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An ample literature exists on both the tax-advantaged management of equity portfolios and global tactical asset allocation (GTAA), but not so for tax-aware GTAA. Just as with equity portfolios, it is no secret that the alpha from tactical asset allocation can be easily exceeded by the increased taxes that result from profitable turnover. Indeed, in a low-yield environment, earning *any* positive alpha after the effects of fees, inflation, and taxes are subtracted is a daunting goal.[1] This has led many investors to embrace passive and buy-and-hold portfolios, for which low turnover leads to a smaller tax bill. We argue that abandoning GTAA in favor of reduced taxes may be an overly simplistic response to the challenge. Investors can harvest GTAA alpha as long as taxes are *managed*.

[1] Consider that real bond yields, in late 2018, are around 1.0%. Subtract taxes and even small management fees, and bond portfolios are underwater. Meanwhile, stocks yield 1.8% but deliver barely 1.0% after taxes. Furthermore, long-term historical growth in earnings and dividends averages just over 4.0%, of which nearly 3.0% is due to inflation, leaving real growth of 1.4% over the past century. Around 1.0% of this disappears in taxes, leaving us with an expected gain, after fees, inflation, and taxes, of only 1.0% to 1.5%. This is what we can expect if valuations remain as lofty as they are today and if pretax alpha is not negative. Any mean reversion in valuation levels can easily drive this figure below zero, as is now the case with bonds.

There are well-established tools for harvesting GTAA alpha, and there are tax management techniques that can reduce the drag on returns faced by taxable investors. To explore the trade-off between taxes and GTAA alpha, we apply tax-lot selection in trading and loss harvesting, two well-known tax management techniques for a long-only unlevered multiasset strategy. We extend the pretax analysis of multiasset-class portfolios by Aked et al. (2017) with the exchange-traded fund (ETF) tax management approach of Bouchey, Brunel, and Li (2016). We document that taxable investors can capture most of the benefits of GTAA and even improve their after-tax returns, if they incorporate the proactive management of tax consequences as an explicit part of the investment process.

Investors can draw on a rich academic literature in both time-series and cross-sectional return predictability in their search for GTAA alpha. With respect to the time series, Campbell and Shiller (1988), Fama and French (1989), and Cochrane (2008) documented the predictability of equity return, showing that higher yields (carry) and lower valuations (value) are associated with higher future returns, and Moskowitz, Ooi, and Pedersen (2012) showed that a security's own past return (momentum) can be a predictor of its future return. With respect to the cross section of returns, Asness, Moskowitz, and

Pedersen (2013) found that value and momentum predict returns, and Koijen et al. (2016) found that carry predicts return for a variety of asset classes. Whereas the bulk of this literature addresses return predictability in the time series of an asset class and within the cross section of an asset class, considerably less attention has been paid to the GTAA investor's challenge of tactically allocating among asset classes. Recently, Blitz and Van Vliet (2008), Haghani and Dewey (2016), and Aked et al. (2017) have addressed this challenge, documenting that carry, momentum, and value can be applied across asset classes in multiasset-class portfolios to harvest statistically significant GTAA alpha.

Investors also have a rich literature on the impact of taxes on actively managed portfolios. The increased trading often not only raises transaction costs, but also imposes an additional performance drag from realizing gains, particularly those deemed to be short term, as explored by Jeffrey and Arnott (1993) and Arnott, Kalesnik, and Schuesler (2018) and a host of articles in between. Some of these—notably, Berkin and Ye (2003)—have identified a number of tax management techniques that can be employed to mitigate the drag taxes impose on investor returns.[2] Apelfeld, Gordon, and Fowler (1996) and Davidson (1999) provided initial answers in the context of US equity and fixed-income portfolios, respectively. Brunel (1997) offered an initial discussion of the factors that make tax-aware investing different from its tax-oblivious alternative, identifying the "upside-down" notion that (diversifiable) volatility might be an asset.

A crucial next step came when Stein and Narasimhan (1999) introduced the concept that a manager can be active for tax management reasons. The manager can accept some active risk or tracking error. This activity has been called *systematic loss harvesting*. Brunel (1999) extended the strategy, initially proposed within a portfolio focused solely on equities, to a multiasset-class portfolio. Brunel (2001, 2002) then offered a final step in the analysis by including the role of derivatives in enhancing tax efficiency. Finally, Bouchey, Brunel, and Li (2016) extended previous work in security-level tax management to the employment of ETF exposures.

[2]Some strategies take taxes into account in the management of portfolio trading; others proactively trade (e.g., loss harvesting) in the quest for a reduced tax bill. The former places a lower tax bill as a secondary investment goal, and the latter places tax management as a primary goal, at least co-equal with the quest for pretax alpha.

THE TACTICAL MODEL

We conduct our analysis over a 38-year span from January 1980 through December 2017, using an array of asset classes that includes equities, fixed income, and real estate investment trusts (REITs), as listed in Exhibit 1. The exhibit shows that the higher-risk assets have tended to have higher returns, as expected. The GTAA strategy is diversified across asset classes and uses the ubiquitous carry, value, and momentum factors to tactically allocate weights in an unlevered portfolio. Our backtest begins in 1980, five years after the start date of the dataset, to allow for a seed period to begin our value and momentum measures. The number of asset classes available for inclusion in our dataset increased from an initial 8 in 1980 to 16 by the end of the period.[3]

Carry, value, and momentum have been extensively studied in equity, fixed income, and other asset classes. Little published research, however, applies these factors *across* asset classes. In this article, we follow the factor definitions and GTAA methodology of Aked et al. (2017). Each of the three factors was well known in 1980, and each has a deliberately simple definition. Our simple definitions would be a plausible starting point for anyone seeking to build a more nuanced strategy. In other words, we consciously do not seek to maximize our backtest results.

Carry is the expected return of an asset class under the assumption that its valuation will remain constant. For fixed income, we use the current nominal yield of the relevant index, adjusting the fixed-income assets by a negative growth rate proportional to the inception-to-date average downgrades and defaults calculated from the Moody's annual default table for speculative-grade bonds.[4] For equity, we use the current dividend yield of the relevant index and a nominal growth rate. We define the nominal growth rate as the sum of the inception-to-date real US earnings growth from Robert Shiller's Online Data and the trailing three-year inflation rate. Similarly, for REITs we adjust the current dividend yield by the inception-to-date average real dividend-per-share growth and the trailing three-year inflation rate.

[3]This span includes two of the largest equity bull markets in history, 1982–2000 and 2009–2017, so any tactical moves out of equities pull down performance. In this sense, even a 38-year span may not be representative of likely future results.

[4]Bonds have roll-down yield and optionality, which can modestly affect the carry. We choose to keep things simple, with a focus on yield to maturity.

EXHIBIT 1
Summary of Asset Class Indexes

Asset Class	Asset Type	Index Name	Total Return	Income Return	Capital Return	Volatility	Backtest Inception
EM Equities	Stocks	MSCI Emerging Markets	11.36%	2.64%	8.71%	22.71%	01/31/1993
US Small-Cap Equities	Stocks	Russell 2000	11.00%	1.75%	9.25%	19.18%	01/31/1984
Dev ex-US Equities	Stocks	MSCI EAFE	9.47%	2.63%	6.84%	17.09%	01/31/1980
US Large Growth Equities	Stocks	Russell 1000 Growth	11.09%	1.83%	9.25%	16.89%	01/31/1984
REITs	Stocks	FTSE NAREIT ALL REITS	10.80%	7.71%	3.09%	16.42%	01/31/1980
US Large Equities	Stocks	S&P 500	11.80%	2.76%	9.03%	14.83%	01/31/1980
US Large Value Equities	Stocks	Russell 1000 Value	12.01%	3.63%	8.38%	14.41%	01/31/1984
EM Bonds	Bonds	J.P. Morgan EMBI+	9.25%	8.43%	0.82%	13.00%	01/31/1999
Long Treasuries	Bonds	Barclays US Treasury Long	8.00%	5.26%	2.74%	9.71%	02/28/1995
High Yield Bonds	Bonds	Barclays US Corporate High Yield	9.07%	10.64%	–1.57%	8.28%	08/31/1988
EM Local Bonds	Bonds	J.P. Morgan GBI-EM	5.69%	9.84%	–4.15%	7.18%	01/31/1999
TIPS	Bonds	Barclays US Treasury US TIPS	5.45%	3.99%	1.46%	5.54%	04/30/2002
Leveraged Loans	Bonds	J.P. Morgan Leveraged Loans	5.90%	7.87%	–1.97%	5.49%	01/31/1997
BarCap Agg Bonds	Bonds	Barclays US Aggregate	7.68%	6.74%	0.94%	5.37%	01/31/1980
Intermediate Credit	Bonds	Barclays US Intermediate Corporate	7.86%	7.09%	0.78%	4.91%	01/31/1980
Global Agg ex-US Bonds	Bonds	Barclays Global Agg USD	6.07%	4.05%	2.02%	2.83%	02/28/1995

Notes: Returns and volatilities are measured over the backtest period from January 1980 through December 2017. All asset class returns are calculated in US dollars and are unhedged. The Barclays Capital US Aggregate Bond Index, January 1976–December 2017, is back-spliced with Ibbotson Associates Intermediate-Term Government Bond Index, January 1975–December 1976. The Barclays Capital Long US Treasury Index, January 1992–December 2017, is back-spliced with Ibbotson Associates US Long-Term Government Bond Index, January 1975–December 1992. J.P. Morgan Leveraged Loan Index, January 2007–December 2016, is back-spliced with Credit Suisse Leveraged Loan Index, January 1992–December 2007.

Sources: Research Affiliates, LLC, using data from Bloomberg, Robert Shiller's Online Data, Moody's, and REIT.com.

In contrast to carry, *value* assumes that prices will mean revert toward historical norms. Often, value assumes that yields, yield spreads, or valuation multiples (e.g., cyclically adjusted price-to-earnings ratios) revert toward their respective long-term historical means. In the interest of simplicity and parsimony, we simply use the negative of a security's latest five-year return as a measure of value that can easily be applied across asset classes. We are therefore assuming that asset classes with unusually strong five-year performance will likely disappoint, and vice versa.

Momentum assumes prices will continue trending higher or lower and is well documented across geographies, asset classes, and time periods. Once again, in the interest of simplicity and parsimony, our momentum indicator is the trailing one-year return of the asset class.

In addition to testing each factor by itself, we also examine a combination strategy, which puts equal emphasis on carry, value, and momentum. By using extraordinarily simple measures of value, carry, and momentum, equally weighted, we seek to avoid the all-too-common pitfalls of data mining, in which a model is built on a foundation of past returns, to those historical data, and then tested on the selfsame data.

To gauge the impact of transaction costs on the tactical models, we impose a 0.10% transaction cost for every trade. This amount may be a bit high if we are trading futures, swaps, forwards, or no-load mutual funds but is probably much too low if we are trading individual stocks, bonds, and other assets.[5] All returns are shown net of transaction costs but gross of any investment management fees or fund expense ratios.

[5] By considering the full trading costs of ETF implementation using information from the ITG trade-cost system, 10 bps per 100% turnover would occur at an aggregate investment size of over $25 billion. To erode all the after-tax alpha, over $800 billion would need to be invested following the same strategy with all transactions occurring on one given day a month. Our analysis assumes linearly extrapolated transaction costs from those estimated by the ITG trade-cost system, given $1 billion in trades.

PORTFOLIO CONSTRUCTION

The primary benchmark we consider for the strategy is the equally weighted, 1/*N*, portfolio. This portfolio also has some turnover and incurs both trading costs and taxes. We measure performance for the equally weighted portfolio (the benchmark), tactical portfolio (the model), and tax-aware tactical portfolio (the strategy) for which we manage turnover in a fashion that seeks to proactively reduce the portfolio's tax liabilities.

For a given signal, we rank the asset classes and calculate the percentile scores. We overweight assets with a percentile score higher than 50% and underweight assets with a percentile score lower than 50%. We actively tilt the weight by ± 1/*N*; the underweight asset classes are given a zero weight, and the overweight asset classes are then equally weighted. For a portfolio with 16 asset classes (listed in Exhibit 1), the benchmark weight is 6.25% for each asset class. In the tactical portfolio, eight asset classes will each have a 12.5% weight and eight will have zero weight.[6] The portfolio construction approach we adopt was investigated in greater depth by Aked et al. (2017).

One difference between the Aked et al. (2017) methodology and ours is related to the momentum factor. To mitigate the high turnover in the momentum portfolio, we apply the following banding methodology. Each month we add a positive return hurdle to the momentum signal for asset classes that were overweighted the prior month, and we subtract the same value of hurdle for asset classes that were underweighted. The hurdle makes asset classes that were over- or underweighted the prior month more likely to remain over- or underweighted this month. For example, if we apply a hurdle rate of 2.5%, the turnover of the momentum strategy is reduced from 173% to 99%, and the turnover for the combination strategy is reduced from 71% to 48%. The after-tax returns are essentially identical—within 4 bps—to those of the higher turnover strategies.[7]

TAX MANAGEMENT

Bouchey, Brunel, and Li (2016) provided a survey of the tax management literature and proposed a systematic approach for tax management using ETFs. One of the advantages of tax management using ETFs is that several funds are normally available to represent an asset class. For example, one fund might track the S&P 500 Index, and another might track the Russell 1000 Index. Both funds fill the role of US large-cap equity, but because they are not substantially identical securities, selling one to realize a tax loss and buying the other does not trigger wash-sale tax treatment. In this article, we assume investors can enjoy the benefits of loss harvesting without exiting the preferred asset classes in precisely this way. In an actual portfolio, the tax management would create some active risk or tracking error generated by the return differences between the not-quite-identical ETF substitutes. In our backtest, we use index returns and not ETF returns, so our results do not reflect the tracking error that would result from the ETF substitutions.

For smaller accounts—less than US$1 million—implementation with ETFs would likely be the most efficient. For larger accounts, it becomes increasingly cost effective to implement with individual securities. The greater granularity of securities creates more opportunities for tax management; thus, the benefits of tax management we show in our analysis are understated.

To measure returns on an after-tax basis, we assume the highest marginal federal tax rates for 2018 for individuals in the United States: 23.8% for long-term capital gains and dividends and 40.8% for short-term capital gains and interest. We assume that REIT income is a mix of dividends and gains, which are taxed at an average rate of 33.4%. For simplicity, we apply these tax rates over the entire period and do not adjust them to align with the various tax law changes that have occurred since the 1980s.

After-tax returns are measured both on a preliquidation and a postliquidation basis. We assume that a tax liability is incurred in the month income is received and capital gains are realized. The portfolios are given full credit for net realized losses, and we assume these

[6] This deliberately simple algorithm will capture less alpha and incur more turnover than is necessary. Most practitioners would favor a more nuanced approach—for example, preferring a graduated bet so that an asset class moving from the first to the tenth decile would trigger a larger trade than a move from the fifth to the sixth decile. Our choice of algorithm was predicated on eliminating avoidable data mining.

[7] To those who suspect data mining, we would note this decision was made before we started our backtests. The 4-bps return differential did not have any bearing on our strategy design. It is interesting to note, however, how little benefit is derived from the last one-third of the turnover.

losses are used to offset gains from other assets that are external to the portfolio. A large benefit to the tax management of investment portfolios is the deferral of capital gains tax owed. By deferring capital gains tax payable, an investor can continue to invest and enjoy returns on the tax liability not currently payable. Investors do not know when an unrealized tax liability (on unrealized capital gains) may be payable, if at all.

AFTER-TAX EXCESS RETURN DECOMPOSITION

To decompose the sources of return, we compare the tax-managed GTAA portfolio (the strategy portfolio) to two benchmarks: the equally weighted portfolio (the benchmark portfolio) and the non–tax-managed GTAA portfolio (the model portfolio). We use the following notation:

- r is the tax-managed GTAA strategy return,
- m is the model (non–tax-managed GTAA portfolio) return,
- b is the benchmark (non–tax-managed equally weighted) return,
- r', m', b' are the after-tax returns for the respective portfolios, and
- r'', m'', b'' are the after-tax and liquidation returns for the respective portfolios.

We calculate the pretax, after-tax, and postliquidation returns for each of these portfolios. We define *tax impact* as the difference between the after-tax and pretax returns. A negative tax impact means that taxes reduce the return, whereas a positive tax impact indicates that a tax benefit has been created, such as realizing a capital loss. For our purposes, we assume an investor has other holdings and can eventually make use of realized losses from tax-loss harvesting. This assumption is aggressive—but realistic—for most investors. Most investors periodically face capital gains taxes outside their liquid investment portfolio.[8]

[8]For investors who cannot use losses harvested from this portfolio as an offset against gains elsewhere in their overall portfolio, the tax impact of the portfolio will typically have a hard upper-bound of zero. This means that the tax alpha from tax-aware investing cannot be more positive than (i.e., cannot do more than neutralize) the initial active strategy's negative tax alpha.

The *pretax excess return* is the return of the model portfolio minus the pretax return of the equally weighted benchmark. This isolates the excess returns of the tactical model. The *after-tax excess return* is defined as the after-tax return of the tax-managed portfolio minus the after-tax return of the equally weighted benchmark.

$$\textit{Pretax excess return} = a = m - b$$

$$\textit{After-tax excess return} = a = r - b$$

$$\textit{Post-liquidation excess return} = a = r - b$$

The after-tax excess return can be decomposed into three components: pretax excess return of the model portfolio, passive tax difference from tactical trading of the model portfolio, and additional after-tax value added from active tax management. The *tax difference* is the increase in taxes resulting from tactical trading (assuming more tax will be paid as a result of additional transactions and positive alpha) and is calculated as the difference in tax impact between the non–tax-managed model and the benchmark. The *value added from tax management* is the difference in the after-tax return between the tax-managed portfolio and the passive tax-managed model portfolio. This difference includes benefits from tax-loss realization and any performance differences caused by the implementation:

$$\textit{After-tax excess} = \textit{Pretax excess} + \textit{Tax difference} + \textit{Tax management value-add}$$

$$a = a + t + v$$

where

$$t = (m - m) - (b - b)$$

and

$$v = r - m$$

We further decompose the tax difference and tax management value-add into the parts that are attributable to full portfolio liquidation at the end of the period. The liquidation tax can be thought of as the capital gains tax paid when selling the securities at the end of the period:

$$a = a + t + v$$

EXHIBIT 2

After-Tax Returns for the Combination Carry, Value, and Momentum Tactical Strategy, 1980–2017

	Formula	Pre-Tax Return (x)	After-Tax Return (x′)	Tax Impact (x′ – x)	Post-Liquidation Return (x″)	Liquidation Impact (x″ – x′)	Effective Tax Rate (x – x′)/x	Volatility	Turnover
Portfolios									
Equal-Weight Benchmark	b	10.10	7.26	–2.83	6.92	–0.34	28.1%	8.6	12
Combination CVM Model	m	11.37	8.02	–3.35	7.72	–0.30	29.5%	9.2	48
Tax-Managed Strategy	r	11.33	8.72	–2.60	8.28	–0.45	23.0%	9.2	69
Excess Returns									
Model Excess Return	$(m – b)$	1.27	0.75	–0.51	0.79	0.04		3.2	
Tax-Mngmt Excess Return	$(r – m)$	–0.04	0.71	0.74	0.56	–0.15		0.1	
Strategy Excess Return	$(r – b)$	1.23	1.46	0.23	1.35	–0.11		3.2	
After-Tax Return Decomposition									
Pre-Tax Excess Return	$(m – b)$	1.27							
+ Tax Difference	$(m′ – m) – (b′ – b)$	–0.51							
+ Tax-Mngmt Excess Return	$(r′ – m′)$	0.71							
= After-Tax Excess Return	$(r′ – b′)$	1.46							
Post-Liquidation Return Decomposition									
After-Tax Excess Return	$(r′ – b′)$	1.46							
+ Liquidation Impact	$(r″ – r′) – (b″ – b′)$	–0.11							
= Post-Liquidation Excess Return	$(r″ – b″)$	1.35							

Notes: After-tax returns are shown on a preliquidation basis and assume that realized losses are used to offset gains external to the portfolio. Postliquidation returns include the tax related to liquidation of all assets at the end of the investment time period. Returns are reduced by a 0.10% transaction cost for every 100% of turnover and do not reflect investment advisory fees, which would reduce the returns presented. The effective tax rate is calculated as the difference between after-tax and pretax returns divided by the pretax return. Turnover is one way and is calculated as the lesser of the buy and sell turnover.

Sources: Research Affiliates, LLC, and Parametric Portfolio Associates, LLC, using data from Bloomberg, Robert Shiller's Online Data, Moody's, and REIT.com.

where

$$t = (m - m) - (b - b)$$

and

$$v = r - m - v$$

OUR FINDINGS

Our results reported in Exhibit 2 show that taxes have a major negative impact on returns. Our simple benchmark, an equally weighted portfolio, delivers a very respectable 10.10% annualized return over the period of January 1980 to December 2017. After taxes, that return drops to 7.26%. Net of inflation, which averaged 3.1% a year over our 38-year analysis period, taxes consumed fully 40% of the real return, even with the rather benign tax treatment of a quasi-passive rebalanced portfolio. After annualized liquidation costs of 0.34%, the benchmark portfolio's return falls to 6.92% a year, or just 3.82% net of inflation.

Our deliberately naive GTAA (Combination CVM) model, using very simple measures of carry, value, and momentum, adds a fairly robust 1.27% of incremental return, while boosting portfolio risk by a modest 0.6% to 9.2% annual volatility, defined as the standard deviation of annual returns. However, only half of that return remains after taxes. Apropos of Jeffrey and Arnott's (1993) question, "Is your alpha big enough to cover its taxes?" our answer is "Yes, barely." And there will be long spans when investor portfolios are underwater net of taxes.

The after-tax excess return decomposition shows that, over the 38-year period, the extra tax liability caused by tactical trading can be more than made up for by tax-loss harvesting. Tax-aware investing reduces

the pretax return of the GTAA strategy by a scant 4 bps (11.33% versus 11.37%). The postliquidation return, however, is 1.35% ahead of the postliquidation return of the benchmark, thus recapturing the entire tax consequence of the tactical tax-managed strategy with room to spare. Net of inflation and taxes, the tax-managed strategy produced a 5.17% annualized real after-tax return, an impressive spread over the 3.82% annualized real after-tax return of the equally weighted benchmark.

Even a fixed-weight benchmark portfolio has turnover. As the allocations drift from the desired target weights with daily market movements, the portfolio needs to be periodically rebalanced. Following standard convention, we rebalance the fixed-weight benchmark monthly, although a fixed-weight portfolio can be rebalanced more or less frequently. The equally weighted benchmark incurs a 12% one-way annual turnover. To calculate one-way turnover we average the smaller of the buys or sells as a proportion of the total assets for a given month-end, then annualize by multiplying by 12. We do not include the initial purchase or final liquidation because they correspond to cash flows. In our analysis, we assume zero cash flows during the 38-year test.

The only trades assumed to occur in the model portfolio are those necessary to rebalance to the GTAA strategy. The model portfolio has active allocations, which change meaningfully month to month; thus, we would expect, and do in fact find, a higher level of turnover. The higher turnover, or greater number of trades, in the active model portfolio should concern an investor because higher turnover leads to higher transaction costs and generally to a higher realization of capital gains and therefore to a higher tax liability. The model portfolio has a turnover of 48%, about four times higher than the more-passive benchmark portfolio.

When moving from the GTAA model portfolio to the tax-managed portfolio, turnover (perhaps surprisingly) increases further. The additional turnover consists of only those trades that are expected to reduce the tax bill. The experience described in the tax management literature is that the turnover generated by active tax management is meaningful, in many cases double the amount of the unmanaged portfolio. In our case the turnover increases from a moderate 48% to a higher—but definitely not double—level of 69%. We will return to this finding when we drill down into the substrategy and subperiod decompositions to allow for a more intuitive understanding of why turnover from active tax management is lower than expected.

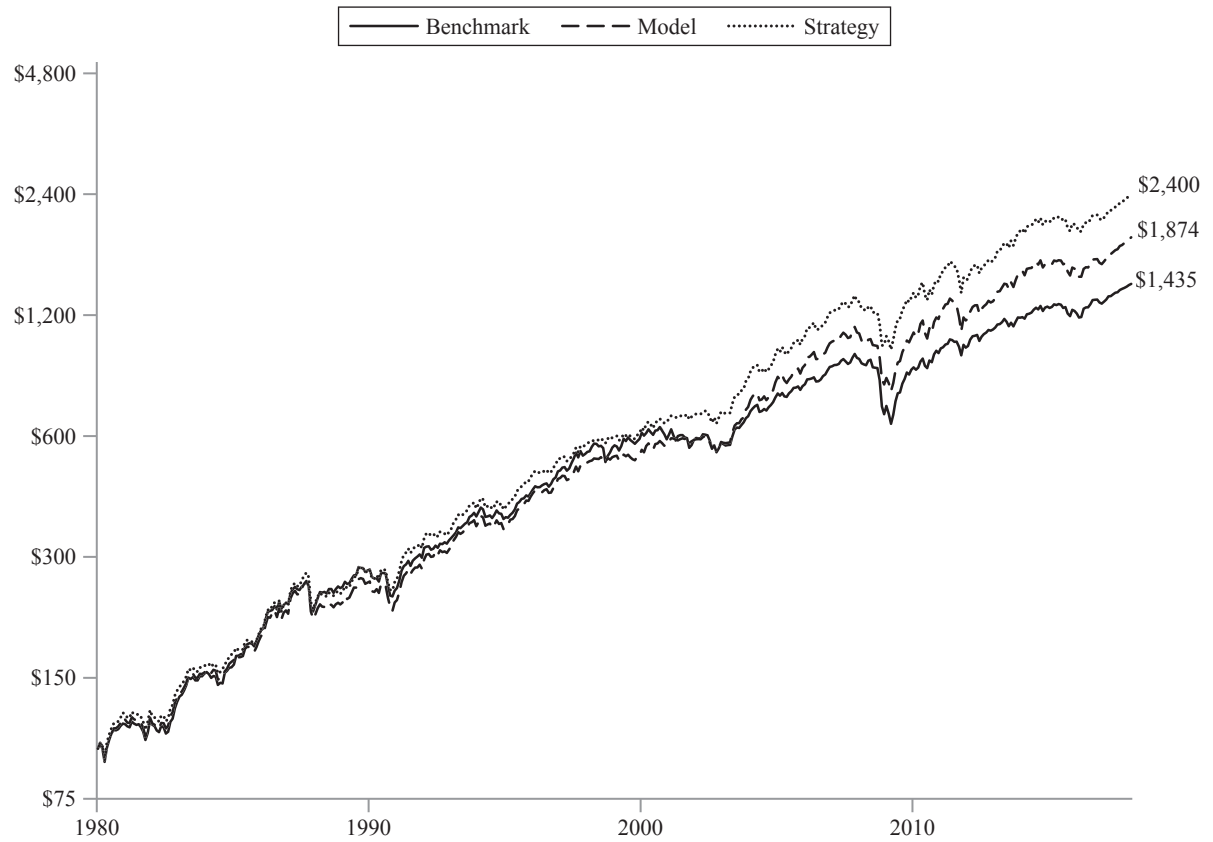
Although the benefits of tax management are reliable and correlate very strongly with marginal tax rates, past returns are not predictive. Past is not prologue. The average yield of stocks and bonds over the 38-year period of our analysis was 100 bps and 340 bps more, respectively, than today's yields. Furthermore, these historical returns were bolstered by bull markets in both stocks and bonds, as equity yields dropped from 5.6% to 1.7% and bond yields fell from 10.3% to 2.9%. Capital gains from these tumbling yields boosted equity market returns by around 3.2% a year and bond returns by about 1.4% a year.[9] Therefore, the 4% and 5% real returns over the last 38 years are likely to be drastically lower in today's low-yield environment. An after-tax alpha of 1% or 1.5%—from GTAA paired with tax-aware implementation—becomes massively important if the after-tax real return of the benchmark is only 0% to 2%.

Exhibit 3 illustrates the growth in wealth of the benchmark, GTAA model, and tax-managed strategies from the initial $100 invested in each on January 1, 1980 to the after-tax preliquidation values earned as of December 31, 2017. At the end of 38 years, the benchmark would have turned its beginning $100 into $1,435. The active GTAA strategy added $439 more than the benchmark, generating 31% higher end-point wealth; put another way, the cumulative alpha it earned is more than four times the initial investment. Likewise, building on the benchmark and active GTAA returns, active tax management added a further $526 over the GTAA model portfolio, earning the investor 24 times the initial $100 investment.

[9] To shape future expectations, we need to apply two haircuts. In a balanced portfolio of roughly half stocks and half bonds, the drop in yields of each (1.0% and 3.4%, respectively) will matter. Some of this drop in yields, however, especially on the bond side, is due to falling inflation expectations. Recall that average inflation was 3.1% over the 38-year span of our analysis, and today's forward-looking inflation expectation is roughly 1.0% lower. If stock yields are 1.0% lower and real bond yields are 2.4% lower, perhaps the appropriate haircut is 1.7% (the midpoint between the two). If past returns were boosted by falling yields—by 3.2% for stocks and by 1.4% for bonds—then we should trim our expectations by another 2.3% (again, the midpoint between the two). These haircuts wipe out almost the entire real after-tax return for our equally weighted global balanced portfolio. Our blunt assessment is that without tactical alpha and tax alpha, nothing is left.

EXHIBIT 3

Growth of $100 in After-Tax Return for the Equally Weighted Strategy Benchmark, GTAA Model, and Tax-Managed GTAA Strategy, 1980–2017



Notes: After-tax returns are shown on a preliquidation basis and assume that realized losses are used to offset gains external to the portfolio. Returns are reduced by a 0.10% transaction cost for every 100% of turnover and do not reflect investment advisory fees, which would reduce the returns presented.

Sources: Research Affiliates, LLC, and Parametric Portfolio Associates, LLC, using data from Bloomberg, Robert Shiller's Online Data, Moody's, and REIT.com.

These results are in nominal terms, so real wealth grows by less. The $2,400 ending value for the tax-managed GTAA strategy, when adjusted for the impact of inflation, would have a lower purchasing power of $744, if expressed in 1980 dollars. When we adjust all the end-point values for inflation, our most striking result is that the real after-tax wealth creation from the tax-managed GTAA strategy almost doubles that of the equally weighted benchmark.[10] Because the tax effects can be consciously and reliably reduced, the tax alpha is not a product of backtesting; it is a simple mathematical fact. Accordingly, we can reasonably presume that tax-advantaged trading can boost after-tax returns by margins comparable to those we observe in this study.

In Exhibit 4, we show the separate components of our naive tactical model and examine the time-varying nature of the alpha sources. The single-factor strategies follow a pattern similar to the multifactor strategy. Each strategy earns a respectable pretax excess return over the 38-year span but loses 34% to 75% of the gain in taxes. With the unsurprising exception of momentum, tax-advantaged trading recoups all of the taxes lost from the active asset allocation in each of the strategies, with room to spare. For carry, value, and the combined strategy, this earns an after-tax excess return for the tax-aware strategies

[10] The CPI All Items deflator from 1980 through 2017 is 3.22. Therefore, the wealth creation of the tax-managed GTAA strategy in today's dollars is $2,400 – $322 = $2,078. Similarly, the after-tax benchmark generated $1,435 – $322 = $1,113, just over half as much.

EXHIBIT 4

GTAA Portfolios, After-Tax Return Decompositions and Turnover, 1980–2017

	Pre-Tax Excess Return	Tax Difference	Tax-Management Excess Return	After-Tax Excess Return	Liquidation Impact	Post-Liquidation Excess Return	Model Turnover	Portfolio Turnover	Post-Liquidation Benchmark Return	Post-Liquidation Model Return	Post-Liquidation Strategy Return
GTAA Portfolios											
Carry	0.51	–0.38	0.89	1.02	–0.29	0.73	26	56	6.92	6.89	7.65
Value	1.87	–0.64	0.83	2.07	0.02	2.09	30	61	6.92	8.35	9.01
Momentum	1.14	–0.40	0.13	0.88	0.01	0.89	99	112	6.92	7.66	7.81
Combination	1.27	–0.51	0.71	1.46	–0.11	1.35	48	69	6.92	7.72	8.28
Combination by Decade											
1980–1989	–0.36	–0.40	0.75	–0.01	0.05	0.05	47	70	10.20	9.78	10.25
1990–1999	0.35	–0.79	0.80	0.35	0.26	0.61	63	91	7.92	7.96	8.53
2000–2009	3.61	–0.75	1.23	4.09	–0.65	3.44	42	75	3.97	6.74	7.41
2010–2017	1.38	–0.38	0.64	1.64	–0.15	1.50	35	50	5.63	6.76	7.12
Carry											
1980–1989	–2.20	–0.19	0.73	–1.66	0.44	–1.22	22	46	10.20	8.42	8.99
1990–1999	–0.18	–1.05	0.95	–0.28	0.45	0.17	35	68	7.92	7.26	8.09
2000–2009	2.54	–0.63	1.82	3.74	–0.83	2.91	25	77	3.97	5.77	6.89
2010–2017	2.01	–0.23	0.55	2.34	–0.45	1.89	19	38	5.63	7.20	7.52
Value											
1980–1989	0.23	–0.60	0.95	0.57	–0.38	0.19	24	54	10.20	9.86	10.39
1990–1999	1.01	–0.65	1.12	1.48	0.30	1.78	38	79	7.92	8.85	9.70
2000–2009	4.69	–0.75	1.16	5.09	–0.71	4.38	36	77	3.97	7.54	8.35
2010–2017	1.33	–0.52	0.73	1.54	0.04	1.58	20	41	5.63	6.81	7.20
Momentum											
1980–1989	0.35	–0.21	0.23	0.38	–0.08	0.30	101	118	10.20	10.27	10.50
1990–1999	0.03	–0.53	0.20	–0.30	0.07	–0.23	136	154	7.92	7.60	7.69
2000–2009	3.30	–0.49	0.31	3.12	–0.22	2.90	76	101	3.97	6.76	6.87
2010–2017	0.71	–0.10	0.03	0.65	0.07	0.72	73	87	5.63	6.32	6.35

Notes: After-tax returns are shown on a preliquidation basis and assume that realized losses are used to offset gains external to the portfolio. Postliquidation returns exclude the tax related to liquidation of all assets at the end of the investment time period. Returns are reduced by a 0.10% transaction cost for every 100% of turnover and do not reflect investment advisory fees, which would reduce the returns presented. Turnover is one way and is calculated as the lesser of the buy and sell turnover.

Sources: Research Affiliates, LLC, and Parametric Portfolio Associates, LLC, using data from Bloomberg, Robert Shiller's Online Data, Moody's, and REIT.com.

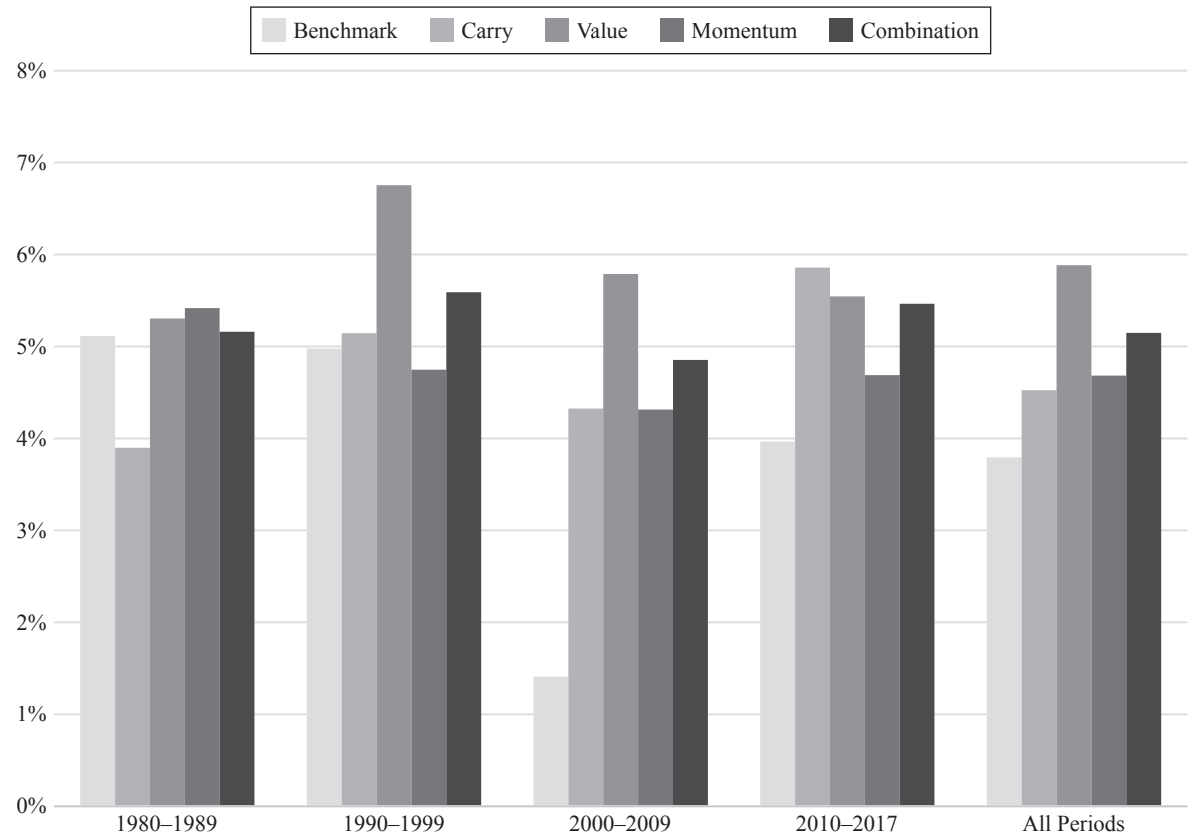
that is larger than the pretax excess return for the same strategies without tax-aware trading.

The momentum strategy has a much lower tax management excess return than the other strategies because of both the high turnover of the strategy and the character of that turnover. In up markets, the momentum strategy, as a matter of course, realizes short-term gains; in down markets, it realizes most of the available tax losses. Consequently, additional loss-harvesting trading does not have much of an impact.

Conversely, because the carry and value strategies buy more when asset prices fall and sell more when asset prices rise, the strategies' contra-trading leaves ample room to tax manage the tax liability. The tax-managed strategy for carry and value, at 56% and 61%, respectively, is roughly double that of the active and non–tax-managed model turnover of 25% and 30%, respectively. In contrast, the amount of tax management in a momentum portfolio is limited. Therefore, the GTAA model's turnover, already constrained by the use of a turnover band at 99%, only increases to 112%. The increase in total portfolio turnover from tax management is lower than we

Exhibit 5

Postliquidation Real Returns by Strategy and Decade, 1980–2017



Notes: Postliquidation returns exclude the tax related to liquidation of all assets at the end of the investment time period. Returns are reduced by a 0.10% transaction cost for every 100% of turnover and do not reflect investment advisory fees, which would reduce the returns presented.

Sources: Research Affiliates, LLC, and Parametric Portfolio Associates, LLC, using data from Bloomberg, Robert Shiller's Online Data, Moody's, and REIT.com.

had expected. Exhibit 2 shows that the contribution of the momentum portfolio is the main driver of the lower-than-expected growth in turnover as a result of the momentum model automatically handling much of the benefit of tax management within the strategy.

We report the postliquidation real return by strategy for each decade in Exhibit 5. The degree to which GTAA can add value has varied across each of the decades. At the start of the 1980s, with Volker in charge of the Federal Reserve, high short-term rates led to a slowing of inflation expectations over the subsequent two decades. The carry model's poor showing is a function of the disinflationary environment dominating the variation in real yields, a factor that our simple GTAA approach does not consider; our live strategies and those of many competitors, however, do (and did at the time) take some of these nuances into account.

More interestingly, the real after-tax returns of the tax-managed GTAA strategy and the GTAA model provide far more stability in return outcome than does the benchmark. In the 38-year period (nearly four decades), the lowest strategy return was carry in the 1980s, and the highest strategy return was value in the 1990s, defining the range as 3.9%–6.8% a year in real terms. The benchmark, or the passively rebalanced equally weighted portfolio, delivered a range of real returns from 1.4% a year in the 2000s to 5.1% a year in the 1980s. Interestingly, the seemingly less-diversified strategy portfolios each provide a more stable return stream than does the default benchmark.

The decade-by-decade results show some variability in the excess return earned by the various strategies and are, of course, influenced by start- and end-date dependencies. In particular, the after-tax returns are path dependent. For example, a portfolio that has been appreciating for several decades will have a different after-tax return in the subsequent decade than a portfolio that starts the decade in cash.

The GTAA factor and combination portfolios did not fare well, net of taxes, in the 1980s. Although the pretax excess return was –0.36%, tax management brought the after-tax performance essentially square to the benchmark on both a before- and after-liquidation basis (–0.01% and 0.05%, respectively). In the 1990s, taxes and tax management offset each other, delivering 0.35% a year and 0.61% a year, respectively, in after-tax value creation on a pre- and postliquidation basis. Indeed, after these lackluster decades for active asset allocation, an investor might reasonably have asked, "Why bother?" In all decades, however, tax-advantaged investing recouped the entire tax cost of active tactical management, bringing the after-tax excess return into positive territory; since the end of the 1980s, the after-tax value-add is more than respectable. Even in the 1980s, the benefits of diversification are evident because all of the negative postliquidation excess return came from the carry portfolio, down 1.2% relative to the equally weighted benchmark.

With two immense bear markets and one immense bull market (plus the early months of the 2009–2017 bull market), the decade of the 2000s presented the best opportunity to be tactical. With a relentless bull market in the early years of the 2010s, it is unsurprising that the tactical models have not been overly helpful. If we have a full bull-to-bear cycle in the decade of the 2010s, the efficacy of the tactical models and the efficacy of tax-advantaged trading will likely be more impressive than that over the last 38 years.

ADAPTING TO DIFFERENT INVESTOR PREFERENCES

One of the goals of our study is to analyze model portfolios with various risk-and-return profiles. For illustrative purposes, we construct three simple variations on the equally weighted portfolio to serve as benchmarks for our conservative, moderate, and aggressive strategies. These tailored benchmarks are described in Exhibit 6. More refined benchmark allocations could easily be constructed, depending on the investor's particular objectives, but the illustrative examples will suffice for our purposes here.

EXHIBIT 6
Strategy Benchmark Weights

Asset Class	Conservative	Moderate	Aggressive
EM Equities	–	6.25%	10%
US Small-Cap Equities	–	6.25%	10%
Developed ex-US Equities	–	6.25%	10%
US Large-Cap Growth Equities	–	6.25%	10%
US Large-Cap Equities	–	6.25%	10%
US Large-Cap Value Equities	–	6.25%	10%
REITs	10%	6.25%	10%
High-Yield Bonds	10%	6.25%	10%
EM Bonds	10%	6.25%	10%
EM Local Currency Bonds	10%	6.25%	10%
Long Treasuries	10%	6.25%	–
TIPS	10%	6.25%	–
Leveraged Loans	10%	6.25%	–
BarCap Agg Bonds	10%	6.25%	–
Interm Credit	10%	6.25%	–
Global Agg ex-US Bonds	10%	6.25%	–
Total	100%	100%	100%

Sources: Research Affiliates, LLC, and Parametric Portfolio Associates, LLC, using data from Bloomberg, Robert Shiller's Online Data, Moody's, and REIT.com.

We define a conservative and an aggressive portfolio to flank our moderate equally weighted benchmark. The conservative portfolio gives equal weight to 10 asset classes that have relatively lower risk and higher income. Likewise, the aggressive portfolio is an equally weighted allocation to the 10 asset classes with relatively higher risk and lower income. Exhibit A1 in the online supplement shows the tactical asset allocations for the three portfolios from 1980 to 2017.

As Exhibit 7 shows, the composition of risk and return varies monotonically from the conservative to the aggressive portfolios. The improvement in Sharpe ratio is greatest for the moderate portfolio. Tactical asset allocation is a game of breadth. As Aked et al. (2017) found, the higher the number of asset classes with low correlation, the greater the ability to add active return. GTAA benefits from the diversification of portfolios in the body of the risk spectrum and is hobbled by the specificity at the wings, whether at the low- or high-risk levels. In addition, note the change in the character

EXHIBIT 7
Pretax GTAA Performance across the Risk Curve

	Conservative		Moderate		Aggressive	
Portfolio	**BM**	**Strategy**	**BM**	**Strategy**	**BM**	**Strategy**
Pre-Tax Total Return	9.05	9.69	10.10	11.37	11.06	12.52
Pre-Tax Income Return	7.51	7.84	5.49	5.11	4.93	4.75
Pre-Tax Capital Return	1.54	1.85	4.61	6.26	6.13	7.78
Volatility	5.97	6.18	8.63	9.20	12.85	13.07
Sharpe Ratio	0.78	0.85	0.66	0.76	0.52	0.62
Excess Return vs. Benchmark		0.64		1.27		1.46
Tracking Error		1.86		3.22		2.49
Info Ratio		0.34		0.39		0.59
Turnover	7.1	35.4	12.1	47.7	12.0	39.4

Sources: Research Affiliates, LLC, and Parametric Portfolio Associates, LLC, using data from Bloomberg, Robert Shiller's Online Data, Moody's, and REIT.com.

of the return, with lower-risk asset classes delivering a higher proportion of their return as income, rather than as capital. This observation will be important when we examine the after-tax returns.

In Exhibit 8, we explore the return decomposition by strategy benchmark and decade. As expected, lower-risk asset classes deliver a higher proportion of their return as income, rather than as capital, thus decreasing the potential benefit of tax management.[11] Higher-risk asset classes, with both higher volatility and a higher proportion of capital return, rightly serve as better actors in the performance of tax management. Exhibit A2 in the online supplement shows the time series of the after-tax growth of $1, and Exhibit A3 in the online supplement shows the regressions of the returns of the tactical portfolios on their respective strategy benchmarks for the conservative, moderate, and aggressive risk profiles. In most of these cases, tax management is not only beneficial but nearly necessary to justify the additional tax liability resulting from active management.

Tax management is a strategy better realized at a higher risk level; the aggressive-model portfolio yields a tax-managed excess return of 1.02% a year compared to 0.60% a year for the more income-intensive conservative-model portfolio. Because more asset classes provide more trading opportunities and the moderate portfolio typically invests in a wider array of markets, portfolio turnover is highest for the moderate portfolio at 48% a year, relative to the turnover of 35% and 39% a year, respectively, for the conservative and aggressive portfolios. Including tax management turnover, the three strategies yield surprisingly similar turnover rates, from 59% for the conservative portfolio to 71% for the aggressive portfolio. The decade-level results are similar to those for the factor and combination tactical portfolios, with pretax returns varying substantially by decade, a consistent tax drag resulting from the additional tactical trading, and the potential for tax management to enhance after-tax returns.

In summary, Exhibit 9 shows postliquidation returns versus volatility, graphically demonstrating the extent to which marrying active asset allocation and tax management is necessary to realize sufficient excess return. The opportunity to add after-tax return relative to a passively rebalanced diversified portfolio is dependent on both the cross-sectional volatility of return and the proportion of return delivered by price changes (i.e., capital gains) rather than income. The conservative portfolio, with an annual volatility of 6% and over 80% of its pretax return delivered as income, delivers an added value of 79 bps a year over the 38-year period. The moderate portfolio, which has an annual volatility of 9% and

[11] We also studied the effect of replacing the fixed-income asset classes with a tax-exempt bond asset class (municipal bonds). On an after-tax basis, the results were similar to those shown here. Pretax returns were reduced because fewer opportunities were available to tactically add value. This reduction was offset by the tax-exempt status of the income. In the context of a diversified portfolio, we prefer to use a broader set of fixed-income asset classes to avoid concentration risk and to apply tax management techniques to help boost after-tax returns.

EXHIBIT 8

Model Portfolios, After-Tax Return Decompositions and Turnover, 1980–2017

	Pre-Tax Excess Return	Tax Difference	Tax-Management Excess Return	After-Tax Excess Return	Liquidation Impact	Post-Liquidation Excess Return	Model Turnover	Portfolio Turnover	Post-Liquidation Benchmark Return	Post-Liquidation Model Return	Post-Liquidation Strategy Return
Model Portfolios Full Period											
Conservative	0.64	–0.40	0.60	0.84	–0.06	0.78	35	59	5.53	5.94	6.31
Moderate	1.27	–0.51	0.71	1.46	–0.11	1.35	48	69	6.92	7.72	8.28
Aggressive	1.46	–0.53	1.02	1.96	0.06	2.02	39	71	8.16	9.25	10.19
Conservative by Decade											
1980–1989	–0.38	–0.12	0.80	0.31	–0.08	0.22	34	70	7.55	7.05	7.77
1990–1999	0.92	–0.42	0.73	1.23	–0.14	1.08	34	62	5.83	6.33	6.91
2000–2009	1.11	–0.49	0.87	1.49	–0.43	1.06	31	60	4.93	5.50	5.99
2010–2017	0.85	–0.57	0.42	0.69	–0.07	0.62	24	37	3.71	4.18	4.33
Moderate by Decade											
1980–1989	–0.36	–0.40	0.75	–0.01	0.05	0.05	47	70	10.20	9.78	10.25
1990–1999	0.35	–0.79	0.80	0.35	0.26	0.61	63	91	7.92	7.96	8.53
2000–2009	3.61	–0.75	1.23	4.09	–0.65	3.44	42	75	3.97	6.74	7.41
2010–2017	1.38	–0.38	0.64	1.64	–0.15	1.50	35	50	5.63	6.76	7.12
Aggressive by Decade											
1980–1989	1.07	–0.82	1.01	1.26	0.10	1.36	46	73	12.31	13.08	13.67
1990–1999	1.86	–0.85	1.32	2.33	–0.09	2.25	39	75	9.78	11.03	12.03
2000–2009	1.89	–0.19	2.06	3.76	–0.72	3.04	34	99	3.52	5.27	6.56
2010–2017	0.89	–0.56	0.86	1.19	0.08	1.27	37	61	7.07	7.80	8.34

Notes: Excess returns are measured versus the strategy benchmark, which has static portfolio weights across the available asset classes. After-tax returns are shown on a preliquidation basis and assume that realized losses are used to offset gains external to the portfolio. Postliquidation returns include the tax related to liquidation of all assets at the end of the investment time period. Returns are reduced by a 0.10% transaction cost for every 100% of turnover and do not reflect investment advisory fees, which would reduce the returns presented. Turnover is one way and is calculated as the lesser of the buy and sell turnover.

Sources: Research Affiliates, LLC, and Parametric Portfolio Associates, LLC, using data from Bloomberg, Robert Shiller's Online Data, Moody's, and REIT.com.

a pretax return evenly split between income and capital gains, generates a greater active return, clocking in at 135 bps a year. Finally, the highest risk portfolio, with an annual volatility of 13% and 60% of its return in the form of capital gains, has an active return that jumps to 202 bps a year.

Over the 38 years in our analysis, an investment in the moderate benchmark portfolio resulted in an aggregate real tax bill of $272 in 1980 dollars per $100 initial investment.[12] In contrast, the additional wealth created by the active strategy, and which included active tax management, resulted in an aggregate tax liability of $342 in 1980 dollars. The combination of GTAA and tax management results in a better outcome for both investor and taxing authority.

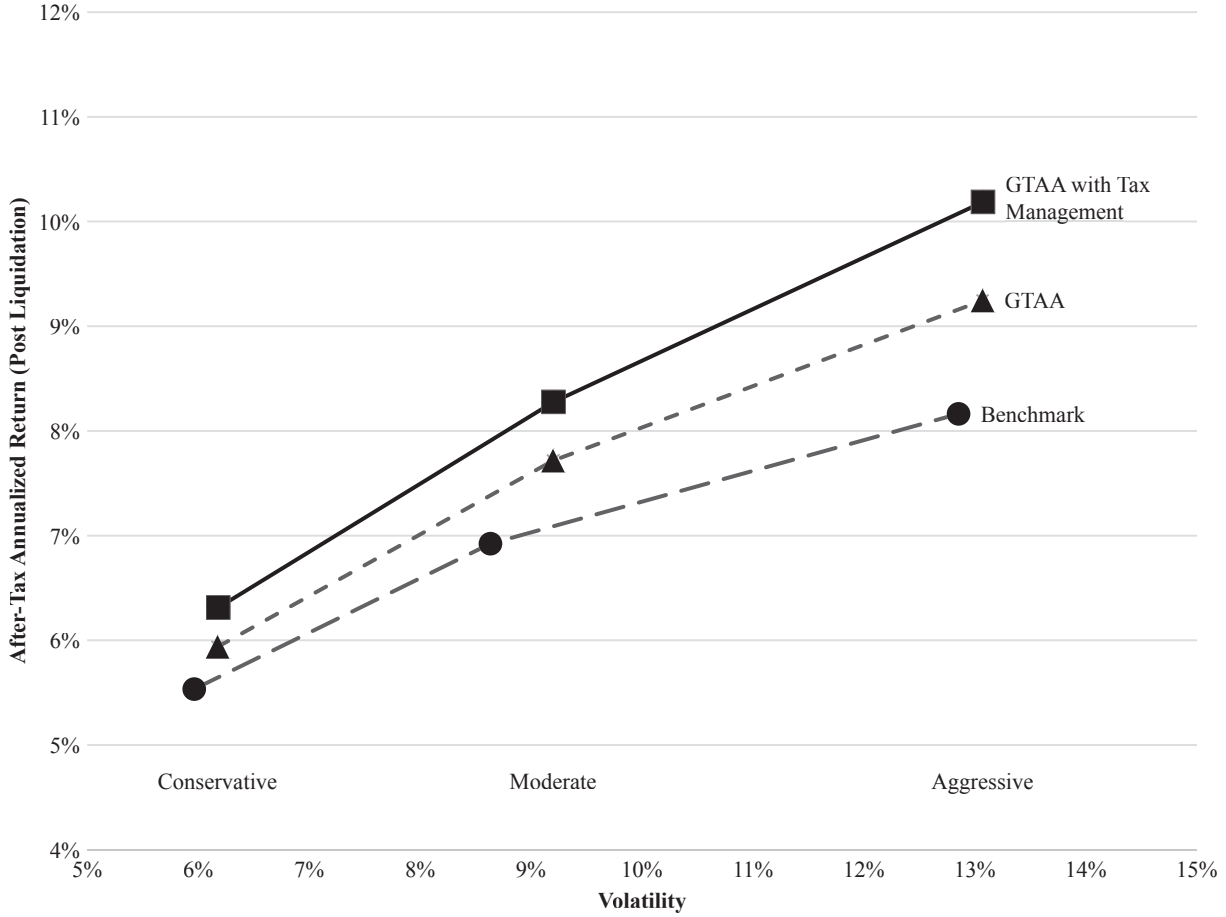
CONCLUSION

Our approach to the combination of GTAA and active tax management is limited by the simplifying assumptions we have made. We have adopted a simple GTAA program that could be refined and advanced in many directions. Additionally, we only allow tax management to occur at the aggregate asset-class level. Many before us have shown the superior investment returns that can be gained by opportunistically trading at a more granular level, such as individual securities or sectors. We leave for further analysis the benefits that can be had by further dividing asset classes to create

[12] The aggregate real tax bill is calculated by computing the real tax liability for each month over the 38-year span based on the difference between the pretax and after-tax returns of the portfolio.

EXHIBIT 9

Postliquidation Returns versus Risk by Strategy Benchmark, 1980–2017



Notes: The benchmark holds static portfolio weights across the available asset classes. Postliquidation returns include the tax related to liquidation of all assets at the end of the investment time period. Returns are reduced by a 0.10% transaction cost for every 100% of turnover and do not reflect investment advisory fees, which would reduce the returns presented.

Sources: Research Affiliates, LLC, and Parametric Portfolio Associates, LLC, using data from Bloomberg, Robert Shiller's Online Data, Moody's, and REIT.com.

more dimensions for both GTAA and active tax management. Finally, the greatest assumption we have made is that a perfect replacement asset can be used to avoid triggering the wash-sale rule. Although we admit our assumption is naive in this respect, the practical exercise of finding appropriate exposures would result in an additional tracking error to the strategy that would have an equivalent expected return. Despite these limitations, our research makes it clear that investors can engage in strategies that are both tactical and tax aware.

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