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WHO WE ARE

ReSolve Asset Management is a quantitative, systematic investment firm that relies on in-depth, academically backed and empirically proven practices for strategy construction. Our approach is designed to produce innovative strategies that perform in live trading and range from global tactical to cutting edge alpha.

Our solutions are based on evidence not theory

EXPERIENCED LEADERSHIP TEAM

ReSolve’s leadership team has over 50 years combined experience in asset management for private clients and small institutions. The team’s approach to investing blends the rigour of academic research methods with the hard-nosed practicality required to implement functional investment strategies in risky markets. Passionate educators, Adam, Mike and Rodrigo have authored the book *Adaptive Asset Allocation - Dynamic Global Portfolios Designed to Profit in Good Time and Bad*, as well as several research papers that rank in the top 1% of most downloaded research on the academically renowned SSRN network. The team is also responsible for the popular GestaltU.com investment blog.

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Objective

ReSolve Global Adaptive Asset Allocation strategies (AAA) harness two of the most powerful smart beta factors, momentum and low beta, to regularly calibrate a diversified portfolio of global asset classes in response to material changes in world markets. AAA mandates are built to target a specified level of portfolio risk in order to accommodate investors’ diverse risk preferences. To manage portfolios to different risk targets, portfolio holdings will often vary across mandates; for example, lower risk mandates would be expected to hold a larger proportion in bonds on average, while more aggressive mandates would exhibit an equity bias and modest use of leverage when appropriate. Where necessary, overall portfolio exposure will expand and contract in response to observed changes in portfolio risk.

By combining the strong historical return character of the momentum factor with global diversification and risk management, AAA portfolios aim to deliver steady growth with specific risk targets and controlled maximum losses, regardless of economic or market environment.

Background

A brief history of modern portfolio theory

For most of us, the ultimate goal of investing is to achieve a target wealth (or portfolio income) with the lowest possible risk. The vehicle we use to realize this ambition is our investment portfolio. But what mix of investments is most likely to help us realize our ambitions?

Modern Portfolio Theory (MPT) is a Nobel Prize winning mathematical model that relates the expected return and risk of a portfolio to the returns and risks of its individual constituents, after accounting for the effects of diversification. If thoughtfully applied, it can be a valuable tool in the construction of a reasonably efficient portfolio to meet the needs of most investors.

It is useful to think of MPT as a machine. When you feed the machine information about the assets being considered for a portfolio, it produces new information about portfolios constructed from those assets. Specifically, MPT takes in information about the expected return, risk, and correlation for each asset under consideration for investment. In return, it produces information about all of the portfolios that maximize portfolio expected returns at each level of portfolio risk. Portfolios which maximize expected return at each level of risk are said to be ‘efficient’ portfolios, and the continuum of all portfolios which maximize return at each level of risk is called the ‘efficient frontier’. Figure 1. provides an illustration of the MPT machine and the efficient frontier.
Unfortunately, the MPT machine is only as useful as the information it receives about the assets under consideration. In fact, the nature of the model is such that small errors contained in the information that is fed into the model are amplified within the machine. For this reason, Dr. Richard Michaud, a pioneer in portfolio optimization describes MPT as, “A molehill of garbage in, a mountain of garbage out.”

The fact is, MPT has earned a bad reputation in many investment circles because it is so sensitive to user error. But this is not the fault of MPT – after all, MPT is just math. Rather, and perhaps unsurprisingly, MPT doesn’t work very well if you don’t feed it useful information. It’s a simple case of GIGO: Garbage In → Garbage Out.

The problem is that traditional approaches to asset allocation assume that assets will always act in accordance with their long-term average behavior. That is, that markets will deliver steady returns with stable risk, and exhibit consistent relationships with one another. However, a simple observation of asset class behavior through history quickly dispels this illusion. Figure 2 demonstrates the wild swings in returns, volatility, and correlation experienced by stocks and bonds over the past century.

**Figure 2. Ranges of returns, volatility and correlation for U.S. stocks and Treasury bonds.**

Source: ReSolve Asset Management. Data from CSI Data. Past Performance is not necessarily indicative of future results.
Introducing Adaptive Asset Allocation

One of the most important axioms in finance is that the best estimate of tomorrow’s value is today’s value. This prompts the question: if we can measure the value of portfolio estimates today (or over the recent past), and they are better estimates over the near-term than long-term average values, why not construct portfolios based on this current information? That is, why wouldn’t we choose for our portfolios to adapt over time based on observed current conditions?

It is worth noting that the overall objective of asset allocation is to deliver the highest returns per unit of risk, where risk is usually defined in terms of volatility. The ratio of a portfolio’s return to its volatility is called the Sharpe ratio, and this is one of the most fundamental measures of performance in finance.

Putting together the building blocks

In this section, we will walk through a case study of asset allocation methods to demonstrate the advantage that accrues from using recent observed portfolio parameters to regularly adapt portfolios to changing market conditions. Please note that this analysis is for illustration only, and does not reflect the actual methodology for any ReSolve solutions.

Our study will consider a portfolio consisting of 10 major global asset classes. Where possible, we draw total return data from Exchange Traded Funds (ETFs). However, prior to ETF inception we use the following sources in order of preference to extend the dataset back to 1995: proxy ETFs in the same asset class; passive no-load mutual funds; underlying indexes; and no-load active mutual funds. The exercise is meant to be illustrative, but we have done our best to use investible assets where possible.

- U.S. stocks
- European stocks
- Japanese stocks
- Emerging market stocks
- U.S. REITs
- International REITs
- U.S. 7-10 year Treasuries
- U.S. 20+ year Treasuries
- Commodities
- Gold

First, consider a naïve investor, with no knowledge of expected relative asset class performance, risk, or correlation information. A rational investor, lacking any information to bias his choices, may logically choose to simply hold each asset in the portfolio in equal weight. Going back to 1995, holding our basket of assets in equal weight, and rebalancing monthly, an investor would have experienced the following portfolio growth profile [Exhibit 1]. Note that all risk statistics assume end-of-month values.

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1 Technically, the Sharpe ratio measures the ratio of excess returns to volatility, where returns are measured in excess of the risk free rate. However, for simplicity all Sharpe ratios in this brochure are simple ratios of returns / volatility.
Putting together the building blocks


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<td>Positive Rolling Years</td>
<td>77.6%</td>
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<tr>
<td>Growth Over $1</td>
<td>$4.62</td>
</tr>
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</table>

Source: CSI Data, ReSolve Asset Management. Simulated performance.*

Before we move on, let’s review how to interpret the chart and data table from Exhibit 1. The chart shows the growth of $1 invested in the strategy on January 1st, 1995 through December 2015, where it has grown to $4.62. It offers a visual representation of the growth in the portfolio through time, which is summarized in the table below the chart. For example, the compound returns, which took the portfolio from $1 twenty years ago to $4.62 today, equates to growth of 7.6% per year.

The chart is also informative because you can see the path the portfolio took to get from $1 to $4.62, which included a big dip about 2/3 of the way along in 2008. From visual inspection, you can see that the portfolio lost about 40% of its value in the 2008-2009 bear market. This is confirmed by glancing at the Max Drawdown row in the table, where we learn that in fact the maximum drawdown was a drop of 37.2% from peak to trough.

* Past results are not necessarily indicative of future results. It is expected that the simulated performance presented in this document will vary as a result of both improvements to our simulation methodology and the underlying data sets used for simulation. Please review the disclosures at the end for more information.
Thought

“[A]n asset’s ability to diversify a portfolio is a function of its volatility, and its correlation with the portfolio. If assets are held in equal weight, high volatility assets like stocks will overwhelm the diversifying properties of lower volatility assets like bonds and inflation protected securities.”

Adam Butler

Please also note the portfolio volatility and simple Sharpe ratio. The volatility of the portfolio over the entire period averaged 11.4%, which means the simple Sharpe ratio was 7.6% / 11.2% = 0.7. Lastly, we provide the percentage of all 12-month periods where an investor would have experienced positive absolute returns. In this case, an investor would have seen positive performance over 77.6% of rolling years.

Now let’s assume that an investor believes he has some information only about each asset’s risk, but no knowledge of returns or correlations. This is useful because in the equally weighted case above, the portfolio’s risk is overwhelmingly determined by higher volatility assets in the portfolio, like stocks, RETIs and commodities. Low risk bonds have virtually no opportunity to deliver their diversification properties because they are overwhelmed by equity risk. We learned from Exhibit 1 how that concentrated risk can manifest in terms of investor experience – recall that 40% drop in 2008.

If our goal is to ensure the portfolio is truly more balanced, so that each asset class has an equal opportunity to contribute both returns and diversification, perhaps lower volatility assets should have greater weight in the portfolio, and higher volatility assets should have lower weight. We express this logic in Exhibit 2, where we observe the actual volatility of each asset in the portfolio over the past 60 days, and adjust the allocations at each monthly rebalance period so that each asset contributes the same daily volatility to the portfolio.

source: CSI Data, ReSolve Asset Management. Simulated Performance.*
**Quote**

“The source of the long-term positive performance is better diversification, in particular making assets like bonds and commodities count as much, but not more than, equities.”

Cliff Asness

<table>
<thead>
<tr>
<th>Jan 1995-Dec 2015</th>
<th>Equal Weight</th>
<th>Risk Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compound Return</td>
<td>7.6%</td>
<td>8.0%</td>
</tr>
<tr>
<td>Volatility</td>
<td>11.4%</td>
<td>8.7%</td>
</tr>
<tr>
<td>Sharpe Ratio</td>
<td>0.7</td>
<td>0.9</td>
</tr>
<tr>
<td>Maximum Drawdown</td>
<td>-37.2%</td>
<td>-22.5%</td>
</tr>
<tr>
<td>Positive Rolling Years</td>
<td>77.6%</td>
<td>83.8%</td>
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<tr>
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<td>$4.62</td>
<td>$4.98</td>
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</tbody>
</table>

By simply sizing each asset in the portfolio so that it is expected to contribute the same amount of risk, the return delivered per unit of risk (Sharpe ratio) increases from 0.7 to 0.9 relative to the equal-weight portfolio. Of course, this improvement is mostly a function of less overall portfolio risk, as the returns are very similar. Not surprisingly, less volatility also means more consistent returns (84% positive years) and lower maximum drawdowns (-23% vs. -37% for equal weight). And we get all of this benefit simply from preventing the lunatics (stocks) from running the asylum (portfolio).

Exhibit 2 isolated the effect of risk management on portfolio outcomes. In other words, we observed the results from playing a little portfolio defense. Now let’s put our offense on the field by introducing information about expected returns. To generate our return estimates, we will draw on one of the most widely validated properties of markets: momentum. The momentum effect has been observed across most global markets*, and describes the phenomenon where assets that have performed well recently tend to continue to perform well over the next few weeks.

To harness the momentum effect, each month we will sort assets by their returns over the past six months. Those assets that have delivered better than average returns will be held in the portfolio for the next month. Assets are then re-sorted and portfolios are reformed with the top assets each month through time. In addition, we will hold these top assets so that they contribute equal portfolio volatility using the same technique we used for Exhibit 2. The results are in Exhibit 3.

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* Alex Greyserman & Kathryn Kaminski: “Trend Following with Managed Futures: The Search for Crisis Alpha”

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It’s clear that adding a momentum tilt to portfolio holdings substantially improves risk-adjusted performance, with a major boost to returns and a large reduction in drawdowns. The Sharpe ratio jumps from 0.9 for risk weighting on its own, to 1.3 with risk-weighted momentum. Returns rise to 14.1% per year, with a manageable increase in volatility. In fact, since drawdowns were smaller, we can deduce that most of the extra volatility was observed on the upside.

So far, we have observed a step-by-step improvement as we introduced methods to better distribute portfolio risk and harness the momentum factor. Our one missing ingredient is diversification. We have not taken any steps to account for different asset correlations as we construct portfolios.

Remember that diversification has the effect of lowering the risk of a portfolio because some assets in the portfolio are ‘zigging’ while others are ‘zagging’. Importantly, two assets can have a low correlation, and therefore effectively diversify each other, even while both assets are moving in the same average direction. That is, two assets can both be rising in price on average, but be negatively correlated.
“Diversification has the effect of lowering the risk of a portfolio because some assets in the portfolio are ‘zigging’ while others are ‘zagging’. Importantly, two assets can have a low correlation, and therefore effectively diversify each other, even while both assets are moving in the same average direction.”

To understand why, consider Figure 3, which shows two securities with positive return trajectories, but that move in opposite directions at each period. As a result, the two securities have perfect negative correlation, while the portfolio of the two securities moves in a straight line, up and to the right. In this way, two risky assets with equal volatility and perfect negative correlation can be combined to form a portfolio with zero volatility and a positive return.

![Figure 3. Negatively correlated assets with positive returns.](image)

Source: ReSolve Asset Management. For illustrative purposes only.

Of course, in practice there are almost never two assets with perfect negative correlation, but MPT provides a framework to assemble assets with low correlation in order to maximize portfolio returns while minimizing volatility. In fact, we are able to find the portfolio with the highest expected returns at any specified level of risk. Since we are using the momentum factor to find assets with the highest expected returns, our process will find portfolios with the highest momentum achievable at our target level of volatility.

In Exhibit 4., we bring all of the concepts discussed so far together in order generate portfolios with strong momentum, and which account for asset class risks and correlations. Specifically, portfolios are reformed each month from assets in the top half by momentum across multiple historical periods, such that they produce the maximum momentum achievable with 8% portfolio volatility.
Exhibit 4: 10 Assets, Top Half by 1, 3, 6, 9 and 12 Month Momentum, Mean-Variance Target 8% Volatility, Rebalanced Monthly (1995-2015).

<table>
<thead>
<tr>
<th></th>
<th>Equal Weight</th>
<th>Risk Weight</th>
<th>Momentum</th>
<th>Mean-Variance 8%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compound Return</td>
<td>7.6%</td>
<td>8.0%</td>
<td>14.1%</td>
<td>15.4%</td>
</tr>
<tr>
<td>Volatility</td>
<td>11.4%</td>
<td>8.7%</td>
<td>10.4%</td>
<td>9.3%</td>
</tr>
<tr>
<td>Sharpe Ratio</td>
<td>0.7</td>
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<td>1.3</td>
<td>1.6</td>
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<td>Maximum Drawdown</td>
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<tr>
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<td>77.6%</td>
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<td>95.4%</td>
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<td>Growth Over $1</td>
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<td>$4.98</td>
<td>$15.73</td>
<td>$20.27</td>
</tr>
</tbody>
</table>

Jan 1995-Dec 2015

Recall that our naïve equal weight portfolio delivered just 7.6% returns with volatility of 11.4% and a maximum peak-to-trough drawdown of almost 40%. After making thoughtful use of MPT by introducing adaptive momentum, volatility and correlation factors we observe an almost 8 percentage point boost to returns, with lower risk. As such, the Sharpe ratio is boosted by over 100%, while the maximum drawdown observed over 20 years was under 10% (with end of month observations).

ReSolve’s Advanced Signal Extraction Technology (A.S.E.T.)

In practice, ReSolve employs a significantly more robust implementation of these concepts, which helps drastically stabilize the signal-to-noise ratio across momentum, volatility and correlations. ReSolve’s edge lies in our Advanced Signal Extraction Technology (A.S.E.T.), a proprietary quantitative process that applies best practices from information science and machine learning with the goal of producing meaningfully more reliable signals for live trading.

“The riskiest moment is when you’re right. That’s when you’re in the most trouble, because you tend to overstay the good decisions. So, in many ways, it’s better not to be so right. That’s what diversification is for. It’s an explicit recognition of ignorance. And I view diversification not only as a survival strategy but as an aggressive strategy, because the next windfall might come from a surprising place.”

Peter Bernstein

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Thought

“By combining good defense (risk allocations) with strong offense (momentum emphasis) and the Nobel Prize winning concepts of MPT, it is possible to deliver strong returns in most market environments.”

Enhanced returns the right way

We’ve seen how combining diverse global asset classes to maximize diversification using dynamic estimates of portfolio variables leads to resilient portfolios across most environments. However, up until now we have presented just one portfolio, with one risk and return profile. While this portfolio may meet the needs of a large portion of investors, many investors have a preference for higher returns, and can tolerate more risk. Fortunately, it’s easy to meet the objectives of almost any investor by employing the Capital Market Line (CML).

Dr. William Sharpe received the Nobel Prize in 1990 for his theory on asset pricing, which he originally proposed in 1962. Central to his theorem was the proof that everyone should own the most diversified portfolio. Then, since investors can borrow or lend at a rate below the return on this portfolio, investors should scale exposure to the portfolio up or down to meet individual return targets. The line that describes the relationship between risk and return at each level of exposure is the CML.

Figure 4. provides an example of this concept. First consider the blue curve, which represents a typical ‘efficient frontier’ approach to portfolio construction. Under this framework, an investor who wishes to increase his returns must resort to taking a highly concentrated position in the highest returning assets. Most often this means investors must concentrate their risk in equities, and sacrifice diversification. In contrast, Sharpe asserted that it is preferable to preserve diversification by holding the most diversified portfolio at all times, but scaling exposure to this portfolio using leverage. By borrowing at a low rate to invest in a diversified portfolio with higher returns, it is possible to achieve a return similar to a concentrated portfolio in equities, but at substantially less risk. In fact, it is possible to achieve virtually any return or risk target by moving up or down the CML with the required amount of leverage.

Figure 4. Efficient frontier and the Capital Market Line

Source: ReSolve Asset Management, 2015. For illustrative purposes only.
The studies presented above illustrate the benefit of creating balanced portfolios of major global asset classes which adapt through time to changes in risk, correlations and momentum. It should be clear that by combining good defense (risk allocations) with strong offense (momentum emphasis) and the Nobel Prize winning concepts of MPT, it is possible to deliver strong returns in most market environments.

ReSolve’s higher volatility target mandates employ the CML by using leverage thoughtfully to achieve a higher target of risk and return. However, since portfolio risk changes through time in response to changes in asset risks and correlations, ReSolve scales leverage exposure dynamically with the goal of maintaining the target risk across all market environments. As a result, in highly volatile markets portfolio exposure may be less than 100%, implying a substantial holding in cash. On the other hand, the Strategy may require the use of different levels of leverage to meet the target risk during periods of low volatility.

As such, by dynamically scaling the diversified Adaptive Asset Allocation portfolio to target higher risk, the Strategy should be expected to deliver higher returns commensurate with the risk taken.

ReSolve’s Optimal Volatility Range (R.O.V.R.)

While the risk targeting process described thus far is theoretically intuitive, in practice accurately estimating portfolio volatility is a complex endeavour that requires advanced quantitative methods. As a result, we apply a process we call the ReSolve Optimal Volatility Range (R.O.V.R.), a proprietary quantitative tool specifically designed to more precisely estimate and manage portfolio exposure to the stated risk mandate. This unique tool allows ReSolve to more closely deliver on the investor experience they signed up for independent of market conditions.

The Next Generation of Portfolio Management

The studies presented above illustrate the benefit of creating balanced portfolios of major global asset classes which adapt through time to changes in risk, correlations and momentum. It should be clear that by combining good defense (risk allocations) with strong offense (momentum emphasis) and the Nobel Prize winning concepts of MPT, it is possible to deliver strong returns in most market environments.
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