Institutional Investor Journals

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The Journal of Portfolio Management

VOLUME 44, NUMBER 3 www.iijpm.com WINTER 2018

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An efficient stock market is beneficial to society and increases gross domestic product (GDP) through the optimal allocation of capital. To incorporate new information into stock prices, trading is needed. However, for investors, trading decreases returns because, before costs, active investing is a zero-sum game. Still, trading levels are anomalously high, which results in a drag on global GDP (French [2008]). Excessive trading can be directly linked to investor overconfidence (see Odean [1998] and Scheinkman and Xiong [2003]). However, even rational portfolio managers who are not overconfident could trade excessively to give a signal to clients and employers that they are worth earning their fees (see Dow and Gorton [1997]). In fact, mutual fund performance is negatively affected by the amount of trading (see Carhart [1997]; Cremers and Pareek [2016]).

Market-weighted passive investing is increasingly popular because it barely involves trading, thus limiting transaction costs, and incurs low implementation costs. However, with passive buy-and-hold market investing, one also assumes the stock market to be efficient.[1] Paradoxically, if everyone attempted to invest passively, the market would become highly inefficient, so trading is necessary to ensure fair prices. Many empirical asset pricing studies indeed show that the stock market is inefficient with regard to risk. The capital asset pricing model (CAPM) predicts a positive relation between systematic risk and return, but empirical tests show a flat or even negative relation. Even in the early 1970s, some early tests of the CAPM showed that low-risk stocks have high risk-adjusted returns (e.g., Haugen and Heins [1975]). This low-volatility effect or low-risk anomaly did not receive much attention until the 1990s.[2] Driven by this academic evidence, low volatility has emerged as a distinctive and popular investment style since the 2000s. The financial crises of 2008 highlighted that this defensive style differs from traditional value investing, which unlike low volatility did not offer protection during the 2008 stock market crash.

Low-volatility investing is not a passive strategy. To construct a low-volatility portfolio or a low-volatility index, regular rebalancing is required because the risk of stocks varies over time. For example, most telecom stocks were very volatile in the 1990s but became less volatile in the 2010s. An interesting question is how much trading is actually needed to efficiently construct and maintain a low-volatility portfolio. There is a growing body of literature on low-volatility investing. Many of these studies show risk reduction levels of around 25%, whereas single-counted turnover levels vary between 20% and as high as 120%. Higher turnover implies higher trading costs, and several studies have showed that the abnormal profits from fast strategies such as momentum and short-term reversal vanish after transaction costs are taken into account (e.g., Avramov, Chordia, and Goyal [2006]).

The aim of this article is to investigate the relation between turnover and the amount of risk reduction.[3] Because differences in turnover are caused by differences in portfolio construction methodology, look-back period, sample period, or inclusion of international stocks, we aim to control for these separate effects in two ways. First, we employ an empirical literature study and regress the volatility reduction on the amount of turnover and control for characteristics such as methodology and sample definition. Second, we empirically investigate the relation of turnover and risk reduction with portfolio simulations and keep all other things equal. These two approaches supplement each other and help to give a robust estimate of the relation between turnover and volatility reduction. This helps us to answer the question of how much turnover is needed to create an efficient low-volatility portfolio or index.

We find that an efficient low-volatility strategy needs little trading. In addition, low-volatility stocks are more liquid and cheaper to trade, primarily because they are much larger than the average stock. The literature study and empirical results reveal a concave relation between risk reduction and trading levels. Each further increase in turnover results in smaller marginal reductions in volatility. The law of diminishing returns also applies to other factors such as value and momentum, and integrating them into a multifactor low-volatility strategy is an efficient way to either increase alpha or reduce turnover further.

In the remainder of this article, we first briefly discuss why investors trade too much and how much trading takes place in low-volatility stocks and estimate the costs of trading these stocks. Second, we investigate how much turnover is actually needed to reduce volatility using a meta-study. Third, we empirically test the relation between turnover and volatility reduction, in a controlled study. We also test the relation between exposure to value and momentum factors and turnover and integrate these factors into a multifactor low-volatility strategy. We end with concluding remarks and implications for investors.

TRADING LOW-VOLATILITY STOCKS

Excessive trading hurts investment returns. For example, Carhart [1997] found that mutual fund turnover is significantly negatively related to net mutual fund performance, and Odean [1999] showed that most actively trading retail investors have the lowest returns. Excessive trading is either caused by overconfidence or agency effects. When stocks show large price fluctuations, this noise (Black [1986]) could work as a catalyst, increasing the amount of trading in these volatile stocks. Falkenstein [2009] argued that high-volatility stocks are more attention grabbing and more prone to overconfidence, resulting in higher traded volumes and lower returns.

Who are net buyers of low-volatility stocks? Evidence from retail investors, mutual fund managers, and hedge funds shows a positive relation between volatility and trading. First, Odean [1999] showed that most active private traders are drawn to the risky part of the market and tend to buy high-volatility stocks. Second, Cremers and Pareek [2016] showed that the most successful mutual funds that outperform their benchmarks by 2% trade little and have positive exposure to low-risk stocks and other proven factors. Third, Blitz [2018] showed that hedge funds are net buyers of high-volatility stocks, going against the evidence that points in the direction of buying low-volatility stocks. From these studies, a common pattern arises: The most active investors tend to trade in the most volatile part of the market and have negative exposure to low-volatility stocks.

How much trading takes place in low-volatility stocks? Schwert [1989] reported a positive relation between stock return volatility and the dollar traded volume in stocks. Thus, he found lower trading activity in low-volatility stocks. Chordia, Huh, and Subrahmanyam [2007] confirmed this finding also when controlling for several other factors, such as value and momentum. To measure the amount of turnover in low-volatility and high-volatility stocks, we sort the largest 3,000 global stocks based on their historical three-year weekly stock return volatility. For each volatility quintile, Exhibit 1 reports the market capitalization in billions of U.S. dollars, average daily dollar trading volume, and turnover. Turnover is defined as the percentage market value of a stock traded in a year.

The average low-volatility stock has a turnover of 77%, whereas the average high-volatility stock has

EXHIBIT 1
Turnover in Volatility-Sorted Stocks

	Volatility (3-year)	Market Cap (billion $)	Daily Volume (million $)	Turnover (annual)
Panel A: Volatility-Sorted Portfolios				
Low volatility Q1	16.3%	$22,938	$67.9	77%
Q2	21.3%	$14,308	$55.4	101%
Q3	25.4%	$10,091	$51.3	132%
Q4	31.1%	$7,633	$48.5	165%
High volatility Q5	45.0%	$4,873	$52.6	281%
Panel B: Turnover-Sorted Portfolios				
Low Turnover	21.9%	$14,833	$27.0	47%
Q2	23.3%	$16,369	$50.9	81%
Q3	25.1%	$13,015	$57.7	115%
Q4	27.9%	$9,845	$63.2	167%
High Turnover	37.4%	$5,782	$77.0	346%

Notes: This exhibit shows the relation between stock turnover, volatility, and market capitalization for the largest 3,000 global stocks as of January 1, 2015. Panel A shows five quintile portfolios of stocks sorted on three-year stock return volatility. Market capitalization is in billions of USD, and average daily dollar volume is defined over the past 260 trading days. Annual stock turnover is defined as the daily dollar volume divided by the market capitalization multiplied by 260 trading days and expressed as percentage. Panel B shows the results for portfolios directly sorted on turnover.

a much higher turnover of 281%, in line with findings reported by Schwert [1989]. Thus, turnover in high-volatility stocks is almost four times higher than in low-volatility stocks. The relation between the average quintile volatility and average quintile turnover is very strong: The group correlation is 99.6%. Furthermore, low-volatility stocks are almost five times larger than high-volatility stocks—US$23 billion versus US$5 billion. In sum, low-volatility stocks are 30% more liquid as measured by traded dollar volume; thus, the fact that they are bigger more than compensates for the lower turnover. We also sort stocks based on stock turnover. Panel B shows that stocks with low turnover also have lower volatility, which confirms the direct link between stock price volatility and stock turnover. Thus, low-volatility stocks have lower turnover, and low-turnover stocks have low volatility. Unreported results also show that turnover has predictive power for volatility, on top of volatility.

Trading cost models often assume a positive relation of costs with volatility and a negative relation with volume and market capitalization (e.g., Keim and Madhavan [1997]). A typical low-volatility stock will be cheaper to trade because it has a higher market capitalization; higher volume and low price fluctuations will give brokers a lower profit and loss volatility. In an extensive study on trading costs, Frazzini, Israel, and Moskowitz [2012, table IV] showed that the average low-volatility stock is 3 bps cheaper to trade compared to an average stock. Using these results, the transaction costs can be estimated to be 14 bps for the average stock, 11 bps for the average low-volatility stock, and 7 bps for ultra-large stocks that dominate the market portfolio. The difference between these costs is mainly driven by market impact costs, which are higher for smaller stocks with higher volatility.

Another important factor determining a transaction cost estimate is the dollar volume traded. Tracking a low-volatility index with $10 billion will be more expensive than tracking the same index with $1 billion worth of assets. Thus, the assets under management level is also important, especially when strategies grow in size. In the next section, we consider the amount of trading needed to construct a systematic low-volatility strategy.

LITERATURE ON TURNOVER AND VOLATILITY REDUCTION

How much turnover is needed to create and maintain a low-volatility or minimum variance portfolio? To answer this question, we carry out a meta-study using previous analyses presented in the literature. We started with 89 low-volatility articles. From this long list, only those studies that report turnover levels are included. Finally, the sample period should be at least 20 years. Some articles contain several robustness analyses and can therefore be used more than once. Of course, there are limitations to this approach. First, many studies do not explicitly aim to control turnover because this was not the main objective of the study. Second, many of the studies can be based on the same underlying data, which is different than meta-studies in the field of medicine where samples are fully independent. Still, this method could provide additional insights.

Exhibit 2 documents the sample period (e.g., 1963–2012) and equity market (e.g., U.S. stocks) for each study. The exhibit also reports which method was used for portfolio construction: a ranking-based approach versus a minimum variance optimized approach. In total, we employ 21 analyses that report

EXHIBIT 2
Literature Review, Volatility Reduction, and Turnover

Authors	Turnover	Vol. Reduction	Universe	Method	Period
Chow et al. [2014]	19%	19%	U.S.	Ranking	1967–2012
Nielsen and Aylursubramanian [2008]	20%	27%	Global	Minvar	1995–2007
Soe [2012]	22%	21%	U.S.	Minvar	1991–2011
Chow et al. [2014]	24%	27%	Global	Ranking	1987–2012
Thomas and Shapiro [2009]	30%	28%	U.S. 3,000	Ranking	1986–2007
Soe [2012]	30%	25%	U.S.	Ranking	1991–2011
Shah [2011]	31%	20%	U.S. 1,000	Ranking	1968–2010
Shah [2011]	31%	23%	U.S. 1,000	Minvar	1968–2010
Exhibit 4 – Port 8	32%	28%	Global	Ranking	1989–2013
Clarke, de Silva, and Thorley [2006]	32%	24%	U.S.	Minvar	1968–2005
de Silva [2012]	35%	28%	U.S.	Ranking	1968–2005
Clarke, de Silva, and Thorley [2013]	40%	19%	U.S. 1,000	Minvar	1968–2010
Chow et al. [2014]	45%	25%	U.S.	Minvar	1967–2012
Chow et al. [2014]	47%	34%	Global	Minvar	1987–2012
Kuo and Li [2013]	48%	36%	Global ex U.S.	Minvar	1987–2011
Kuo and Li [2013]	49%	25%	U.S.	Minvar	1967–2011
Baker and Haugen [2012]	84%	25%	U.S.	Ranking	1990–2011
Baker and Haugen [2012]	96%	22%	Global AC	Ranking	1990–2011
Fallon and Davis [2013]	96%	37%	U.S. 1,000	Minvar	1989–2012
de Boer, Campagna, and Norman [2013]	112%	31%	Global	Minvar	1978–2012
Clarke, de Silva, and Thorley [2006]	119%	24%	U.S.	Minvar	1968–2005
Average of 21 analyses	50%	26%	14 U.S.	12 Minvar	31 years

Notes: This exhibit contains 21 analyses that report turnover in relation to volatility reduction. The columns contain the names of authors of the study with year of publication, single-counted turnover, volatility reduction, universe, portfolio construction method, and sample period. The last row contains the total and average values of all analyses.

both volatility reduction and turnover in 13 published academic journal articles and working papers. Some of these papers show multiple results comparing two methodologies (e.g., Shah [2011]; Soe [2012]); some show results for both U.S. and global markets (e.g., Baker and Haugen [2012]; Kuo and Li [2013]). Clarke, de Silva, and Thorley [2006] explicitly showed results with and without a turnover constraint, and Chow et al. [2014] showed results for two methods and two markets. These studies are therefore included more than once in this meta-analysis. The base-case result from the empirical section of this article is included as one observation in this study.[4]

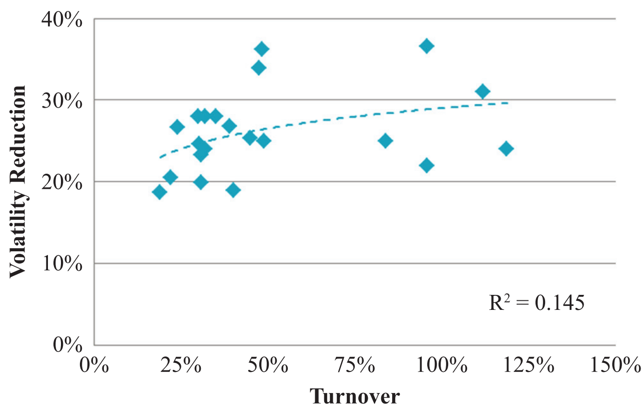
The 21 analyses report an average volatility reduction of 26%, varying between 19% and 37%. The average turnover is 50%, varying between 19% and 119%. We test whether the amount of turnover is positively related to the achieved amount of volatility reduction. We find a weak positive linear relation with a statistically insignificant coefficient (t-value, 1.39). Only 5% of the variation in volatility reduction can be explained with the amount of turnover. Graphical inspection in Exhibit 3 confirms this weak relation.

Exhibit 4 shows the regression outcomes, with both single-factor models and a multifactor model. When log turnover is used instead, we also find an insignificant positive nonlinear relation, but the relation becomes stronger (t-value, 1.80). Quick wins can be made for moderate levels of turnover, but they quickly level off to zero. We therefore continue with log turnover as the explaining variable. When we control for other variables, we find that the methodology, either ranking or mean-variance optimization, has no significant impact on risk reduction. This is in line with the findings of Soe [2012].

Low-volatility investing works both within countries and across countries (e.g., Baker and Haugen [2012]; de Boer, Campagna, and Norman [2013]). Interestingly,

EXHIBIT 3

Volatility Reduction and Turnover: Literature Meta-Study



Note: This exhibit contains 21 analyses that report turnover (x-axis) in relation to volatility reduction compared to broad market indexes (y-axis).

EXHIBIT 4

Relation between Volatility Reduction, Turnover, and Control Variables

	Constant	Log (turnover)	Method	Universe	#Years	R^2
Coefficient	**0.29****	0.04				15%
t-value	(14.73)	(1.80)				
Coefficient	**0.30****		0.03			7%
t-value	(17.56)		(1.16)			
Coefficient	**0.25****			**–0.05***		21%
t-value	(12.90)			(–2.24)		
Coefficient	**0.32****				0.00*	15%
t-value	(8.78)				(–1.81)	
Coefficient	**0.33****	0.02	0.03	–0.04	0.00	42%
t-value	(2.31)	(0.19)	(1.50)	(–1.64)	(–1.47)	

Notes: This exhibit shows the low-volatility literature meta-analysis regression results. Turnover is defined as the single-counted turnover as reported in the different studies. Log(turnover) is the natural log transformation of the turnover variable. Method is a dummy variable that takes a value of 1 for a minimum variance approach and 0 for a heuristic ranking approach. The Universe dummy variable is 1 for U.S. markets and 0 for global markets. Finally, the #Years variable measures the length of the samples. Both the coefficient and the t-value are reported. N = 21.

*** and * indicate statistical significance at the 1%, and 5% level, respectively.*

global samples show more scope for risk reduction than U.S.-only samples (*t*-value, −2.24), which is probably caused by the greater breadth and diversification potential of the global samples. The coefficient is −0.05, which means that studies using a global sample show on average 5% more volatility reduction than U.S. studies. Shorter samples also show more risk reduction, but at marginal significance. When all variables are combined, the factors lose statistical significance, with universe still being the strongest factor. Thus, international diversification helps to improve a low-volatility strategy, a finding not explicitly discussed in the literature on low-volatility investing.[5] These results also indicate that the implied empirical or methodological choices leading to higher turnover do not significantly increase the amount of risk reduction.

To summarize, the 21 studies combined show that the amount of turnover is weakly related to risk reduction but subsumed by other variables, as it does not survive the robustness tests. Based on these results, as shown in Exhibit 3, it appears that 30% turnover should be enough to achieve approximately 25% volatility reduction.

EMPIRICAL RELATION TURNOVER AND VOLATILITY REDUCTION

In addition to the literature study, we directly test the influence of turnover on the amount of risk reduction using simulations to control for all factors. We use one sample with a fixed time period and apply one specific methodology. By doing this, all other variables that influence the outcomes are held constant. We consider a global database, employ a ranking approach, and use the 3,000 most liquid stocks over the period January 1989 to December 2013. At the start of the sample, we construct a portfolio consisting of 500 stocks with the lowest historical three-year volatility. We use equal-weighted buy-and-hold positions of 20 bps, and positions are only brought back to 20 bps if they exceed 40 bps. Rebalancing takes place on a monthly basis, and stocks are sold when they fall out of the top 20% of the ranking.

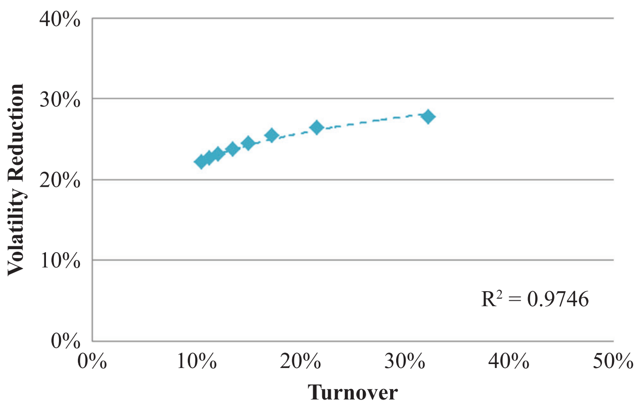
The market portfolio consists of all stocks weighted by their market capitalization. For this sample period, even the market portfolio has a turnover of 5% due to initial public offerings, delistings, and reinvested cash dividends. The base-case low-volatility portfolio has 32% turnover and risk reduction of 28%. Some of this turnover can be prevented because some stocks might drop to rank 21% and be sold and bought back when the rank is 19% again. A way to prevent this sensitivity around this threshold is to sell a stock when it drops significantly below 20%. We lower this sell threshold in steps of 10%. A lower sell threshold means holding on longer to a position in the portfolio and hence lower (single-counted) turnover. In total, we test eight low-volatility strategies with different sell-thresholds. Exhibit 5 shows the relation between risk reduction and turnover of the different simulated portfolios.

Volatility reduction varies between 22% and 28% and turnover varies between 11% and 32%. The graph looks very similar to Exhibit 3, although on a different scale, and the relation becomes near perfect because all other factors are held constant. The relation between turnover and low-volatility exposure is again concave; that is, each further increase in turnover results in smaller marginal exposure to low volatility. The first 10% turnover gives 22.5% risk reduction, and the second 10% turnover gives 3.5% additional risk reduction, whereas the next 10% gives 2.0% additional risk reduction. Clearly, each unit of additional turnover generates less additional low-volatility exposure. In this global sample, less than 20% turnover is needed to achieve 25% volatility reduction.

Exhibit 6 contains more detailed statistics on the eight different low-volatility portfolios with different turnover levels. Usually, turnover is related to alpha or

EXHIBIT 5

Volatility Reduction and Turnover: Simulations



Notes: This exhibit contains eight global low-volatility portfolios for the period 1989–2013, with turnover (x-axis) related to volatility reduction compared to the market-weighted index (y-axis).

EXHIBIT 6

Relation between Volatility Reduction and Turnover: Simulations

Panel A: Portfolio Characteristics Statistics

	Market	Port1	Port2	Port3	Port4	Port5	Port6	Port7	Port8
Gross return	6.5%	9.8%	9.6%	9.7%	9.8%	10.0%	10.1%	10.4%	10.4%
Volatility	15.7%	12.3%	12.2%	12.1%	12.0%	11.9%	11.7%	11.6%	11.4%
Alpha	–	5.3%	5.2%	5.3%	5.5%	5.8%	6.0%	6.4%	6.5%
Beta	1.00	0.68	0.68	0.67	0.66	0.65	0.63	0.62	0.60
Sell threshold	–	90	80	70	60	50	40	30	20
Number of stocks	3,000	472	445	446	447	450	452	454	457
Turnover	5%	11%	11%	12%	14%	15%	17%	22%	32%
Volatility reduction	–	22%	23%	23%	24%	24%	25%	26%	28%

Panel B: Relation Volatility Reduction and Turnover

	Constant	Turnover	Log(turnover)	R^2
Coefficient	**0.20****	**0.25****		90%
t-value	(31.97)	(7.28)		
Coefficient	**0.34****		**0.05****	97%
t-value	(53.23)		(15.16)	

Notes: This exhibit shows eight simulated low-volatility portfolios with varying degrees of turnover and the market portfolio. The 3,000 largest global stocks are used for the period January 1989–December 2013. For each portfolio, the exhibit reports average arithmetic gross average returns, volatility of monthly returns, CAPM alpha, market beta, the sell threshold, and the resulting turnover. The final row shows the amount of total volatility reduction. Panel B shows the same regression results as in Exhibit 4, but now only turnover and Log(turnover) are used as explanatory variables for the volatility reduction. N = 8 because the other variables (method, universe, and #years) are constant.

*** indicates statistical significance at the 1% level.*

outperformance (see Qian, Sorensen, and Hua [2007]). In the previous analyses, volatility reduction was used as a proxy for alpha because alpha was not consistently reported. The simulations show that alpha and volatility reduction are highly correlated (98%); the alphas range from 5.3% to 6.5%. Panel B of Exhibit 6 shows the regression analyses. Similar to the literature study, the simulations show that log turnover gives a better description than turnover. The R^2 goes up from 90% to 97% and the coefficient is 0.05, in line with the 0.04 from the literature study.

TURNOVER AND FACTOR EXPOSURE

Exposure to the low-volatility factor can be achieved at relatively low turnover and therefore at low implementation costs. For other factors, getting efficient exposure could be more challenging. Momentum is known to be a high turnover strategy, and this fast factor is not included in asset pricing models such as the Fama and French three- and five-factor models. Still, the momentum premium is statistically very significant. Furthermore, value is known to generate significant risk-adjusted returns before costs. In this section, we will consider the relation of value and momentum with turnover and integrate these factors into an enhanced low-volatility strategy.

We use the same global sample of the largest 3,000 stocks for the period January 1989 to December 2013. Value is defined as the price/earnings (P/E) ratio, and momentum is defined as the past 12-month return, with the last month skipped (12-1 price momentum). Again, we use equal-weighted buy-and-hold positions of 20 bps, and positions are only brought back to 20 bps if they exceed 40 bps. Rebalancing takes place on a monthly basis, and stocks are sold when they fall out of the top 20% of the ranking. To compare the different factor strategies, we focus on gross CAPM alpha. To change the turnover levels, we vary the sell threshold for the different strategies.

Exhibit 7 shows that the different factor strategies generate about 4% to 6% gross alpha, in line with results of previous empirical studies. In all cases, the relationship is nonlinear, and the gains in alpha are decreasing for each additional unit of turnover. The concave relation between alpha and turnover is in line with the results of Grinold and Stuckelman [1993]. Still, the amount of turnover needed to achieve these levels differs. To achieve a gross alpha of 6% for value 70%, turnover is needed; for momentum, more than 160% is needed. For all factors, a diminishing return curve means that harvesting these factors' premiums partly is more cost efficient than harvesting them fully.

A recent study by Fitzgibbons et al. [2016] showed that integrating factors is more efficient than simply mixing factors, driving up alpha and netting some of the trades. We therefore integrate value and momentum factors into an enhanced low-volatility strategy and create a multifactor low-volatility strategy, again with varying levels of turnover. For comparison, we also depict the single-factor low-volatility strategy. Again, a diminishing alpha capture curve appears, but the multifactor low-volatility strategy is more efficient compared to the single-factor low-volatility strategy. In general, this strategy generates the most alpha per unit of turnover. For example, when turnover is increased from 20% to 30%, about 2% of additional alpha can be captured with an integrated low-volatility approach. If the alpha target is fixed and turnover should be minimized, an alpha target of 4.5% requires 35% turnover in single-factor low-volatility strategy, whereas an integrated multifactor low-volatility strategy would only require 15% of turnover.

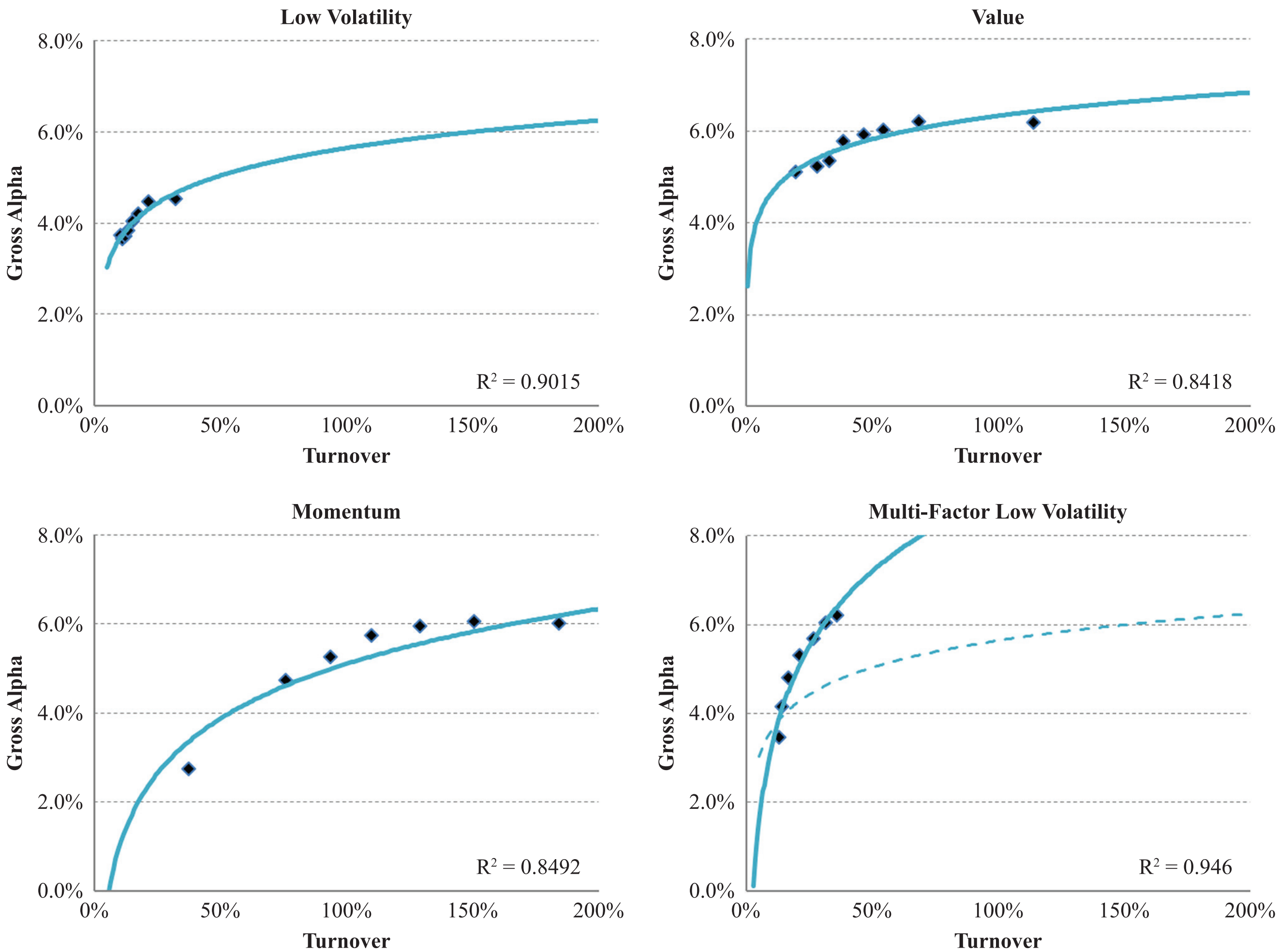
CONCLUSIONS AND IMPLICATIONS

Low-volatility stocks are larger and more liquid than the average stock and therefore are relatively cheap to trade (11 bps). In addition, only a limited amount of turnover is needed to create a low-volatility portfolio or index. From the literature and empirical tests, we find that a turnover level of 30% is enough to create an effective low-volatility strategy. Combined, the 11-bps cost per trade and 30% single-counted turnover amounts to 7 bps trading costs per year.

As an illustration, the MSCI Minimum Volatility Index (Nielsen and Aylursubramanian [2008]) has a turnover of 20%, whereas the S&P Low Vol and FTSE Minimum Variance have turnover levels of 51% and 49%, respectively.[6] Thus, these low-volatility indexes have annualized transaction costs varying between 5 and 11 bps. For 100% + high-turnover strategies, this number exceeds 20 bps. The cost of active management should be kept as low as possible, especially since the trading cost of a market-weighted index is only 1 bp.

EXHIBIT 7

Turnover Related to Value and Momentum Exposure



Notes: This exhibit shows the gross alpha of low volatility, value (P/E ratio), momentum (12-1M), and low volatility with integrated value and momentum factors vs. the amount of annualized single-counted turnover. The exhibit shows four times eight simulated factors with varying degrees of turnover. The 3,000 largest global stocks are used for the period January 1989–December 2013. The single-factor low-volatility is shown in dashed lines in the bottom-right graph for comparison purposes.

Some valid reasons to explain a higher turnover in a low-volatility strategy could be to capture additional alpha by inclusion of factors such as value and momentum or to manage concentration risks. The law of diminishing returns is also visible for other factors, such as value and momentum, and integrating them into a multifactor low-volatility strategy is an efficient way to increase alpha at low trading costs.

However, even a low-volatility manager or index designer could be tempted to trade too much, either because of overconfidence or to give a clear signal about investment skills and indicate that the active management fees are justified. This study shows that little trading is needed to implement an efficient low-volatility strategy. Investors should therefore be critical if a low-volatility index or manager has more than 30% turnover per year.

ENDNOTES

[1]At least a passive investor signals that he or she does not expect to be able to structurally outperform the market on a risk-adjusted basis after implementation costs. These include transaction costs, taxes, market impact costs, and management and broker fees.

[2]Fama and French [1992] showed that beta is not related to return, but focused on size and value instead, which do predict return. Falkenstein [1994] and Ang et al. [2006] showed that stocks with high (idiosyncratic) volatility have anomalously low returns, and Blitz and van Vliet [2007] gave international evidence. Blitz, Falkenstein, and Van Vliet [2014] provided an overview of explanations for the low-risk effect.

[3]Most of the CAPM alpha of low-volatility stocks comes from risk reduction because the outperformance is relatively small and less stable across samples. Therefore, we focus on risk reduction but also show CAPM alpha in the simulations.

[4]Coefficients and *t*-values remain about the same, and conclusions do not change if this study is excluded.

[5]Baker and Haugen [2012] visually showed the largest volatility reduction for the United States, whereas Blitz and van Vliet [2007] showed 3% more risk reduction for global markets versus the United States (33% global versus 30%, 29%, and 29% for the United States, Europe, and Japan, respectively).

[6]The MSCI minimum volatility index starts in April 2008, the S&P low-volatility indexes start in May 2011, and FTSE minimum variance indexes start in August 2012. For turnover levels, see Market watch: SPLV and VMVFX. The FTSE minimum variance indexes have an explicit turnover constraint of 60% (5% per month).

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