



Building a Better Deep Value Portfolio

Difficulties Mastered Are Opportunities Won

David Kupersmith
Managing Director

Adrienne Ross
Vice President

Ashwin Thapar
Managing Director

March 2017

Every investor can remember times when markets seemed truly dislocated and exceptional opportunities were abound — times when extraordinary market forces pushed prices very far from fair value.

Yet the unfortunate reality is that, all too often, market dislocations fail to turn into profitable investments. Many investors find themselves unable to take action; and those who do are often forced out of positions at the worst possible time. So why does this happen? And is there a solution for investors looking to turn regret into profit?

In this paper we describe a “deep value” trading strategy that combines a rigorous quantitative framework with discretionary oversight to address the challenges inherent to opportunistic investing. By taking such an approach, investors can gain access to a unique stream of returns — one that is valuable on both a stand-alone basis as well as in a broader portfolio context.

We thank Gregor Andrade, April Frieda, Jeremy Getson, Pete Hecht, Antti Ilmanen, Ronen Israel, David Kabiller, Michael Katz, Joey Lee, Thomas Maloney, Nick McQuinn, Tobias Moskowitz, Lars Nielsen, Lasse Pedersen, Andrew Quinn, Scott Richardson, Rodney Sullivan, Daniel Villalon, and Simon Wills helpful comments and suggestions.

AQR Capital Management, LLC
Two Greenwich Plaza
Greenwich, CT 06830
p: 203.742.3600
f: 203.742.3100
www.aqr.com

Introduction

Contrarian strategies that take advantage of deep value trades — extreme dislocations in markets — are somewhat of a holy grail among investors. The idea of earning outsized profits from opportunities created by forced selling and other extraordinary market forces can be alluring. Yet, in practice, opportunistic investing is often near impossible to execute successfully; it is the unfortunate reality that the challenges associated with identifying, entering and sticking through deep value trades prevent investors from taking sufficient advantage of them.

This paper presents a potential solution. We start by defining deep value opportunities, and then describe some of their drivers as well as some of the challenges associated with taking advantage of them. Next, we present a strategy that we think addresses some of those challenges head on. In particular, while often considered the exclusive domain of discretionary investors, we think deep value is best approached by pairing discretionary expertise with a quantitative framework that allows for broad screening of global opportunities and a rigorous approach to risk management. Implementing such a strategy may allow investors to successfully incorporate that elusive opportunistic element into their portfolios.

Introducing Deep Value

In normal market conditions, there is typically a balance between buyers and sellers at what we call a “fair” market price: one where prices trade close to fundamentals.¹ Deep value episodes are times when these conditions break down, leading to meaningful divergences and outsized valuation opportunities. This can be in the context of a

single security/market — for example, the S&P trading at a very high earnings multiple — or a long/short value strategy that takes long positions in cheap asset versus short positions in rich ones. A quantitative measure of the size of dislocations in a given value strategy is the “value spread” — the spread in valuations between cheap and expensive assets.² While this is always positive,³ its magnitude can vary meaningfully over time. **Exhibit 1** shows historical valuation spreads between cheap and expensive U.S. stocks as an example.

Exhibit 1 | Valuation Spreads Over Time

U.S. Stock Selection Value Spread

January 1984-October 2015



Source: AQR. The universe covers U.S. companies from Xpressfeed with a price greater than \$1. We calculate the spread as the difference in Book-to-Price (“B/P”) ratio of a portfolio of cheap stocks (with high B/P ratios,) and expensive stocks (with low B/P ratios). For illustrative purposes only.

A deep value strategy would focus on the extremes — only trading when valuation spreads are very wide, which creates the potential for greater profit on convergence.⁴ Indeed, academic literature has documented a positive historical relationship between the value spread and future returns to value strategies.⁵

What causes these episodes of deep value? Drivers can vary from instance to instance, but they typically relate to market inefficiencies such

1 Regular value strategies tend to exploit these small dislocations.

2 For directional strategies, the value spread measures the difference between market price and fundamental value of the asset in question.

3 Technically it could be zero if every stock traded at the same valuation multiple, but we haven’t seen an example of that yet, and don’t expect to.

4 Very wide may be defined as greater than two standard deviations, for example.

5 Asness et al. (2000), Cohen et al. (2001), Liew et al. (2017) all document a positive relationship between value spreads and future returns for a value strategy, though Chandra et al. (2015) show that value spreads are less effective at predicting the returns of other investment “styles,” such as defensive. Past performance is not a guarantee of future performance.



as behavioral biases, liquidity constraints and non-profit-maximizing decisions by investors. These reasons are summarized in **Exhibit 2** and described in detail in the Appendix.

Exhibit 2 | Deep Value Opportunities Can Occur Because of One (or Some, or All) of the Following

- Forced selling due to redemptions, risk management, leverage, asset/liability mismatch
- Asymmetric demand from hedgers
- Non-profit maximizing buyers of securities (e.g., central banks, government agencies)
- Irrational markets due to emotion/fear/greed
- Overreaction to changing fundamentals
- Regulatory changes and restrictions
- Board-level allocation decisions by asset owners
- Government backstops
- Illiquidity

Challenges to Deep Value Investing

While a strategy focused on the most attractive opportunities has obvious merits, its implementation also creates numerous challenges. To start, investors must have the expertise to monitor and trade a broad range of markets as a prerequisite for accessing a broad set of opportunities. Moreover, even those able to identify deep value trades often struggle with choosing an entry point and the appropriate sizing of positions. And the most challenging aspect of deep value can simply be the willingness to act: investors must have the conviction to invest in challenging markets and time periods; that might mean buying when market consensus is to sell, or holding onto potentially profitable positions when conditions are deteriorating (thereby incurring losses). In other words, because these trades can be difficult and daunting, few investors are well-

positioned to take advantage of them.

In theory, we expect that longer-term investors may have a natural edge when it comes to opportunistic investing; they should by definition be able to tolerate more volatility and short-term losses in the pursuit of long-term gains. However, the reality is that even longer-term investors can be faced with short-term liquidity needs or changes in risk appetite. For example, during the events of 2008, some endowments and pension plans — prototypical long-term investors — were forced to sell into unreceptive markets due to cash flow requirements (e.g., capital calls from private commitments).⁶ And even in the absence of such explicit liquidity constraints, crisis events can cause long-term investors to lose their nerve, de-risk and act as if they are more short-term.

More generally, many investors also face operational frictions (such as board approvals) for these types of capital allocations, which can hold up the process and result in missed opportunities. Even if an investor has the conviction to stay the course, boards or capital providers — seeing cheap assets getting cheaper — may not. It is unsurprising that some of the root causes of deep value opportunities coincide with reasons why many investors are unable to take advantage of them; the silver lining is that these trades are even more compelling for those who can.

How to Take Advantage of Deep Value?

We believe that to address some of the aforementioned challenges, a deep value strategy should use a combination of quantitative insights and discretionary expertise. In particular, it should incorporate three crucial components: first, the broad expertise needed to build a diversified portfolio; second, careful risk management, including “dry powder” for periods when dislocations increase; and finally, the

⁶ Ilmanen (2011).



conviction required to stick with it, even when the going gets tough. The combination of these three components — rather than each in isolation — helps address the challenges associated with deep value investing.

To demonstrate how these components might work together in practice, we construct a historical simulation of a deep value trading strategy, what we call the Simplified Deep Value Strategy (“the Strategy”). The Strategy consists of extreme valuation trades, defined as those with value spreads greater than two standard deviations above historical averages, across a broad range of markets.⁷ We now turn to a discussion of that Strategy and its components.

Broad Expertise

Deep value opportunities tend to be rare in individual markets, which means it is crucial to screen broadly. This allows access to a much greater opportunity set and ensures that the portfolio benefits from deep value trades across time and market environments. By contrast, consider the opposite approach: single-market timing, or attempting to call turning points at extremes in a single market. Not only would such an approach rarely yield any trades — perhaps one or two per decade⁸ — but even when trades are found, resulting portfolios would be heavily concentrated. This would leave investors exposed to idiosyncratic moves, and the possibility of extreme losses if the dislocation worsened before it normalized.

In the Simplified Deep Value Strategy, we build a hypothetical diversified portfolio of opportunistic trades by looking for dislocations (two standard deviation events) in quantitative valuation metrics across 11 different asset allocation and

stock selection strategies.⁹ Quantitative valuation metrics allow an investor to process large sets of data across many asset classes and geographies in the search of dislocations. Examples of such metrics are book-to-price ratios in equities, or real exchange rates in currencies.

In practice, when evaluating deep value opportunities across markets, we think it’s important to combine both quantitative and qualitative insights. Consider a company facing an accounting scandal — this company may see an extreme reduction in stock price that may not be immediately reflected in its quantitative fundamental metric, such as book value. A purely quantitative screen would suggest a long position, in what is in reality a “value trap.” In-depth discretionary evaluation of opportunities identified by quantitative screens plays the important role of differentiating true opportunities from mis-measured valuation signals. This qualitative filtering is especially important for deep value portfolios as there are fewer holdings and the focus is on assets experiencing large dislocations; this is in contrast to a quantitative strategy that takes advantage of small dislocations across a large numbers of securities.¹⁰

Dry Powder

Another important component of deep value investing is prudent portfolio construction and risk management that reserves “dry powder” for periods of stress. This means (1) sizing individual trades small enough, especially at first, so that you can hold onto trades (and even add to them) if conditions worsen, and (2) take less risk at the portfolio level during normal or quiet times, so that risk can be increased during periods of broad dislocations.

⁷ For a more thorough discussion of this strategy, please see Liew et al. (2017).

⁸ Asness et al. (2016).

⁹ Asset allocation strategies include pairs trading and relative value trading in Developed Currencies, Emerging Currencies, Global Equity Indices, U.S. Equity Indices, Emerging Equity Indices, Government Bond Futures and Interest Rate Futures. Stock selection strategies include within-industry and broad universe stock selection in Europe, Japan, the U.S., and the U.K. For a full list of valuation signals, please see Appendix B.

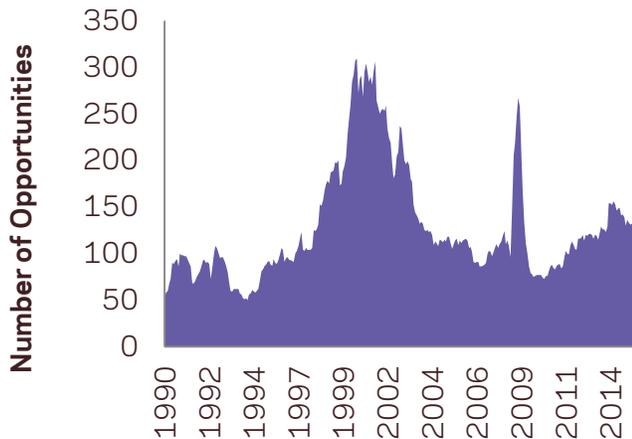
¹⁰ Another approach to avoiding value traps is to incorporate other systematic investment themes, like quality.



Practically, prudent use of dry powder means not being forced to sell at the wrong times — it allows investors to profit from, rather than cause, deep value opportunities. Consider the tech bubble. While it may seem obvious in retrospect that tech stocks were overvalued, few investors profited from the bubble bursting, and many suffered losses. Part of the difficulty was the strength of the price rise: those who went short early on in any kind of meaningful size were forced out of positions by losses. **Exhibit 3** looks at dislocations

Exhibit 3 | Extreme Dislocations Tend to Occur in Clusters

Sample Opportunity Set for Deep Value January 1990-September 2015



Source: AQR proprietary value signals across multiple asset classes. This graph tracks over multiple value signals, and identifies an opportunity when it is greater than 2 standard deviations from its historical mean. See the description of the Strategy in Appendix B for more details. For illustrative purposes only and not representative of a portfolio that AQR currently manages. Hypothetical performance results have certain inherent limitations, some of which are disclosed in the back.

back to 1990 and shows that extreme dislocations have tended to occur in clusters; the Tech Bubble and Global Financial Crisis were notable in terms of the number of potential trades. It's important to note that opportunities can also exist during normal market conditions, but they tend to be less

prevalent, more idiosyncratic and therefore more difficult to uncover.

In the Simplified Deep Value Strategy, new trades are sized to target a low level of risk at inception and positions are then held in all trades until convergence happens — even if losses occur in the interim. In fact, if losses lead to widening dislocations (often the case), the process actually increases rather than decreases positions in response.¹¹ At the sample portfolio level, risk is proportional to the number of opportunities available. That is, the Strategy tends to operate with lower levels of risk in more “normal” market conditions; that way, it can actually increase risk in periods of broad market dislocation.

Conviction

Last, the conviction and courage to know you're doing the right thing - however difficult it may be - is essential to the long-term profitability of this type of investing. Even if an individual investor has the expertise required to identify opportunities and the capital ready to deploy, they may not be *willing* to take action — particularly in challenging market environments. Moreover, those who act must then be prepared to hold on to (or add to) trades that experience adverse moves; painful short-term losses can often lead investors to preemptively abandon course, potentially selling positions that could eventually be profitable.

In other words, while it is straightforward to describe the rules of and simulate a deep value trading strategy, it can be challenging to actually implement it in practice. Buying when others are selling can be a daunting proposition — one that is easier said than done. It is important for investors to put themselves in a position to be able to act “long-term” during tough times, by effectively locking in the required conviction ahead of time.

¹¹ When a two standard deviation (STD) event is first observed in a strategy, a trade is added to the portfolio. Thereafter, positioning is increased if the STD event increases by 1 (e.g., moves from 2 to 3), and decreased when the STD event decreases by 1 (e.g., moves from 4 to 3). When the STD event decreases below 1, the trade is removed entirely. Total risk is controlled at the portfolio level.



This can mean having a pre-approved plan for opportunistic contrarian trading, or pre-funding a strategic allocation to a dedicated deep value Strategy.

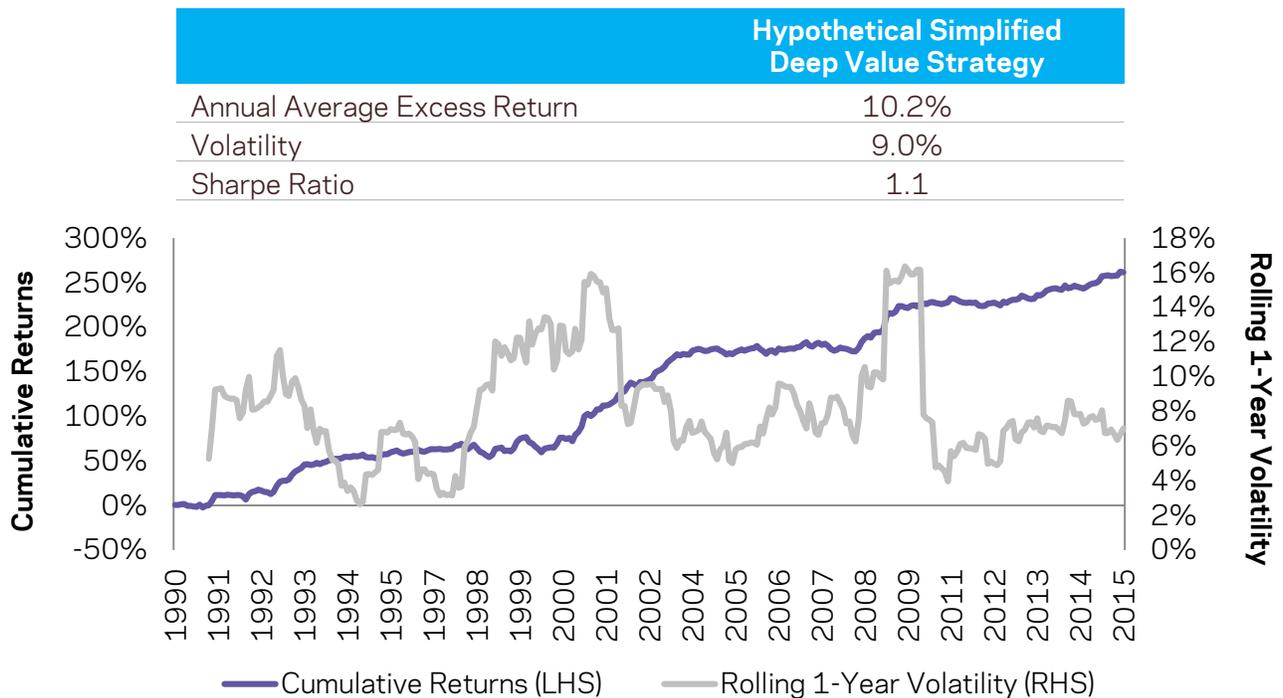
Historical Performance of Deep Value

To examine the efficacy of this approach, we can look at **Exhibit 4**, which shows the returns to the Strategy. As described, the Strategy screens across a diverse set of value signals, and takes small initial positions in those exceeding two standard deviations from historical means. Positions are held until dislocations converge, and increased if they further widen beforehand. Portfolio risk is proportional to the number of available opportunities.¹² It is important to note

that the potential positive impact of discretionary oversight is not reflected in these numbers, but we believe the results still provide useful insight on the potential returns and risk profile of such a strategy. From our simulation we see that the Strategy was profitable historically, earning an average 10% returns per year for the period shown, with a realized Sharpe ratio of roughly 1.1. Notably, the time profile of the accrual of these returns is highly episodic. While the Strategy is profitable in most periods, returns are somewhat concentrated in sub-periods when dislocations were particularly pronounced. Intuitively, this also corresponds to the periods in which the Strategy targeted the greatest amount of risk.

Exhibit 4 | Episodic Accrual of Returns

Hypothetical Simplified Deep Value Performance Statistics
January 1990-September 2015



Source: AQR and AQR Data library. Returns are gross of transaction costs. Sharpe ratios are computed in excess of LIBOR. See the description of the Strategy in Appendix B for more details. For illustrative purposes only and not representative of a portfolio that AQR currently manages. Hypothetical performance results have certain inherent limitations, some of which are disclosed in the back.

¹² For more details on strategy construction, please see Appendix B.



Exhibit 5 | Diversification Benefits of Deep Value**Hypothetical Simplified Deep Value Portfolio Compared to Other Investments**

January 1990-September 2015

Part A: Correlations and Beta

	Global Equities	Global Bonds	Commodities	Hedge Funds (all)	Hedge Funds (Systematic Macro)	Hedge Funds (Relative Value)
Beta	0.0	-0.1	0.0	0.0	-0.2	0.2
Annualized Alpha	10.3%	10.4%	10.2%	10.1%	11.4%	8.7%

Part B: Hypothetical Deep Value in a Portfolio Context

	Diversified Portfolio (50/30/10/10)*	+10% Deep Value	+20% Deep Value	+30% Deep Value
Average Excess Return	3.2%	3.9%	4.6%	5.3%
Volatility	9.5%	8.5%	7.7%	7.0%
Sharpe Ratio	0.3	0.5	0.6	0.8

Source: AQR. Data is based on MSCI World, Barclays Global Aggregate, GSCI, HFRI Fund Weighted Composite. Alpha in Part A is an annualized estimate based on univariate regressions. *In Part B, the Diversified Portfolio is 50% Global Equities, 30% Global Bonds, 10% Commodities and 10% Hedge Funds. For illustrative purposes only and not representative of a portfolio that AQR currently manages. Hypothetical performance results have certain inherent limitations, some of which are disclosed in the back.

Finally, **Exhibits 5** shows how an approach like this may fit within a broader portfolio context. Part A shows the potential diversification benefits of the Strategy to other traditional and alternative investments: it is relatively uncorrelated with equities, bonds and commodities, as well as a broad hedge fund index. Unsurprisingly, amongst hedge funds, it is mildly correlated to relative value strategies, while negatively correlated to systematic macro indices that tend to take a trend following approach. The Strategy also provides positive alpha to both traditional and alternative investments.¹³

Part B shows the benefit of adding the Simplified Deep Value Strategy to an existing diversified portfolio (50% equities, 30% bonds and 10% each commodities and hedge funds). Marginal allocations to the Strategy have the effect of

increasing average returns and decreasing portfolio volatility, leading to an overall improvement in Sharpe ratio.

Conclusion

There are potentially large benefits to deep value investing, but these can be challenging to harvest; we have observed many periods of meaningful deep value opportunities, but few investors have been able to profit from them.

We believe that committing ahead of time to a dedicated deep value strategy, that marries a quantitative framework with discretionary oversight, can help investors meet these challenges. Doing so can provide valuable diversification benefits for many portfolios, and may even provide that idiosyncratic source of return that many investors hope to find from manager “alpha.”

¹³ While not shown here, the Strategy is also lowly correlated and adds alpha to regular value strategies, such as Fama-French's HML approach; see Liew et al. (2017) for a more comprehensive discussion of this. It is also worth mentioning that the results shown here are specific to timing value only and only at extremes; Asness et al. (2017) discuss the impact of value timing (not only at extremes) for other styles, and find that value timing of other factors is, generally, a weak addition for long-term investors holding well-diversified factors, including value.



Appendix A | Why Do Deep Value Opportunities Exist?

Liquidity Crises

Liquidity crises evolve through a feedback mechanism where losses, increased margin requirements, and increased volatility reinforce each other.¹⁴

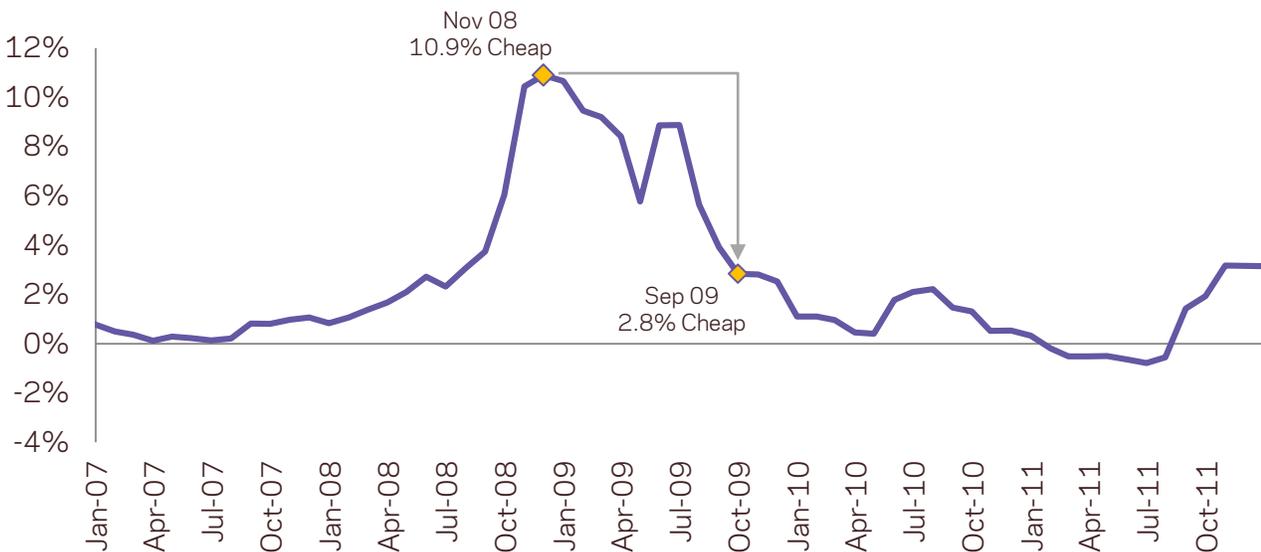
This is consistent with what happened in the Global Financial Crisis of 2008, when there were a number of structural dislocations, representing exceptional value opportunities, across a wide range of markets. One compelling example occurred in the convertible bond market in the second half of 2008. A panic in the levered market caused overnight financing to dry up. As a result, convertible bonds had cheapened to the point where they were attractive to hold on an un-levered basis (relative to equities). This dislocation was so significant that convertible bonds were selling at the greatest discount to fair value in 23 years.¹⁵

Exhibit A1 shows that in 2007, the discount of converts to their theoretical value started to widen. However, rather than converging back to fair value, the widening continued and accelerated in 2008; by November 2008, they sold at a 10.9% discount relative to their theoretical values. This means that investors who were able to purchase bonds at these very “cheap” levels could earn outsized profits if the extreme dislocation between market prices and fair values converged. Indeed, the sample study also shows what was seen roughly one year later, prices had converged closer to fair value and were trading at a more normal discount level of 2.8%. Those who entered the trade too early, or at too large of a size may have struggled to hold the position as the dislocation widened.

Exhibit A1 | Dislocated Markets Can Create Opportunities

Hypothetical Median Discount of Convertible Bonds to Their Theoretical Values

January 2007-December 2011



Source: AQR/CNH proprietary models. For illustrative purposes only and not representative of a portfolio that AQR currently manages. Hypothetical performance results have certain inherent limitations, some of which are disclosed in the back.

¹⁴ Pedersen (2009), Brunnermeier and Pedersen (2009).

¹⁵ According to AQR/CNH proprietary dataset of U.S. convertible bonds of publicly-traded issuers dating back to 1985, containing more than 700,000 data points.



Irrational Markets

Opportunities can result from excessive euphoria. Irrational shifts in investor sentiment can lead to bubbles and overvaluations, as well as crashes and market undervaluations. The tech bubble was a blow to the efficient market concept that “prices fully reflect all available information.”¹⁶ The tech bubble wasn’t just a cross-sectional “micro” efficiency phenomenon (value versus growth within the stock market), but the whole market itself was priced at extremely high levels (versus any measure of fundamentals).¹⁷ Many investors are familiar with the fact that tech stocks were very expensive, but it is less well known that the tech bubble created meaningful dislocations across industries, even in sectors unrelated to technology. Simply put, the opportunity set for deep value was rich.

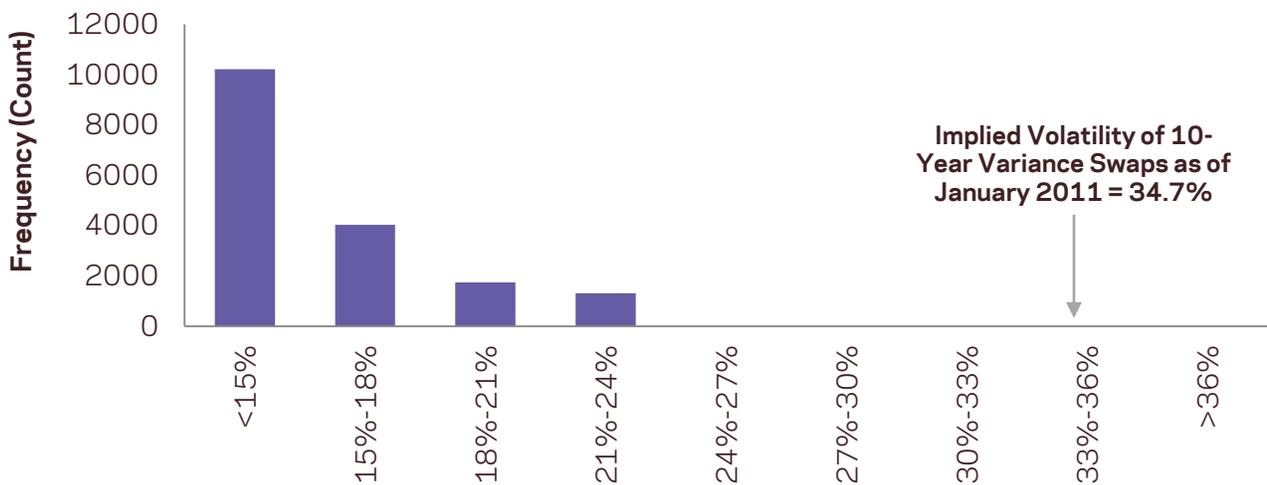
Asymmetric Demand/Supply

Outside of broad market dislocations, deep value opportunities can result from a persistent imbalance between “natural buyers” and “natural sellers” in a particular market. In many industries, asset-liability mismatches often require hedging with very specific securities, which can create a source of natural buyers.¹⁸ An imbalance occurs when there is a lack of natural sellers to take the other side.

A clear example of this has occurred in the variance swap market. Variable-annuity plans typically have a payout structure that is heavily tied to equity markets; they are therefore highly vulnerable to large moves in equity markets. One way that they typically hedge this risk is by purchasing variance swaps. However, a lack of natural sellers in this market (very few market participants are positioned to profit from periods of higher variance) means that variance swaps typically trade at a premium to fair value. Because banks can be unwilling to execute these transactions due to margin requirements and mark-to-

Exhibit A2 | Asymmetric Demand Can Create Opportunities

10-Year Rolling Realized S&P 500 Volatility, Daily Frequency
January 1946-January 2011



Source: AQR analysis based on broker estimates. For illustrative purposes only. Please read important disclosures at the end of this document.

¹⁶ Fama (1970); Asness and Liew (2014).

¹⁷ Asness and Liew (2014).

¹⁸ It can also create a source of natural sellers too.



market concerns, the premium can be driven to extreme levels; this is what was seen in January 2011 when implied volatility was at 34.7%, higher than realized volatility in almost any 10-year period since 1946, as shown in **Exhibit A2**. This divergence meant that variance swaps were extremely expensive relative to their history, which created a potential profit opportunity for investors to sell variance swaps. Those who were able to trade against variable annuity demand pressure could have meaningfully profited, as variance swaps eventually reverted to more fairly priced levels.

Board Level Allocation Decisions

Individuals and groups (particularly committees) have a strong tendency to rely on three- to five-year performance evaluation horizons. As a result, they often buy the last three to five years' winners and sell multiyear laggards. This multiyear return chasing can be explained by the human tendency to extrapolate (one of the strongest behavioral biases).¹⁹ The result is that multiyear winners tend to become overpriced and multiyear losers underpriced,²⁰ helping to explain the existence of both regular and deep value opportunities.

In addition, the structure of organizations is such that they are subject to peer risk. Peer risk can trigger peer chasing, or buying whatever is popular among peer institutions. Even if an institutional investor is not naturally a return chaser, if they face peer risk and peers chase returns, then they may also be forced to do so. This type of herding behavior might be one of the worst kinds, since collectively these investors and their peers could be large enough to push market prices away from fair values;²¹ and possibly very far from fair values.

Non-Profit-Maximizing Market Participants

Extreme mispricing can also occur because non-profit-maximizing market participants exist, such as when governments and central banks intervene in markets. For instance, government agencies or central banks may buy securities not because they are undervalued, but rather to pursue a specific policy goal, such as an inflation target. Monetary policy programs, such as quantitative easing, can drive prices away from fair value. And price pressure can be further exacerbated by the fact that few participants are willing to position themselves against these large institutions. When markets are distorted by a participant buying without regard for any notion of value (and possibly trying to push prices away from fair value) it can cause inefficiencies and potential deep value opportunities.²²

Appendix B | Description of Simplified Deep Value Strategy

The Simplified Deep Value Strategy simulation describes historical returns to a purely systematic strategy attempting to exploit historical deep value dislocations in sub-strategies across 11 asset classes and regions. In each sub-strategy we divide the universe into subsets (by industry for stock selection, and by pairs of assets in other strategies). The length of historical sample (varies due to data availability), valuation factor used, and number of subsets in each sub-strategy are listed in the table below.

Within each subset and time period, we sort assets according to the relevant valuation metric as of that

¹⁹ De Bondt and Thaler (1985); AQR Capital Management (2014a).

²⁰ Asness and Liew (2014); Asness (2009).

²¹ AQR Capital Management (2014a).

²² Brunnermeier and Pedersen (2009); Mitchell and Pulvino (2011).



date, and form a portfolio that is long the top $1/3$ and short the bottom $1/3$. Portfolios are capitalization-weighted in stock selection sub-strategies, and equal-weighted in other sub-strategies. We then compute the valuation spread of the portfolio by comparing the average valuation of the long portfolio to the short portfolio, and compute an expanding z-score of this valuation spread. We finally create a combined portfolio consisting of only those subsets, across all asset classes and regions, in which the z-score exceeds two (“included subsets”). In this portfolio, each included subset is scaled to target a fixed level of risk, and there is an additional risk cap at the portfolio level (all included subsets are scaled down proportionally if this cap is hit).

This process is repeated in each time period, with component subset portfolios being removed when z-scores decline below two, and additional subsets added if their z-scores exceed two. Positions also increase in existing component subset portfolios if z-scores increase beyond three or four. Sub-strategies are scaled to have an equal risk contribution from asset allocation and stock selection strategies. Returns are measured on a monthly basis.

Description of Strategies and Valuation Signals in Simplified Deep Value Simulation

Strategy	Start Date	Valuation Signal
Developed Currencies	1/1/1990	Real Exchange Rate
Emerging Currencies	1/1/1996	Real Exchange Rate
Global Equity Indices	1/1/1990	Book-to-Price Ratio
European Equity Country Selection	1/1/1990	Book-to-Price Ratio
Emerging Equity Indices	1/1/1990	Book-to-Price Ratio
US Equity Indices	1/1/1990	Book-to-Price Ratio
Global Bonds	1/1/1990	Real Bond Yield
Interest Rate Futures	1/1/1990	Adjusted Real Short Rate
Inflation Breakevens	1/1/1997	Inflation Risk Premium
Swap Spreads	1/1/1997	Swap Spread Fair Value
U.S. Stock Selection	1/1/1990	Book-to-Price Ratio
U.K. Stock Selection	1/1/1990	Book-to-Price Ratio
Europe Stock Selection	1/1/1990	Book-to-Price Ratio
Japan Stock Selection	1/1/1990	Book-to-Price Ratio



References

- AQR Capital Management (2014a), “Alternative Thinking: Bad Habits and Good Practices,” AQR, Third Quarter 2014.
- Asness, Cliff (2009), “Seven Thoughts on Running Big Money For the Long-Term,” *AQR Working Paper*.
- Asness, Cliff, Andrea Frazzini, Ronen Israel and Tobias J. Moskowitz (2015), “Fact, Fiction, and Value Investing,” *SSRN Working Paper*.
- Asness, Cliff, Jacques A. Friedman, Robert Krail and John Liew (2000), “Style Timing: Value versus Growth,” *The Journal of Portfolio Management*, Vol. 26, No. 3.
- Asness, Cliff, Antti Ilmanen and Thomas Maloney (2016), “Market Timing: Sin a Little,” *AQR Whitepaper*.
- Asness, Cliff and John Liew (2014), “The Great Divide,” *Institutional Investor*.
- Asness, Cliff, Tobias J. Moskowitz and Lasse H. Pedersen (2013), “Value and Momentum Everywhere,” *Journal of Finance*, Vol. 68, 929-985.
- Asness, Cliff, Antti Ilmanen, Ronen Israel and Tobias J. Moskowitz (2015), “Investing with Style,” *Journal of Investment Management*, Vol. 13, No. 1, 27-63.
- Asness, Cliff, Swati Chandra, Antti Ilmanen and Ronen Israel (2017), “Contrarian Factor Timing is Deceptively Difficult,” *Forthcoming Journal of Portfolio Management*.
- Brunnermeier, Markus K., and Lasse H. Pedersen (2009), “Market Liquidity and Funding Liquidity,” *Review of Financial Studies* 22, 2201-2238.
- Cohen, R. B., C. Polk and T. Vuolteenaho (2003), “The Value Spread,” *Journal of Finance* 58 (2), 609-641.
- Chandra, S., L. Nielsen and A. Ilmanen (2015), “Are Defensive Stocks Expensive? A Closer Look at Value Spreads,” *AQR Whitepaper*.
- De Bondt, Werner F.M. and Richard Thaler (1985), “Does the Stock Market Overreact?” *Journal of Finance*, Vol. 40, No. 3, 793-805.
- Fama, Eugene F. (1970), “Efficient Capital Markets: A Review of Theory and Empirical Work,” *Journal of Finance*, Vol. 25, No. 5, 383-417.
- Fama, Eugene F., and Kenneth R. French (1992), “The Cross-Section of Expected Stock Returns,” *Journal of Finance*, Vol. 47, No. 2, 427-465.
- Fama, Eugene F., and Kenneth R. French (1993), “Common Risk Factors in the Returns on Stocks and Bonds,” *Journal of Financial Economics*, Vol. 33, 3-56.
- Fama, Eugene F., and Kenneth R. French (1996), “Multifactor Explanations of Asset Pricing Anomalies,” *Journal of Finance*, Vol. 51, 55-84.
- Fama, Eugene F., and Kenneth R. French (2012), “Size, value, and momentum in international stock returns,” *Journal of Financial Economics*, Vol. 105, 427-472.
- Ilmanen, Antti (2011), *Expected Returns*, Wiley.
- Liew, John, Lasse H. Pedersen and Ashwin Thapar (2017), “Deep Value,” *AQR Working Paper*.
- Mitchell, Mark and Todd Pulvino (2001), “Characteristics of Risk and Return in Risk Arbitrage,” *Journal of Finance*, Vol. 56, No. 6, 2135-2175.
- Mitchell, Mark and Todd Pulvino (2012), “Arbitrage Crashes and the Speed of Capital,” *Journal of Financial Economics*, Vol. 104, No. 3, 469-490.
- Mitchell, Mark, Lasse H. Pedersen and Todd Pulvino (2007), “Slow Moving Capital,” *American Economic Review Papers*.
- Pedersen, Lasse H. (2009), “When Everyone Runs for the Exit,” *NBER Working Paper*, No 15297



Biographies

David Kupersmith, *Managing Director*

David is a senior member of AQR's Global Asset Allocation team and a portfolio manager for AQR's Global Macro strategy. In these roles, he provides economic research into macro themes, market dislocations and structural changes across asset classes. Prior to AQR, David was a partner and the head of discretionary macro trading at Third Wave Global Investors. Before that he was a director at Citigroup and a principal and head trader at Harbor Street Capital Management. David earned a B.A. in history from Amherst College and an M.B.A. from Columbia Business School.

Ashwin K. Thapar, *Managing Director*

Ashwin is a senior researcher and portfolio manager in AQR's Global Asset Allocation group. In these roles, he heads research for currencies and global equity index futures, and oversees strategies in these asset classes across AQR's product line. Ashwin also sits on the firm's Alternative Investment and Long Only Investment Committees, and is a portfolio manager of several of the firm's products aimed at both alpha generation and risk mitigation. Ashwin earned a B.Sc. in finance and a B.A. in mathematics from the University of Pennsylvania, graduating summa cum laude in both fields.

Adrienne Ross, *Vice President*

Adrienne is a member of the research and portfolio management team in the Global Stock Selection group. In this role, she monitors portfolio performance, reviews accounts with clients, and presents stock selection strategies to investors. She has published research in *The Journal of Portfolio Management*, *The Journal of Economic Geography* and the Federal Reserve Bank of New York. Prior to AQR, she worked in the Institutional Account Management group at PIMCO. She began her career as a researcher at a macroeconomic think tank in Canada. Adrienne earned a B.A. in economics and mathematics from the University of Toronto and an M.A. in quantitative finance from Columbia University.



Notes



Notes



Notes



Disclosures

This document has been provided to you solely for information purposes and does not constitute an offer or solicitation of an offer or any advice or recommendation to purchase any securities or other financial instruments and may not be construed as such. The factual information set forth herein has been obtained or derived from sources believed by the author and AQR Capital Management, LLC ("AQR") to be reliable but it is not necessarily all-inclusive and is not guaranteed as to its accuracy and is not to be regarded as a representation or warranty, express or implied, as to the information's accuracy or completeness, nor should the attached information serve as the basis of any investment decision. This document is intended exclusively for the use of the person to whom it has been delivered by AQR, and it is not to be reproduced or redistributed to any other person. The information set forth herein has been provided to you as secondary information and should not be the primary source for any investment or allocation decision.

Past performance is not a guarantee of future performance.

This presentation is not research and should not be treated as research. This presentation does not represent valuation judgments with respect to any financial instrument, issuer, security or sector that may be described or referenced herein and does not represent a formal or official view of AQR.

The views expressed reflect the current views as of the date hereof and neither the author nor AQR undertakes to advise you of any changes in the views expressed herein. It should not be assumed that the author or AQR will make investment recommendations in the future that are consistent with the views expressed herein, or use any or all of the techniques or methods of analysis described herein in managing client accounts. AQR and its affiliates may have positions (long or short) or engage in securities transactions that are not consistent with the information and views expressed in this presentation.

The information contained herein is only as current as of the date indicated, and may be superseded by subsequent market events or for other reasons. Charts and graphs provided herein are for illustrative purposes only. The information in this presentation has been developed internally and/or obtained from sources believed to be reliable; however, neither AQR nor the author guarantees the accuracy, adequacy or completeness of such information. Nothing contained herein constitutes investment, legal, tax or other advice nor is it to be relied on in making an investment or other decision.

There can be no assurance that an investment strategy will be successful. Historic market trends are not reliable indicators of actual future market behavior or future performance of any particular investment which may differ materially, and should not be relied upon as such. Target allocations contained herein are subject to change. There is no assurance that the target allocations will be achieved, and actual allocations may be significantly different than that shown here. This presentation should not be viewed as a current or past recommendation or a solicitation of an offer to buy or sell any securities or to adopt any investment strategy.

The information in this presentation may contain projections or other forward-looking statements regarding future events, targets, forecasts or expectations regarding the strategies described herein, and is only current as of the date indicated. There is no assurance that such events or targets will be achieved, and may be significantly different from that shown here. The information in this presentation, including statements concerning financial market trends, is based on current market conditions, which will fluctuate and may be superseded by subsequent market events or for other reasons. Performance of all cited indices is calculated on a total return basis with dividends reinvested.

Diversification does not eliminate the risk of experiencing investment losses. Broad-based securities indices are unmanaged and are not subject to fees and expenses typically associated with managed accounts or investment funds. Investments cannot be made directly in an index.

The investment strategy and themes discussed herein may be unsuitable for investors depending on their specific investment objectives and financial situation. Please note that changes in the rate of exchange of a currency may affect the value, price or income of an investment adversely.

Neither AQR nor the author assumes any duty to, nor undertakes to update forward looking statements. No representation or warranty, express or implied, is made or given by or on behalf of AQR, the author or any other person as to the accuracy and completeness or fairness of the information contained in this presentation, and no responsibility or liability is accepted for any such information. By accepting this presentation in its entirety, the recipient acknowledges its understanding and acceptance of the foregoing statement.

The data and analysis contained herein are based on theoretical and model portfolios and are not representative of the performance of funds or portfolios that AQR currently manages. Volatility targeted investing described herein will not always be successful at controlling a portfolio's risk or limiting portfolio losses. This process may be subject to revision over time

Hypothetical performance results (e.g., quantitative backtests) have many inherent limitations, some of which, but not all, are described herein. No representation is being made that any fund or account will or is likely to achieve profits or losses similar to those shown herein. In fact, there are frequently sharp differences between hypothetical performance results and the actual results subsequently realized by any particular

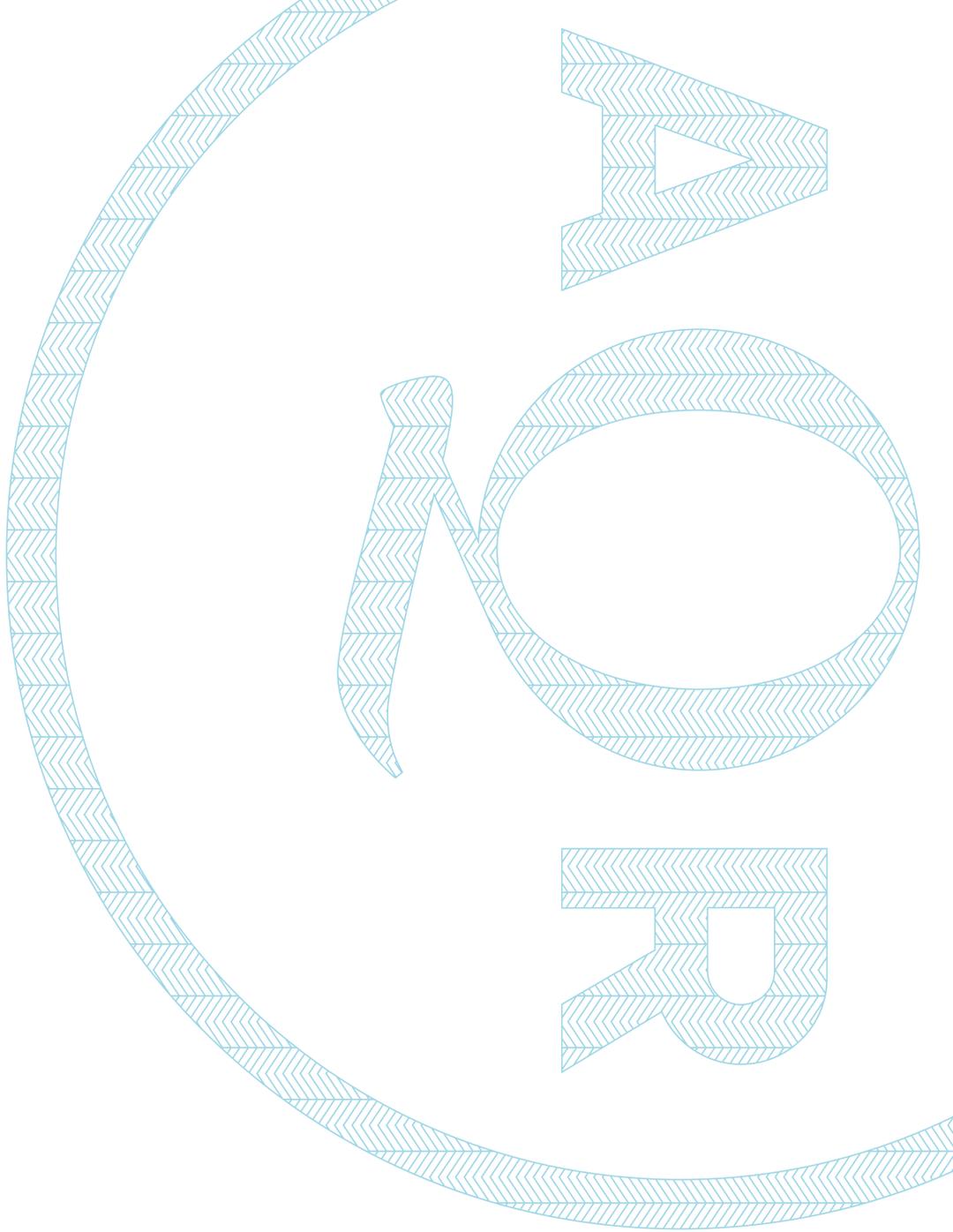


trading program. One of the limitations of hypothetical performance results is that they are generally prepared with the benefit of hindsight. In addition, hypothetical trading does not involve financial risk, and no hypothetical trading record can completely account for the impact of financial risk in actual trading. For example, the ability to withstand losses or adhere to a particular trading program in spite of trading losses are material points which can adversely affect actual trading results. The hypothetical performance results contained herein represent the application of the quantitative models as currently in effect on the date first written above and there can be no assurance that the models will remain the same in the future or that an application of the current models in the future will produce similar results because the relevant market and economic conditions that prevailed during the hypothetical performance period will not necessarily recur. 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, all of which can adversely affect actual trading results. Discounting factors may be applied to reduce suspected anomalies. This backtest's return, for this period, may vary depending on the date it is run. Hypothetical performance results are presented for illustrative purposes only.

There is a risk of substantial loss associated with trading commodities, futures, options, derivatives and other financial instruments. Before trading, investors should carefully consider their financial position and risk tolerance to determine if the proposed trading style is appropriate. Investors should realize that when trading futures, commodities, options, derivatives and other financial instruments one could lose the full balance of their account. It is also possible to lose more than the initial deposit when trading derivatives or using leverage. All funds committed to such a trading strategy should be purely risk capital.

The white papers discussed herein can be provided upon request.





AQR Capital Management, LLC

Two Greenwich Plaza, Greenwich, CT 06830

p: +1.203.742.3600 | f: +1.203.742.3100 | w: aqr.com