Agenda

Introduction: What Is "Managed Volatility"?

Historical Evidence: Risk and Return Around the World

Behavioral Explanation: Will the Low-Risk Anomaly Persist? Answers from Psychology

Execution: Capturing the Mispricing

Application: Asset Allocation

Conclusions
What is Managed Volatility?
Introduction

Finance **theory** says that investors who buy higher risk stocks will be compensated with higher returns

The empirical **reality** is that a relationship between measures of risk and return is hard to find

Simple conclusion: Combine lower risk stocks into a **managed volatility** portfolio
Finance theory says the market portfolio should lie on the efficient frontier and outperform the minimum variance portfolio.
The empirical reality is that minimum variance portfolios have outperformed the market, but with less risk.

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U.S. Evidence: Lower Risk Stocks Have Earned High Average Returns (1968-2010)

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Historical Evidence

The Low Volatility Anomaly is Apparent Around the World (January 1998-September 2011)

<table>
<thead>
<tr>
<th>Region</th>
<th>Simulated Minimum Variance Portfolios</th>
<th>Benchmarks*</th>
</tr>
</thead>
<tbody>
<tr>
<td>GLOBAL</td>
<td>5%</td>
<td>7%</td>
</tr>
<tr>
<td>EAFE</td>
<td>7%</td>
<td>13%</td>
</tr>
<tr>
<td>EUROPE</td>
<td>7%</td>
<td>4%</td>
</tr>
<tr>
<td>EM**</td>
<td>13%</td>
<td>10%</td>
</tr>
<tr>
<td>US</td>
<td>5%</td>
<td>5%</td>
</tr>
<tr>
<td>CANADA</td>
<td>7%</td>
<td>7%</td>
</tr>
<tr>
<td>JAPAN</td>
<td>4%</td>
<td>10%</td>
</tr>
</tbody>
</table>

Source: Acadian Asset Management LLC, Acadian Asset Management LLC, *MSCI World, MSCI Europe, MSCI EAFE, MSCI US, MSCI Canada and MSCI JP. ** EM simulation begins January 2004. For illustrative purposes only. This is meant to be an example and is not intended to represent investment returns generated by an actual portfolio. The simulated results do not represent actual trading or an actual account, but were achieved by means of retroactive application of a model designed with the benefit of hindsight for the period specified above. Results are gross and would be reduced by advisory fees. Results do not reflect transaction costs, other implementation costs and do not reflect advisory fees or their potential impact. Reference to the benchmark is for comparative purposes only. Every investment program has the opportunity for loss as well as profit. Index Source: MSCI Copyright MSCI 2012. All Rights Reserved. Unpublished. PROPRIETARY TO MSCI.

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Historical Evidence

Performance Under Various Market Conditions

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Historical Evidence

The Cumulative Difference Over Many Years is Significant

A minimum variance portfolio compounds to $107, versus $50 for the S&P 500 from January 1968 through December 2010

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Observations

- Low-risk stocks have realized high average returns
- Low-variance returns compound to higher cumulative returns
- High Sharpe Ratio for simulated managed volatility portfolios (not reflected in measures like Information Ratio)
Behavioral Explanation

Why a Low-Volatility Anomaly?

Behavioral explanations have two ingredients
1. Investor psychology
2. Limits to arbitrage

1. Psychology: Investors are attracted to risky stocks
   • Overconfidence
   • Representativeness
   • Lottery preferences

2. Limits to arbitrage: Institutional investors are constrained
   • Handcuffed to index benchmarks
   • Buying a low-beta stock creates tracking-error risk
OVERCONFIDENCE

In one psychological study, young adults were asked to rank themselves.

When asked to rate “the ability to get along with others”

- 100% put themselves in the top half of the population
- 60% rated themselves in the top 10% of the population
- 25% humbly thought they were in the top 1% of the population

Behavioral Explanation

OVERCONFIDENCE

In one psychological study, young adults were asked to rank themselves.

When asked about leadership

- 70% rated themselves in the top quartile in leadership
- Only 2% felt they were below average

OVERCONFIDENCE

In one psychological study, young adults were asked to rank themselves.

Regarding athletic ability

- 60% said they were in the top quartile of athletic ability
- Only 6% said they were below average

# Behavioral Explanation

## OVERCONFIDENCE

<table>
<thead>
<tr>
<th>General knowledge question</th>
<th>Answers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Three fourths of the world’s cacao comes from where?</td>
<td>Africa or South America</td>
</tr>
<tr>
<td>2. Which causes more deaths in the U.S.?</td>
<td>Appendicitis or pregnancy &amp; childbirth</td>
</tr>
<tr>
<td>3. When was the first air raid?</td>
<td>1849 or 1937</td>
</tr>
<tr>
<td>4. Adonis was the god of?</td>
<td>Love or vegetation</td>
</tr>
<tr>
<td>5. Khalil Gibran was most inspired by which religion?</td>
<td>Buddhist or Christian</td>
</tr>
<tr>
<td>6. Dido and Aeneas is an opera written by whom?</td>
<td>Berlioz or Purcell</td>
</tr>
<tr>
<td>7. Potatoes are native to where?</td>
<td>Ireland or Peru</td>
</tr>
</tbody>
</table>

## Behavioral Explanation

### OVERCONFIDENCE

<table>
<thead>
<tr>
<th>Answers</th>
<th>% Correct</th>
<th>Number of cases of extreme overconfidence*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Africa</td>
<td>4.8%</td>
<td>15</td>
</tr>
<tr>
<td>Appendicitis</td>
<td>19%</td>
<td>13</td>
</tr>
<tr>
<td>1849</td>
<td>26.2%</td>
<td>10</td>
</tr>
<tr>
<td>Vegetation</td>
<td>31%</td>
<td>10</td>
</tr>
<tr>
<td>Christian</td>
<td>33.3%</td>
<td>7</td>
</tr>
<tr>
<td>Purcell</td>
<td>33.3%</td>
<td>2</td>
</tr>
<tr>
<td>Peru</td>
<td>35.7%</td>
<td>10</td>
</tr>
</tbody>
</table>

Representativeness

Linda is 31 years old, single, outspoken and very bright. She majored in philosophy. As a student she was deeply concerned with issues of discrimination and social justice, and also participated in antinuclear demonstrations.

Which of the two alternatives is more probable?

A) Linda is a bank teller.
B) Linda is a bank teller and is active in the feminist movement.

List 3 great stock investments over the last 20 years

List 3 horrible stock investments over the last 20 years
## Behavioral Explanation

### REPRESENTATIVENESS

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Behavioral Explanation

REPRESENTATIVENESS

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Behavioral Explanation

STOCKS AS LOTTERIES
Behavioral Explanation

STOCKS AS LOTTERIES

Test #1

Choose one of the following:

A ) ($6,000, p=0.45)
B ) ($3,000, p=0.90)

Behavioral Explanation

STOCKS AS LOTTERIES

Test #2

Choose one of the following:

C ) ($6,000, p=0.001)
D ) ($3,000, p=0.002)

Behavioral Explanation

STOCKS AS LOTTERIES

Test #1

A) ($6,000, p=0.45)
N=66  14%

B) ($3,000, p=0.90)
  86%

Test #2

C) ($6,000, .001)
N=66  73%

D) ($3,000 .002)
  27%

Behavioral Explanation

STOCKS AS LOTTERIES

For unlikely events, people overweight the probability. Thus, people are willing to overpay for a small chance to get rich. Lottery tickets have negative expected value.

Behavioral Explanation

STOCKS AS LOTTERIES

Do people treat stocks like lottery tickets? In Taiwan they seem to:

Taiwan lottery is extremely popular
- 8% of government budget comes from lottery
- Absenteeism on lottery days (“paralyzed”)

Taiwan stocks and lotteries are substitutes
- Big lottery jackpots => substantially lower trading volume
- Effect is strongest in stocks with lottery features such as high return volatility and skewness.

Treating stocks as lotteries creates mispricings
- Individual investors lose 2.2% of GDP/year.
- Individuals lose, institutions win.


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Behavioral Explanation

STOCKS AS LOTTERIES

More generally, if people view some stocks as lottery tickets, then those stocks will have negative expected value.

People own small number of stocks – 80% of individual’s portfolios have fewer than 5 stocks.

Investors buy stocks that look like lottery tickets (positively skewed)


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OVERCONFIDENCE

- Investors are overconfident in their forecasts
- More volatile stocks generate more disagreement, and more extreme optimists... optimists drive prices with short sales constraints

REPRESENTATIVENESS*

- Investors emphasize salient stories, like Microsoft, Whole Foods, Genzyme as representative of risky stocks, underweighting the high a priori likelihood of failure for similar firms

STOCKS AS LOTTERIES

- Volatile stocks, given limited liability, are positively skewed
- Investors accept a high probability of loss, low probability of jackpot

*Not a recommendation to buy or sell a specific security.
Behavioral Explanation

Why doesn’t smart money capitalize?

- Mandates often focus on Information Ratio
- An explicit or implicit Information Ratio mandate handcuffs the institutional investment manager...

See Baker, Bradley, and Wurgler (2011) for details

In a nutshell: to a cap-weighted benchmark-sensitive investor, low volatility stocks are risky
Behavioral Explanation

Benchmarks eliminate the link between risk and return

- Consider overweighting a high alpha, low beta stock
- An easy decision with a maximum Sharpe Ratio mandate
- But it may not be a good bet from the perspective of maximizing Information Ratio

For illustrative purposes only
Behavioral Explanation

Will the low risk anomaly persist?
Yes, as long as:

• Behavioral foundations remain intact

• Institutional managers remain benchmark constrained
Execution

The Mechanics Of Managed Volatility Portfolios

- Incorporate return forecasts
- Carefully manage risk
- Consider transaction costs and other dimensions in portfolio construction
Understanding Managed Volatility: Industry Exposures (1999-2010)

Source: Acadian Asset Management LLC. AAM Universe of Securities For illustrative purposes only. This is meant to be an example of industry exposures and is not intended to represent exposures generated by an actual portfolio. The simulated results do not represent actual trading or an actual account, but were achieved by means of retroactive application of a model designed with the benefit of hindsight for the period specified above. Results reflect transaction costs and other implementation costs. Results do not reflect advisory fees or their potential impact. Every investment program has the opportunity for loss as well as profit.
Execution

Understanding Managed Volatility: Region and Country Exposures (1999-2010)

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Observations

A Sophisticated Portfolio Construction Process

- Incorporating security correlations may help reduce risk below simple volatility sorted portfolios

Alphas

- Holding higher expected return stocks may increase returns without increasing risk

Careful Active Management May Add Value to Minimum Variance Portfolios
Managed Volatility Lies Between Stocks and Bonds

An equity strategy that has
- Returns similar to the aggregate market, with
  - Lower risk
  - Lower correlation with benchmark-tied strategies

...Can be used in many ways. For example, as a potential
- Risk reducer
- Return enhancer
- Liquidity buffer
- Hedge fund alternative
- Equity diversifier
- Target-date fund enhancer
Managed Volatility Lies Between Stocks and Bonds

- To reduce potential risk level, replace a portion of the stock allocation with a managed volatility portfolio
- To increase potential returns, replace a portion of both stock and bond allocations with a managed volatility portfolio

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An Example of Asset Allocation Across U.S. Stocks, Bonds, and Cash

### Historical Risk, Return, And Correlation 1968-2010

<table>
<thead>
<tr>
<th></th>
<th>Annualized Returns (%)</th>
<th>Standard Deviation (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stocks</td>
<td>9.5%</td>
<td>15.6%</td>
</tr>
<tr>
<td>Bonds</td>
<td>8.1%</td>
<td>10.2%</td>
</tr>
<tr>
<td>Cash</td>
<td>5.6%</td>
<td>0.8%</td>
</tr>
<tr>
<td>Minimum Variance</td>
<td>11.5%</td>
<td>11.1%</td>
</tr>
</tbody>
</table>

### Minimum Variance

- Stocks: 1.00
- Bonds: 0.19
- Cash: -0.01
- Minimum Variance: 0.76

### Risk-Reducing Asset Allocation

<table>
<thead>
<tr>
<th></th>
<th>0%</th>
<th>10%</th>
<th>20%</th>
<th>30%</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Stocks</td>
<td>50%</td>
<td>40%</td>
<td>30%</td>
<td>20%</td>
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<tr>
<td>Bonds</td>
<td>40%</td>
<td>40%</td>
<td>40%</td>
<td>40%</td>
<td>40%</td>
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<tr>
<td>Cash</td>
<td>10%</td>
<td>10%</td>
<td>10%</td>
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<td>10%</td>
</tr>
<tr>
<td>Minimum Variance</td>
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<td>10%</td>
<td>20%</td>
<td>30%</td>
<td>40%</td>
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<tr>
<td>Annualized Return</td>
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<td>8.8%</td>
<td>9.0%</td>
<td>9.2%</td>
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<td>Annualized Risk</td>
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<td>7.9%</td>
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<tr>
<td>Sharpe Ratio</td>
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<td>0.35</td>
<td>0.39</td>
<td>0.43</td>
<td>0.47</td>
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### Risk-Maintaining Asset Allocation

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<th></th>
<th>0%</th>
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<th>20%</th>
<th>30%</th>
<th>40%</th>
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</thead>
<tbody>
<tr>
<td>Stocks</td>
<td>50%</td>
<td>46%</td>
<td>42%</td>
<td>37%</td>
<td>31%</td>
</tr>
<tr>
<td>Bonds</td>
<td>40%</td>
<td>34%</td>
<td>28%</td>
<td>23%</td>
<td>19%</td>
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<tr>
<td>Cash</td>
<td>10%</td>
<td>10%</td>
<td>10%</td>
<td>10%</td>
<td>10%</td>
</tr>
<tr>
<td>Minimum Variance</td>
<td>0%</td>
<td>10%</td>
<td>20%</td>
<td>30%</td>
<td>40%</td>
</tr>
<tr>
<td>Annualized Return</td>
<td>8.6%</td>
<td>8.9%</td>
<td>9.1%</td>
<td>9.4%</td>
<td>9.7%</td>
</tr>
<tr>
<td>Annualized Risk</td>
<td>9.4%</td>
<td>9.4%</td>
<td>9.4%</td>
<td>9.4%</td>
<td>9.4%</td>
</tr>
<tr>
<td>Sharpe Ratio</td>
<td>0.31</td>
<td>0.34</td>
<td>0.37</td>
<td>0.40</td>
<td>0.43</td>
</tr>
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</table>

In the above tables, stocks refer to the S&P 500 Index and bonds refer to the Barclays U.S. Government Aggregate Index. Source: Acadian Asset Management LLC, AAM US, CRSP, CRSP®, Center for Research in Security Prices, Graduate School of Business, The University of Chicago. Used with permission. All rights reserved. crsp.uchicago.edu, S&P Universe of Securities. For illustrative purposes only. This is meant to be an example of asset allocation and is not intended to represent investment returns generated by an actual portfolio. The simulated results do not represent actual trading or an actual account, but were achieved by means of retroactive application of a model designed with the benefit of hindsight for the period specified above. Results are gross would be reduced by advisory fees. Results reflect transaction costs and other implementation costs. Reference to the benchmark is for comparative purposes only. Every investment program has the opportunity for loss as well as profit. Index Source: Copyright © 2012, Standard & Poor’s Financial Services LLC. All rights reserved.
Observations

- The risk of managed volatility is between stocks and bonds
- Risk reducing versus risk maintaining approach
Low risk stocks have earned higher returns
  • Around the world, over long time periods

This anomaly is likely to persist
  • Investor preferences and expectations
  • Standard benchmarks limit arbitrage

Managed volatility portfolios seek to exploit the low-risk anomaly
  • Advanced portfolio construction process
  • Potential for market returns with 20-30% lower risk

Managed volatility fits naturally in asset allocation between equity and fixed income
Conclusion

Use of Hypothetical Performance Disclosure

Hypothetical performance results have many inherent limitations, some of which are described below. No representation is being made that any account will or is likely to achieve profits or losses similar to those shown. In fact, there are frequently sharp differences between hypothetical performance results and the actual performance results subsequently achieved by any particular trading program.

One of the limitations of hypothetical performance results is that they are generally prepared with the benefit of hindsight. In addition, hypothetical trading does not involve financial risk, and no hypothetical trading record can completely account for the impact of financial risk in actual trading. For example, the ability to withstand losses or to adhere to a particular trading program in spite of trading losses are material points which can also adversely affect actual trading results. There are numerous other factors related to the markets in general or to the implementation of any specific trading program which cannot be fully accounted for in the preparation of hypothetical performance results and all of which can adversely affect actual trading results.
Conclusion

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