
Bonds Are Different: Active Versus Passive Management in 12 Points

AUTHORS

Jamil Baz
Managing Director
Global Head of
Client Analytics

Ravi Mattu
Managing Director
Global Head of Analytics

James Moore
Managing Director
Head of the Investment
Solutions Group

Helen Guo
Vice President
Client Analytics

Opinions in the active-passive investment debate have drifted poles apart over recent years. We revisit this discussion by contrasting equity and fixed income markets in the U.S. We look at performance numbers and find that, unlike their stock counterparts, active bond mutual funds and exchange-traded funds (ETFs) have largely outperformed their passive peers after fees. We offer conjectures as to why bonds are different from stocks. This may be due to the large proportion of noneconomic bond investors, the benchmark rebalancing frequency and turnover, structural tilts in fixed income space, the wide range of financial derivatives available to active bond managers, and security-level credit research and new issue concessions. At a macro level, we believe that a purely passive market would cause severe market risk and resource misallocations. Realistically, neither passive nor active investors can fully dominate at equilibrium. Of course, passive management has its virtues. Yet there is reason to believe that, unchecked, passive management may encourage free riding, adverse selection and moral hazard.

POINT #1 – ACTIVE BOND FUNDS AND ETFS LARGELY OUTPERFORMED THEIR MEDIAN PASSIVE PEERS

Despite the general presumption of underperformance, more than half of the active bond mutual funds and ETFs beat their median passive peers in most categories over the past 1, 3, 5, 7 and 10 years, with 63% of them outperforming over the past 5 years. In contrast, only 43% of active equity mutual funds and ETFs outperformed their median passive peers over the past 5 years. Taking the three largest categories within fixed income for the same 5-year period, 84%, 81% and 60% of active funds and ETFs outperformed their median passive peers in intermediate-term, high yield and short-term categories, respectively. Within equity, most active funds and ETFs in each of the three largest categories – large growth, large blend and large value – underperformed (see Figure 1).

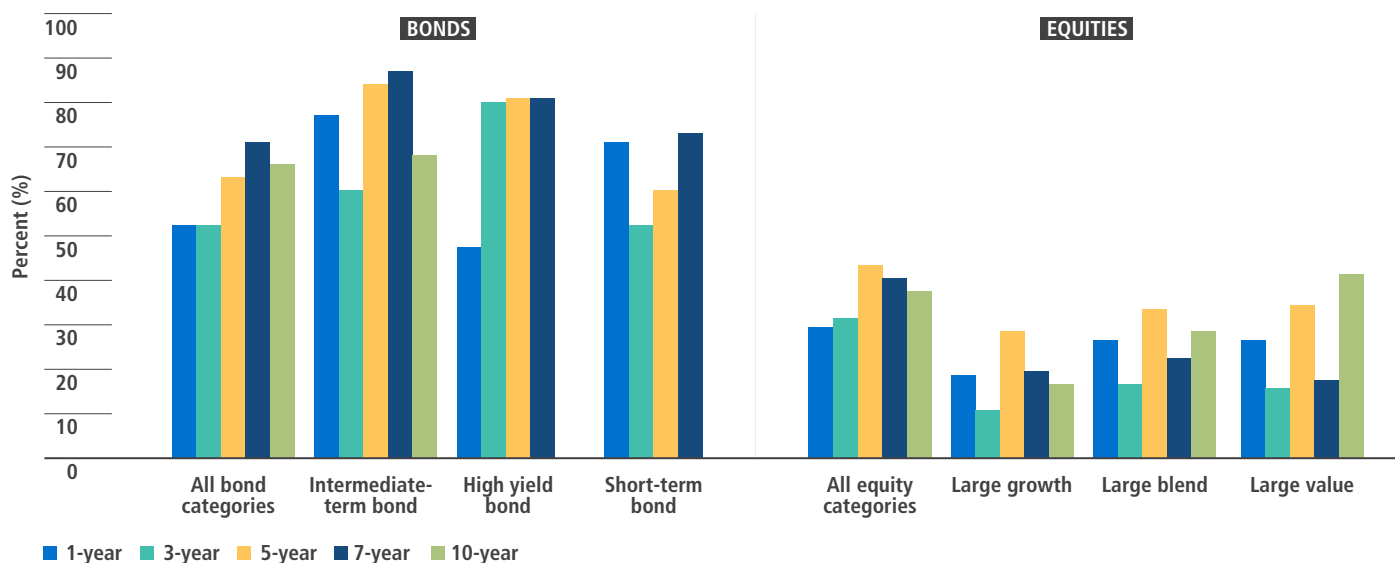
These results should come with one caveat. The fact that active bond funds and ETFs outperformed passive does not necessarily mean all active outperformed passive. Active bond managers also include non indexed investors such as central banks, commercial banks, large parts of the insurance industry and retail. Some of these investors operate under tight constraints which may affect their performance (more on this in Point #4).

POINT #2 – ACTIVE BOND FUNDS AND ETFS LARGELY OUTPERFORMED THEIR BENCHMARKS EXCEPT WHEN THE COST OF BENCHMARK REPLICATION WAS PROHIBITIVE

Figure 2 shows the percentages of active mutual funds and ETFs that outperformed their primary prospectus benchmarks after fees for the past 1, 3, 5, 7 and 10 years; it shows the aggregated results for broad bond and equity groups and each of the three largest categories within bonds and equity.

Again, more than half of the active bond mutual funds and ETFs beat their benchmarks in most categories over the past 1, 3, 5 and 7 years, with 61% of them outperforming over the past 5 years. This stands in strong contrast with equity results, where only 35% of active funds and ETFs outperformed their benchmarks over the past 5 years. Taking the three largest categories within fixed income for the same 5-year period, 82% and 84% of active funds and ETFs in the Intermediate-Term Bond and Short-Term Bond categories outperformed their benchmarks while only 25% in the High Yield Bond category outperformed. Within equity, most active funds and ETFs in each of the three largest categories – large growth, large blend and large value – underperformed.

Figure 1: Percentage of active mutual funds and ETFs that outperformed their median passive peers after fees



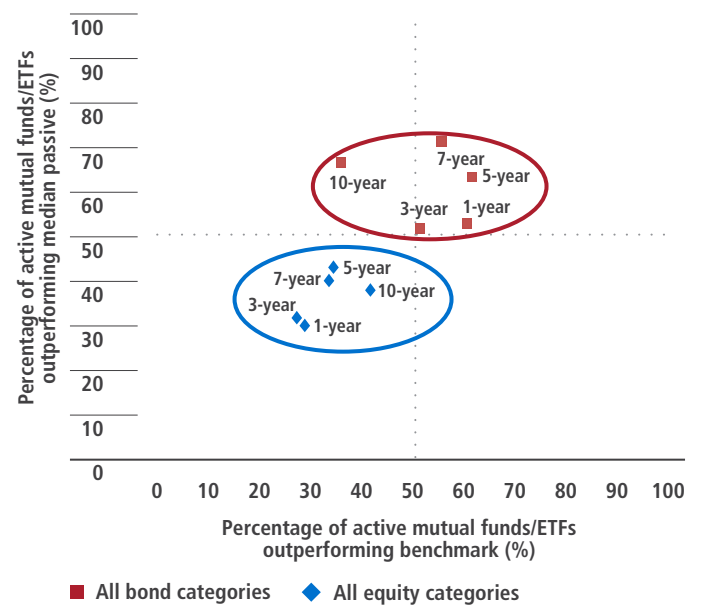
Source: Morningstar Direct as of 31 December 2016. Past performance is not a guarantee or a reliable indicator of future results. The three largest categories are based on numbers of active mutual funds and ETFs with at least one-year return histories. Based on Morningstar U.S. ETF and U.S. Open-End Fund categories (institutional shares only). To avoid potential survivorship bias, we included funds and ETFs that were live at the beginning of each sample period but were liquidated or merged as of 31 December 2016. For the High Yield Bond and Short-Term Bond categories, 10-year outperformance numbers are not available due to the lack of passive peer groups. Chart is provided for illustrative purposes and is not indicative of the past or future performance of any PIMCO product.

Note that active bond funds and ETFs may underperform their benchmarks but still outperform median passive peers. Consider the High Yield Bond category. Although the percentage of active funds and ETFs outperforming their benchmarks for this category appears low, 81% outperformed their median passive peers over the same 5-year period. This indicates the difficulty of replicating the performance of high yield benchmarks, possibly due to the lower liquidity of the market and the high transaction costs for all but the largest issues.

The 10-year period started with what is considered by many to be the worst global financial crisis since the 1930s. During this period, market liquidity dried up and bid-ask spreads widened, dramatically increasing trading costs for both active and passive investors. Because benchmark returns do not reflect these frictional costs, it is more challenging to beat the benchmarks, especially in the relatively illiquid and inefficient market. This may explain the underperformance of active bond funds versus their benchmarks over the 10-year period.

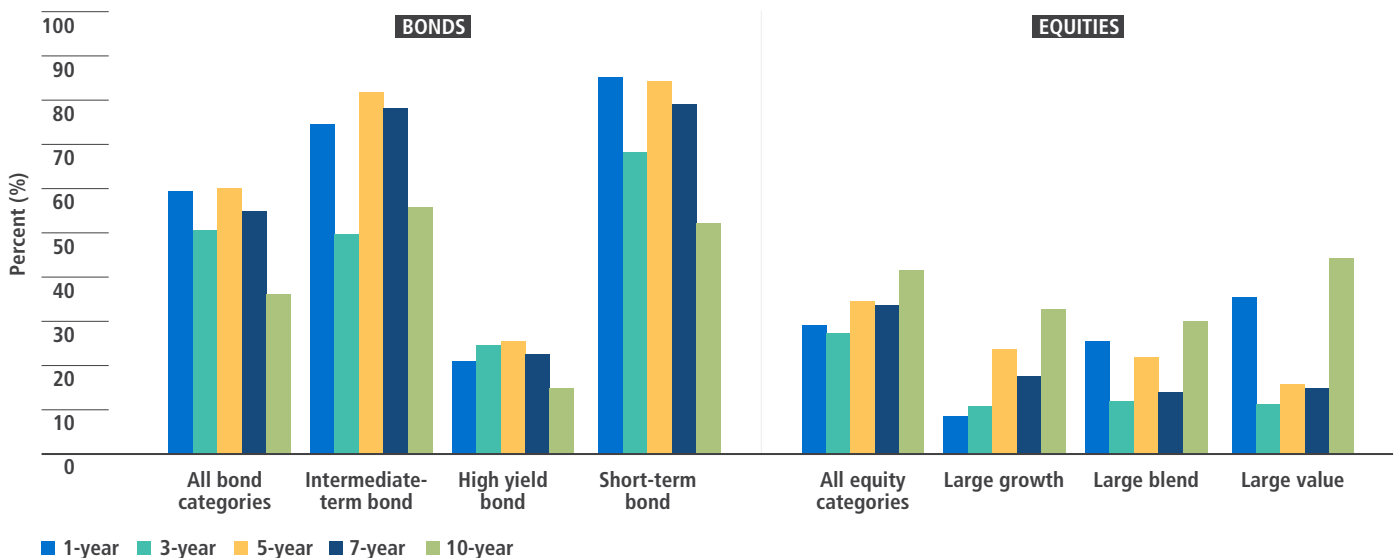
Figure 3 summarizes the two types of outperformance measures for broad bonds and equity groups. The percentages of active bond funds and ETFs outperforming their benchmarks and those outperforming their median passive peers over the past 1, 3, 5 and 7 years all exceeded 50%; more than half outperformed their median passive peers over the past 10 years. In contrast, the percentages for active equity funds and ETFs for both measures and over all time periods considered were less than 50%.

Figure 3: Outperformance over benchmarks and outperformance over median passive peers after fees



Source: Morningstar Direct as of 31 December 2016. Past performance is not a guarantee or a reliable indicator of future results. Based on Morningstar U.S. ETF and U.S. Open-End Fund categories (institutional shares only). To avoid potential survivorship bias, we included funds and ETFs that were live at the beginning of each sample period but were liquidated or merged as of 31 December 2016. Some categories contain funds with a wide range of benchmarks. Chart is provided for illustrative purposes and is not indicative of the past or future performance of any PIMCO product

Figure 2: Percentage of active mutual funds and ETFs that outperformed their primary prospectus benchmarks after fees



Source: Morningstar Direct as of 31 December 2016. Past performance is not a guarantee or a reliable indicator of future results. The three largest categories are based on numbers of active mutual funds and ETFs with at least one-year return histories. Based on Morningstar U.S. ETF and U.S. Open-End Fund categories (institutional shares only). To avoid potential survivorship bias, we included active funds and ETFs that were live at the beginning of each sample period but were liquidated or merged as of 31 December 2016. Some categories contain funds with a wide range of benchmarks. Chart is provided for illustrative purposes and is not indicative of the past or future performance of any PIMCO product.

POINT #3 – ACTIVE MANAGERS SHOULD BE EVALUATED OVER A LONG HORIZON

It is important for bond fund managers to show some healthy skepticism for the performance data – not only because the data could be self-serving, but also because they are inherently noisy.

To illustrate this point, consider the following thought experiment: Suppose that a skilled hypothetical portfolio manager has an information ratio of 0.5. The volatility of the active portfolio is 4.0% and that of the index is 3.3%. The correlation of the portfolio return with the index return is 0.9. Note that all these numbers would be empirically plausible for an active bond manager in the top quartile ranked by risk-adjusted alphas. The question is, how long would it take for the hypothetical active manager to beat the index with a 90% probability? The answer, it turns out, is 7 years. (We show the mathematics behind this example in Appendix 1).

What does it all mean? First, this example illustrates the reality of a low signal-to-noise ratio in bond asset management. Given the higher tracking error and lower information ratios displayed in manager performance, it is even lower for equities. Second, it shows that managers are typically evaluated over too short a time frame: Over 1 year, this hypothetical manager would have a 69% probability of outperforming and over 3 years, the probability would rise to 80%. And third, the answer is very sensitive to assumptions. Table 1 illustrates the relationship between the time it takes to outperform the index with 90% confidence and the information ratio under the volatility and correlation assumptions described above.

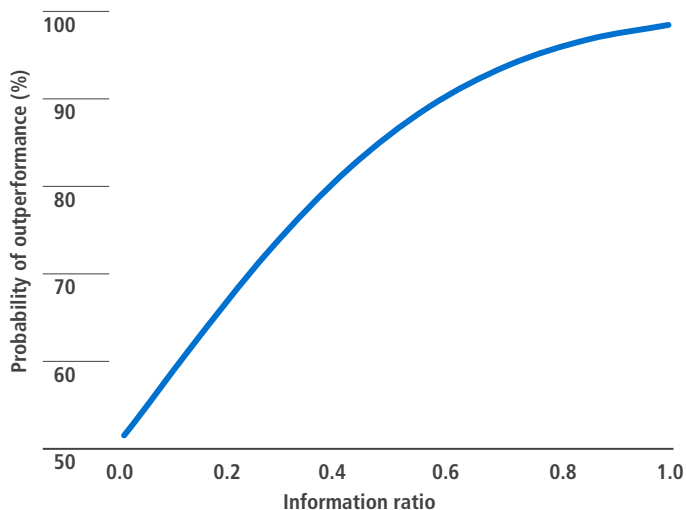
Table 1: Number of years needed for the manager to beat the index with 90% confidence

Information ratio	Years
0.7	3.5
0.5	7.0
0.3	20.0
0.2	48.0

Source: PIMCO. Hypothetical example for illustrative purposes only. Table is provided for illustrative purposes and is not indicative of the past or future performance of any PIMCO product.

If we fix the horizon at 5 years with the same risk assumptions, it appears that the probability of outperformance is an increasing and concave function of the information ratio, as one would expect (see Figure 4).

Figure 4: Probability of outperformance in 5 years



Source: PIMCO. Hypothetical example for illustrative purposes only. Chart is provided for illustrative purposes and is not indicative of the past or future performance of any PIMCO product.

POINT #4: IT IS NOT JUST ABOUT ACTIVE VERSUS PASSIVE

The straw man in the active-passive debate stems from a short paper by William Sharpe titled “The Arithmetic of Active Management”: If passive is defined as holding the market portfolio, and active is everything not passive, then it trivially follows that active managers as a whole, like passive managers, hold the market portfolio at any time. Both groups will therefore generate the same returns before fees. To the extent that active fees are higher than passive fees, passive managers will outperform active managers, on average. Plain and simple, but maybe too much so. It is difficult not to be reminded of Einstein’s quote: “Everything should be made as simple as possible, but not simpler.”

As appealing as Sharpe’s arithmetic is, the deficits of the argument (some of them acknowledged by Sharpe himself) are obvious. To start with, the distinction between active and passive is wanting in bond space. At a minimum, one can divide the investors’ universe into three categories: passive, economic and noneconomic. This is because noneconomic investors are plentiful in fixed income (see Table 2): Central banks buy bonds to depreciate their currency and boost inflation, growth and asset prices; commercial banks and insurance companies may care more about book yield than total return for a variety of reasons, such as accounting rules, other regulations or a simple preference for predictable, low-turnover portfolios. It is worth

noting that these investors make up a meaningful portion of global bond buyers – roughly 53% of the \$102 trillion global bond market.¹ Similarly, because of their guidelines, both noneconomic constrained investors and passive index buyers may be forced to sell all bonds that fall below the investment grade threshold or be late to the game buying bonds whose upgrade is foreseeable because they must wait for a ratings agency imprimatur. The list goes on and on.

To the extent constraints are binding (most of them are), by construction, economic investors tend to outperform noneconomic investors, as the former buy cheap fallen angels from the latter and sell them expensive high-coupon bonds. Active managers potentially may also be compensated by passive managers for providing them with liquidity around changes in index construction. So while active and passive managers may in theory generate the same returns before fees, the further categorization of investors into three groups illustrates that economic investors may outperform passive investors which, in turn, are likely to outperform noneconomic investors before fees.

Table 2: Bond holdings by noneconomic investorsⁱⁱ

Investor group	Bond holdings (\$ trillion)	Investment objective
Central banks		
– Foreign exchange reserves	10.8	Stabilize exchange rates
– Domestic holdings	11.3	Manage money supply
U.S. insurance	4.3	Book yield, predictable income, regulatory-driven capital charges
U.S. banks	2.8	
European insurers	5.3	
European banks	4.7	
Asian banks and insurers	12.6	
Other banks and insurers	2.0 – 3.0	
Total	53.8 – 54.8	↓

Source: Company filings, European Federation, EIOPA, EBA, SNL Financial, Bloomberg and PIMCO. As of 31 December 2016.

There are other assumptions underlying Sharpe's arithmetic that, when violated in reality, may give rise to active management opportunities over passive. For example, Sharpe's work assumes investors have the same investment horizon, risk aversion and tax rate.

POINT #5 – INFORMATION IS VITAL TO TRADING AND REBALANCING

Sharpe's arithmetic implicitly assumes passive investors buy and hold and don't trade securities. In reality, most bond indexes are rebalanced monthly, requiring both active and passive investors to trade, if only because bonds mature, new bonds are issued, and index inclusion and exclusion rules create movement in and out of the index (see Pedersen (2017) for similar arguments for equity). The average turnover rate for the Bloomberg Barclays US Aggregate Bond Index for the past 3 years (as of 31 December 2016) was about 40% per year, half of which was due to new issues of securities. To the extent they do not trade pure noise, active managers seek to be better informed than passive managers. They invest in fixed income strategists, quants, credit analysts and systems to acquire and process relevant information and make better investment decisions. Because their cost of being informed is higher, active managers will typically command higher fees. They also will tend to use their knowledge to seek securities they can buy at a lower offer and sell at a higher bid than passive managers. Given that new securities make up about 20% of the bond market's capitalization every year, a strong active presence in the new bond issuance market has the potential to materially add value for fixed income investors by identifying those issues with the most attractive valuations. Additionally, active bond managers generally strive to secure sizable allocations at concession in the process of syndication of new issues. Last but not least, security-level credit research can provide a decisive advantage in the bond investment process (Worah and Mattu, 2014).

In contrast, most equity indexes are rebalanced annually or quarterly. The annual turnover rate of the S&P 500 index was about 4% for the past year. New issues are generally less than 1% of the market capitalization given that common stocks are generally perpetual securities. Therefore, the contribution of a strong presence in the new issuance market to performance for equity would be much less significant compared with that for bonds. Mauboussin et al. (2017) show a sharp fall in the number of listed stocks in the U.S. since 1996 due to rising listing costs, including higher costs for greater information disclosure. Consequently, listed companies today are bigger, older and better established than they were two decades ago. Mauboussin et al. speculate this trend has contributed to greater informational efficiency and fewer opportunities with material mispricing in the U.S. stock market.

In summary, the higher turnover in bond indexes and lower informational efficiency of bond markets help explain why active bond funds have outperformed more often over our sample period than their equity counterparts.

POINT #6 – OFF-INDEX AND ACTIVE SHARE MATTER

Structural tilts, off-index or otherwise, are bond managers' staples in the battle against the index. Duration, yield curve steepeners, high yielding currencies, high yield credit spreads, agency and non agency mortgage spreads, volatility sales and liquidity premia – to name a few – are structural tilts that can be an important source of durable added value.ⁱⁱⁱ

To show that structural tilts are more than urban myths, we correlate excess returns of active bond funds with excess returns from specific factors, specifically duration, investment grade and high yield spreads (see Table 3). The picture that emerges is clear: Active bond funds and ETFs in the largest taxable bond category, Intermediate-Term Bond, are structurally short duration, long investment grade and long high yield exposure against the index (either directly or indirectly through factor tilts not included in the analysis). Regressing excess return against factors (see Appendix 2) also shows that exploiting credit and liquidity risk premia is a particularly important ingredient in the (not so secret) sauce. Adjusted t-statistics and R-squared show that tilts have been central to portfolios beyond a reasonable doubt (Mattu et al., 2016).

Table 3: Summary statistics for excess fund and factor returns (January 2007-December 2016)

	Mean (annualized)	Volatility (annualized)	Correlation			
			Mean ER	Dur	IG	HY
Mean ER	0.4%	1.9%	1.00	-0.52	0.81	0.89
Dur	0.6%	0.8%	-0.52	1.00	-0.40	-0.49
IG	0.1%	1.0%	0.81	-0.40	1.00	0.87
HY	1.0%	2.9%	0.89	-0.49	0.87	1.00

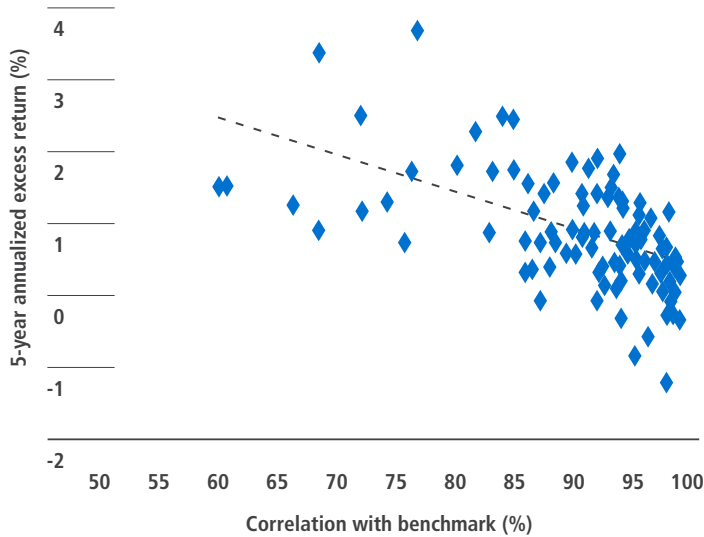
Source: Morningstar and Barclays as of 31 December 2016. Duration: Excess returns of Bloomberg Barclays US Treasury Index over cash (1M OIS), per unit of duration. Investment grade: Excess returns of Bloomberg Barclays US Corporate IG Index over duration-matched Treasuries, per unit of spread duration. High yield: Excess returns of Bloomberg Barclays US Corporate HY Index over duration-matched Treasuries, per unit of spread duration. **Past performance is not a guarantee or a reliable indicator of future results.** Sample consists of average monthly excess returns for active mutual funds and ETFs in "Intermediate-Term Bond" Morningstar category, with Bloomberg Barclays US Aggregate Bond Index as their primary prospectus benchmark and at least 10-year return histories. Table is provided for illustrative purposes and is not indicative of the past or future performance of any PIMCO product.

As is well known, a number of structural tilts are off-index: High yield, as just mentioned, as well as emerging market bonds and currencies, are fertile ground for outperformance opportunities yet are not part of typical bond indexes. This may be another reason active funds have generally done well in fixed income over the sample period. Of course, passive investors can add emerging market and high yield ETFs to their portfolios, but the lack of granularity and the opacity of such ETFs can be problematic, making it difficult to mix and match.

There is a wide range of financial derivatives available to the active bond managers that allow for potentially profitable expressions of investment themes: currency swap basis, futures basis, CDS-cash basis and TBA rolls are such examples. In addition, active bond managers could implement so-called smart strategies such as carry, value and momentum, which have historically displayed substantially positive Sharpe ratios (see, for example, Baz et al., 2015).

A related point is that active share may matter in bond management, meaning that the more portfolio positions differ from the index, the more potential that the fund will outperform. Because we do not have direct access to fund managers' positions, we use the correlation between portfolio returns and index returns as a proxy for the degree of "index hugging" (the higher the correlation, the lower the active share). The correlation between excess returns and portfolio-index return correlations is -0.57 for the past 5 years (see Figure 5). So it may pay to deviate. Or, to put it differently, when an active manager deviates, this may indicate the extent of potentially profitable investment ideas in the portfolio.

Figure 5: A scatter plot of 5-year excess returns against fund-index return correlations



Source: Morningstar and Barclays as of 31 December 2016. **Past performance is not a guarantee or a reliable indicator of future results.** Sample consists of active U.S. mutual funds (institutional shares only) in "Intermediate-Term Bond" Morningstar category with Bloomberg Barclays US Aggregate Bond Index as their primary prospectus benchmark. Chart is provided for illustrative purposes and is not indicative of the past or future performance of any PIMCO product.

POINT #7 – STRUCTURAL TILTS ARE NOT ALWAYS BETA

We are then left with the obvious question: Is the outperformance alpha or beta? On this point, our indecision is final. Beta, of course, refers to systematic risk factors that need to be remunerated at equilibrium, whereas alpha is defined as residual return in an asset pricing equation and is associated with investing and trading skills.

We are skeptical about this alpha-beta debate because systematic factors, as commonly understood today by both academics and practitioners, have weak theoretical underpinnings. How have some trading strategies graduated to systematic factor status? In other words, what is a systematic factor? A realistic answer may be: whatever has worked in the U.S. over the past few decades. Why is "duration" a systematic factor rather than sunspots? Because duration extension has worked over the past 30 years, as opposed to sunspots. And duration has worked because monetary policy has been accommodative and has allowed large returns from carry, roll-downs and capital gains in bond markets. In other words, betas may well be an artifact of the data sample and the ultimate exercise in data mining (Harvey et al., 2015). To come back to the "systematic duration factor," it has been tested over a period that may well be statistically insignificant because it boiled down to a single monetary experiment.

If all this were true, then systematic factor tilts are less beta and more alpha than investors are prone to think. As to the timing of those tilts, there is a strong presumption that they are alpha.

POINT #8 – A PURELY PASSIVE MARKET WOULD CAUSE SEVERE MARKET RISK AND RESOURCE MISALLOCATIONS

What would financial markets, including equities, look like in a world where asset management is purely passive? Not very compelling, it turns out, and for a reason: In a world where every asset manager is passive, the asset management mandate is to replicate the market. Therefore, all assets get absorbed without due consideration of their characteristics – cash flows, governance and broad risk/return parameters. Prices would cease to be informative the day assets got bought without being analyzed. The market would be subject to a degenerate form of Say's law, under which supply creates its own demand, yet suppliers of securities – bond and equity issuers – are better informed about these securities than are purchasers, in this case passive investors. One can easily see how the market equilibrium would become inherently expensive as passive price takers kept buying everything on supply and correlation across securities increased. This would, of course, lead to capital misallocation on a grand scale (with money chasing expensive assets), to a market crash of sorts and to a collapse in confidence.

POINT #9 – NEITHER PASSIVE NOR ACTIVE INVESTORS CAN DOMINATE AT EQUILIBRIUM

Thankfully, it is hard to see how asset management turns 100% passive. In a classic 1980 paper, Grossman and Stiglitz argue that markets cannot be informationally efficient, meaning that prices cannot perfectly reflect available information. Why can't they? Because if they do, there is no incentive for anyone to acquire and process the information, in which case there is no reason to trade and the market becomes passive. But as new information infiltrates this market, discrepancies arise and it becomes profitable to acquire information and trade the market. Clearly, investors have a stronger incentive to become active when most investors go passive, and vice versa. In a world with noneconomic investors, the math gets more complicated but the cost of on-demand liquidity almost certainly goes up, allowing more rents for economic investors. The pendulum will swing as either the passive or the active population dominates the market.

POINT #10 – PASSIVE MANAGEMENT, UNCHECKED, MAY ENCOURAGE FREE RIDING, ADVERSE SELECTION AND MORAL HAZARD

All it takes is a small proportion of active informed investors to ensure market prices are informative. These investors would be the marginal price setters while passive investors would enjoy a piggyback ride. In this context, information derived from prices is a public good. Active management, then, is a public good as well. And an absence thereof, as outlined above, can lead to undesirable outcomes.

Not only may passive management be guilty of free riding, it may also lead to adverse selection and moral hazard. To the extent that index inclusion rules favor large borrowers in bond space, passive investment, by channeling funds into indexes, results in excess demand for large borrowers' debt. This is a clear case of misdirecting capital toward those who deserve it the least, which is sometimes called the Matthew effect: "For he that hath, to him shall be given: and from him that has not shall be taken even that which he hath." Furthermore, by causing higher prices and lower spreads on the debt of relatively profligate borrowers, a flurry of moral hazards emerge: Governments borrowing at artificially low spreads postpone needed reforms, corporations that overborrow misuse the cash, and so on.

Although on the surface low-fee passive vehicles may benefit savers and pensioners, the reality is more nuanced, to put it mildly. In economic parlance, passive investment produces a host of negative externalities. These grow, likely in a non linear fashion, as the fraction invested passively rises materially. A disturbing implication, well known to economists, is that negative externalities ought to be taxed and positive externalities subsidized – all topics beyond the scope of this paper.

POINT #11 – PASSIVE MANAGEMENT HAS ITS VIRTUES

Passive managers' goal is to replicate the performance of a market index by holding the same securities or a sampling of the securities in the index. They do not need to spend resources to beat the benchmarks. As a result, they usually charge much lower fees than active managers. For many investors who want to focus on other investment decisions, such as asset allocation, and only seek index replication at the asset class level, passive investment provides a cost-effective way to access individual markets.

Active managers play an important role in the economy by helping to allocate capital efficiently. However, there will be times when they overinvest in research and information

acquisition in certain markets or market segments. Having a healthy number of passive choices in each market helps keep this in check. Because most indexes are not directly investable, the competition between active and passive managers will allow investors to screen out active managers that charge higher fees without adding value relative to their passive peers. Cremers et al. (2016) find actively managed mutual funds are more active, charge lower fees and generate higher alpha when they face more competitive pressure from low-cost explicitly indexed funds.

The optimal mix of active and passive investment should depend on the market. A highly efficient and liquid market where active managers' investment in research and information acquisition can no longer be adequately compensated by superior performance over passive, on average, may benefit from less active and more passive management.

POINT #12 – THERE IS NO SUCH THING AS PASSIVE (JUST DIFFERENT SHADES OF ACTIVE)

But you probably know that. In its strict definition, passive investment means owning the market and not trading it. Evidently, none of this is true. The market is an ever-evolving set of assets that need to be traded actively for replication purposes. This is more acute with securities that have finite lives and regularly return capital. And it is nigh impossible to replicate the market, if only because of all its private asset components.

What investors generally mean by passive is not even close to pure passive. For example, the common practice among passive managers of trading at the close of business at months' end, instead of trading evenly during the day, is in itself an active decision with sometimes heavy price consequences. Besides, the most popular example of a passive investment is an S&P 500 ETF, yet the market cap of the S&P 500 index (about \$20 trillion) is less than 10% of world wealth (\$241 trillion in 2014, according to Credit Suisse). The very choice of, say, a passive ETF is an active choice. Investors in passive equity ETFs are, sometimes unwittingly, taking a market view. And because investors often buy and sell these passive ETFs, they are actively timing the market. The asset allocation decision is the most active investment decision an investor can make, as it contributes to the majority of the portfolio return, far more than active decisions at the asset class level can do. Even at the asset class level, there are many active decisions to be made in the selection of passive management and performance benchmarks (Dialynas and Murata, 2006).

Since active management is inevitable, and given the outperformance demonstrated over our sample period, why all the fuss over active management? After all, there is no such thing as passive, just different shades of active management.

CONCLUSIONS

Opinions in the active-passive investment debate have drifted poles apart over recent years. We revisit this discussion by contrasting equity and bonds. We look at performance numbers and find that, unlike their stock counterparts, active bond mutual funds have largely outperformed their median passive peers over our sample period. We offer conjectures as to why bonds and stocks differ.

This may be due to:

- the large proportion of noneconomic bond investors
- benchmark rebalancing frequency and turnover
- structural tilts in fixed income space
- the wide range of financial derivatives available to active bond managers
- security-level credit research and new issue concessions

At a macro level, we believe that a purely passive market would cause severe market risk and resource misallocations. Realistically, neither passive nor active investors can fully dominate at equilibrium. Of course, passive management has its virtues. Yet there is reason to believe that, unchecked, passive management may encourage free riding, adverse selection and moral hazard.

We thank Markus Aakko, Mark Anson, Charles de Segundo, Chris Dialynas, Mohsen Fahmi, Sudi Mariappa, Vasant Naik, Rama Nambimadom, Emmanuel Roman, Steve Sapra, Lutz Schloegl, Emmanuel Sharef, and Mihir Worah for valuable comments on earlier versions of the manuscript, and Robert Selouan for data support.

APPENDIX 1: SIGNAL VERSUS NOISE

Consider a money manager whose portfolio value P follows a geometric Brownian motion:

$$\frac{dP}{P} = \mu_P dt + \sigma_P dW_P.$$

The money manager is trying to beat an index that also follows a geometric Brownian motion:

$$\frac{dI}{I} = \mu_I dt + \sigma_I dW_I.$$

dW_P and dW_I have correlation ρ . The time unit is 1 year.

We can state the values of the processes at time t :

$$P_t = P_0 \exp \left[\left(\mu_P - \frac{1}{2} \sigma_P^2 \right) t + \sigma_P \sqrt{t} Z_P \right],$$

$$I_t = I_0 \exp \left[\left(\mu_I - \frac{1}{2} \sigma_I^2 \right) t + \sigma_I \sqrt{t} Z_I \right].$$

Z_P and Z_I are two standard normal random variables with correlation ρ .

The probability that the manager beats the index at time t :

$$P \left(\frac{P_t}{P_0} > \frac{I_t}{I_0} \right) = P \left(\left(\mu_P - \frac{1}{2} \sigma_P^2 \right) t + \sigma_P \sqrt{t} Z_P > \left(\mu_I - \frac{1}{2} \sigma_I^2 \right) t + \sigma_I \sqrt{t} Z_I \right)$$

$$= P \left(\sigma_P Z_P - \sigma_I Z_I > - \left[\left(\mu_P - \frac{1}{2} \sigma_P^2 \right) - \left(\mu_I - \frac{1}{2} \sigma_I^2 \right) \right] \sqrt{t} \right)$$

$$= P \left(\frac{\sigma_P Z_P - \sigma_I Z_I}{\sqrt{\sigma_P^2 + \sigma_I^2 - 2\rho\sigma_P\sigma_I}} > - \frac{\left[\left(\mu_P - \frac{1}{2} \sigma_P^2 \right) - \left(\mu_I - \frac{1}{2} \sigma_I^2 \right) \right] \sqrt{t}}{\sqrt{\sigma_P^2 + \sigma_I^2 - 2\rho\sigma_P\sigma_I}} \right)$$

$$= \Phi \left(\frac{\left[\left(\mu_P - \frac{1}{2} \sigma_P^2 \right) - \left(\mu_I - \frac{1}{2} \sigma_I^2 \right) \right] \sqrt{t}}{\sqrt{\sigma_P^2 + \sigma_I^2 - 2\rho\sigma_P\sigma_I}} \right)$$

where Φ is the cumulative distribution function (CDF) of a standard normal random variable. Define the information ratio as the ratio between annualized alpha and tracking error, i.e., $\frac{\mu_P - \mu_I}{\sqrt{\sigma_P^2 + \sigma_I^2 - 2\rho\sigma_P\sigma_I}}$. The probability of outperformance can be estimated given assumptions on the horizon, the information ratio, and the volatility and correlation parameters.

See Ambarish and Siegel (1996) for a more detailed discussion.

APPENDIX 2: SUMMARY OF FUND-SPECIFIC REGRESSIONS OF MONTHLY ALPHAS ON RISK FACTOR RETURNS BY ALPHA QUARTILE (JANUARY 2007–DECEMBER 2016)

Quartiles	Average annualized alpha	Average parameter estimates				Average NW t-stat				Average Adj R2
		Constant	Dur	IG	HY	Constant	Dur	IG	HY	
1st	-0.45%	-0.06%	-0.41	0.05	0.44	-1.29	-1.11	0.46	2.67	48%
2nd	0.27%	0.01%	-0.25	0.22	0.29	0.32	-0.71	0.97	2.56	46%
3rd	0.56%	0.01%	-0.14	0.51	0.45	0.34	-0.35	1.52	3.51	57%
4th	1.19%	0.05%	-0.24	0.45	0.60	1.17	-0.53	1.05	3.18	51%

Source: Morningstar and Barclays as of 31 December 2016.

Duration: Excess returns of Bloomberg Barclays US Treasury Index over cash (1M OIS), per unit of duration.

Investment grade: Excess returns of Bloomberg Barclays US Corporate IG Index over duration-matched Treasuries, per unit of spread duration.

High yield: Excess returns of Bloomberg Barclays US Corporate HY Index over duration-matched Treasuries, per unit of spread duration.

Quartiles are based on 10-year annualized alphas. Newey-West heteroskedasticity and autocorrelation consistent t-statistics (Newey and West, 1987) are reported.

Sample consists of monthly alphas for active mutual funds and ETFs in the "Intermediate-Term Bond" Morningstar category, with Bloomberg Barclays US Aggregate Bond Index as their primary prospectus benchmarks and 10-year return histories.

REFERENCES

- Ambarish, Ramasastry and Lester Siegel. 1996. "Time Is the Essence." *Risk*, 9:41-42.
- Baz, Jamil, Nicolas M. Granger, Campbell R. Harvey, Nicolas Le Roux and Sandy Rattray. 2015. "Dissecting Investment Strategies in the Cross Section and Time Series." SSRN, November 2015.
- Cremers, Martijn, Miguel A. Ferreira, Pedro Matos and Laura Starks. 2016. "Indexing and Active Fund Management: International Evidence." *Journal of Financial Economics*, 120, no. 3: pages 539-560.
- Dialynas, C. P. and A. Murata. 2006. "The Active Decisions in the Selection of Passive Management and Performance Bogeys." *Advanced Bond Portfolio Management: Best Practices in Modeling and Strategies* (eds F. J. Fabozzi, L. Martellini and P. Priaulet). John Wiley & Sons, Inc., Hoboken, NJ, USA.
- Gerakos, Joseph, Juhani T. Linnainmaa and Adair Morse. 2016. "Asset Managers: Institutional Performance and Smart Betas." Working paper.
- Grossman, Sanford J. and Joseph E. Stiglitz. 1980. "On the Impossibility of Informationally Efficient Markets." *The American Economic Review* 70, no. 3.
- Harvey, Campbell R., Yan Liu and Heqing Zhu. 2015. "...and the Cross-Section of Expected Returns." Available at SSRN: <https://ssrn.com/abstract=2249314>.
- Mauboussin, Michael J., Dan Callahan and Darius Majd. 2017. "The Incredible Shrinking Universe of Stocks – The Causes and Consequences of Fewer U.S. Equities." Credit Suisse research paper.
- Moore, James. 2017. "Bonds Are Different." PIMCO *Viewpoint*. www.pimco.com.
- Mattu, Ravi K., Mukundan Devarajan, Steve Sapra and Dzmitry Nikalaichyk. 2016. "Fixed Income Manager Selection: Beware of Biases." www.pimco.com.
- Newey, Whitney K. and Kenneth D. West. 1987. "A Simple, Positive Semi-Definite, Heteroskedasticity and Autocorrelation Consistent Covariance Matrix." *Econometrica* 55, no. 3.
- Pedersen, Lasse Heje. 2017. "Sharpening the Arithmetic of Active Management." Available at SSRN: <https://ssrn.com/abstract=2849071>.
- Sharpe, William F. 1991. "The Arithmetic of Active Management." *The Financial Analysts' Journal*, 47, no. 1.
- Worah, Mihir P., and Ravi K. Mattu. 2014. "The Secret of Active Portfolio Management." PIMCO *Viewpoints*. www.pimco.com.

ⁱ The Bank for International Settlements as of 30 June 2016.

ⁱⁱ An earlier version of this table appeared in Moore (2017). The "Domestic Holdings" line item reflects the value of bonds denominated in each central bank's domestic currency held by the Bank of Japan, European Central Bank, the U.S. Federal Reserve and the Bank of England.

ⁱⁱⁱ Gerakos et al. (2016) state that the outperformance of their actively managed institutional accounts between 2000 and 2012 is explained almost entirely by tactical factor tilts.

BIOGRAPHIES

Jamil Baz is a managing director and global head of client analytics. Previously at PIMCO, he was a portfolio manager on the global team. Prior to rejoining PIMCO in 2016, he was a senior managing director and chief investment strategist of the Man Group. Previously, he was a managing director in macro proprietary trading at Goldman Sachs in London and global chief investment strategist at Deutsche Bank. Earlier in his career he co-ran European fixed income research at Lehman Brothers and worked in derivatives and liability management at the World Bank. He has 31 years of investment experience and holds a Ph.D. from Harvard University, an SM degree from the MIT Sloan School of Management and a master's degree from the London School of Economics.

Ravi K. Mattu is a managing director and global head of analytics in the Newport Beach office. He oversees portfolio management analytics, client facing analytics and the asset expert team in the Advisory group. Prior to joining PIMCO in 2011, Mr. Mattu was head of research and strategy for Citadel Securities and previously served as Citadel Investment Group's chief fixed income strategist. Before joining Citadel, he worked at Lehman Brothers for 17 years and held a number of senior positions, including global head of equities and fixed income research, head of quantitative fixed income research and head of securitized product research. He has 35 years of investment experience and holds an MBA from the University of Chicago and a graduate degree from the Indian Institute of Management, Ahmedabad. He received a bachelor's degree in electrical engineering from GB Pant University in India.

James Moore is a managing director in the Newport Beach office. He is head of the investment solutions group and leads our global team of pension solutions strategists. Prior to joining PIMCO in 2003, he was in the corporate derivative and asset-liability strategy groups at Morgan Stanley and responsible for asset-liability, strategic risk management and capital structure advisory work for key clients in the Americas and Pacific Rim. Dr. Moore also taught courses in investments and employee benefit plan design and finance while at the Wharton School of the University of Pennsylvania, where he earned his Ph.D. with concentrations in finance, insurance and risk management. He has 22 years of investment experience and holds undergraduate degrees from Brown University.

Helen Guo is a vice president and quantitative research analyst in the client analytics group in the Newport Beach office. She joined PIMCO in 2011 and specializes in research and modeling to provide customized solutions to clients on asset allocation and risk management. She has seven years of investment experience and holds a Ph.D. in economics and a master's degree in statistics from Stanford University.

This paper contains **hypothetical analysis**. Hypothetical and simulated examples have many inherent limitations and are generally prepared with the benefit of hindsight. There are frequently sharp differences between simulated results and the actual results. There are numerous factors related to the markets in general or the implementation of any specific investment strategy, which cannot be fully accounted for in the preparation of simulated results and all of which can adversely affect actual results. No guarantee is being made that the stated results will be achieved.

Management risk is the risk that the investment techniques and risk analyses applied by an active manager will not produce the desired results, and that certain policies or developments may affect the investment techniques available to active manager in connection with managing the strategy.

Performance results for certain **charts and graphs** may be limited by date ranges specified on those charts and graphs; different time periods may produce different results. Charts are provided for illustrative purposes and are not indicative of the past or future performance of any PIMCO product.

All investments contain risk and may lose value. Investing in the **bond market** is subject to risks, including market, interest rate, issuer, credit, inflation risk, and liquidity risk. The value of most bonds and bond strategies are impacted by changes in interest rates. Bonds and bond strategies with longer durations tend to be more sensitive and volatile than those with shorter durations; bond prices generally fall as interest rates rise, and the current low interest rate environment increases this risk. Current reductions in bond counterparty capacity may contribute to decreased market liquidity and increased price volatility. Bond investments may be worth more or less than the original cost when redeemed.

Swaps are a type of derivative; swaps are increasingly subject to central clearing and exchange-trading. Swaps that are not centrally cleared and exchange-traded may be less liquid than exchange-traded instruments. **Derivatives** may involve certain costs and risks, such as liquidity, interest rate, market, credit, management and the risk that a position could not be closed when most advantageous. Investing in derivatives could lose more than the amount invested.

There is no guarantee that these investment strategies will work under all market conditions or are suitable for all investors and each investor should evaluate their ability to invest long-term, especially during periods of downturn in the market. Investors should consult their investment professional prior to making an investment decision.

The **correlation** of various indexes or securities against one another or against inflation is based upon data over a certain time period. These correlations may vary substantially in the future or over different time periods that can result in greater volatility. It is not possible to invest directly in an **unmanaged index**.

This material contains the current opinions of the manager and such opinions are subject to change without notice. This material is distributed for informational purposes only and should not be considered as investment advice or a recommendation of any particular security, strategy or investment product. Information contained herein has been obtained from sources believed to be reliable, but not guaranteed.

PIMCO provides services only to qualified institutions and investors. This is not an offer to any person in any jurisdiction where unlawful or unauthorized. | **Pacific Investment Management Company LLC**, 650 Newport Center Drive, Newport Beach, CA 92660 is regulated by the United States Securities and Exchange Commission. | **PIMCO Europe Ltd** (Company No. 2604517) and PIMCO Europe Ltd - Italy (Company No. 07533910969) are authorised and regulated by the Financial Conduct Authority (25 The North Colonnade, Canary Wharf, London E14 5HS) in the UK. The Italy branch is additionally regulated by the CONSOB in accordance with Article 27 of the Italian Consolidated Financial Act. PIMCO Europe Ltd services and products are available only to professional clients as defined in the Financial Conduct Authority's Handbook and are not available to individual investors, who should not rely on this communication. | **PIMCO Deutschland GmbH** (Company No. 192083, Seidlstr. 24-24a, 80335 Munich, Germany) is authorised and regulated by the German Federal Financial Supervisory Authority (BaFin) (Marie-Curie-Str. 24-28, 60439 Frankfurt am Main) in Germany in accordance with Section 32 of the German Banking Act (KWG). The services and products provided by PIMCO Deutschland GmbH are available only to professional clients as defined in Section 31a para. 2 German Securities Trading Act (WpHG). They are not available to individual investors, who should not rely on this communication. | **PIMCO (Schweiz) GmbH** (registered in Switzerland, Company No. CH-020.4.038.582-2), Brandschenkestrasse 41, 8002 Zurich, Switzerland, Tel: + 41 44 512 49 10. The services and products provided by PIMCO (Schweiz) GmbH are not available to individual investors, who should not rely on this communication but contact their financial adviser. | **PIMCO Asia Pte Ltd** (8 Marina View, #30-01, Asia Square Tower 1, Singapore 018960) is regulated by the Monetary Authority of Singapore as a holder of a capital markets services licence and an exempt financial adviser. The asset management services and investment products are not available to persons where provision of such services and products is unauthorised. | **PIMCO Asia Limited** (Suite 2201, 22nd Floor, Two International Finance Centre, No. 8 Finance Street, Central, Hong Kong) is licensed by the Securities and Futures Commission for Types 1, 4 and 9 regulated activities under the Securities and Futures Ordinance. The asset management services and investment products are not available to persons where provision of such services and products is unauthorised. | PIMCO Australia Pty Ltd ABN 54 084 280 508, AFSL 246862 (**PIMCO Australia**). This publication has been prepared without taking into account the objectives, financial situation or needs of investors. Before making an investment decision, investors should obtain professional advice and consider whether the information contained herein is appropriate having regard to their objectives, financial situation and needs. | **PIMCO Japan Ltd** (Toranomon Towers Office 18F, 4-1-28, Toranomon, Minato-ku, Tokyo, Japan 105-0001) Financial Instruments Business Registration Number is Director of Kanto Local Finance Bureau (Financial Instruments Firm) No. 382. PIMCO Japan Ltd is a member of Japan Investment Advisers Association and The Investment Trusts Association, Japan. Investment management products and services offered by PIMCO Japan Ltd are offered only to persons within its respective jurisdiction, and are not available to persons where provision of such products or services is unauthorized. Valuations of assets will fluctuate based upon prices of securities and values of derivative transactions in the portfolio, market conditions, interest rates and credit risk, among others. Investments in foreign currency denominated assets will be affected by foreign exchange rates. There is no guarantee that the principal amount of the investment will be preserved, or that a certain return will be realized; the investment could suffer a loss. All profits and losses incur to the investor. The amounts, maximum amounts and calculation methodologies of each type of fee and expense and their total amounts will vary depending on the investment strategy, the status of investment performance, period of management and outstanding balance of assets and thus such fees and expenses cannot be set forth herein. | **PIMCO Canada Corp.** (199 Bay Street, Suite 2050, Commerce Court Station, P.O. Box 363, Toronto, ON, M5L 1G2) services and products may only be available in certain provinces or territories of Canada and only through dealers authorized for that purpose. | **PIMCO Latin America** Edificio Internacional Rio Praia do Flamengo, 154 1o andar, Rio de Janeiro – RJ Brasil 22210-906. | No part of this publication may be reproduced in any form, or referred to in any other publication, without express written permission. PIMCO is a trademark of Allianz Asset Management of America L.P. in the United States and throughout the world. ©2017, PIMCO.

Newport Beach Headquarters

650 Newport Center Drive
Newport Beach, CA 92660
+1 949.720.6000

Hong Kong

London

Milan

Munich

New York

Rio de Janeiro

Singapore

Sydney

Tokyo

Toronto

Zurich

pimco.com
blog.pimco.com