	Excess Return TDF w/o PE	Excess Return TDF w PE	Investment (t)	FV Standard TDF (t)	FV Optimized TDF (t)
1	1	5.04%	5.31%	$6,424	$6,892.31	$6,909.65
1	2	5.04%	5.31%	$6,424	$14,287.07	$14,341.68
1	3	5.04%	5.31%	$6,424	$22,220.91	$22,335.56
1	4	5.04%	5.31%	$6,424	$30,733.12	$30,933.79
1	5	5.04%	5.31%	$6,424	$39,865.87	$40,182.04
2	6	5.04%	5.31%	$6,424	$49,664.40	$50,129.45
2	7	5.04%	5.31%	$6,424	$60,177.25	$60,828.89
2	8	5.04%	5.31%	$6,424	$71,456.48	$72,337.21
2	9	5.04%	5.31%	$6,424	$83,557.97	$84,715.56
2	10	5.04%	5.31%	$6,424	$96,541.65	$98,029.71
3	11	5.04%	5.31%	$6,424	$110,471.85	$112,350.41
3	12	5.04%	5.31%	$6,424	$125,417.56	$127,753.76
3	13	5.04%	5.31%	$6,424	$141,452.81	$144,321.59
3	14	5.04%	5.31%	$6,424	$158,657.03	$162,141.96
3	15	5.04%	5.31%	$6,424	$177,115.43	$181,309.55
4	16	5.04%	5.31%	$6,424	$196,919.46	$201,926.20
4	17	5.04%	5.31%	$6,424	$218,167.19	$224,101.48
4	18	5.04%	5.31%	$6,424	$240,963.89	$247,953.21
4	19	5.04%	5.31%	$6,424	$265,422.47	$273,608.12
4	20	5.04%	5.31%	$6,424	$291,664.08	$301,202.55
5	21	5.04%	5.31%	$6,424	$319,818.70	$330,883.12
5	22	5.04%	5.31%	$6,424	$350,025.79	$362,807.54
5	23	5.04%	5.31%	$6,424	$382,434.98	$397,145.44
5	24	5.04%	5.31%	$6,424	$417,206.80	$434,079.29
5	25	5.04%	5.31%	$6,424	$454,513.49	$473,805.34
6	26	5.04%	5.31%	$6,424	$494,539.83	$516,534.68
6	27	5.04%	5.31%	$6,424	$537,484.09	$562,494.35
6	28	5.04%	5.31%	$6,424	$583,558.99	$611,928.58
6	29	5.04%	5.31%	$6,424	$632,992.75	$665,100.04
6	30	5.04%	5.31%	$6,424	$686,030.23	$722,291.25
7	31	4.84%	5.10%	$6,424	$741,549.24	$782,275.82
7	32	4.84%	5.10%	$6,424	$801,004.54	$846,669.26
7	33	4.84%	5.10%	$6,424	$864,675.22	$915,795.62
7	34	4.84%	5.10%	$6,424	$932,860.16	$990,002.76
7	35	4.84%	5.10%	$6,424	$1,005,879.41	$1,069,664.12
8	36	4.39%	4.66%	$6,424	$1,079,520.35	$1,150,445.81
8	37	4.39%	4.66%	$6,424	$1,158,051.06	$1,236,809.52
8	38	4.39%	4.66%	$6,424	$1,241,796.20	$1,329,140.95
8	39	4.39%	4.66%	$6,424	$1,331,102.02	$1,427,852.49
8	40	4.39%	4.66%	$6,424	$1,426,337.75	$1,533,385.00
9	41	4.13%	4.40%	$6,424	$1,524,171.95	$1,642,206.30
9	42	4.13%	4.40%	$6,424	$1,628,247.97	$1,758,264.21
9	43	4.13%	4.40%	$6,424	$1,738,964.04	$1,882,039.98
9	44	4.13%	4.40%	$6,424	$1,856,743.80	$2,014,046.83
9	45	4.13%	4.40%	$6,424	$1,982,037.91	$2,154,832.14

	Standard TDF	TDF including PE
Total TDF value at T	$1,982,037.91	$2,154,832.14
Delta $		$172,794.23
Delta %		8.72%

Table 7: Increase in the Amount Saved at Maturity of the 45-year TDF including in Private Equity as Compared to the Standard TDF (with $6,424 p.a. Pension Contribution).

Table 7 shows, based on this study, the increase in total savings that a pension plan member would have available in year 45 if Private Equity was added to the TDF. The exposures to Private Equity and the corresponding return assumption we chose mirror the findings of this study: i.e. Private Equity exposures for 7.1%, 6.98%,6% and 5.28% in rebalancing periods 1-6, 7, 8 and 9, respectively.

Endnotes

1. Median participant income in the United States of America in 2015 was approximately $73,000. At an 8.8% pension contribution rate of median income, this amounts to approximately $6,424 of annual pension savings. These results are based on the assumption that the TDF's allocation to Private Equity is 7.1% in rebalancing period 1-6, 6.98% in rebalancing period 7, 6% in rebalancing period 8 and 5.28% in rebalancing period 9. Please see Table 7 in the Appendix for the detailed calculations. See also https://pressroom.vanguard.com/nonindexed/HAS2016_Final.pdf. Past performance is no guarantee of future performance.

2. https://am.jpmorgan.com/gi/getdoc/1383271688187. Link accessed on 11/11/2016. For the purpose of this study, J.P. Morgan Asset Management's 2016 Long-term Capital Markets Assumptions were selected as reference data. Our aim was to base our analysis on a widely-used, well-established (this particular publication is in its 20th edition), and highly transparent dataset published by a reputable third-party. On the same basis we selected the Fidelity data we used for our glide path modelling.

3. Note that J.P. Morgan sources its Private Equity data from the Burgiss Manager Universe, which contains the full transactional history between LPs and their fund investments; as such, J.P. Morgan's return assumptions are net of manager fees. Due to the change in the asset allocation across asset classes, the TDF may be subject to a different fee profile that may impact net returns. This study has not taken such potential fee changes impact on net returns into account. In addition, the performance of the indices reflects reinvestment of dividend and, where applicable, capital gains distributions. Future exchange rate fluctuations may significantly impact gross and net returns.

4. http://fundresearch.fidelity.com/mutual-funds/category-performance-annual-total-returns/FREE. Link accessed on 8/19/2015. The Fidelity data is being used for educational purposes only and not for commercial reasons.

5. https://www.fidelity.com/mutual-funds/fidelity-fund-portfolios/freedom-funds-manage. Link accessed on 8/19/2015.

6. We used a mean-variance optimization framework in this study. Please see Cochrane (2001) for further reference.

7. https://pressroom.vanguard.com/nonindexed/HAS2016_Final.pdf. Link accessed on 11/11/2016.

8. We calculated the total dollars saved over a 45-year period if a pension plan member had made equal annual dollar contributions investing in a TDF with an allocation to Private Equity of 7.1% in rebalancing period 1-6, 6.98% in rebalancing period 7, 6% in rebalancing period 8 and 5.28% in rebalancing period 9. We then repeated this calculation for a TDF that does not include Private Equity. The difference in the amount saved (at maturity) between the two TDFs is equal to the additional savings that would have accrued had the retiree chosen the TDF including an allocation to Private Equity over a standard TDF. For exact details of the calculations and the assumptions made, please see Table 7 in the Appendix.

9. We chose to include the specific allocation to Private Equity of 9.4% as the PEGCC Public Pension Fund Analysis (2014) found that U.S. pension funds invest 9.4% of their portfolio in Private Equity on a dollar-weighted basis (http://www.investmentcouncil.org/app/uploads/2014-pension-fund-analysis2.pdf). Link accessed on 11/11/2016.

10. Swensen (2000)

11. https://www.blackrock.com/investing/literature/brochure/investment-trends-brochure.pdf. Link accessed on 11/11/2016.

12. For further reference regarding the construction of retirement investment products using Modern Portfolio Theory please see https://corporate.morningstar.com/us/documents/Indexes/AssetAllocationIndexRulebook.pdf. Link accessed on 11/11/2016.

13. We used a mean-variance optimization framework in this study. Please see Cochrane (2001) for further reference.

14. https://am.jpmorgan.com/gi/getdoc/1383271688187. Link accessed on 11/11/2016.

15. http://fundresearch.fidelity.com/mutual-funds/category-performance-annual-total-returns/FREE. Link accessed on 8/19/2015.

16. Note that the results in this study are expressed in terms of expected excess returns. For the sake of brevity, we omit the term "excess" and instead refer to expected excess returns as expected returns, or simply returns. Expected excess returns are obtained if one subtracts the risk-free rate from expected returns.

17. https://web.stanford.edu/~wfsharpe/art/sr/sr.htm. Link accessed on 11/11/2016.

18. Fixing the risk of the TDF is synonymous to imposing a constraint on the optimization. We imposed restrictions in order to test whether we can improve investors' welfare relative to the TDF excluding Private Equity irrespective of investors' preferences.

19. We used data from Fidelity to derive the appropriate glide path (http://fundresearch.fidelity.com/mutual-funds/category-performance-annual-total-returns/FREE). Link accessed on 8/19/2015.

20. Note that Private Equity was constrained to a maximum weight of 10% in any rebalancing period. All other asset classes where constrained to a +/-5% allocation change as measured against the standard TDF's allocation. Further, we constrained all weights to obtain a minimum value of 0% as we did not consider short- selling a viable investment strategy in the TDF setting.

21. Further, various studies in the academic literature discuss the impact of return intervals on beta estimates; these studies point out that if the chosen time horizon is shorter than the true one, beta estimates may be biased (e.g. Levhari and Levy (1977)).

22. Often portfolio optimization exercises face the problem of producing corner solutions, especially when restricting weights to be strictly positive (no short-selling restriction). Corner solutions emerge when the optimization algorithm generates highly concentrated weights in few asset classes, which results in an insufficiently diversified portfolio. Corner solutions do not indicate that Modern Portfolio Theory (hereafter, MPT) is flawed, but rather underline the idea that MPT is sensitive to the accuracy of its inputs. To obtain sensible allocation ranges we restrict the exposure of the optimized TDF to Private Equity to be between

0% and 10%. To remedy this issue further we restrict the weights of all other asset classes to be within +/- 5% of the standard TDF (for reference see Fabozzi, Focardi and Kolm (2006)).

23. Where appropriate, we reported numbers rounded to one decimal place in the main body of the document.

24. We calculated the total dollars saved over a 45-year period if a pension plan member had made equal annual dollar contributions investing in a TDF with an allocation to Private Equity of 7.1% in rebalancing period 1-6, 6.98% in rebalancing period 7, 6% in rebalancing period 8 and 5.28% in rebalancing period 9. We then repeated this calculation for an allocation that does not include Private Equity (standard TDF). The difference in the amount saved (at maturity) between the two TDFs is equal to the additional savings that would have accrued has the retiree chosen the TDF including an allocation to Private Equity over a standard TDF. For exact details of the calculations and the assumptions made.

25. We imposed a short-selling restrictions to avoid negative weights and proportionally redistributed all possible negative weight allocations to non-Private Equity asset classes that retained positive weights after the reallocation process.

26. We chose to include the specific allocation to Private Equity of 9.4% as the PEGCC Public Pension Fund Analysis (2014) found that U.S. pension funds invest 9.4% of their portfolio in Private Equity on a dollar-weighted basis (http://www.investmentcouncil.org/app/uploads/2014-pension-fund-analysis2.pdf). Link accessed on 11/11/2016. As a further robustness and sensitivity tests, we analyzed the performance of the TDF with allocations to the next integer below and above the 9.4% Private Equity allocation – hence, the 8% and 10% allocation choices.

27. http://fundresearch.fidelity.com/mutual-funds/category-performance-annual-total-returns/FREE. Link accessed on 8/19/2015.

28. https://am.jpmorgan.com/gi/getdoc/1383271688187. Link accessed on 11/11/2016.

29. Note that risk is measured as the annualized standard deviation of returns.

30. https://am.jpmorgan.com/gi/getdoc/1383271688187. Link accessed on 11/11/2016.

31. https://am.jpmorgan.com/gi/getdoc/1383271688187. Link accessed on 11/11/2016.

32. Based on Pantheon's reclassification of the original Fidelity TDF asset classes

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**All views presented in this article are of the author's, and should not be considered an endorsement by the CAIA Association.*

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Pershing Square, Ackman and CP Rail: A Case of Successful "Activism"?

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Pershing Square, an activist hedge fund owned and managed by William Ackman, began hostile maneuvers against the board of CP Rail in September 2011 and ended its association with CP in August 2016, having netted a profit of $2.6 billion for his fund. This Canadian saga, in many ways, an archetype of what hedge fund activism is all about, illustrates the dynamics of these campaigns and the reasons why this particular intervention turned out to be a spectacular success… thus far.

Governance at CP Rail

In 2009, the Chairman of the board of CP Rail asserted that the company had put in place the best practices of corporate governance; that year, CP was awarded the Governance Gavel Award for Director Disclosure by the Canadian Coalition for Good Governance. Then, in 2011, CP ranked 4th out of some 250 Canadian companies in the Globe & Mail Corporate Governance Ranking[1]. Yet, this stellar corporate governance was no insurance policy against shareholder discontent.

Indeed, during the summer of 2011, a group of 20 portfolio managers were gathered in a New York City bistro to discuss opportunities in the transportation sector. During pre-diner cocktail, one of the investors spoke critically about the governance of CP. "He was exasperated that the company's board had not thrown out the chief executive, Fred Green."[2]

That investor admitted that the previous winter had been grueling for rail transportation, but blaming the weather to justify CP's poor results was, according to him, just another lame excuse made by Fred Green to avoid taking responsibility. His views were shared by many other portfolio managers who turned belligerent about CP's Board and wondered why no activist fund had yet spotted the opportunity offered by CP. A phone call was made to Paul Hilal, an associate at Pershing Square Capital

Management (Pershing Square), an activist hedge fund. That phone call triggered the most highly mediatized proxy contests in Canada. Thou shalt never (henceforth?) underestimate the power of discontented shareholders.

Ackman attacks

Pershing Square began purchasing shares of CP on September 23, 2011. They filed a 13D form on October 28th showing a stock holding of 12.2%; by December 12, 2011, their holding had reached 14.2% of CP voting shares, thus making PS the largest shareholder of the company.

A few weeks after Pershing Square disclosed its acquisition of CP shares, Ackman asked to meet the Chairman of the Board of CP, John Cleghorn. A meeting was scheduled on November 2, 2011 at the Montreal airport. Ackman reminisced: "Although I'd said we wanted to talk about a management change, he and Fred Green were there. After three of us made a presentation, Mr. Cleghorn said, 'I've spoken to the board and want to let you know we're 100 percent behind Fred.' I couldn't believe the board made its decision before hearing our case."[3]

On December 15, 2011, CP issued a press release announcing the appointment (effective immediately) of Tony L. Ingram and Edmond L. Harris as directors on CP's Board. "Both Tony and Ed have extensive and valuable railway experience. I am confident that Canadian Pacific will benefit from their operational expertise and sound business knowledge." said John Cleghorn.[4]

These appointments were a form of concession to Ackman.[5] Tony L. Ingram was the former COO of the CSX,[6] while Edmond L. Harris held the same position at the CP for 11 months before retiring. The latter was well respected by the financial analysts and by the industry in general; his (surprise) departure from the CP raised numerous questions at the time since he was closely associated with the potential successful execution of the multi-year plan[7] (CP's strategic plan). These appointments were well received by Ackman, who nonetheless judged them as being too little, too late, and the proxy contest was officially launched.

In the Chairman's letter to shareholders from the 2011 annual report (signed on March 5, 2012), John Cleghorn wrote that:

> […] Even through a challenging operating environment in 2011, CP has made great strides in the areas of governance, management and operations. The Board believes that Pershing Square's demand for management change would put at severe risk the significant forward momentum the Company is making on the Multi-Year Plan.
>
> On behalf of the Board, I would like to extend our appreciation to Fred Green and his management team for aggressively and successfully implementing our Multi-Year plan and creating superior value for our shareholders and customers.

Ackman responded by inviting all shareholders and other interested parties to a public Town Hall Meeting (held on February 6, 2012) and, with Hunter S. Harrison (retired CEO of CN and his candidate for CEO of CP, his side) made a fact-based presentation about the shortcomings and failings of the CP board and management. Harrison and Ackman stated that their goal for CP was to achieve an operating ratio of 65 for 2015 (down from 81.3 in 2011).

The Board and Fred Green Respond to Ackman... and Harrison

The Board formally responded to the allegations of Ackman in its Management Proxy Circular of March 22, 2012 and Fred Green used the occasion of an investor presentation, on March 27, 2012, to make his case.

The Board qualified Harrison's (and Ackman's) targets of "shot in the dark," showing a lack of research and a profound misunderstanding of CP's reality. Green mentioned that Hunter Harrison was a wrong choice as a potential successor since Harrison's reputation precedes him in Canada and several of CP's customers have said they would consider moving their business elsewhere if Mr. Harrison were appointed CEO[8] of CP.

Relying on an independent consultant report (Oliver Wyman Group), Green mentioned that Harrison's target for CP's operating ratio was not achievable since CP's network was characterized by steeper grades and greater curvature thus adding close to 6.7% to the operating ratio compared to its competitors.[9]

The independent consultant's report was used to buttress several arguments:[10]

"In its report, Oliver Wyman concluded that the Multi-Year Plan (as of October 31, 2011) was both reasonable and achievable in the overall context of expected market conditions, the competitive environment and the action plans supporting major productivity initiatives.

Oliver Wyman also concluded that an operating ratio of 65 for 2015 was neither realistic nor achievable. This conclusion was based on industry experience with respect to the time needed by the other five largest Class I railroads to achieve a 1300 basis point operating improvement from a starting point of 78.

[…] In its assessment of the reasonableness of the assertion that an operating ratio of 65 could be achieved for 2015, Oliver Wyman identified important inherent structural differences between Canadian Pacific and CN franchises that support its conclusions. Principal among these is the significant difference between main line grades and severity of curvature on comparable routes. Canadian Pacific has a more limiting track structure as a result of routes determined when Canadian Pacific and CN were originally constructed. Oliver Wyman's comprehensive and in-depth review of track charts, timetables and traffic flows has determined that Canadian Pacific must operate an additional 203 main line AC locomotives to compensate for its steeper grades and more severe degree of track curvature relative to CN. This requirement to operate with this greater number of locomotives results in higher expenses for fuel, equipment maintenance and depreciation."

The Board also made the following claims:[11]

- "the Board has significant breadth and depth of expertise and experience, including in the railroad and complementary industries, with a recognized commitment to the highest standards of corporate governance; the Other Pershing Square Nominees have no evident railroad industry experience and add no other complementary industry experience;

- the Board has engaged with Mr. Ackman and maintains an open invitation for him to join the Board, an invitation which Mr. Ackman has so far declined. Instead, Pershing Square has launched an unnecessary and costly proxy contest;
- Pershing Square has disclosed no specific plan to achieve its stated operating ratio targets (the Board points out that Hunter Harrison, in an interview with Business News Network, when asked to provide a concrete example of how he would reduce CP's operating ratio, he answered "Well, I think we would first of all, first of all we would build a team and a plan");
- the only stated goal of Pershing Square is to install Mr. Harrison as President and CEO, who the Board believes is not the right leader for Canadian Pacific;
- Pershing Square proposal is ill-conceived and introduces unwarranted risk to shareholder value. Pershing Square has demonstrated a lack of understanding of Canadian Pacific's business.

The Board asserted that Pershing Square had, on numerous occasions, made fallacious statements to support its demand that Fred Green be replaced by Hunter Harrison. For example, Pershing Square "claimed that Canadian Pacific's mobile assets (rail cars and locomotives) were poorly utilized and cited this as a 'big deficiency' on the basis of comparative operating metrics from 2010". In fact, according to CP's Board, "Pershing Square ignored the marked improvements Canadian Pacific has achieved in 2011. Through February 2012, Canadian Pacific has achieved a level of rail car utilization surpassing that reported by CN for the fourth quarter of 2011."[12]

To be fair to Fred Green, his actions as CEO as outlined in Appendix I, do have merit even if eventually he failed to achieve the goals he targeted.

Ackman's retort

These arguments did not sway or deter Ackman. On April 4th 2012, he came out swinging in a scathing letter to CP shareholders disparaging CP's Board of directors in general, and its CEO, Fred Green, in particular. According to M. Ackman, "under the direction of the Board and Mr. Green, CP's total return to shareholders from the inception of Mr. Green's CEO tenure to the day prior to Pershing Square's investment was negative 18% while the other Class I North American railways delivered strong positive total returns to shareholders of 22% to 93%."[13] Thus, according to him, "Fred Green's and the Board's poor decisions, ineffective leadership and inadequate stewardship have destroyed shareholder value."[14]

Ackman demanded that the Board be restructured and the CEO replaced by a leader able to "transform its 'culture of excuses' into one of performance and accountability."[15]

Ackman's letter contained some damning statistics on CP's performance, particularly with respect to all important "operating ratio," showing that CP's performance is the worst of the 6 largest rail operators in North America (and CN the best by a wide margin).

Again, Ackman reiterated that their goal was to achieve an operating ratio of 65 for 2015 (down from 81.3 in 2011).

He lobbied investment funds to support his slate of nominees for the board, as well as the hiring of Hunter S. Harrison (the recently retired CEO of CN) as CEO for CP.

Ackman's letter makes a forceful case for hiring Harrison:

"Hunter Harrison is a seasoned chief executive with a proven, unrivaled track record of operational and cultural transformation. He is a change agent with deep railroad operating experience and a thorough familiarity with all aspects of the Canadian rail industry, including its customers, freight flows, terminal operators, unions (and union leaders), suppliers, regulations, terrain, and weather patterns."

Of course, in Ackman's world (and apparently in Harrison's too), no moral or ethical qualms are triggered by the hiring of a recently retired executive from the direct competitor of CP, a man who had signed a binding non-compete agreement on leaving CN and who has been lavishly paid for his services at CN.

Appendix II presents large excerpts from Ackman's letter to shareholders outlining his criticism of CP's management and board as well as his proposed plan of action.

The parties were now on a path towards a full-blown confrontation in the form of a proxy fight around nominees for the board of directors.

Structural differences between CP and other railway companies

Whether shareholders sided with one party or the other would hinge in part on the issue of structural impediments to the performance of CP. Clearly, as stated on multiple occasions, an unquestioned premise of the CP management was that significant structural differences between the CP and the other railway companies imposed higher operating costs on CP. That premise was unquestioned and accepted as a fact by the CP management and its Board as well as by financial analysts and other members of the railroad industry. The magnitude of the operating disadvantage that CP had to endure was estimated at some 6.7% by Green as well as by Oliver Wyman, the consulting firm hired by the Board of CP. This structural impact on costs was, it seems, exacerbated in periods of extreme weather conditions.

Harrison, the putative CEO for CP, would not have any of this, made light of these "impediments" to CP's performance. During the Town Hall Meeting held by Pershing Square, Ackman asked Harrison to share his thoughts on the notorious structural differences at the CP[16]:

"I didn't hear anything about structural differences when they were on top [the CP]. The Rockies, they've always been there. They always will be there. I know it's gonna be difficult to justify a capital investment to get that grade down (laughs). It kind of depends on where you are. I remember coming to Montreal at first and kind of reading back in the files.

I looked at the files after the IPO and one of the things that CN was talking about then was the improvement they were gonna make in their performance, in their operating performance, but they cautioned everyone to 'Please don't think we gonna get to US types standards, it's just not structurally possible, it's not in the

cards'. Now, as we went flying past, over the performance in the US, guess what the US carriers said? Don't ever expect us to beat the Canadian standards; it's just not in the cards. They get their healthcare paid for. Our fringes are 40%, theirs are only 15 or 20%, so it's kind of where you are.

Look, every railroad has structural… Every business has structural issues. That's what management's paid to deal with. There's no perfect franchise that I know of. So, you spend your time and energy fixing those things not making excuses about them because guess what happens, you start believing your excuses and then the team starts believing we can't get that thing done because we've got structural issues

So, look… It snows everywhere. It snows on CN, it snows on CP. Some winters are rougher than others but, we need to be prepared for them. So, I'm not a big believer in… that there are structural hardships that this franchise cannot overcome."

As shown in Appendix III, the gap in operating ratio between CP and CN had not always been as wide. In fact, CP had a lower operating ratio than CN during a period of time in the 1990s (Of course, CN was a Crown corporation at that time). The gap eventually widened, reaching unprecedented levels during Fred Green's tenure (the last full year of operating ratios attributable to Green was in 2011).

A Proxy Advisor Invites Itself to the Debate

Just a few weeks before the annual meeting of shareholders where the board candidates proposed by PS were challenging the nominees of management, ISS (Institutional Shareholder Services) – the largest proxy advisory firm – published a report which strongly supported Pershing Square's position "because the dissidents have demonstrated a compelling case that poor board oversight has allowed the company's performance to drift further and further below both its peers and its potential over at least half a decade, it seems clear that change on the board is needed."[17] The CP now had to defend itself against a new and influential party. The company issued a press release to respond to ISS[18]:

- "ISS operates from a false premise and maintains a double standard with respect to CP's Multi-Year Plan and Pershing Square's failure to provide any strategic or operational plan,
- ISS fails to take into account the development and aggressive and successful execution of the Company's Multi-Year Plan,
- ISS has failed to recognize the risk to shareholder value and the delay to the continued execution of the Multi-Year Plan related to Pershing Square's proposal to replace CP's current CEO, Fred Green, with Hunter Harrison,
- ISS attacks the Board's decision to commission the Oliver Wyman report in response to Pershing Square's CEO ultimatum and unrealistic OR target of 65 by 2015, while overlooking the flaws in Pershing Square's thesis,
- ISS's flawed justifications for recommending the Pershing Square nominees are based on incorrect and incomplete information and reflect a lack of objectivity,
- The ISS report contains a number of errors,
- Having failed to present to CP shareholders a balanced analysis of the opportunities and risks before the Company, ISS puts forward spurious reasons to vote against CP's directors, and
- The dissemination of the ISS report to the media prior to receipt by the company and certain ISS subscribers reflects poorly on ISS's professionalism and, by extension, on the recommendation put forward by ISS."

The Ontario Teachers' Pension Plan also publicly confirmed its intention to support Pershing Square's proposed candidates for the board. This public support from a large and respected institutional fund was another strike against the CP. Then, a survey of institutional investors representing 45% of CP's outstanding shares showed that 94% of them would vote for the board nominees proposed by Ackman.[19]

Two other proxy advisory firms, Egan-Jones Proxy Services and Glass Lewis & Co., also endorsed Ackman's position on Canadian Pacific Railway.[20] The perspective looked decidedly gloomy for CP's Board and CEO at the upcoming annual meeting of shareholders.

Annual Meeting of Shareholders Held on May 17, 2012, and Changes to CP's Board

A few hours before the annual meeting, CP issued a press release in which it stated that Fred Green had resigned as CEO, and that five other directors, including the Chairman of the Board, John Cleghorn, would not stand for re-election at the company's shareholder meeting.

Pershing Square had won the proxy fight; all the nominees proposed by Ackman were elected. Quickly thereafter on June 28, just a little more than a month after the shareholders' meeting, Hunter Harrison was appointed CEO. Meanwhile, two other directors (member of the pre-Pershing CP's Board) announced that they were stepping down. Only a few days after Harrison took over as chief executive, Tony Ingram, another director appointed under the older management, also resigned on July 5. Thus, with the addition of Hunter Harrison recently appointed to the Board and the resignation of a third director, the Pershing group now had the majority on the board with 8 of the 14 board members.

Canadian Pacific Railway under E. Hunter Harrison

"Harrison has been making his way across Canada and the northern United States since taking on the job June 29, and he keeps asking: Why do we do this? What do we do with that? When he gets unsatisfactory answers, red tape gets cut, rules are changed, trains are operated differently, and the like."[21] Within just a few weeks, he made several changes that had an immediate impact on the operations. For example:

- A CP intermodal train changes crews 13 times between Montreal and Vancouver. Harrison asked, 'why are these supposed hotshots scheduled to dwell in places like Ignace and Chapleau, Ont., for 20 minutes or longer when a step off-step on crew change takes more like five minutes?.' So schedules are being tightened. Harrison figures that limiting crew changes of intermodal trains to a brisk 5 minutes will take six hours out of the cross-country trip.

- Harrison wondered why so many intermodal trains are stopping along the way to pick up or set off just a few containers at the smaller ramps in Calgary, Regina, and Winnipeg. Try doing this in winter and then timing how long it takes to get a train's air back up in -35 degree Fahrenheit weather. The result was that Vancouver-Toronto trains 110-111 (train numbers assigned to a specific route) were abolished and in their places trains 100-101 were created with no work en route and high priority (green light during traffic controls, and other trains on the tracks have to take the siding to let them pass in priority). The first 101 arrived in Vancouver 17 hours earlier than 111 would have gotten there under the old schedule.

After some 18 months at the helm of CP, Harrison rationalized the operations as well as resources, human and material. The newcomer CEO took a series of measures to transform CP[22]:

- New executive leadership team, including a new Senior Operations lead team (also recruited from CN!) with a mandate for centralized planning and decentralized execution, to eliminate bureaucracy and have service decisions made faster and closer to the customer;
- Revamped intermodal and merchandise train service resulting in faster transit times for customers;
- Closure of hump-switching yards in Toronto, Winnipeg, Calgary and Chicago - producing significant cost savings and more efficient operating practices. A hump-switching yard is an artificially elevated area within a classification yard where the force of gravity is used to move rail cars along a network of marshalling tracks. Those humps were from the 1950s and 1960s; at that time, 80 to 85% percent of the cars that the CP handled had to be sorted, classified or switched. Harrison mentions that "the nature of our business has changed. Bulk and intermodal, which compromises over 70 percent of our business, is all handled in unit trains. We certainly didn't need classification yards. We're going to a more flat switching mode of operation."[23]
- Closure of intermodal terminals in Milwaukee, Obico (Toronto), and Schiller Park (Chicago) - reducing footprint and operating expenses while also facilitating efficient operating practices and reduced end-to-end transit times;
- Improved train service and network velocity resulting in the need for 195 fewer locomotives and 3,200 fewer leased rail cars; this reduced company-controlled railcars and locomotives by 35 percent and 43 percent, respectively.[24] The reduction has been possible through gains in efficiency everywhere on the network. For example, by initiating change in the intermodal markets, the CP took a day out of service from Vancouver to Toronto, and Vancouver to Chicago, both ways (the service is now offered in four days instead of five). By taking a day out of the transit time, "it reduces the overall requirements for locomotives on the system by about 40 locomotives."[25] In some cases the transit time was reduced by even more than a day.
- 4,550 positions have been eliminated,[26] thus decreasing the workforce by 27 percent.[27] Most of these positions were eliminated by attrition, and the majority of the reduction came from the operations, as Harrison would put it in its own style: "If you take 500 locomotives out and 10,000 cars out, obviously you don't need as many mechanics."[28] Part of the reduction also came from the customer service department in Winnipeg (about 75% of the 800 employees)[29] – the new approach puts the responsibility of the customer service (keeping the customer happy) on the person actually delivering the service.
- Relocated CP's corporate headquarters from downtown Calgary to new office space at CP-owned Ogden Yard, "a move that cut costs but also keeps Canadian Pacific's focus on freight operations front and center for corporate employees."[30] Harrison says: 'It's going to save us about $17 million or $18 million annually, and I think over time, it's a better environment for the employees. […]It's a way to take those people out of headquarters and kind of let them be out there and see what the business is all about. It's not about downtown bank buildings and glass towers. It's about railroading."[31]
- New longer sidings program to improve asset utilization and increase train length and velocity. A siding is a low-speed track section distinct from a running line that may be used for marshalling, stabling, storing, loading and unloading vehicles. CP had short sidings (5,000-6,000 feet) and the new program foresees the building of 12,000-15,000 feet sidings to eliminate bottlenecks that will allow the CP "to run longer trains more effectively without adversely affecting speed and velocity."[32]

Harrison communicates non-stop about the importance of his *Five Foundations* to railroad success, which serves as a guide for the change he wishes to instill to CP: 1° provide service; 2° control cost; 3° optimize assets; 4° operate safely and 5° develop people.

In the first edition of a new magazine for employees (now called *Canadian Pacific Magazine*, replacing the former publication *Momentum*), Harrison observed "If you look at the recent history of CP, it's been an operating company run by marketing people. There are a lot of good railroaders here, a lot of talent to build on. I've sensed some excitement, with people saying, 'Oh, these guys want to railroad again.' So we're letting people know that we're getting back to the basics."

Unlike his predecessor, who was quite discreet in employee publications, Harrison uses this communication tool to impart his vision and strategic orientations, to unveil upcoming major capital expenditures, and to promulgate the results obtained since the leadership change (and give a positive connotation to the word "change"). The magazine is now targeting a readership of railroad people, with topics like the Spike-Driving Championships, interviews with employees working on railroad specialties sharing their passion for what they do, and numerous photographs of locomotives and hump yards. The aim is to create and consolidate a winning culture through the sharing of accomplishments and operational achievements.

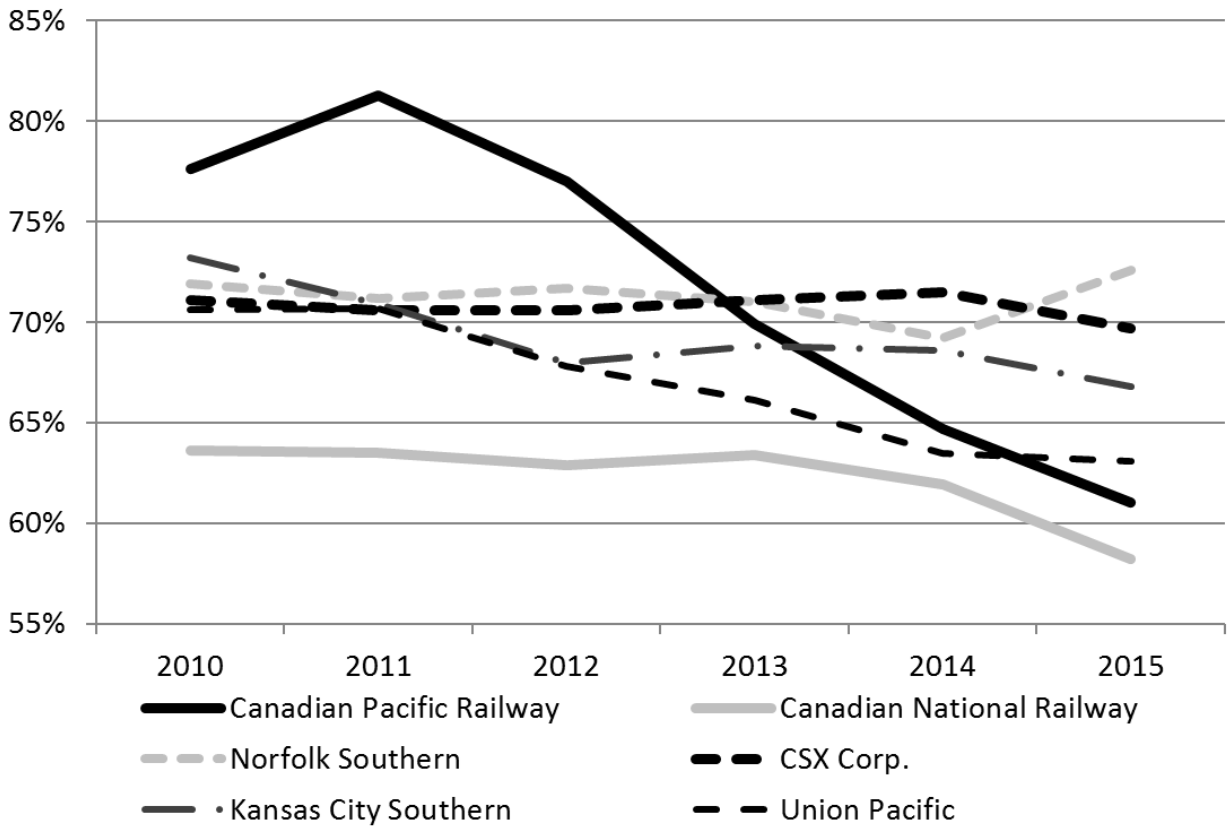


Exhibit 1: Operating ratio, compared to other Class 1 railroad companies

According to Harrison, the rhythm of transformation deployed by the CP exceeds largely all expectations. All the targets set when he arrived have been attained and even exceeded. The decrease in the work force and all the changes made were completed without apparently harming customer service.[33] When the CP unveiled its 2013 results, everything seemed to indicate that Pershing Square was right to request the change.

Under Harrison's leadership, CP's operating ratio improved dramatically (see Figure 2), challenging CN for performance leadership and shattering forever the *"structural difference" argument*.

Appendix IV presents other key performance indicators in the railroad industry and their evolution since 2010. **Appendix V** maps out the evolution of different ratios and indicators during Green and Harrison's respective tenure (first years of Harrison's tenure, showing the quick change), with some comparisons to the CN.

Despite the drastic measures undertaken by Harrison, revenues increased by 7.7% in 2013. Most interestingly, all the key performance indicators, financial and operational (except for AT who remained stable) swiveled in the opposite direction of the enduring trend from the previous years as shown in **Appendix VI**.

The financial markets did, of course, reward handsomely these operating performances. As the shown in Exhibit 2, CP's shares now trade at more than 4 times their price when Pershing Square first started buying shares of CP. In **Appendix VII**, this graph is included and displays the major events and their impact on CP's stock price.

CP's saga became the epitome of how a hedge fund can create value for shareholders by changing board members, management and thus strategies.

Ackman exits CP

During 2015, CP tried – unsuccessfully – to acquire Norfolk Southern Rail, a disappointing outcome. Yet, the drive for more efficiency at CP was relentless. By the end of 2015, CP was the second best among Class I railroads in North America in terms of operational ratio, as shown in Figure 3. CP is now vying with CN for first place.

Almost exactly five years after first buying shares of CP, Ackman confirmed in August 2016 that Pershing Square would sell its remaining shares of CP, thus formally exiting the "target." Harrison was still CEO, and Keith Creel was officially named to succeed him starting on July 1, 2017. In his usual style, Harrison declared:[34] "The board said, 'Look, we've got the opportunity to have two pretty good railroaders during a transition period and that's not the worst thing in the world,'" The succession should assure continuity in the way Harrison has led CP.

Over those five years, CP has generated a compounded annualized total shareholder return of 45.39% (between September 21, 2011 and August 31, 2016), a performance well above the CN and the S&P/TSX 60 index (see Exhibit 2 and Appendix VII). Pershing Square pocketed **some $2.6 billion in profits for its venture into CP**.[35]

With massive reductions in the workforce, a transformation of the operations and a radical change of the CP's organizational culture, CP is undoubtedly a different company from what it was before the proxy fight. In early September 2016, Bill Ackman resigned from CP's Board.

Hunter Harrison's declaration about Ackman's resignation[36] provides a fitting conclusion to this whole episode: "He [Ackman] saw an opportunity at CP, worked hard to bring me in to the fold, and delivered for shareholders and the board. Over the last four years we have built a better CP and that model remains in place to continue to deliver not just for shareholders, but for customers and employees. We thank Bill for everything he has done and wish him well in the future."

Analysis: why was Pershing Square so successful in this case?

Why was the CP intervention such an apparent success, when, in several other instances, Pershing's brand of activism was far less successful? Mr. Ackman's forays into J.C. Penney, Target, and Borders gave results ranging from mediocre to abysmal.

In an article published in the Financial Post, a number of critical features of this saga are singled out to explain the particular success of this intervention:[37]

1. A rare case of perfectly transferable talent

The recently retired CEO of Canadian National Railways (CN), the best performing railroad company in North America, was soon to be freed from the legal (if not the ethical) constraints on his joining a direct competitor. This man, Hunter Harrison, is acknowledged as a highly skilled and innovative railroader… and he was ready and willing to take over as CEO of CP.

In the Canadian context, such behaviour is not quite gentlemanly. Imagine the high performing CEO of the Royal Bank of Canada who, soon after retirement, would join the Bank of Montreal as CEO. But both Ackman and Harrison are Americans who could not care less about the mores and values of the Canadian business world.

Of course, recruiting Harrison came at a price, some $44M in 2012. Harrison then turned around and recruited Keith Creel (then executive vice-president and chief operating officer at CN) to follow him as CP's President and Chief Operating Officer (and most probably Harrison's successor).

This sort of opportunity to recruit the recently retired CEO of the company's best performing competitor is rare in practice. Ackman has learned that lesson when as the largest shareholder of J.C. Penney (a chain of department stores), he pressured its board of directors to replace the CEO by Ackman's choice: Ron Johnson, at the time president of Apple retail. That turned out to be a disastrous choice. Johnson was let go 17 months later to be replaced by the very CEO he had replaced.

So, an "activist" hedge fund unhappy with the performance of the current CEO of a targeted company calls on the recently retired CEO of a direct competitor who happens to be ready to jump ship and hit the ground running. How rare is that?

2. A simple, well-defined industry

The North American Railroad Industry is extremely well defined. The same companies have been serving this market for decades; their networks are well-established. Performance measures are standard across the industry, which makes for easy comparability across firms. Thus, it is a simple task for management, the board

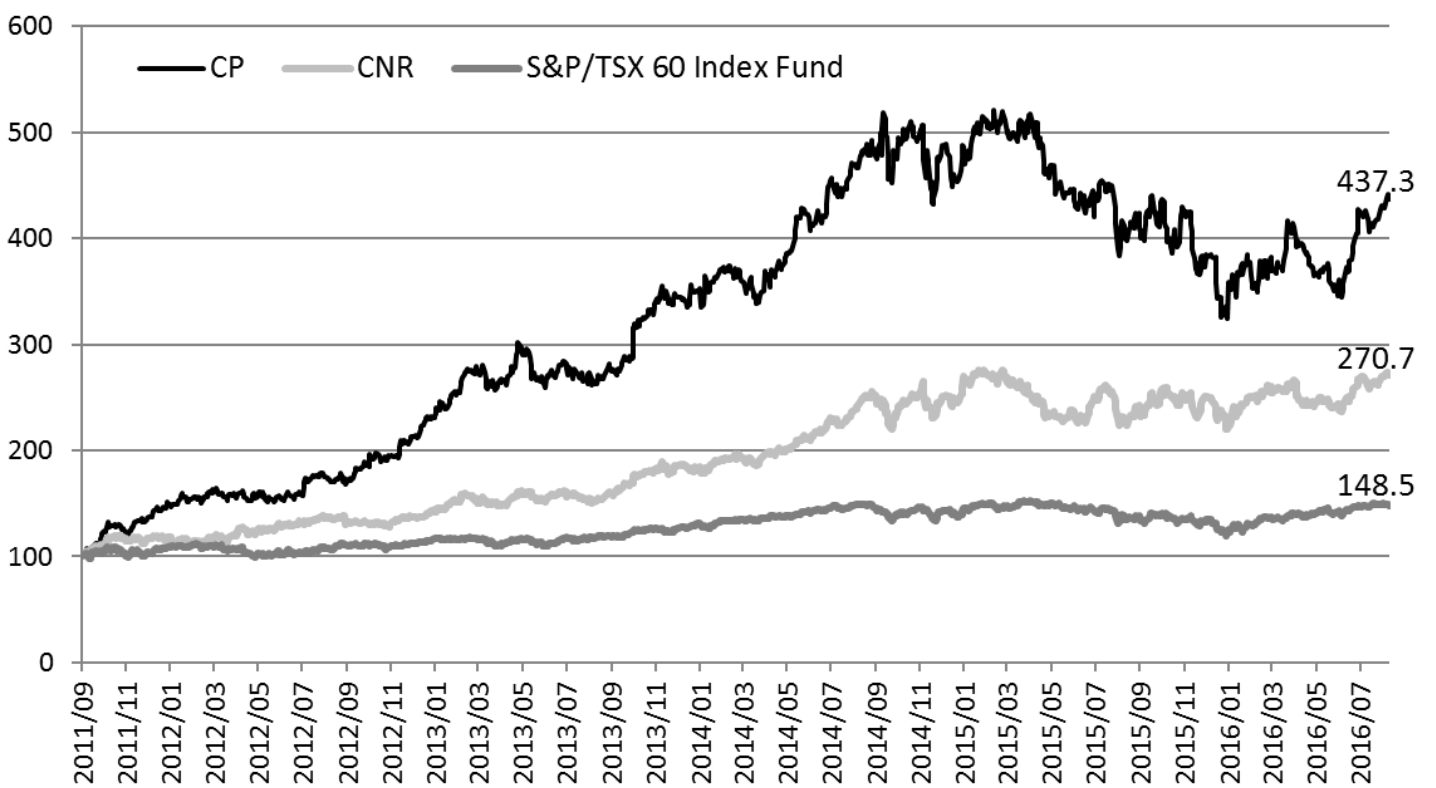


Exhibit 2: Evolution of CP's stock price compared to CN and S&P/TSX 60 index (basis 100).

of directors and investors to benchmark any company against its peers. Unfortunately for CP, its score was substantially lower than its peer group and the gap was widening year after year. But, it was widely accepted (including by financial analysts following the industry) that there were structural factors which explained a good part of this inferior performance. As for the part under the control of management, vigorous action plans were being implemented to bring CP's performance much closer to its peers within five years. That was certainly the firm conviction of the CP board.

3. A prestigious and experienced Canadian board of directors

The board of CP had a nec plus ultra membership drawn from the Canadian business elite, the "royalty of Canadian directors:" former CEOs of the Royal Bank, Cargill, Ipsco, Shell Canada, and Corby Distilleries; current CEOs, scions of old families, a former minister in the Government of Canada. These people had a wealth of business experience and were proud to serve on the board of an iconic corporation whose history is enmeshed with the very history of Canada.

They surely did not lack confidence in their ability to govern the corporation. Indeed, their collective wisdom and governance skills had been recognized repeatedly by various agencies making a business of rating the governance of corporations.

Here comes an upstart "hedge fund" manager from New York who has the gall to criticize their stewardship and to pretend he knows what CP should do to improve its performance. His "bright" insight involves, first of all, the disgraceful suggestion that the CP board chairman go and try to persuade the former CEO of a rival Canadian company to jump ship and join CP!

Here there is more than a whiff of cultural clash between American and Canadian business practices. The differences in values between Americans and Canadians have been well documented,[38] and the cultural clash between Ackman and CP's incumbent board offers yet another example. Indeed, the proposal to hire the former CEO of a competitor must have been viewed as heretic and nonsensical to CP's directors. Such underhand maneuver is just not done in the Canadian business world in general and at CP in particular. CP's culture has been shaped over a hundred years; it is based on the company nurturing its executives, promoting them from within whenever possible.

Not only was Ackman arguing for CP to drop this policy of strict "promotion from within" but was urging CP to hire someone from a direct competitor. Ackman was not inhibited by this Canadian culture (nor was Harrison, an American citizen); he just saw an opportunity.

CP's board could have hired Harrison and gotten all the benefits without the pain of a proxy fight and the humiliation of being rejected by shareholders; but it was, to them an unthinkable breach of the CP culture. In many ways, Pershing Square was merely instrumental to the dramatic operational turnaround undertaken at the CP.

Of course, it is also plausible that a prestigious board, a board made up of experienced former or current executives would be more likely to reject out of hand any suggestion coming from a "financial" sort of player.

4. Massive support from institutional shareholders and other parties

Yet, indifferent to these considerations, large Canadian institutional investors supported Pershing Square's attack on the board of CP. Perhaps tired of CP's stagnating stock price under the leadership of Green, they saw in the hedge fund a vehicle to channel their frustration.

But many other parties also saw the need for change at CP. Indeed, the large proxy advisory firms, the largest Canadian pension funds, eminent and influential experts of the industry, and even the president of Teamsters Canada Rail Conference - Maintenance of Way Employees Division (union representing more than 10% of CP's employees), all supported Ackman in his quest. This is a very rare case where an activist hedge fund enjoyed support that extended beyond the short-term shareholders.

These four features of the CP saga, taken together, are rather unique. Yet, the proof is in the pudding! Under a new leadership, CP has quickly and remarkably improved its performance. What did not seem achievable was achieved. Structural impediments to CP's performance seem to have vanished.

How come the CP board at the time, presumably savvy and experienced, did not spot the mediocre performance of CP, did not challenge the common assertion that structural factors explained CP's poor results? How come no one seemed to notice that the CP performance had been deteriorating? Why were they satisfied with the level and rate of progress proposed by management? Why did they not challenge management about the reasons for CP trailing all other North American railroads.

After all, the critics formulated by Pershing Square were all based on publicly available data. Why could the CP board not see what outsider Pershing Square could spot in a few weeks? The initiatives that Harrison was able to implement swiftly after taking over as CEO constitute a damning indictment of the board (and management) of CP at the time.

Conclusion

Costs and benefits

Let's summarize the benefits and costs of this instance of hedge fund activism. The stock market just loved what was happening at CP and rewarded the company with a booming stock price.

But it should be factored in that over 6,000 CP employees lost their job and the new management exerted unrelenting pressure on the remaining workers to increase productivity. The company claims that it treated fairly those who lost their jobs, that most just took early retirement, etc.

Still, it could be argued that the financial success of CP under Ackman and Harrison was a sort of wealth transfer from workers to shareholders.

Uniqueness of the CP case

The case identified four factors that are rarely present in other cases of activism, a fact which explains why few of these interventions achieve the level of success of the CP case. Indeed, many interventions actually fail and others achieve only moderate success. In fact, a study[39] by Allaire and Dauphin analyzed 259 firms targeted by activist hedge funds, and not a single

case showed any similarity with the CP's case and the perfect alignment of the four factors mentioned above.

Lessons in corporate governance

In this day and age, the CP case teaches us that no matter its size or the nature of its business, a company is always at risk of being challenged by dissident shareholders, and most particularly by those funds which make a business of these sorts of operations, the activist hedge funds.

Of course, a widely held company with weak financial results and a stagnating stock price will inevitably attract the attention of these funds.

But the puzzling question and it is an unresolved dilemma of corporate governance remains: how come the board did not know earlier what became apparent very quickly after the Ackman/ Harrison takeover? Why would the board not call on independent experts to assess management's claim that structural differences made it impossible for CP to achieve a performance similar to that of other railroads? How could the board have known that performances far superior to those targeted by the CEO could be swiftly achieved?

Lurking behind these questions is the fundamental flaw of corporate governance: the asymmetry of information, of knowledge and time invested between the governors and the governed, between the board of directors and management. In CP's case, the directors, as per the norms of "good" fiduciary governance, relied on the information provided by management, believed the plans submitted by management to be adequate and challenging, and based the executives' lavish compensation on the achievement of these plans. The Chairman, on behalf of the Board, did "extend our appreciation to Fred Green and his management team for aggressively and successfully implementing our Multi-Year plan and creating superior value for our shareholders and customers."[40] That form of governance is being challenged by activist investors of all stripes.

Their claim, a demonstrable one in the case of CP, is that with the massive amount of information now accessible about a publicly listed company and its competitors, it is possible for dedicated shareholders to spot poor strategies and call for drastic changes. If push comes to shove, these funds will make their case directly to other shareholders via a proxy contest for board membership.

Corporate boards of the future will have to act as "activists" in their quest for information and their ability to question strategies and performances.

Appendix I

Fred Green's initiatives to improve CP's performance

Green, the CEO of CP from 2006 to 2012, could also argue that he had been a proactive driver of improvements at CP. A few months before officially becoming CP's President and CEO, Fred Green had already started to set the table for important changes. In an internal memo titled "Organizational change for greater success," Green (then as President and COO) wrote in 2006 that "The intent is to build fluidity into all aspects of our business and, by doing so, to improve our operating and financial performance and narrow the operating ratio gap with our direct competitor (Canadian National Railway)." At the time, a source in the industry familiar with the decentralization plan mentioned that "Fred knows that a big part of the problem is nobody is really watching the shop close enough at the field operations level. […] If they pull up their socks, they can equal CN's performance."

However, the operating ratio climbed gradually from 75.4% in 2006 to 78.6% in 2008. Blaming the economic downturn for this mediocre performance, Green launched in 2008 a new campaign titled Execution Excellence for Efficiency (E3) featuring initiatives such as running longer trains and renegotiating fuel contracts with freight customers. CP had also instituted a hiring freeze, trimmed staff travel budgets and restricted discretionary expenses as part of the campaign.

In 2009, the operating ratio stands at 79.1%. In a continuous effort to control costs, Green issued an internal memo to the roughly 3,000 non-union staff across Canada in which he was asking them to burn off vacation days. He was also ending the system in place, which allowed up to 52 weeks of holiday time to be banked. This initiative was put in place to strengthen the balance sheet since "unused vacation is a liability for which the company maintains an accrual."

The initiatives put in place do have an impact, especially over the intermodal train lengths. On average, these trains went from 63 railcars in 2008 to 90 in 2010 . The CP also invested in new technologies for railway optimization.

Even if there was a few notable achievements in 2011, such as the addition and extension of sidings (at the foundation of the train lengthening strategy) that allowed the CP to establish a record year for train weight, the operating ratio went up to 81.3%. The CP adopted a new multi-year plan, built around three key initiatives:

1. driving volume growth;
2. expanding network capacity to safely and efficiently support higher volumes and;
3. cost control.

These initiatives were backed by the following multi-year programs:

- First Mile-Last Mile – this program drives improvements in service, asset velocity and enables low-cost growth by reducing railcars and creating additional terminal capacity.
- Scheduled Bulk – we continue to schedule our bulk train operations as part of our Integrated Operating Plan. In grain, our efforts involve leveraging our grain elevator footprint by scheduling all aspects of our grain shipments, including First Mile-Last Mile switching and bulk unit operations, all centered around a simplified network of origin grain hubs.
- Long Trains – this program is driving increased train lengths; improving service, safety, productivity and efficiency. It includes targeted infrastructure enhancements and the use of proprietary train marshaling software, which maximizes the use of distributed locomotive power.

- Fuel Efficiency – this program targets year-over-year improvements in fuel efficiency and reduced emissions. It consists of the acquisition of new locomotives, the remanufacturing of older locomotives and using new technologies which improve train handling and reduces idling. This program is enhanced by the disciplined execution of the Integrated Operating Plan, improving velocity and driving fleet productivity.
- Locomotive Reliability Centres – we are consolidating the number of major locomotive repair facilities from eight to four highly efficient super shops which will result in improved maintenance capabilities, lower unit costs, reduced overheads and improved locomotive availability and reliability.

To increase track speeds, the CP was to invest approximately $250 million over the next few years to upgrade the network on CP's North Line (which runs from Winnipeg to Edmonton). Once done, these upgrades would reduce route miles for some shipments by between 5% - 10%. The plans' target is to reach an operating ratio between 70% and 72% by 2014, and between 68.5% and 70.5% by 2016.

The last Multi-Year Plan reiterated several elements from the previous plans. However, the arrival of Pershing Square in September of the same year shifted management's time and effort to coping with the challenge of PS, a common and perturbing occurrence when companies are under attack by activist hedge funds.

But the fact remains that for several years preceding the proxy contest by Pershing Square, CP's key financial indicators were inferior to those of comparable competitors. Indeed, the graphs in Appendix II show decreasing ROS, ROA and ROE at CP between 2010 and 2012 (and even since 2009 for the ROS), while all its competitors have improved these indicators over the same period. CP was also at the bottom of the pack on those three performance indicators in 2012. For instance, CP's return on equity of 9.93% in 2012 was dismally low when compared to CN's ROE of 24.70%.

Appendix II

Excerpt from the letter from Ackman to CP shareholders

April 4th 2012

Some of the Board's and Mr. Green's failures are outlined below.

- Mismanagement of Operations – Mr. Green and the Board have mismanaged CP's physical assets and its talented employees, resulting in poor operating performance.
  - Industry-Worst Operating Performance – CP's key indicator of performance – its operating ratio – highlights the Company's industry-worst operating performance. Notably, CP's closest comparable and competitor – Canadian National Railway Company (CNR) – has the best operating ratio (63.5% in 2011 or a full 17.8 percentage points better than CP's), enabling it to generate nearly twice the profit for each dollar of revenue as CP. Over Mr. Green's tenure, CP's pre-tax operating profit has declined 1% despite the inclusion of profits from a substantial acquisition. Excluding the profits from that acquisition, we estimate that pre-tax operating profits have declined 10% or more.
  - Over the six years since Mr. Green became CEO, other railroads have substantially improved their performance, but CP's operating ratio deteriorated (i.e., increased) by 3.6 percentage points from the middle of the pack to last place. This deterioration is due to Mr. Green's mismanagement of CP's physical assets and talented employees. The following chart (Figure 1) compares CP's operating ratio versus its competitors during Mr. Green's tenure (CP is in red and lower is better):
- Failure to Serve Customers Has Led to Market Share Losses – Poor management leads to poor service

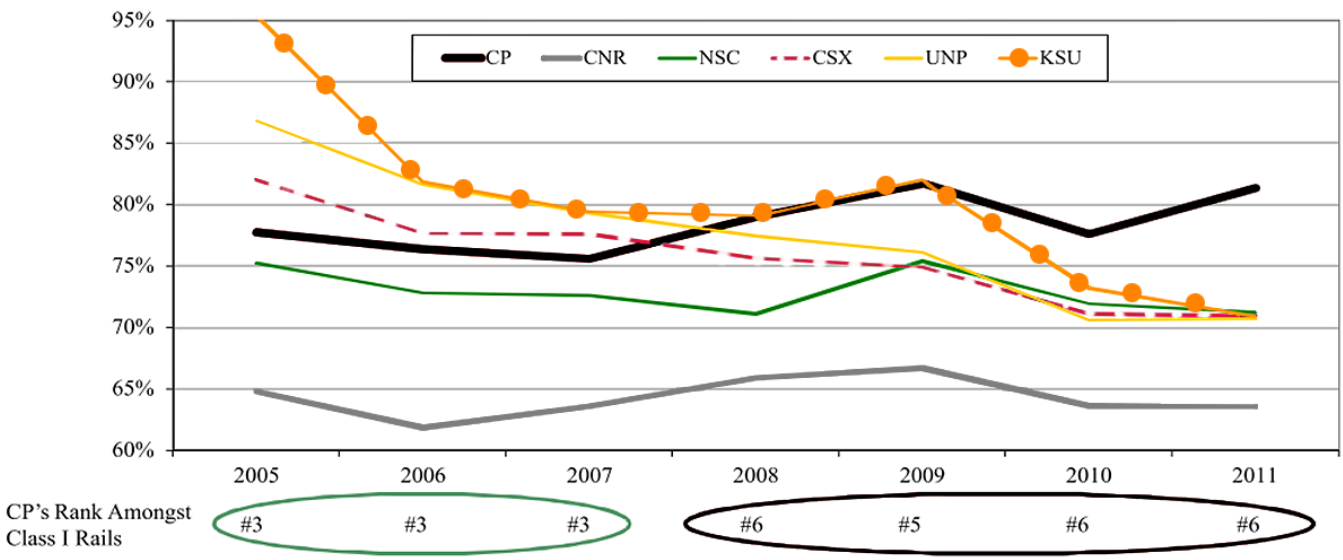


Figure 1: Operating Ratio by Year
As the above chart (Figure 1) illustrates, the operating ratios of every other North American railroad improved (i.e., declined) over Fred Green's tenure, while CP's, uniquely, deteriorated (i.e., increased).

and market share losses. Compared to its principal competitor CNR, CP has longer transit times per mile, less reliable transit times, and less reliable railcar availability. As a result, CP has lost market share to CNR over the last six years, including 7.4 percentage points of intermodal market share, despite CP's completing a substantial acquisition during that period. This underscores the critical and urgent importance of improving service levels because customers vote with their feet.

- Mismanagement of Capital – The Board's and Mr. Green's inadequate and imprudent stewardship of shareholder capital over the past six years has further harmed CP and its shareholders.

o Overpayment for the DM&E – In 2008, under Mr. Green's leadership and with the Board's approval, CP purchased the Dakota, Minnesota & Eastern Railroad (DM&E) at a price of approximately 18 times pre-tax operating profit. The consensus among the investment community at the time and since has been that CP grossly overpaid for DM&E, by many accounts by over 30%.

o Excessive Borrowings to Finance the DM&E Purchase, and Poor Share Buyback Decisions, Resulted in Substantial Shareholder Dilution – Having overpaid for the DM&E, the Board and Mr. Green compounded the problem by financing the DM&E acquisition with excessive debt, contributing to an over-leveraging of the Company's balance sheet. As a result, during the depths of the financial crisis in February 2009, CP had to raise equity by selling $511 million of stock at fire-sale prices – at $36.75 per share – when they had previously completed repurchasing $517 million of stock at $63.03, only 14 months earlier, materially diluting shareholder value. At the same time, other railroads, whose balance sheets had been protected by boards and management with more effective and prudent oversight, created substantial shareholder value by repurchasing their shares at extremely attractive prices during the financial crisis.

o Mishandled Capital Investment – CP's balance sheet mismanagement limited CP's capital investment during the recession – a time when materials, third-party labour costs, and the opportunity cost of network disruption are the least costly. Even as the Board and Mr. Green failed to make important fluidity-enhancing capital investments at opportune times, they squandered shareholder capital on excessive locomotive and car stock. For instance, even though CP's locomotive productivity is already demonstrably below that of CNR, CP has announced that it will spend $500 million for new and replacement locomotives. This new capital commitment comes just a year after Ed Harris – CP's then-COO and current Board member – stated in 2010: "[CP] doesn't need more locomotives. [CP] already has one of the best fleets that I've ever seen in my travels whether as a consultant or a prior executive." (CP Analyst Day June 2010)

o Inadequate Returns on Capital – The bottom line report card on the incumbent Board and management's stewardship of shareholder capital is CP's return on invested capital (ROIC). CP's ROIC was only 7.1% for 2011, a full 3.6 percentage points lower than CNR's.

- Mismanagement of Executive Ranks – One of a board's and CEO's critical functions is attracting, retaining, developing, managing and holding accountable a company's executive ranks. Fred Green and the Board have failed to properly manage CP's executive ranks.

o Management Instability – The Board and Mr. Green have presided over a revolving door with five COO changes, and three CFO changes in fewer than six years. This instability has handicapped CP's operations and financial functions.

o Lack of Accountability – Mr. Green has proposed and attempted to implement "detailed plan" after "detailed plan" after "detailed plan" over his tenure (over 10 distinct plans and initiatives in all). Each plan was rolled out with fanfare and promises for substantial improvements. Each was accompanied with claims of impressive progress and improved metrics. Yet, none of these detailed plans reversed CP's deteriorating performance. The Board nevertheless continues to refuse to hold Mr. Green accountable for his failure to execute. Instead, the Board is now embracing yet another "multi-year plan" – much of which is a rebranding of prior initiatives – accompanied by yet another raft of claims of progress and promises.

- Mismanagement of Executive Compensation – Despite Mr. Green's unacceptable performance during his tenure, the Board continues to compensate him as though his performance has been meritorious. This failure to properly manage executive compensation has materially contributed to CP's decline.

o Unacceptably Low Performance Targets – The Board has set Mr. Green's individual performance objectives so low that even though CP has consistently and substantially lagged behind its peers, the Board has deemed Mr. Green to have met all but one of those individual performance objectives during his tenure.

o Excessive CEO Compensation – The Board has paid Mr. Green $32 million from 2006-2011, even though total returns to shareholders were negative 18% over the same period (the date before Pershing Square's initial purchases of CP shares), a period during which every other Class I North American railroad delivered solid returns.

o Excessive Management Compensation – Even as CP's performance has languished, the Board increased the Cost of Management Ratio (named executive officer compensation as a percentage of net income) from 1.2% of net income in 2006 to 2.5% in 2011. Stated simply, income to shareholders has languished while compensation to executive management has increased.

- Weak Ownership Commitment – The Board's current directors (excluding Mr. Green) collectively have an equity stake of less than 0.3% in CP, and nearly all of these equity interests were granted as director compensation.

In summary, poor decisions, ineffective leadership and inadequate stewardship by current CEO Mr. Green and the CP Board, compounded by a deficient corporate culture, have severely degraded CP, Canada's iconic railroad. All stakeholders – customers, employees, and shareholders – and the economy have suffered from this failure.

The Solution: A Restructured Board and the Right New CEO

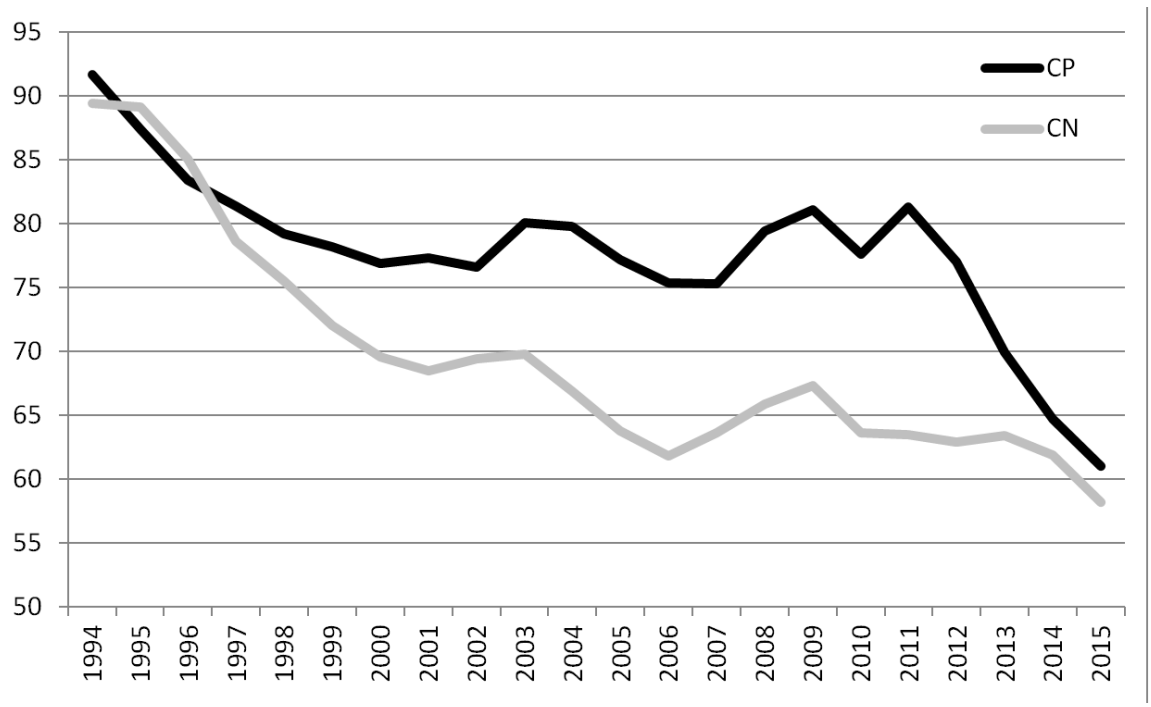
Electing the seven Nominees for Management Change will reset the Board's culture and composition, ensure that shareholders' voices will be heard, and deliver an unequivocal shareholder mandate that will catalyze essential management change.

We believe the Nominees for Management Change are the right directors and Hunter Harrison is the right new CEO for the job. We are confident that upon meeting Hunter and considering the alternatives, the reconstituted Board in its entirety will conclude that Hunter Harrison is the ideal CEO choice.

Why Hunter Harrison?

Hunter Harrison is a seasoned chief executive with a proven, unrivaled track record of operational and cultural transformation. He is a change agent with deep railroad operating experience and a thorough familiarity with all aspects of the Canadian rail industry, including its customers, freight flows, terminal operators, unions (and union leaders), suppliers, regulations, terrain, and weather patterns."

Appendix III



Evolution of the operating ratio (% - left scale) for the CP and CN (1994-2015)

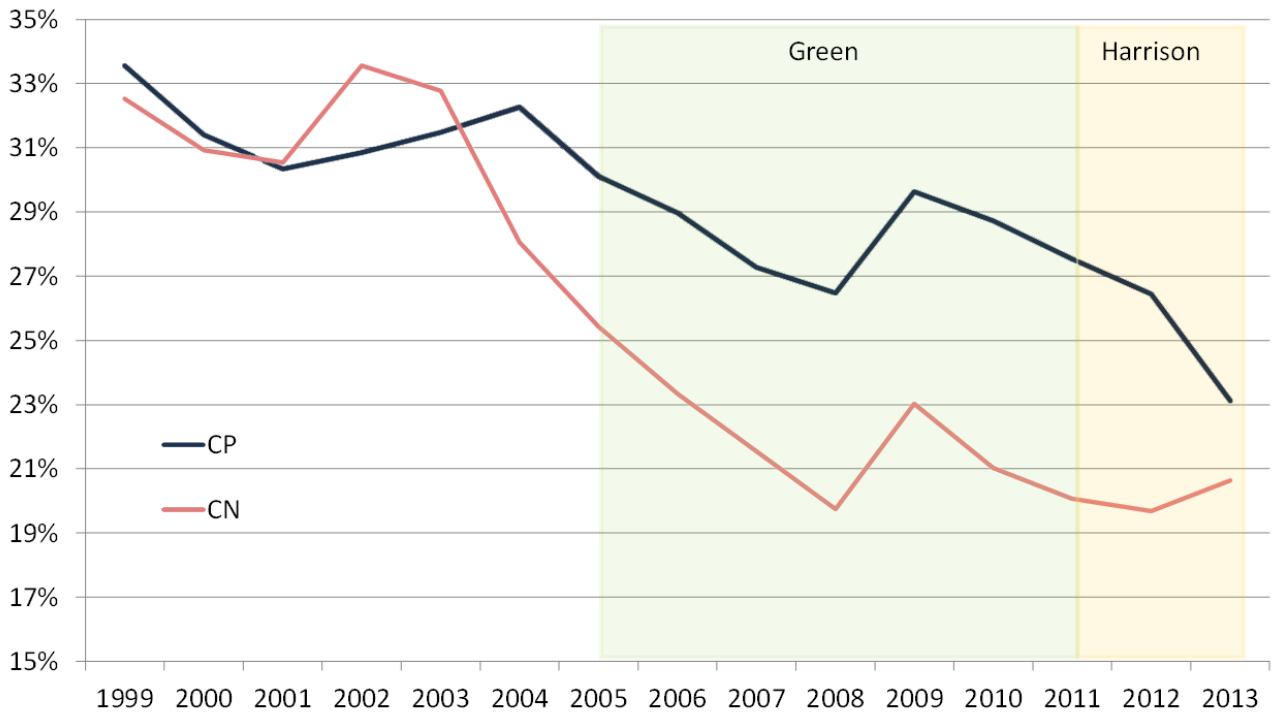
Appendix IV

Key Performance Indicators	2015	2014	2013	2012	2011	2010
Operating Ratio (adjusted)	61.1%	64.7%	69.9%	77.0%	81.3%	77.6%
Freight gross ton-miles ("GTM") (millions)	263,333	272,862	267,629	254,354	247,955	242,757
Train miles (thousands)	34,047	36,252	37,817	40,270	40,145	39,576
Average train weight – excluding local traffic (tons)	8,314	8,076	7,573	6,709	6,593	6,519
Average train length – excluding local traffic (feet)	6,935	6,682	6,530	5,981	5,665	5,660
Fuel efficiency (U.S. gal. of fuel consumed/1,000 GTMs)	0.994	1.035	1.06	1.15	1.18	1.17

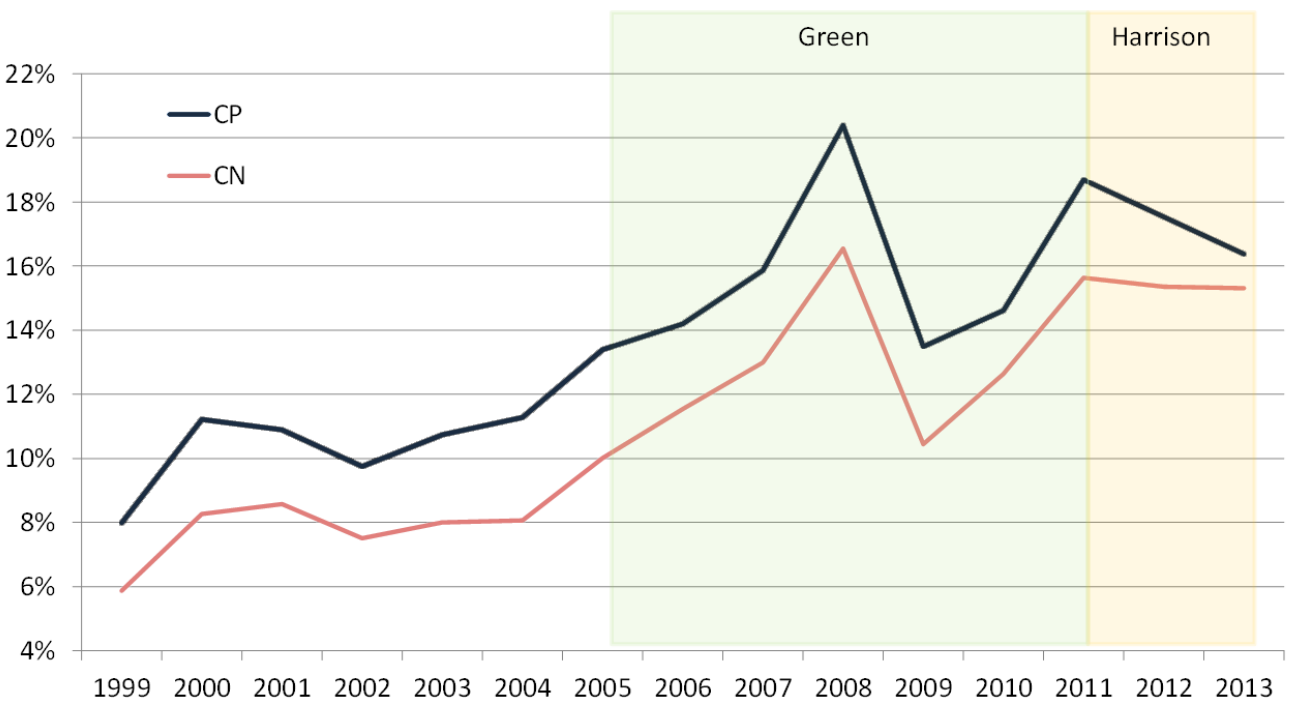
Source of data: CP annual reports.

Appendix V

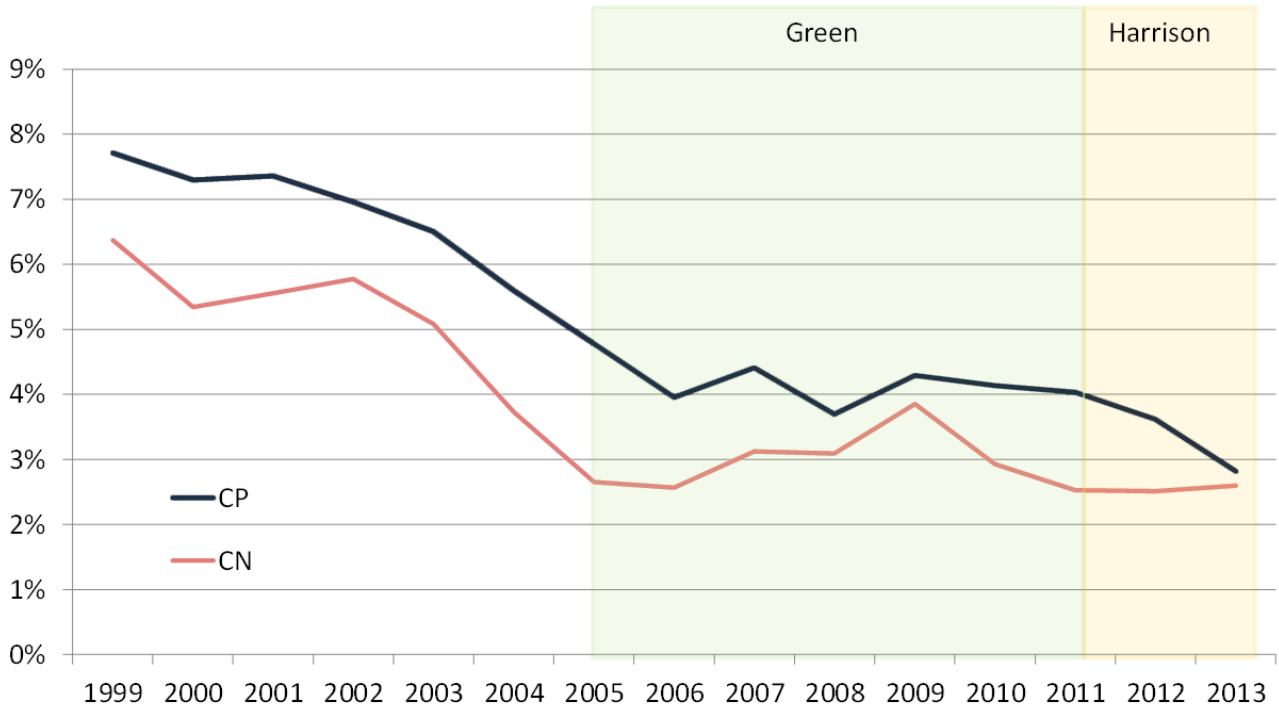
Evolution of ratios and operating statistics



Salary and benefits as a % of total revenues



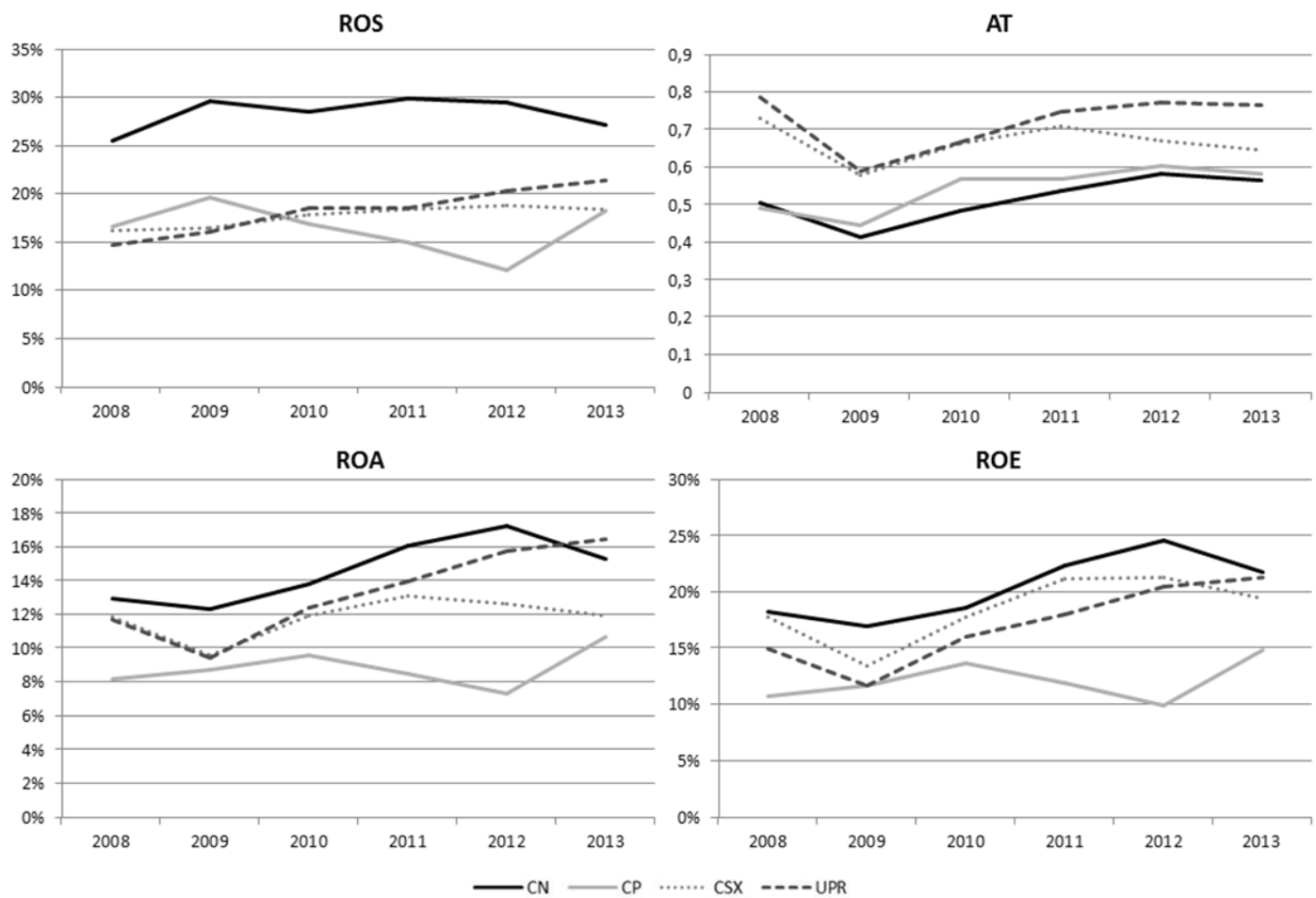
Fuel expenses as a % of total revenues



Fuel expenses as a % of total revenues

Appendix VI

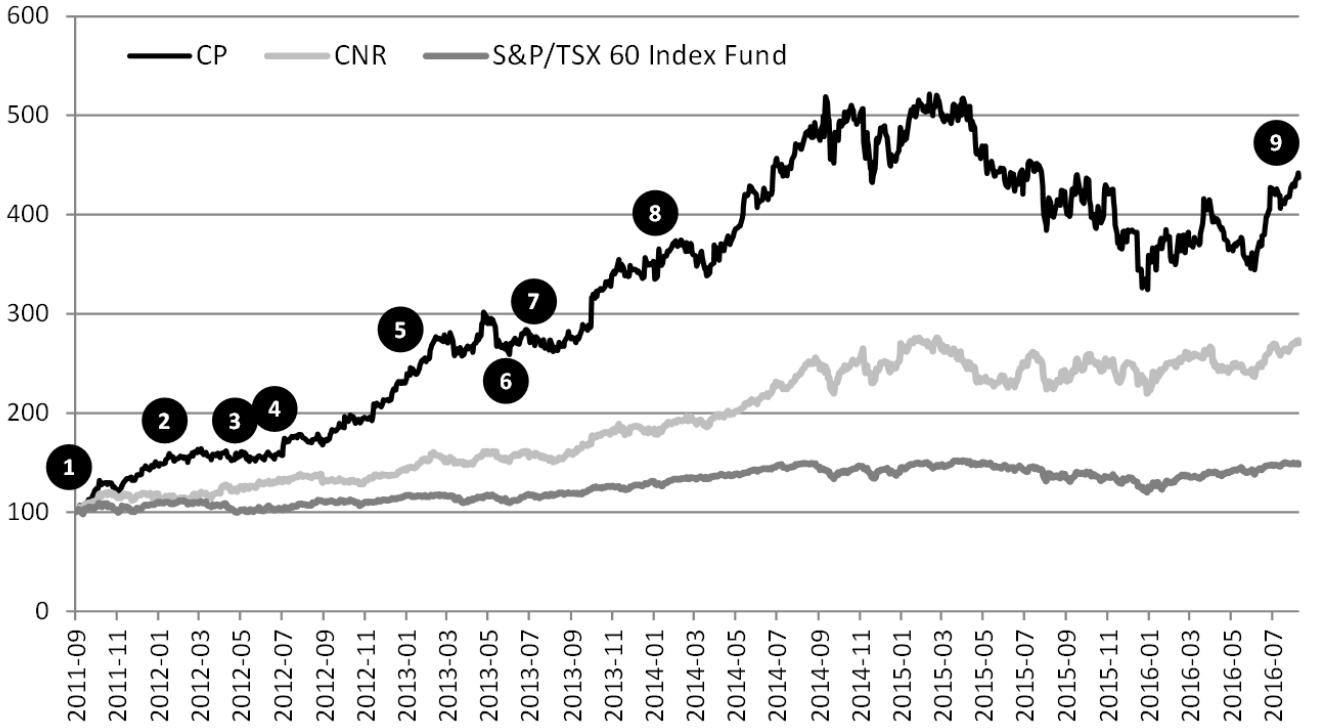
Selection of Performance Indicators



Class 1 Companies, Railroad Industry (2008-2013)

Appendix VII

CP's Share Price* Evolution Comparatively to CN and the S&P/TSX 60 Index, from September 23, 2011, to August 31, 2016 (Basis 100)



**Prices adjusted for dividends and splits. Source of data: http://www.finance.yahoo.com*

1. Beginning of shares purchases by Pershing Square in order to acquire an interest in the CP (September 23, 2011)
2. Public Town Hall Meeting in Toronto held by William Ackman to denounce CP's management and governance, and asking shareholders to vote for a change (February 6, 2012)
3. Annual Meeting of Shareholders, vote in favor of Pershing Square's proposal for change (May 17, 2012)
4. Hunter Harrison is appointed CEO, following his election as Director on CP's Board (June 28, 2012)
5. 2012 Fourth quarter results (January 29, 2013). 6 months after Hunter Harrison's arrival, the operating ratio for the quarter reaches 74.8%, comparatively to 78.5% for the same quarter a year before.
6. Pershing Square announce its intent to sell about 30% of its interest in the CP (June 3, 2013)
7. Disclosure of 2013 first semester results (July 24, 2013). The operating ratio for the period reaches 73.9% comparatively ton81.3% for the same period a year before. These results mark the first year anniversary of Hunter Harrison's tenure.
8. On January 29, 2014, the CP disclosed its 2013 4th quarter results. The operating ratio was reduced to 65.9% for the quarter, and to 69.9% for the year, relatively to 74.8% and 77% for the comparable periods, respectively. Hunter Harrison was named CEO of the year for 2013 by Morningstar and Top Turnaround CEO of the Year by Canadian Business.
9. August 2016, Pershing Square sells the remaining shares of CP and officially exits.

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Professor Yvan Allaire is the Executive Chair of the Institute for Governance of Public and Private Organizations (IGOPP). A professor of strategy for many years, he co-founded the strategy consulting group SÉCOR Inc., and was executive vice-president at Bombardier Inc (1996-2001) and Chairman of Bombardier Capital (1999-2001). Professor Allaire was also Chair of the Global Council on the Role of Business of the World Economic Forum in 2013 and 2014.

Professor Allaire is the author of several IGOPP policy papers, which offer new perspectives on a range of controversial issues including dual-class voting shares, corporate citizenship, the place

of women on boards of directors, say-on-pay by shareholders and executive compensation, among others. Prolific author, Professor Allaire has published many award-winning articles on strategy and is the co-author of several books on strategy and governance.

Yvan Allaire holds a B.Sc. Com (Summa cum laude) and an MBA from Université de Sherbrooke, and a Ph.D. from the Massachusetts Institute of Technology (MIT). He is a Fellow of the Royal Society of Canada.

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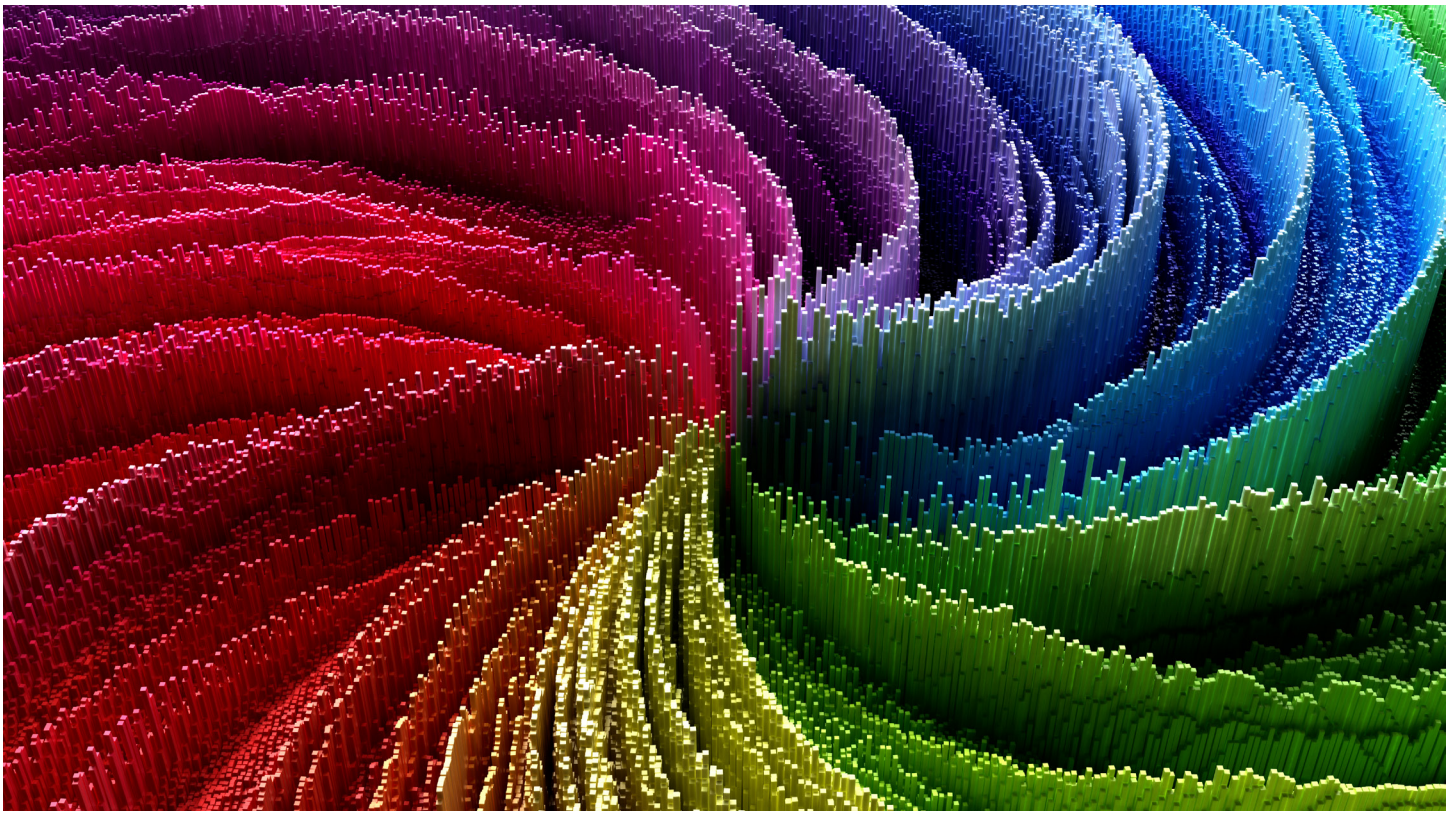
François Dauphin is director of research of the Institute for Governance of Private and Public Organizations (IGOPP), and is responsible for designing research and publishing applied research papers and practical cases on topics related to corporate governance and financial regulation. Prior to joining IGOPP in 2014, François worked at the Quebec Chartered Professional Accountants Order where he was responsible for reviewing and developing material used in the continuous learning program in management and management accounting. Previously, Francois spent five years as Director, finance and strategic investments at Capital GVR, a private holding. Prior to joining Capital GVR, François was Research Coordinator of the J. A. Bombardier Chair in Transnational Management at Université du Québec à Montréal (UQAM). François is a lecturer at UQAM where he teaches strategic change leadership. He holds an MBA from UQAM and is a member of the Quebec Chartered Professional Accountants Order.



The Merits and Methods of Multi-Factor Investing

Andrew Innes
S&P Dow Jones Indices

The Risk of Choosing Between Single Factors

Given the unique cycles across the returns of single-factor strategies, how can those market participants without a factor view avoid putting all their eggs in the wrong basket?

The Cyclicality of S&P DJI's Single-Factor Indices

Single-factor equity strategies have been widely adopted to harvest the unique risk premium of a particular systematic factor that could reward market participants over time. Out of the widely accepted equity factors extensively studied in academic literature,[1] S&P DJI's single-factor index offerings include four key factors: quality, value, momentum, and low volatility.[2] The application of these single-factor strategies in the form of simple, rules-based indices has enabled market participants to seek active returns while benefiting from the low-cost, transparent methodology of passive investing.[3]

As seen in Exhibit 1, all of the long-term equity factors have distinct active returns that have all been susceptible to significant periods of underperformance relative to the S&P 500. Each factor exhibits unique cycles that can be attributed to the market environment[4] and corresponding stage in the economic cycle.[5] Therefore, single-factor strategies may be better suited to market participants with long time horizons, given their potential for long cyclical drawdowns. It is also worth noting that the active returns of each factor have varied greatly over the long term, and it may be incorrect to assume their relative strengths will continue indefinitely.

Using Multi-Factor Combinations to Diversify Risk

As the story of factor-based investing progresses, advocates of these systematic return

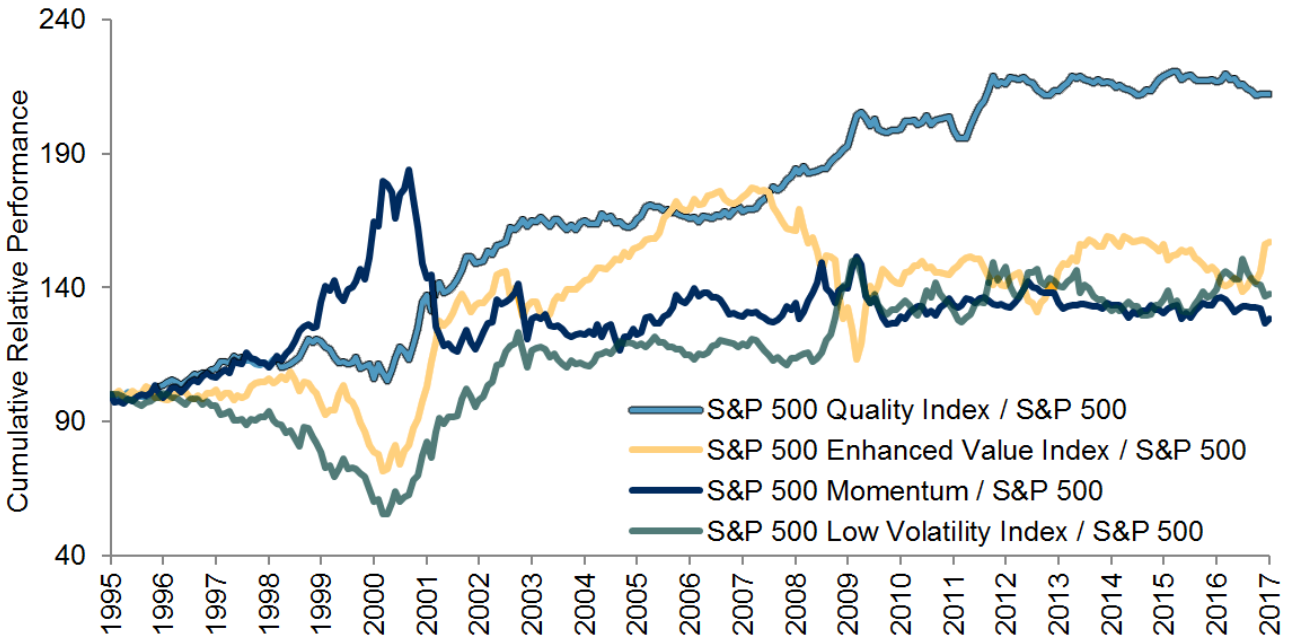


Exhibit 1: The S&P 500 Single-Factor Indices Have Unique Active Returns
Source: S&P Dow Jones Indices LLC. Data from Dec. 31, 1994, to Jan. 31, 2017. Performance based on total return in USD. Past performance is no guarantee of future results. Chart is provided for illustrative purposes and reflects hypothetical historical performance. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with back-tested performance.

drivers are increasingly looking to multi-factor combinations to seize upon the potential diversification benefits. In much the same way as combining different asset classes, each with its own risk/return profile, the returns of many of the established equity factors can be combined in an attempt to diversify the portfolio and provide more stable excess returns. Fortunately, most equity factor returns have low correlations, particularly in times of market stress.[6]

Thus, one can logically deduce that using multiple equity factors as building blocks when creating a combined diversified portfolio may allow market participants to increase the frequency of outperformance over shorter time horizons.

Introducing a Multi-Factor Index of Indices Approach

Until recently, market participants wishing to gain exposure to multiple factors and motivated by the diversification benefits of a combined approach have primarily done so by managing their allocations to a collection of single-factor strategies. This approach represents a multi-factor index of indices, in which each underlying index contains constituents chosen based only on a single factor. For our example below, we have created a multi-factor index of indices with equal weights between the S&P 500 Quality Index, S&P 500 Enhanced Value Index, S&P 500 Momentum, and S&P 500 Low Volatility Index (rebalanced semi-annually). As each of the S&P 500 single-factor indices contains the top 100 stocks, our combined portfolio may contain up to 400 stocks (although there are generally substantially fewer, owing to crossover of constituents between the indices).

Multi-Factor Strategy Outperformed More Frequently Than Single-Factors

Exhibit 2 shows that the single-factor indices often outperformed the S&P 500 on a risk-adjusted basis over most time horizons during the period studied. However, the frequencies of risk-adjusted outperformance were notably lower for shorter holding periods, with frequencies less than 50% for the enhanced value and momentum factors over one- to five-year rolling windows. Interestingly, the outperformance frequencies varied greatly between the different factor indices. For example, across all the five-year investment windows, the quality and low volatility indices outperformed 98% and 92% of the time, respectively, while the enhanced value and momentum indices only outperformed 45% and 48% of the time, respectively. This suggests that market participants would have needed significant foresight when allocating tactically between the factors to ensure that they were exposed to the winning factors at the right time.

Fortunately, for those with an agnostic view regarding factors, the index of indices represents an alternative approach that fared as well as or better than the best-performing single factor over all horizons.[7] The diversification benefit of holding equal exposure between the four single-factor indices (rebalanced semiannually)

ROLLING WINDOW	S&P 500 QUALITY INDEX	S&P 500 ENHANCED VALUE INDEX	S&P 500 MOMENTUM	S&P 500 LOW VOLATILITY INDEX	INDEX OF INDICES
1 Year	65.7%	47.2%	48.0%	59.4%	79.5%
3 Years	78.7%	44.3%	40.9%	77.8%	96.5%
5 Years	97.6%	45.1%	48.1%	92.2%	100.0%
10 Years	100.0%	54.1%	63.0%	100.0%	100.0%
15 Years	100.0%	86.0%	64.0%	100.0%	100.0%

Exhibit 2: Frequency of Risk-Adjusted Outperformance to the S&P 500 Over Varying Time Horizons
Index of indices is a hypothetical portfolio.
Source: S&P Dow Jones Indices LLC. Average of monthly rolling data from Dec. 31, 1994, to Jan. 31, 2017. Performance based on total return in USD. Past performance is no guarantee of future results. Table is provided for illustrative purposes and reflects hypothetical historical performance. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with back-tested performance.

contributed to its outperformance to the S&P 500 on a risk-adjusted basis 80% of the time over a one-year period and 97% of the time over a three-year period.

Factor Exposure Dilutions in a Multi-Factor Index of Indices

The relative simplicity and lack of required factor view when adopting an equal-weighted, multi-factor index of indices approach may be compelling to market participants. However, combining single-factor indices to create a multi-factor index of indices results in a portfolio of stocks that are only selected based on their merits with regard to a single factor. Therefore, since their exposures to desired secondary factors could be relatively weak, the combined portfolio may suffer from a dilution effect in overall factor exposures.

Low Secondary Factor Exposures in Single-Factor Indices

There are several ways to measure the factor exposures within a portfolio; for instance, one could calculate the regression coefficients with respect to each of the desired factor returns. However, since our concern is focused on index construction, it seems prudent to measure factor exposures in terms of the factor scores[8] of the selected stocks—much like how the top quintile is selected in S&P DJI's factor indices methodology.

Exhibit 3 shows the relative factor exposures of each top-quintile S&P 500 single-factor portfolio, expressed in terms of their weighted-average factor scores.

We can see that each top quintile portfolio generally had low secondary factor exposures. For instance, the top 100 stocks in the S&P 500 ranked in terms of their value score typically had below-average quality and momentum scores; their weighted-average ranks were at the 43rd percentile and 40th percentile, respectively. Unsurprisingly, it is unlikely that the best value stocks in the S&P 500 (or elsewhere) would have already experienced considerable price momentum or be considered of the highest quality. Similar rationale can help us understand other low or negative correlations between the various factor combinations.

Diluted Net Exposures in a Multi-Factor Index of Indices

Exhibit 4 shows the weighted-average factor z-score percentiles for an index of indices containing quality, value, and momentum.

PORTFOLIO	WEIGHTED-AVERAGE PERCENTILE RANK OF FACTOR Z-SCORES			
	QUALITY	ENHANCED VALUE	MOMENTUM	LOW VOLATILITY
Top Quintile S&P 500 Quality Index	91	33	57	64
Top Quintile S&P 500 Enhanced Value Index	43	90	40	49
Top Quintile S&P 500 Momentum	54	32	91	58
Top Quintile S&P 500 Low Volatility Index	59	42	57	91

Exhibit 3: Factor Scores of Top-Quintile, Single-Factor Portfolios

Source: S&P Dow Jones Indices LLC. Data from Dec. 31, 1994, to Jan. 31, 2017. Factor z-scores are calculated semi-annually according to S&P DJI's Single-Factor Index methodology and are expressed as a weighted average of their percentile ranks within the S&P 500. Table is provided for illustrative purposes and reflects hypothetical historical performance. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with back-tested performance.

The lines representing factor exposures of the combined portfolio over time indicate considerable factor exposure dilution compared with the top quintile offered by the respective single-factor indices (see Exhibit 3). The average exposures to the desired factors in a multi-factor index of indices are comparable to second and third quintile stocks. In terms of the frequency of distribution for each desired factor, fewer than 40% of the stocks selected are in the top quintile. The significant distribution of stocks in the lower quintiles may be affecting portfolio performance.

An Alternative Multi-Factor Approach: Stock-Level Selection

Given that the negative correlation of factor scores appears to cause a degree of factor exposure dilution when adopting a multi-factor index of indices, we set out to examine whether there may be a more optimal approach to constructing a multi-factor index.

Target Multi-Factor Portfolio

Exhibit 5 illustrates the alternative selection process involved in a stock-level multi-factor strategy. This "bottom-up" process involves combining individual factor scores for each stock to create a multi-factor score. The multi-factor score is then used to select a more concentrated portfolio of "all-rounders," characterized by exposures that are fairly evenly distributed across all of the desired return drivers. The intention of this approach is to mitigate the factor exposure dilution inherent in a multi-factor index of indices.

In Exhibit 5, we used the example of quality, value, and momentum, but the same approach is applicable to any combination of equity factors. The area labeled "Target Multi-Factor Portfolio" in Exhibit 5 represents stocks that have characteristics of all the desired factors. In practice, there are often only a few stocks with high scores across all of the desired

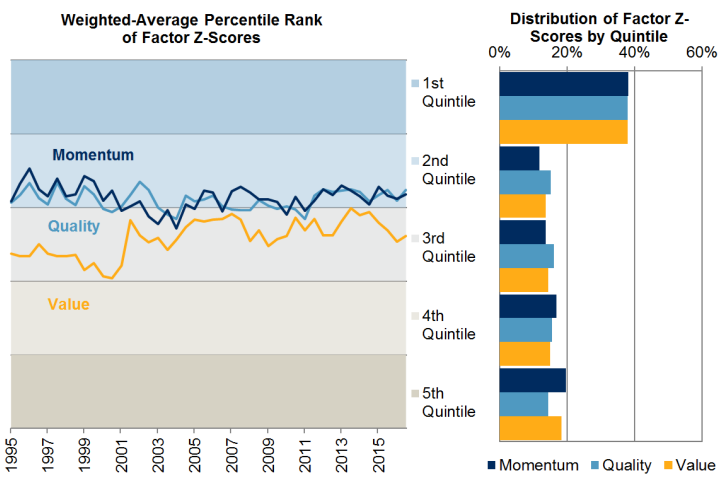


Exhibit 4: Factor Scores of Top-Quintile, Single-Factor Portfolios

Index of indices is a hypothetical portfolio.
Source: S&P Dow Jones Indices LLC. Data from Dec. 31, 1994, to Jan. 31, 2017. Factor z-scores are calculated semi-annually according to S&P DJI's Single-Factor Index methodology and are expressed as a weighted average of their percentile ranks within the S&P 500. Table is provided for illustrative purposes and reflects hypothetical historical performance. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with back-tested performance.

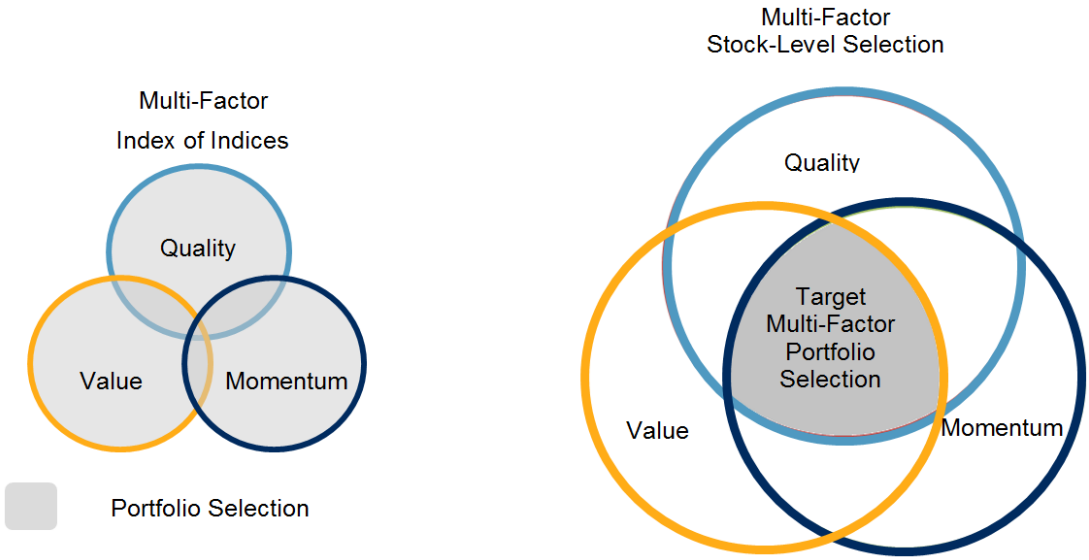


Exhibit 5: A Stock-Level, Multi-Factor Index Targets "All-Rounders"
Source: S&P Dow Jones Indices LLC. Chart is provided for illustrative purposes.

factors, so a compromise must be made to select sufficient stocks to construct a multi-factor portfolio in this way. This compromise may involve lowering the selection criteria for each factor score. Alternatively, selecting the top quintile based on the average of the desired factor scores would seek to find the stocks with the best combined factor characteristics without explicitly choosing a minimum score for any one factor.

Aims of the S&P Dow Jones Multi-Factor Index

While there may be myriad approaches to effectively combine equity risk factors, our aim, in the absence of any tactical factor viewpoint, is to capture high factor exposures across a range of selected equity factors through a simple constituent-level selection approach. In doing so, we seek to measure and compare the factor score exposures to the original multi-factor index of indices approach, while ensuring reasonably fair exposure across the desired return drivers. Each approach will ultimately be judged most viable with respect to the market participants' objectives by comparing the portfolio's risk/return characteristics.

Introducing the S&P 500 Quality, Value & Momentum Multi-Factor Index

The S&P 500 Quality, Value & Momentum Multi-Factor Index is an example of a stock-level selection process. In general terms, this index takes an average of the standardized scores across all three factors for the S&P 500 and then selects the top quintile. The index is rebalanced semi-annually and is weighted with respect to the product of its multi-factor score and its float market capitalization.[9]

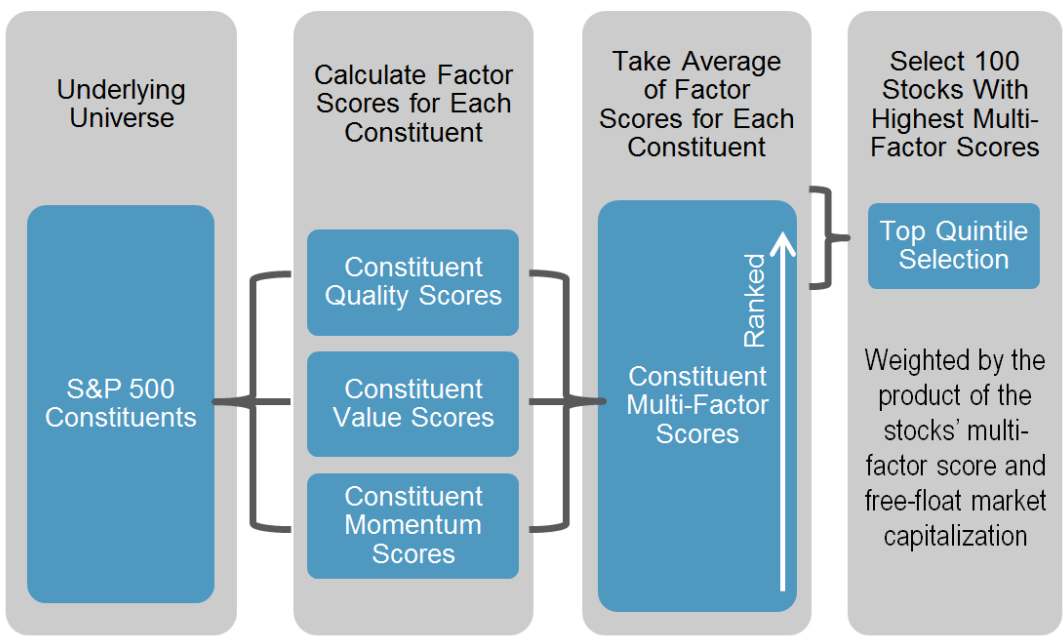
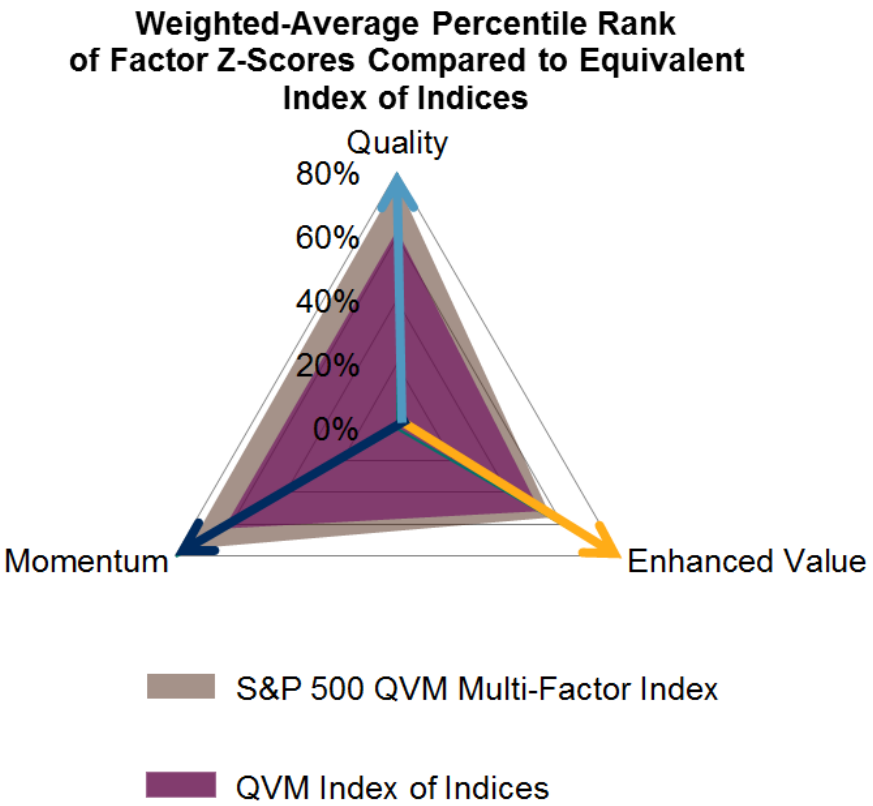


Exhibit 6: S&P 500 Quality, Value & Momentum Multi-Factor Index Simplified Selection Process
Source: S&P Dow Jones Indices LLC. Chart is provided for illustrative purposes.



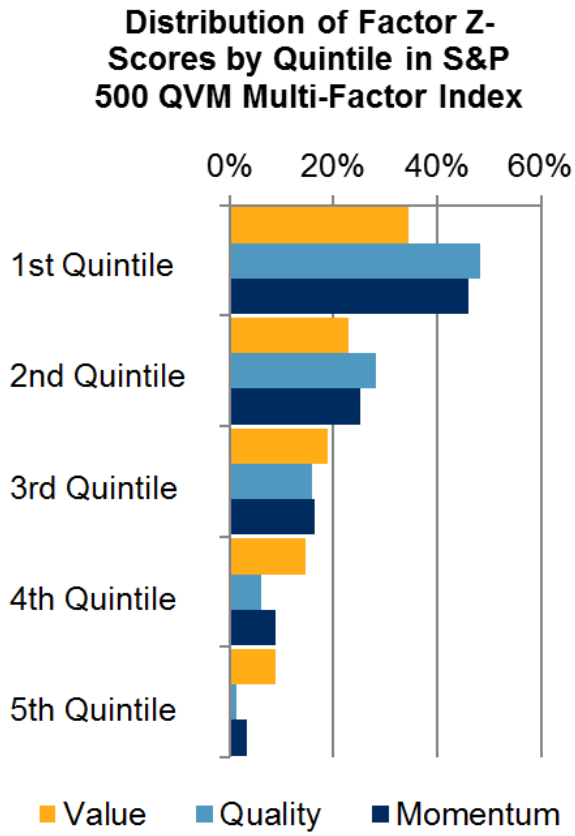


Exhibit 7: Improved Factor Exposures of the S&P 500 Quality, Value & Momentum Multi-Factor Index
QVM Index of Indices is a hypothetical portfolio.
Source: S&P Dow Jones Indices LLC. Data from Dec. 31, 1994, to Jan. 31, 2017. Factor z-scores for the constituents of the S&P 500 Quality, Value & Momentum Multi-Factor Index are calculated semiannually according to S&P DJI's Single-Factor Index methodology and are expressed as a weighted-average of their percentile ranks within the S&P 500. The QVM Index of Indices is an equal-weight portfolio that includes the S&P 500 Quality Index, S&P 500 Enhanced Value Index and S&P 500 Momentum that is rebalanced semi-annually. Charts are provided for illustrative purposes and reflect hypothetical historical performance. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with back-tested performance.

Exhibit 7 shows the distribution of stocks selected in the S&P 500 Quality, Value & Momentum Multi-Factor Index in terms of their factor z-score percentile ranks. Compared with Exhibit 4, it is evident there is an improvement in the number of higher-quintile z-scores across the desired factors when using a stock-level selection process versus an index of indices approach. We also see a reduction in the number of lower-quintile z-scores being selected, compared with the index of indices.

To help quantify this observation, we took a weighted average of the factor z-score percentile ranks. The resultant values (representing factor exposures) are notably superior to an equivalent index of indices, with 77% for quality, 56% for enhanced value, and 76% for momentum (compared with 62%, 52%, and 63%, respectively, for the index of indices).

It is worth noting that the value factor was relatively under-represented, due to it having a more negative correlation in z-scores with quality and momentum (see Exhibit 3). Alternative index construction methods that seek to balance this exposure would ultimately have to make further compromises in selecting lower-percentile stocks for quality and momentum.

Risk/Return Comparison of Multi-Factor Approaches

To analyze the impact of the two approaches to constructing multi-factor indices, we compared the risk/return characteristics of each. To represent our stock-level selection index, we used the S&P 500 Quality, Value & Momentum Multi-Factor Index. An equal-weighted portfolio (rebalanced semi-annually) consisting of the S&P 500 Quality Index, S&P 500 Enhanced Value Index, and S&P 500 Momentum (referred to as "QVM Index of Indices") was used as an equivalent index of indices approach.

Comparison of Portfolio Risk/Return Characteristics

To eliminate any concerns about choosing an arbitrary start date to calculate each portfolio's risk/return characteristics, we instead used rolling 5-, 10-, and 15-year windows over the full available back-tested history, starting on Dec. 31, 1994. This also allows us to appreciate the impact of the investment time horizon on the results.

It is evident from Exhibit 9 that the risk-adjusted returns for the S&P 500 Quality, Value & Momentum Multi-Factor Index were greater than those of the QVM Index of Indices for all the

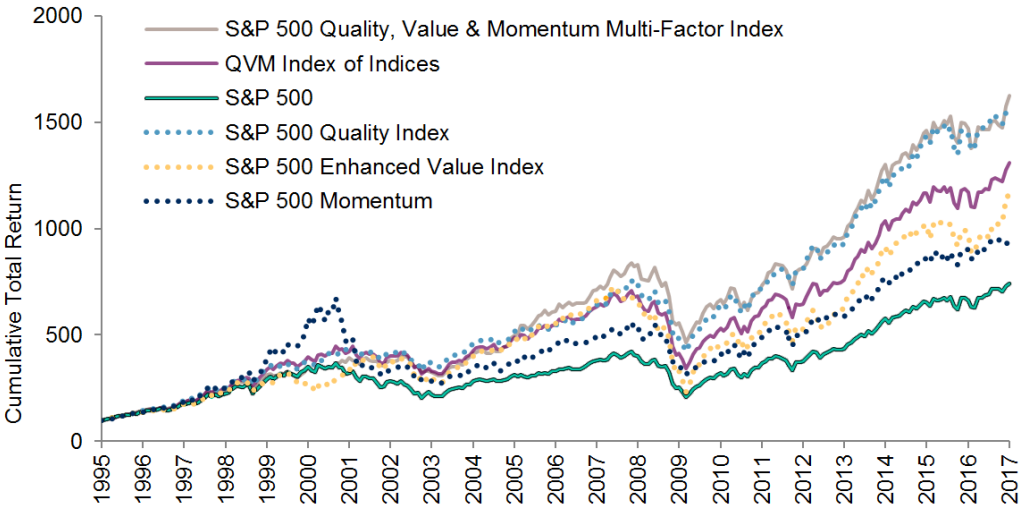


Exhibit 8: S&P 500 Quality, Value & Momentum Index Compares Favorably to the Best-Performing Single-Factor Index

QVM Index of Indices is a hypothetical portfolio.

Source: S&P Dow Jones Indices LLC. Data from Dec. 31, 1994, to Jan. 31, 2017. Index performance based on total return in USD. Past performance is no guarantee of future results. Chart is provided for illustrative purposes and reflects hypothetical historical performance. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with back-tested performance. The QVM Index of Indices is an equal-weight portfolio that includes the S&P 500 Quality Index, S&P 500 Enhanced Value Index, and S&P 500 Momentum that is rebalanced semiannually.

ROLLING WINDOW	S&P 500	S&P 500 QUALITY INDEX	S&P 500 ENHANCED VALUE INDEX	S&P 500 MOMENTUM	QVM INDEX OF INDICES	S&P 500 QUALITY, VALUE & MOMENTUM MULTI-FACTOR INDEX
AVERAGE TOTAL RETURNS (%, ANNUALIZED)						
5 Years	6.90	11.10	9.40	8.00	9.90	11.50
10 Years	5.50	9.70	8.10	6.20	8.40	10.80
15 Years	5.50	9.90	8.20	6.10	8.50	10.50
AVERAGE VOLATILITY (%, ANNUALIZED)						
5 Years	15.30	14.00	19.50	17.30	15.20	14.10
10 Years	15.30	14.00	19.90	17.20	15.40	14.20
15 Years	15.70	14.20	20.40	17.60	15.70	14.40
AVERAGE RISK/RETURN (ANNUALIZED)						
5 Years	0.52	0.84	0.59	0.53	0.72	0.88
10 Years	0.36	0.70	0.43	0.37	0.56	0.77
15 Years	0.35	0.69	0.4	0.35	0.54	0.73
AVERAGE TRACKING ERROR TO S&P 500 (%, ANNUALIZED)						
5 Years	-	5.00	9.90	9.20	3.50	6.50
10 Years	-	5.00	10.00	9.40	3.60	6.80
15 Years	-	5.30	10.30	9.70	3.70	7.10
AVERAGE INFORMATION RATIO TO S&P 500 (ANNUALIZED)						
5 Years	-	0.72	0.3	0.09	0.73	0.56
10 Years	-	0.75	0.27	0.05	0.71	0.66
15 Years	-	0.72	0.29	0.04	0.75	0.61
MAXIMUM DRAWDOWN (MONTHS)						
Full Period	-	39	70	154	51	51
ONE-WAY TURNOVER (%, APPROXIMATE)						
Full Period	-	62	32	118	71	98

Exhibit 9: S&P 500 Single and Multi-Factor Portfolio Risk/Return Characteristics Comparison

QVM Index of Indices is a hypothetical portfolio.

Source: S&P Dow Jones Indices LLC. Rolling window data is the average of annualized figures on a monthly basis from Dec. 31, 1994, to Jan. 31, 2017. Performance based on total return in USD. Past performance is no guarantee of future results. Table is provided for illustrative purposes and reflects hypothetical historical performance. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with back-tested performance. The QVM Index of Indices is an equal-weight portfolio that includes the S&P 500 Quality Index, S&P 500 Enhanced Value Index, and S&P 500 Momentum that is rebalanced semiannually.

rolling time horizons analyzed. Over a 15-year rolling window, the risk-adjusted return figures were 0.73 and 0.54, respectively. These results help support the view that a stock-level multi-factor selection process may reduce dilution of desired factor exposures compared with an index of indices approach, potentially allowing investors to harvest more of the factors' collective risk premia.

In Exhibit 10, the diagonal line represents all points with risk-adjusted returns equal to the S&P 500. Points further above the diagonal line exhibit progressively better risk-adjusted returns compared with the S&P 500.

The compromise in achieving these superior risk-adjusted returns, however, has been increased tracking error to the benchmark. As the S&P 500 Quality, Value & Momentum Multi-Factor Index aims to select only the top quintile of stocks with the best combined factor characteristics, it is ultimately a far more concentrated portfolio than its index of indices counterpart. Therefore, the resultant index suffers from inferior information ratios compared with the index of indices, due to its relatively high tracking error.

Exhibit 11 shows the information ratios for the various single-factor and multi-factor indices over the rolling 15 year window. The diagonal line represents all points with equal information ratios to the S&P 500 Quality, Value & Momentum Multi-Factor Index.

In addition, it is clear the S&P 500 Quality Index competed equally well over all time horizons in terms of risk-adjusted returns and tracking error compared with both multi-factor indices. However, one could argue that holding only this single factor as opposed to other less-successful factors over this period would have required considerable foresight and skill. Therefore, depending on the investment objectives of market participants without a factor viewpoint, one of the multi-factor index approaches could have provided a viable alternative.

Multi-Factor Performance in Various Factor Regimes

Exhibit 12 further illustrates the benefits of combining multiple factors and highlights the improved historical performance of our stock-level approach. Although the S&P 500 Quality, Value & Momentum Multi-Factor Index only outperformed the benchmark in 20% of the months in which none of the corresponding single-factor indices outperformed, these periods represent a mere 8% of the total back-test.

More importantly, in periods when two or three of the single factors outperformed the S&P 500 (representing 59% of the back-test), the multi-factor index outperformed in 66% and 83% of the months, respectively. The average monthly outperformance of the S&P 500 Quality, Value & Momentum Multi-Factor Index in those periods was superior to achieving an average of the single-factor returns.

Analysis of Active Sector Exposures

To assess the differences in sector diversification between the two multi-factor approaches, Exhibit 13 shows their average active sector exposures to the S&P 500. The single-factor indices' average active sector exposures are also given for comparison.

The index of indices approach has the lowest average magnitude of active sector bets between all of the factor portfolios. This finding aligns with the low tracking error of the index of indices portfolio owing to its relatively high number of constituents.

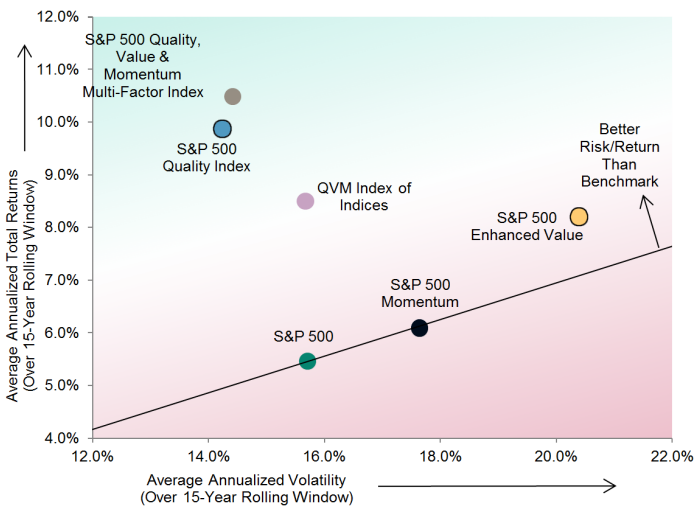


Exhibit 10: S&P 500 Single- and Multi-Factor Average Risk/ Return

QVM Index of Indices is a hypothetical portfolio.
Source: S&P Dow Jones Indices LLC. Rolling window data is the average of annualized figures on a monthly basis from Dec. 31, 1994, to Jan. 31, 2017. Index performance based on total return in USD. Past performance is no guarantee of future results. Chart is provided for illustrative purposes and reflects hypothetical historical performance. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with back-tested performance. The QVM Index of Indices is an equal-weight portfolio that includes the S&P 500 Quality Index, S&P 500 Enhanced Value Index, and S&P 500 Momentum that is rebalanced semiannually.

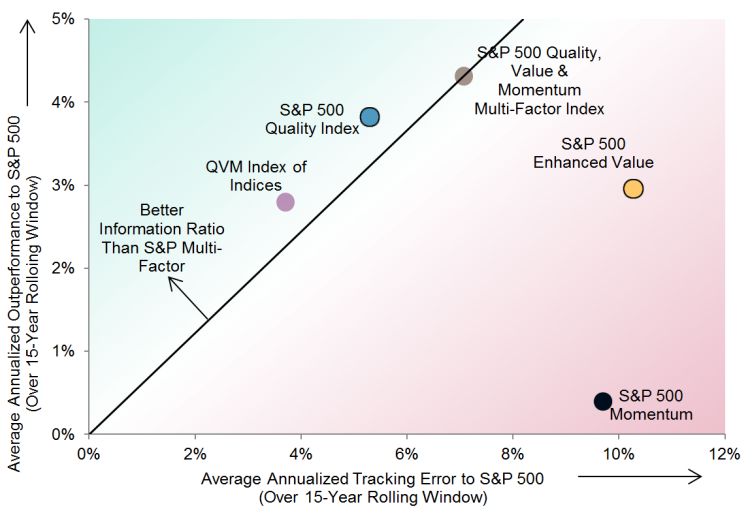


Exhibit 11: S&P 500 Single- and Multi-Factor Average Information Ratios

QVM Index of Indices is a hypothetical portfolio.
Source: S&P Dow Jones Indices LLC. Rolling window data is the average of annualized figures on a monthly basis from Dec. 31, 1994, to Jan. 31, 2017. Performance based on total return in USD. Past performance is no guarantee of future results. Chart is provided for illustrative purposes and reflects hypothetical historical performance. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with back-tested performance. The QVM Index of Indices is an equal-weight portfolio that includes the S&P 500 Quality Index, S&P 500 Enhanced Value Index, and S&P 500 Momentum that is rebalanced semiannually.

REGIMES	0 FACTORS OUTPERFORM	1 FACTOR OUTPERFORMS	2 FACTORS OUTPERFORM	3 FACTORS OUTPERFORM
Number of Months (since Dec. 31, 1994)	20	88	116	41
% of Months (of total back-test)	8	33	44	15
% of Months S&P 500 Quality, Value & Momentum Multi-Factor Index Outperforms (Hit Rate)	20	51	66	83
Average Monthly S&P 500 Quality, Value & Momentum Multi-Factor Index Outperformance (%)	-0.93	-0.37	0.58	1.59
Average Monthly Single-Factor Index Outperformance (%; index of indices approach)	-0.89	-0.37	0.48	1.23

Exhibit 12: S&P 500 Quality, Value & Momentum Multi-Factor Index Relative Performance to S&P 500 in Various Single-Factor Regime Combinations

Index of indices is a hypothetical portfolio.

Source: S&P Dow Jones Indices LLC. Rolling window data is the average of annualized figures on a monthly basis from Dec. 31, 1994, to Jan. 31, 2017. Performance based on total return in USD. Past performance is no guarantee of future results. Table is provided for illustrative purposes and reflects hypothetical historical performance. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with back-tested performance. The index of indices is an equal-weight portfolio that includes the S&P 500 Quality Index, S&P 500 Enhanced Value Index, and S&P 500 Momentum that is rebalanced semiannually.

SECTOR	S&P 500 QUALITY INDEX	S&P 500 ENHANCED VALUE INDEX	S&P 500 MOMENTUM	QVM INDEX OF INDICES	S&P 500 QUALITY, VALUE & MOMENTUM MULTI-FACTOR INDEX
Energy	-1.3%	0.6%	-0.7%	-0.5%	3.3%
Materials	0.6%	1.8%	-0.7%	0.6%	0.5%
Industrials	1.1%	-4.4%	-1.2%	-1.5%	0.9%
Consumer Staples	7.1%	-3.1%	-0.1%	1.3%	4.2%
Consumer Discretionary	1.9%	3.4%	3.1%	2.8%	4.1%
Health Care	5.0%	-5.4%	0.4%	0.0%	-1.6%
Financials	-12.5%	17.1%	-4.0%	0.2%	-1.7%
Information Technology	3.9%	-14.6%	3.3%	-2.4%	-9.2%
Telecommunication Services	-3.0%	-0.9%	-0.7%	-1.5%	-1.3%
Utilities	-2.8%	5.4%	0.5%	1.1%	0.9%
Average Magnitude	3.9%	5.7%	1.5%	1.2%	2.8%

Exhibit 13: S&P 500 Single and Multi-Factor Indices Average Active Sector Exposure Relative to the S&P 500

QVM Index of Indices is a hypothetical portfolio.

Source: S&P Dow Jones Indices LLC. Rolling window data is the average of annualized figures on a monthly basis from Dec. 31, 1994, to Jan. 31, 2017. Performance based on total return in USD. Past performance is no guarantee of future results. Table is provided for illustrative purposes and reflects hypothetical historical performance. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with back-tested performance. The QVM Index of Indices is an equal-weight portfolio that includes the S&P 500 Quality Index, S&P 500 Enhanced Value Index, and S&P 500 Momentum that is rebalanced semiannually.

Comparing the stock-level, multi-factor approach to other top quintile single-factor portfolios, it is evident that the average magnitude of its active sector bets are lower than the S&P 500 Quality Index and S&P 500 Enhanced Value Index; the S&P 500 Momentum, however, is more sector-neutral to the benchmark.

The results demonstrate that the diversification benefits of a multi-factor, stock-level approach may help lower the peak active sector bets compared with the worst-offending single-factor portfolios. However, active sector exposures could still be significant, and market participants may want to consider whether they are comfortable with these over/underweight allocations.

For instance, our stock-level, multi-factor strategy had an average underweight sector exposure of 9.2% in information technology and average overweight exposures to consumer staples and consumer discretionary stocks of approximately 4% each during the period studied. These allocations may also vary greatly through time, as the index attempts to capture the highest factor-combinations in whichever sectors they may appear.

Conclusion

Market participants seeking to target the systematic equity risk premia associated with single factors should understand that historical performances for each factor have been cyclical and have experienced long drawdowns relative to the market. The active returns of each factor have generally displayed low or negative correlations, as they respond differently to the market environment and economic cycles. Hence, market participants adopting a multi-factor approach may reap considerable diversification benefits. Alternatively, market participants wishing to be selective about single equity factors may want to either have long investment horizons or high conviction in their decisions.

As an alternative to choosing between equity factors, multi-factor portfolios can be constructed to diversify factor risk. Market participants considering multi-factor investing should explore the differences between the index of indices approach and the stock-level multi-factor approach. Our analysis shows that those wishing to minimize tracking error relative to the benchmark could have experienced higher probabilities of risk-adjusted outperformance over varying time horizons with a multi-factor index of indices approach. However, since exposure to desired secondary factors could be weak in each single-factor index, a multi-factor index of indices may experience some factor exposure dilution.

The factor exposure dilutions inherent when simply holding multiple single-factor indices may be alleviated by opting to combine factor scores at the stock-level. The back-test of the S&P 500 Quality, Value & Momentum Multi-Factor Index has demonstrated superior risk-adjusted returns of 0.73 over the average of the 15-year rolling windows compared to 0.54 for the hypothetical index of indices approach. This supports the view that the stock-level index construction approach may help reduce factor exposure dilutions, but it may come with the cost of increased tracking error (increased to 7.1% from 3.7% for the index of indices).

For market participants without a factor viewpoint, both multi-factor approaches offered a viable alternative to the best-performing single-factor index. With both options offering a balanced exposure across multiple factors, the choice could be simplified to whether one wishes to maximize risk-adjusted returns on an absolute basis or relative to the benchmark. Ultimately, the decision between a multi-factor index of indices or our stock-level selection approach depends on the market participant's investment objectives.

In conclusion, multi-factor indices may help market participants avoid the potential pitfalls of choosing and timing factors without necessarily missing the upside that the best factor choice may have provided.

Future Innovations in Multi-Factor Indices

The rising popularity and appeal of factor-based indices is pushing innovation within the space of multi-factor investing. Along with expanding the multi-factor index range to encompass even more regions, different factor combinations could also be applied. These could even extend to non-traditional equity factors, such as incorporating ethical and sustainability investment themes in the environmental, social, and governance (ESG) field.[10]

Other areas of progress could include sector-neutral, multi-factor indices that aim to match their sector exposures with that of the corresponding benchmark. Risk model-based optimization methods could also be employed to minimize (or target) tracking error while maximizing exposure to the desired factors.

Advancements are also likely in strategies that isolate the factor risk premium. Market risk is a considerable portion of the overall risk in each of the multi-factor strategies discussed so far. However, the multi-factor risk premium can be isolated by taking a long position in the top quintile of multi-factor stocks and a short position in the lowest quintile. Alternatively, the overall market can be used for the short position, with its exposure matched to the beta of the long portfolio.

As awareness of the potential benefits of multi-factor indices continues to grow, along with the needs of market participants, we can expect ever more interesting and useful index strategies within this area.

Endnotes

1. For further details on factor theory, see Qian, E.E., Hua, R.H., Sorenson, E.H., (2007). Quantitative Equity Portfolio Management.

2. For more information, see the S&P Quality Indices methodology, S&P Enhanced Value Indices methodology, S&P Momentum Indices methodology, and S&P Low Volatility Index methodology.

3. For a thorough overview of equity factors and rationale, see our research paper, "The Story of Factor Based Investing" (Sunjiv Mainie, 2015).

4. Ung, Daniel and Priscilla Luk, "What Is In Your Smart Beta Portfolio? A Fundamental and Macroeconomic Analysis," 2016.

5. Asness, C., "Changing Equity Risk Premia and Changing Betas over the Business Cycle and January," University of Chicago Working Paper (1992).

6. To see more detail on the unique cycles and correlations between factors see our S&P Research paper "Blending Factors in Your Smart Beta Portfolio" (Cheng and Srivastava, 2016).

7. Performance comparison between the index of indices and the best-performing single factor is made in terms of the frequency of outperformance of risk-adjusted returns, as shown in Exhibit 2.

8. To create comparable data sets, the fundamental data within a factor score is standardized into a z-score, defined as the number of standard deviations each value is from its population mean. Using this approach, for example, the z-score of the accruals ratio, leverage, and return on equity can be averaged to provide a single quality score for a stock.

9. To see a more thorough overview of the methodology, please see the S&P 500 Quality, Value & Momentum Multi-Factor Index methodology.

10. For more information on ESG factors, see S&P DJI's "Understanding ESG Investing" by Emily Ulrich (2016).

Author Bio

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Andrew Innes is Associate Director, Global Research & Design (EMEA), at S&P Dow Jones Indices (S&P DJI). The group provides research on global index strategies across all asset classes and is responsible for the conceptualization and design of new index products.

Prior to joining the Global Research & Design team in 2016, Andrew worked in S&P DJI's Custom Index Development group, where he constructed index models to back-test and maintain a wide range of custom indices. Before that, Andrew worked in Portfolio Strategy and Equity Research at ISI Group, Relative Equity Analytics, and MainFirst Bank.

Andrew graduated from Loughborough University with a Bachelor of Engineering (Hons) in Automotive Engineering.

The CAIA Endowment Investable Index

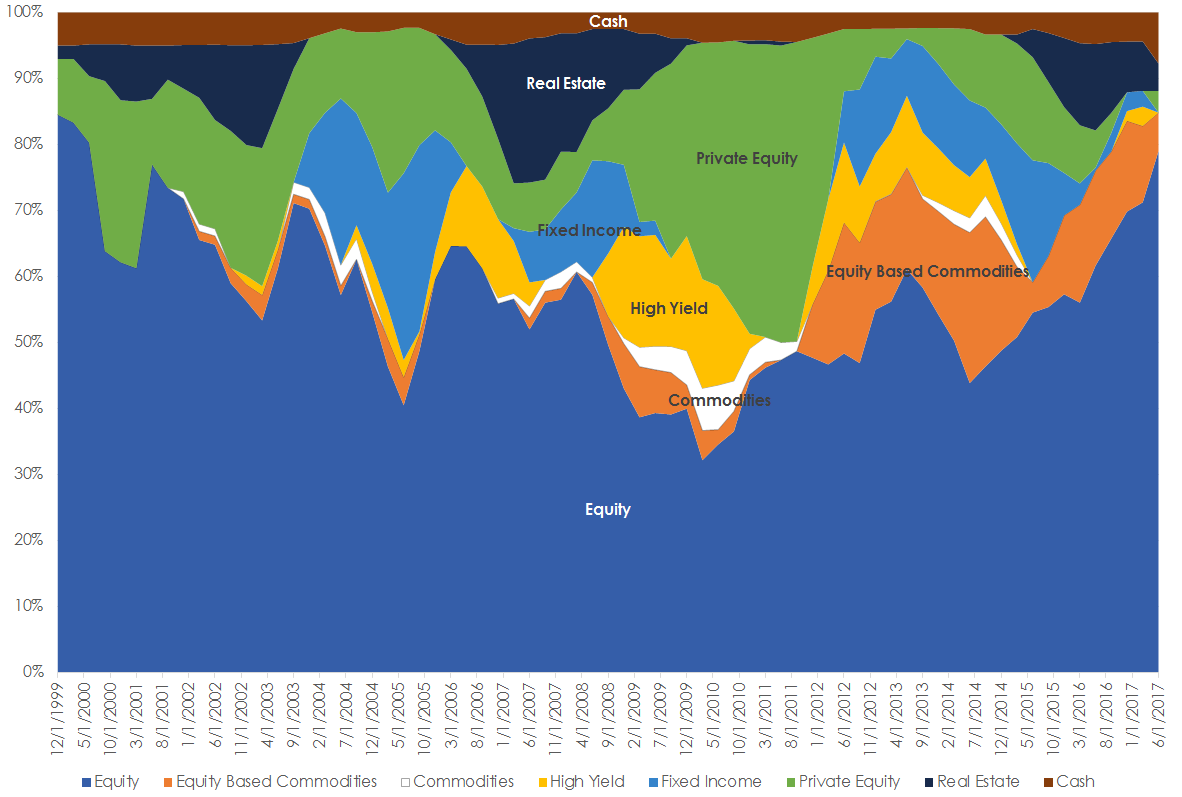
Hossein Kazemi
CAIA Association

Kathryn Wilkens, *CAIA*
Pearl Quest

We present the historical weights, allocation as of month-end June 2017, and historical performance to the replication portfolio that was introduced in our AIAR publication Volume 6 Issue 1.

The below graph shows the exposures of the Multi-Asset ETF portfolio through time. It is important to note that the volatility displayed by these exposures does not imply that endowments alter their asset allocations as frequently as the Multi-Asset ETF portfolio. While an endowment may hold a fixed allocation to various asset classes, the underlying assets/manager may display time-varying exposures to different sources of risk. For instance, a hedge fund manager may decide to increase her fund's exposure to energy stocks while reducing the fund's exposure to healthcare stocks. Though the endowment's allocation to that manager has remained unchanged, its exposures to energy and healthcare sectors have changed. Also, if returns on two asset classes are highly correlated, then the algorithm will pick the one that is less volatile. For instance, if returns on venture capital and small cap stocks are highly correlated, then the program will pick the small cap index if it turns out to be less volatile.

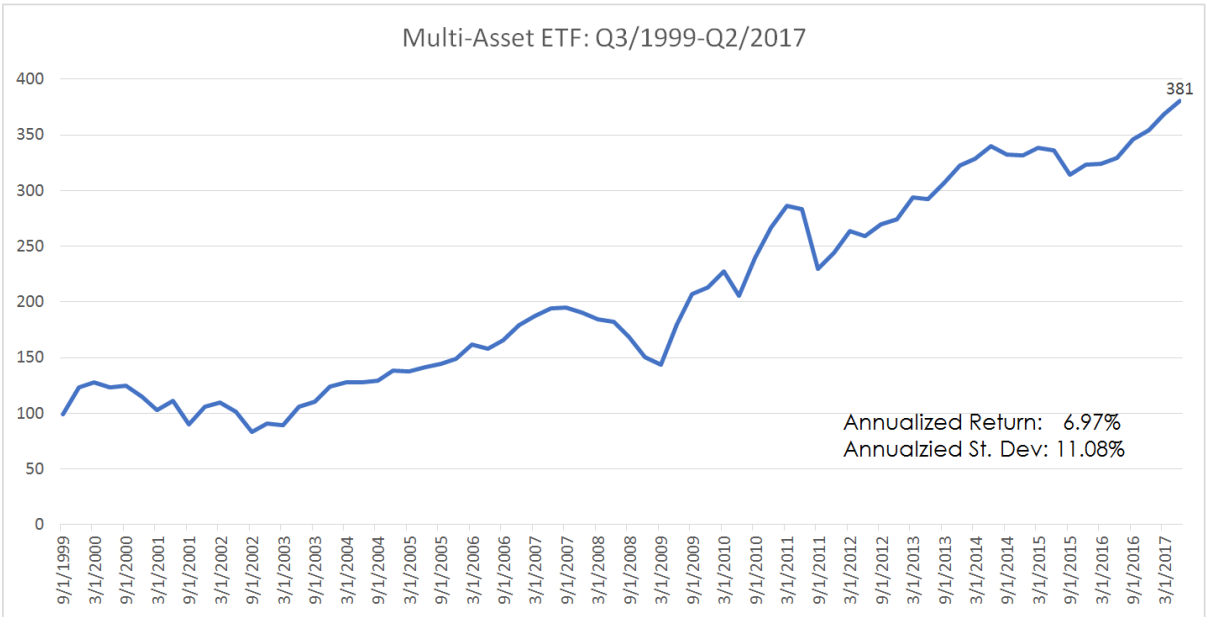
Endowment Index Weights



Allocation Suggested by Algorithm

RUSSELL 2000 ETF	PowerShares QQQ ETF	MSCI World Free	Vanguard FTSE Emerging Markets ETF	Materials Select Sector SPDR® ETF	Energy Select Sector SPDR® ETF	Utilities Select Sector SPDR® ETF	Health Care Select Sector SPDR® ETF	Red Rocks Gbl Listed Private Eqty TR USD	SPDR® Dow Jones Global Real Estate	Treasuries + Cash
25.98%	7.05%	29.79%	7.38%	4.44%	1.40%	2.51%	6.29%	3.29%	4.15%	7.72%

Historical Performance



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Dr. Hossein Kazemi is the Senior Advisor to the CAIA Association's Program. Dr. Kazemi has been involved with the CAIA Association since its inception as a senior advisor and a managing director. In his current role, he helps with the development of the CAIA program's curriculum and directs the CAIA Association's academic partnership program. In addition, he serves as the editor of Alternative Investment Analyst Review, which is published by the Association. He has worked with universities and industry organizations to introduce them to the CAIA program. Dr. Kazemi is Michael and Cheryl Philipp Distinguished Professor of Finance at the Isenberg School of Management, the University of Massachusetts - Amherst. He is the Director of the Center for International Securities & Derivatives Markets, a nonprofit organization devoted to research in the area of alternative investments, a co-founder of the CAIA Association, and home to CISDM Hedge Fund/CTA Database and the Journal of Alternative Investments, the official research publication of the CAIA Association. He has over 25 years of experience in the financial industry and has served as consultant to major financial institutions. His research has been in the areas of valuations of equity and fixed income securities, asset allocation for traditional and alternative asset classes, and evaluation and replication of active management investment products. He has a Ph.D. in finance from the University of Michigan.

Kathryn Wilkens, *Ph.D., CAIA*
Pearl Quest LLC

Kathryn Wilkens is the president and founder of Pearl Quest LLC, a consulting company currently focused on tracking and replication products, and educational services in the alternative investments space. She is also an RIA with S Capital Wealth Advisors and assistant editor for the Journal of Alternative Investments.

About CAIA

Founded in 2002, the CAIA Association is the world leader and authority in alternative investment education. The CAIA Association is best known for the CAIA Charter (www.caia.org), an internationally-recognized credential granted upon successful completion of a rigorous two-level exam series, combined with relevant work experience. Earning the CAIA Charter is the gateway to becoming a Member of the CAIA Association, a global network of more than 9,000 alternative investment leaders located in 90+ countries who have demonstrated a deep and thorough understanding of alternative investing. The CAIA Association now supports 30 vibrant chapters located in financial centers around the world and sponsors more than 150 educational and networking events each year.

MSCI Global Intel Report: Understanding the True Risk of Real Estate Assets*

Max Arkey
MSCI Real Estate

When developing investment strategies, institutional investors in private real estate tend to rely on market-level performance data. But many real estate investors know that every asset is different and even two seemingly identical assets in the same area can produce very different returns. How can they better understand the true risk underlying their exposures when developing their strategies?

The answer may lie in looking at data beyond traditional sector and geographic analyses. By looking at the extreme outperformers and underperformers that drive the tails of total return distribution, we can more readily identify common sources of risk that pervade the entire portfolio.

First, we need to understand why two apparently identical assets in the same geographic area may produce very different investment returns. In short, differences in lease and tenant exposures, as well as the level of active management employed (e.g., refurbishment), can have a big impact on returns.

Before we focus on a narrow area, let's examine how much specific risk existed in office assets across a number of U.K. cities during the 12-month period ended June 2017. Using analysis from Global Intel PLUS, we see that the range of returns within these cities was far broader than that of average returns across these cities (see exhibit 1). Asset-specific risk clearly was very important in these markets.

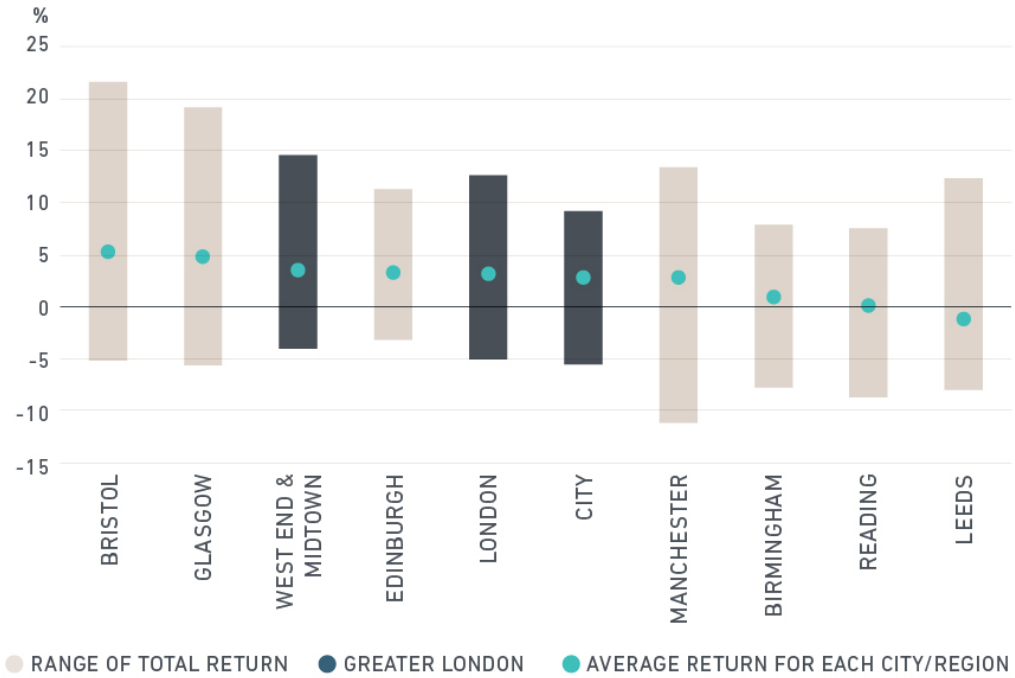
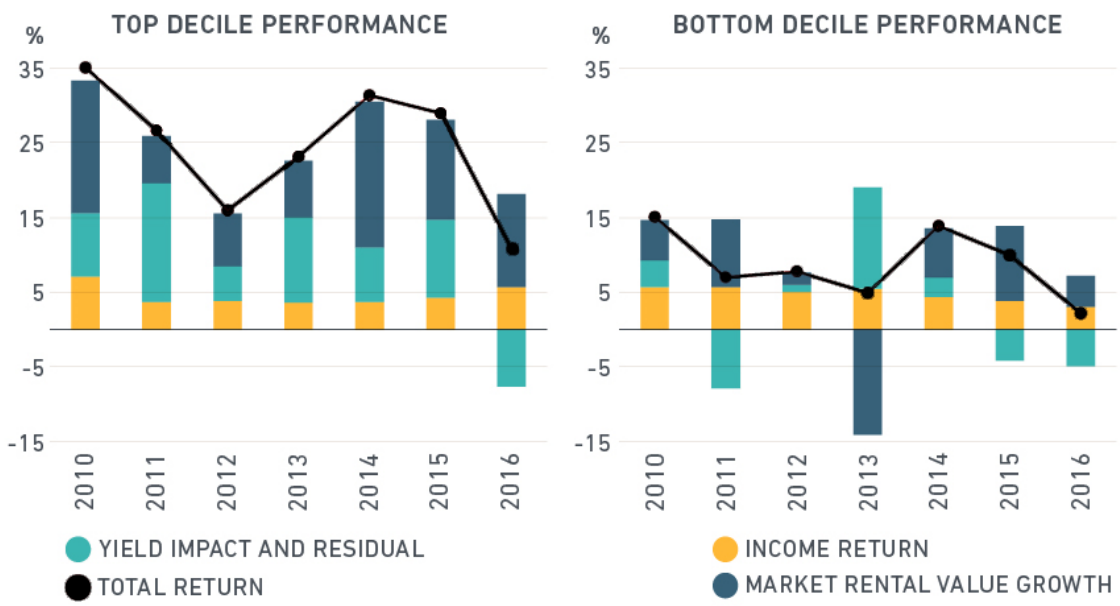


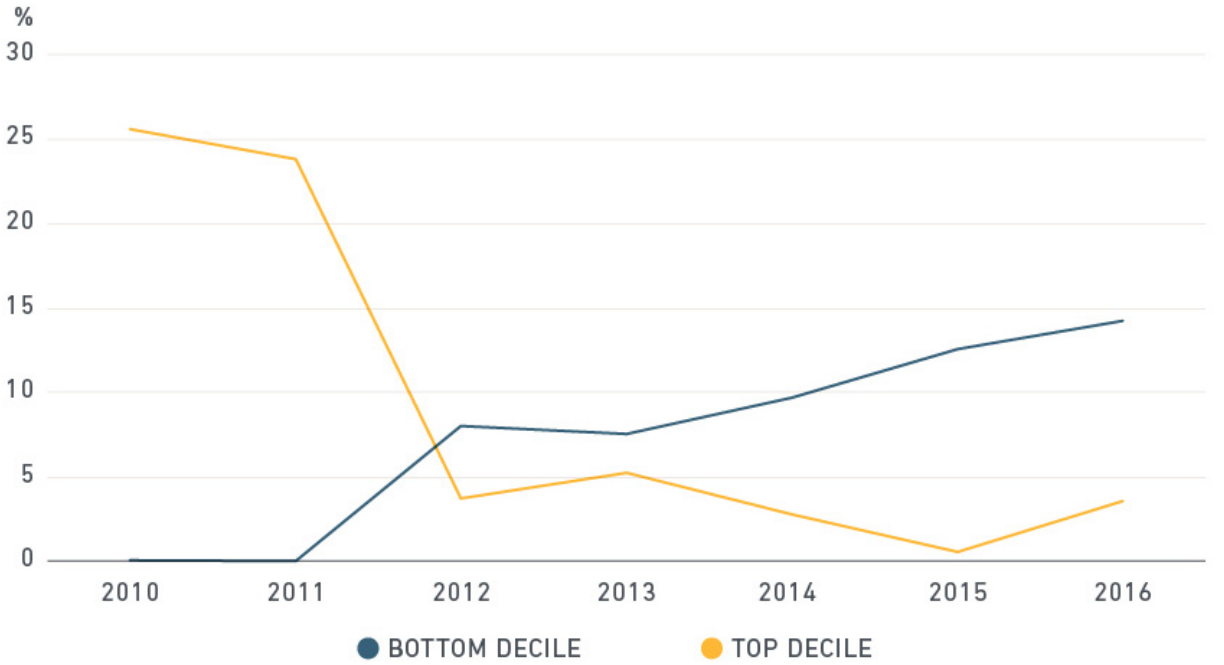
Exhibit 1: Returns Varied More Within Cities Than Across Them
Source: MSCI Real Estate's Global Intel PLUS. Office Total Returns for the 12-month period ended June 2017. City average vs. range (10th to 90th percentiles). Standing investments (reflects only general market movements).

Looking at returns over a longer period showed asset correlations within these markets.[1] The analysis below follows the performance of a consistently held set of offices in Central London over 2010 to 2016, comparing the top and bottom performance deciles. While there was a significant difference in the magnitude of returns between the outperformers and the underperformers, the profile of returns was very similar. This pattern illustrates that general market forces impacted all properties in the office segment similarly over time. Indeed, in 2016, even the best-performing assets were subject to negative yield impact following the summer's Brexit referendum.

While the total-return trends of the two tails were similar, the components of returns varied from year to year. Income return was marginally lower for the top performers, indicating the prime nature of these assets, but there was also more variability in the contribution of yield impact (a component of capital growth) and rental growth in the bottom decile.



Top and Bottom Deciles Showed Similar Long-Term Performance Profile, Despite Asset-Specific Risk
Source: MSCI Real Estate. Annualized total returns of bottom and top performance deciles of City, Midtown and West End office properties. Same-store sample (consistent set of assets).



Vacancy Rate Trends Varied Sharply by Performance Decile
Source: MSCI Real Estate. Average vacancy rates of bottom and top performance deciles of City, Midtown and West End office properties. Same-store sample.

These metrics are generally driven by market-level dynamics. To understand more about the tails of the distribution, we need to examine asset-specific factors, such as vacancy rates. Returns in the top decile were buoyed by a fall in vacancy rates over the period to less than 5% from around 25%, while in the bottom decile they rose to 15% from zero. The best-performing assets initially had weak income profiles but were successfully leased up in an improving market. The worst performers were fully let initially but later suffered tenant loss, which ran counter to generally improving market fundamentals.

Our analysis suggests that variation in asset performance could not be fully explained by sector and geography. It may be important to consider other factors when formulating strategy and understanding risk. Traditionally, performance variation not explained by market selection was attributed to asset selection with the implication that this risk is idiosyncratic. Examining performance along alternative risk dimensions such as vacancy rates may help institutional investors better understand these underlying risk factors.

Endnotes

1. Properties are valued at least annually. To obtain reliable asset correlations, we need data points from a longer time period.

**The author thanks Niel Harmse for his contribution to this post.*

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Max Arkey works in product management at MSCI Real Estate where he heads up indexes and market information products. These analytics are mission critical to the investment process for 19 of the top 20 largest global asset managers, all the way through to specialized domestic investors.
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