**Summary**

- Statistical properties of volatility make this variable forecastable to some degree. This is one of the most profound findings in financial economics with far-reaching implications for asset allocation.
- The relationship between risk (volatility) and returns is not constant. If one assumes this relationship holds through all environments, this implies that only a static asset allocation is sufficient. However, risk-return patterns can fluctuate dramatically, as such: volatility forecasting models are often used to improve upon static allocations through volatility targeting.
- There are almost infinite possibilities in terms of designing a volatility forecasting model. In our view, simpler, broader models are preferable over more complex ones which can lead to overconfident predictions.
- Return streams across asset classes differ, so the statistical properties of volatility differ as well. This means that certain asset classes are better suited than others for a volatility targeting approach.

**Introduction**

Uncertainty is inherent in every financial model. While there are many ways to quantify this uncertainty, volatility is the most widely accepted barometer for this measure. The most practical and straightforward way to measure volatility is as a statistical measure of the dispersion of market returns over a particular period. As a result, volatility has effectively become the expected price of uncertainty in markets. One of the most profound findings in financial economics is that volatility can—to a large extent—be forecasted. Predictability follows from some of the statistical properties of volatility.

The implications of volatility forecasts are evident in several ways. Volatility reaches all corners of the economy. Inaccurate volatility estimates can leave financial institutions without enough capital for operations and investment. Market volatility and its impact on public confidence can have a significant effect on the broader global economy. So, the trade-off between risk (volatility) and return is critical for all investment decisions. In addition, we believe there are relationships between volatility and asset returns that make it possible to systematically increase the risk-adjusted returns on investments (to varying degrees) by applying volatility forecasts to asset allocation decisions.
Volatility Is Not Constant

It would not make much sense to produce forecasts for a variable that does not change much—weather forecasters would not be needed if it was 80 degrees and sunny 365 days a year. In financial markets, volatility is not constant. Any strategic or tactical asset allocation decision is ultimately governed by the trade-off between risk and reward. Conventional wisdom says that greater return is compensation for greater risk.

Assuming a constant relationship between risk and reward leaves only the investor’s risk tolerance as the determining factor for a fixed asset allocation: maximize return at a particular level of risk; or minimize risk at a particular level of target return. Managing portfolios in this way assumes that a static relationship between risk and return exists in all environments and implies a fixed asset allocation.

While the relationship between risk and return appears constant over long periods, the relationship fluctuates dramatically when analyzing it over shorter time frames. For example, over a 35+ year span and using US equities and bonds data, one can see that the risk-reward profile of equities and fixed income has been quite different through the decades (Exhibit 1).

During the 1990s for example, equities added almost 10% annualized return for a roughly 10% increase in volatility. Whereas, in the first decade of the 2000s, equities actually detracted almost 8% annualized for the 13% they added in volatility.

The lack of uniformity of this risk-return profile indicates to us that opportunities existed during the period studied to add considerable value—both from return enhancement as well as risk reduction—from an asset allocation process that was more active. In our view, this argues against having a fixed asset allocation and moving towards a more active asset allocation approach. In addition, the inclusion of asset classes beyond global equities and bonds—specific factor exposures for example—would make the relationship between risk and return even more unstable and less consistent.

Forecasting Volatility Is Possible because of Key Statistical Features

Latency (or volatility clustering) is the characteristic denoting that periods of both high and low volatility tend to persist. This follows from the observation that large changes in asset returns tend to be immediately followed by large changes; the same is true for small changes. To illustrate this, we calculated the autocorrelation (i.e., the correlation of one asset’s return to itself) of the absolute value of returns for three equity indices at different time lags (Exhibit 2). Using the absolute value of the returns enabled us to focus on the change in magnitude of the return rather than the direction of the return.

The magnitude of future returns is dependent on the magnitude of past returns, with this dependence becoming weaker over time. As a result of this relationship, past volatility actually has a reasonable amount of explanatory or predictive power over future volatility. The latency of volatility makes it significantly more forecastable than asset returns.

Another notable characteristic of volatility is the negative and asymmetric relationship between returns and volatility. The calculation of volatility is indifferent to the direction of the market. However, volatility generally rises when the market falls and volatility tends to fall when the market rises (Exhibit 3, page 3). It has been theorized that this relationship is fundamental in nature and is due to what is called the leverage effect. The leverage effect posits that as stock prices fall, companies become more leveraged as the value of their debt rises relative to the value of their equity. As a result, the stock price becomes more volatile.
In addition to this negative correlation, the magnitude of the impact on volatility is significantly larger for downward market moves than it is when the market moves higher. Based on Exhibit 3, the beta of the VIX Index to the S&P 500 Index on negative return days was -3.9 with an r-squared of 0.36 whereas on positive return days the beta was -2.8 with an r-squared of 0.23. The volatility feedback effect suggests that as volatility rises and is priced into the market, there is a commensurate rise in the required return on equity as investors place a higher hurdle rate on returns to achieve their desired risk-adjusted upsides. This leads to an instant decline in stock prices as the volatility immediately reduces the risk-adjusted attractiveness of equities.

The last property we will discuss is mean reversion—volatility tends to revert to a long-term mean. Exhibit 4 shows the behavior of the VIX Index when it is in the top and bottom decile of its historical distribution as it moves back to a long-term average. One can also see that the degree and speed of mean reversion is more pronounced when the level of volatility is high compared to when it is low.

The prevailing thesis behind the mean reverting nature of volatility is related to investor psychology. In periods of low volatility, investors reduce their expectations and thresholds for volatility and as a result, become more sensitive to near-term news flow. This leads to a larger reaction function to new information and higher volatility as a result. Conversely, during periods of elevated volatility investors will increase their expectations and thresholds for volatility and become less sensitive to new information. This should result in lower levels of volatility in subsequent periods.

Models for Volatility Forecasting

The statistical properties of volatility discussed in the preceding section make volatility inherently predictable—to a sufficient degree to be useful to practitioners. There are a number of different models that can be used to forecast volatility, which incorporate different degrees of these characteristics. Moreover, models have varying degrees of success when dealing with different asset classes. In brief, some of the most well-known models are:

**HIS:** Historical models are the most straightforward, using calculations ranging from as simple as a historical mean to moving averages with different weighting schemes (to balance short- and long-term fluctuations).

**Autoregressive Models:** This includes a whole library of methods involving the statistical technique of regressions with a lag of the original data series as predictors.

**Implied Standard Deviation:** These models take information from option markets to calculate the implied volatility.

We discuss these methodologies in greater detail in our paper *Predicting Volatility.*1 The takeaway here would be that there are end-
less possibilities to design a forecasting model with inherent trade-offs as it relates to the volatility properties one wishes to capture.

In our view, a good forecasting model captures all of the key characteristics of volatility with a healthy dose of humility. After all, financial markets are not akin to physical sciences which behave according to some prescribed laws of nature. The standard statistical view assumes that there is some constant and unknown underlying structure to markets. This has led statisticians to build models that are extremely specific and complex. These excessive levels of complexity and precision belie the random nature of future asset prices and engender dangerous levels of overconfidence that these models can predict future events with a high degree of certainty.

Consequently, simpler, broader models—which are able to capture the more general features of volatility and financial returns—will likely provide more robust and transparent predictive abilities over longer, out-of-sample time horizons.

### Applications of Volatility Forecasting: Volatility Targeting

We have shown that the risk–reward trade-off is not constant—particularly over shorter time frames. This means that a static asset allocation can be ineffective. With this in mind, volatility forecasting models are often used to improve upon a fixed asset allocation framework by allocating to a fixed level of volatility instead. This is known as volatility targeting and enables a portfolio to potentially take advantage of volatility forecasts and make allocation decisions.

The return streams of different asset classes display differing degrees of these characteristics (Exhibit 5). The ones which exhibit more of the aforementioned characteristics are better candidates for volatility targeting.

To illustrate the success of volatility targeting on different asset classes we examined each asset class individually and then in combination with cash picking a volatility target. The measure of success is the Sharpe ratio, a measure of risk–adjusted return. The more an asset class favors by volatility forecasting characteristics, the more risk targeting improves the results (Exhibit 6).

Since US Treasuries exhibit none of the volatility forecasting features, the impact from volatility targeting on the risk-adjusted return is minimal. Equities, on the other hand, strongly exhibit all of the characteristics. Hence, a volatility targeting approach can have a significant positive effect on the resulting Sharpe ratio. The impact on commodities and high yield fixed income is minimal; although the latter has many characteristics that would favor volatility targeting, it does not have a strong negative correlation between volatility and returns.

Because a volatility targeting strategy involves being under-exposed to an asset class when its volatility is high and completely exposed when its volatility is low, a strong negative relationship between volatility and returns is a pre-requisite for volatility targeting. High yield fixed income markets have historically experienced some of their strongest returns in periods when volatility was very high—in the 15%–20% range.

### Exhibit 5: Volatility Properties Differ by Asset Class

<table>
<thead>
<tr>
<th>Volatility Clustering Effect</th>
<th>DM Equities</th>
<th>US Equities</th>
<th>EM Equities</th>
<th>Commodities</th>
<th>High Yield Fixed Income</th>
<th>US Treasuries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clustering</td>
<td>Strong</td>
<td>Strong</td>
<td>Strong</td>
<td>Strong</td>
<td>Weak</td>
<td>Weak</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Negative Correlation between Volatility and Returns</th>
<th>DM Equities</th>
<th>US Equities</th>
<th>EM Equities</th>
<th>Commodities</th>
<th>High Yield Fixed Income</th>
<th>US Treasuries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correlation</td>
<td>Strong</td>
<td>Strong</td>
<td>Strong</td>
<td>Weak</td>
<td>Weak</td>
<td>Weak</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fat Tails (Non-Normality)</th>
<th>DM Equities</th>
<th>US Equities</th>
<th>EM Equities</th>
<th>Commodities</th>
<th>High Yield Fixed Income</th>
<th>US Treasuries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fat Tails</td>
<td>Strong</td>
<td>Strong</td>
<td>Strong</td>
<td>Weak</td>
<td>Strong</td>
<td>Weak</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Leverage Effect</th>
<th>DM Equities</th>
<th>US Equities</th>
<th>EM Equities</th>
<th>Commodities</th>
<th>High Yield Fixed Income</th>
<th>US Treasuries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leverage</td>
<td>Strong</td>
<td>Strong</td>
<td>Strong</td>
<td>Weak</td>
<td>Strong</td>
<td>Weak</td>
</tr>
</tbody>
</table>

For the period May 2002 to May 2016
DM Equities = MSCI World Index; US Equities = S&P 500 Index; EM Equities = MSCI Emerging Markets Index; Commodities = Bloomberg Commodity Index; High Yield Fixed Income = Barclays Global High Yield Index; US Treasuries = Barclays US Treasury Index.
Source: Bloomberg

### Exhibit 6: Results by Asset Class

Risk-Adjusted Results Comparison, 2002–2016

<table>
<thead>
<tr>
<th>Sharpe Ratio</th>
<th>Developed Markets Equities</th>
<th>US Equities</th>
<th>Emerging Markets Equities</th>
<th>Commodities</th>
<th>High Yield Fixed Income</th>
<th>US Treasuries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stand-Alone Sharpe Ratio</td>
<td>Strong</td>
<td>Strong</td>
<td>Strong</td>
<td>Weak</td>
<td>Strong</td>
<td>Weak</td>
</tr>
<tr>
<td>Volatility-Targeted Sharpe Ratio</td>
<td>Strong</td>
<td>Strong</td>
<td>Strong</td>
<td>Weak</td>
<td>Strong</td>
<td>Weak</td>
</tr>
</tbody>
</table>

For the period May 2002 to May 2016
The performance quoted represents past performance. Past performance is not a guarantee of future results. This is not intended to represent any product or strategy managed by Lazard. It is not possible to invest directly in an index.
Source: Bloomberg
Conclusion

Uncertainty is at the center of all financial models and volatility is the practical measure of that uncertainty. We should note that volatility and its relationship with returns is not constant, which makes volatility forecasting a worthwhile effort. Fortunately, several characteristics of financial return series make volatility inherently predictable.

As a result, we believe forecasting volatility has important implications for all investors that are focused on risk-adjusted returns. Forecasting methodologies are quite diverse and vary in their degrees of complexity and accuracy. They incorporate varying degrees of these common characteristics of financial return series, with varying degrees of specification to a particular data sample.

Volatility targeting is one method of utilizing a forecasting model to leverage the dynamic relationship between returns and risk in an asset allocation framework. Different asset classes possess differing degrees of these statistical characteristics. This is the key driver of the impact that volatility targeting can have on risk-adjusted returns. Equities in general have the best combination of these volatility properties which leads to favorable risk-adjusted results from a volatility targeting approach.
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Notes
1 Paper available at: http://www.lazardnet.com/docs/sp0/22430/PredictingVolatility_LazardResearch.pdf

Equity securities will fluctuate in price; the value of your investment will thus fluctuate, and this may result in a loss. Securities in certain non-domestic countries may be less liquid, more volatile, and less subject to government supervision than in one’s home market. The values of these securities may be affected by changes in currency rates, application of a country’s specific tax laws, changes in government administration, and economic and monetary policy. Emerging markets securities carry special risks, such as less developed or less efficient trading markets, a lack of company information, and differing auditing and legal standards. The securities markets of emerging markets countries can be extremely volatile; performance can also be influenced by political, social, and economic factors affecting companies in these countries.

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