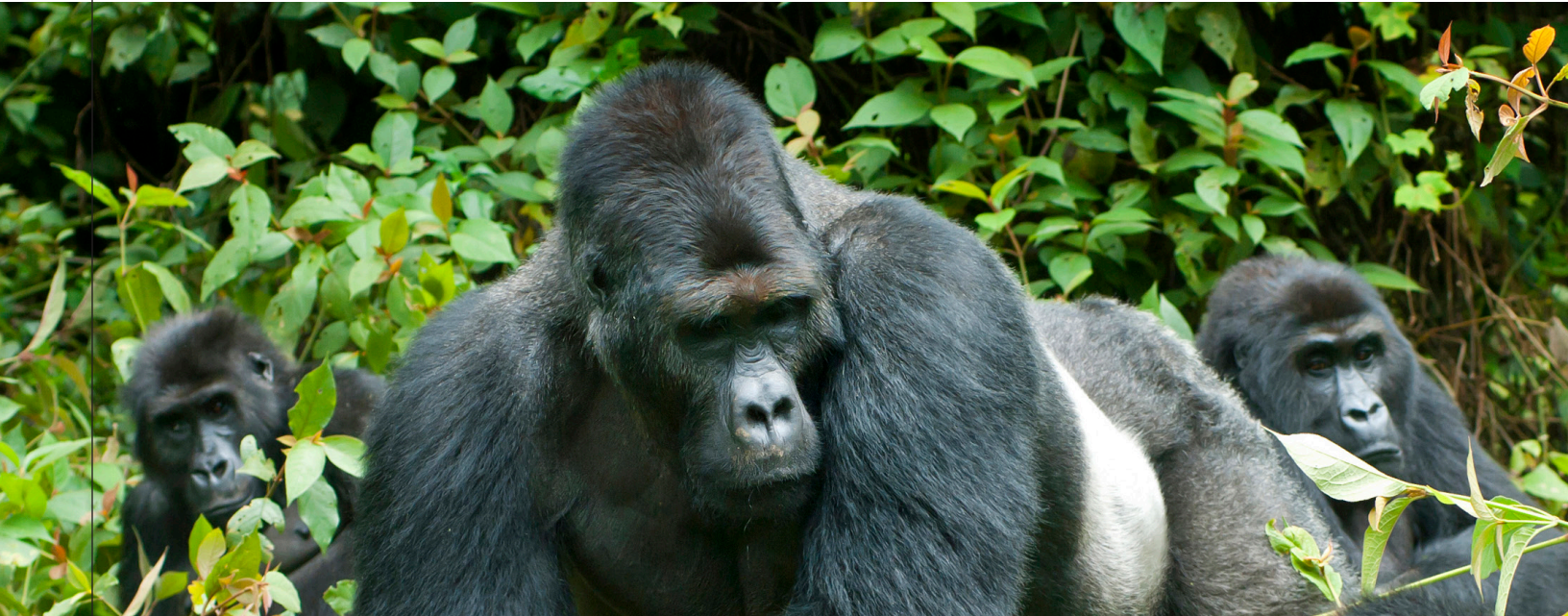


Antecedent Analysis: Navigating A Troop of Gorillas



With the birth of the so-called “Greenspan Put,” the 800-pound gorilla of U.S. monetary policy unleashed itself on capital markets. Today, there is not just one 800-pound gorilla harassing capital markets; there is a troop of gorillas. In our view, easy monetary policies and the resulting malinvestment have prevented fundamentals from fully exerting their influence on prices for more than a decade. As central banks now embark on a disjointed unwinding of their balance sheets, we add to these uncharted paths material concerns about the proliferation of rules-based strategies, the Volcker Rule, and uncoordinated circuit breakers. The ultimate compounding effects of these are as of yet unknown; it is hard to see how it can end well, but the likelihood of market disruption is elevated.

Dynamic Allocation
Strategies Team

“When you have a liquidity event it’s like squeezing an elephant through a keyhole.”

— Mike Thompson, President, S&P Investment Advisory Service

Introduction

The first stage, and foundation, of our investment process (*Where*) focuses on the fundamental valuation of more than 100 equity and bond markets and currencies. This stage currently reveals a broad and midsize set of discrepancies between prices and fundamental values across our investment universe. Figure 1 illustrates. For a long-short investor, these opportunities emanate from both undervaluation and overvaluation. We view some equity markets as attractive, and most of these are seen as unappealing by other investors. These markets include European and emerging equity markets that previously strained under policy and growth uncertainty. The United Kingdom, southern Europe, and select emerging markets such as Brazil, India, China, and Vietnam are some specific examples of markets that we currently find fundamentally attractive. Sovereign bonds, by contrast, look persistently unattractive.

However, concerns from the second stage of our process (*Why*) laid out in this paper imply no rush to short bonds. And while equities are attractive, our belief is that this is a time to be cautious about incurring broad market exposure. Meanwhile, we see ample opportunities for dynamic allocations across markets and currencies.

These *Why* considerations lead us to believe that the next market downturn will be driven by illiquidity, not the leverage that was at the heart of the Global Financial Crisis (GFC) a decade ago. The most illiquid assets, such as private equity, loans, debt, and infrastructure, show classic signs of late-stage bubble activity. We anticipate that in a market downturn, forced selling of assets will come against constrained liquidity, echoing the misfortune of Black Monday in 1987.

We have four concerns that are currently creating navigational risk but that we believe will ultimately provide unique and large opportunities: monetary policy irresponsibility, rules-based strategies, the Volcker Rule, and uncoordinated circuit breakers.

Markets have a history of repeated cycles of euphoria, crashes, and recoveries. Storms are followed by periods of calm that breed complacency and excessive risk-taking until a bubble emerges and ultimately bursts. To understand why these cycles recur, we look at the evolution of market movements and their connections to central bank and government policies. We observe that stimulative central bank policies are associated with rising prices of risky assets, reduced asset price volatility, and more systematic-driven (and less fundamental-driven) markets, all of which sow the seeds of future crises.

Typically, easy monetary policies lower real interest rates and stabilize risk premia, initiating and protracting bull markets. The persistence of stimulative monetary policy forces fundamental investors to struggle against interest rate and asset price manipulation. Meanwhile, quantitative strategies emerge to

Figure 1:
Investment Opportunity Set



Sources: MSCI, Bloomberg, Datastream, William Blair, as of July 2018. **For illustrative purposes only.** The opportunity set represents the aggregate discrepancy between fundamental value and price for a subset of equity and bond markets and currencies included in the team's investment universe. The further prices are from value the larger the opportunity set, and the closer prices are to value the smaller the opportunity set.

exploit temporal common-factor momenta. If policies are sustained long enough, asset price bubbles occur. The end of the cycle begins with central banks unwinding easy money policies. While this allows prices to revert to normal, this often, too, leads to an over-adjustment, which lands in a crash. Monetary and other policy makers counter this decline with new policies and a cycle begins anew.

Too often, the surfeit of regulatory, monetary, and fiscal responses that follow crises is misguided. Not only do policy makers fight the previous war, but they also neglect the fragilities of the resulting order. Well-intended policies and regulations create unintended distortions that have real consequences, often revealed in subsequent crises. Even in hindsight, corrective measures often would not have prevented—and would sometimes even have exacerbated—the previous crises.

The past decades reveal three such waves of policy and asset price interaction that culminated in the crashes of 1987, 2000, and 2008. In each case, central banks were instrumental in propping up bubbles and catalyzing crashes through swings between loose and tight monetary policies.

“We believe the next market downturn will be driven by illiquidity, not the leverage that was at the heart of the Global Financial Crisis.”

“ We now find ourselves in an unprecedented period of loose monetary policy.”

Our study required an assessment of monetary policy, which we consider loose when the Fed engages in unsustainable stimulation of the economy. Often, this is manifested in low or falling interest rates. Other times, it is a failure of the central bank to dampen an overheating economy. One way to gauge monetary policy is to observe the U.S. Federal Reserve's (Fed's) interest rate in relation to the Taylor Rule.¹ On several occasions when this spread has been low or declining, policy has been stimulative. Figure 2 depicts this ratio with two different sets of assumptions for the rule. The gray shading specifies the four waves of loose monetary policy. In the next section, we will discuss these waves in turn.

We now find ourselves in an unprecedented period of loose monetary policy. We believe the resulting market distortions combined with rules-based strategies, the Volcker Rule, and complex circuit breakers are setting the capital markets up for a probable intensified bear market and subsequent large fundamental opportunities. As macro investors, we must be cognizant of the risks these distortions impose and stand ready to navigate market landscapes that both influence and shape new policies.

Four Waves of Policies and Market Crises

Looking back at the past four decades is like watching remakes of the same movie. We watched the original play out in the 1980s, and remakes in the 1990s and 2000s. Now we're on version four. Each version is a little different, but the plot has been the same.

The First Wave

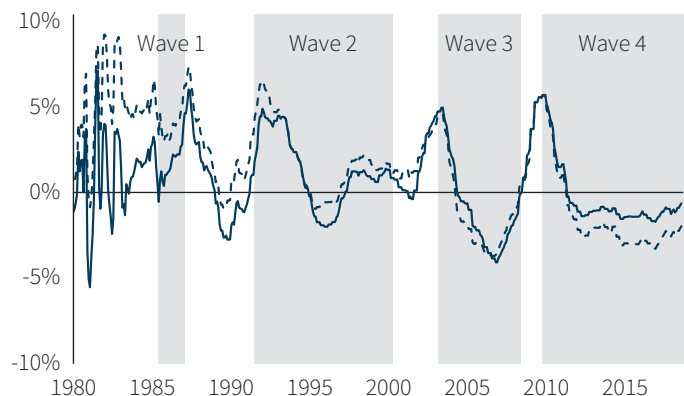
The first episode from which we draw lessons started in the mid-1980s and culminated in the Black Monday stock market crash of October 19, 1987. While this crisis was short-lived, responses to this crisis set in motion much of what motivates our current concerns.

The story began in 1986. Inflation had stabilized after the 1982 recession, but the Fed was facing a new problem—the U.S. trade deficit was swelling, growing to more than 3% of gross domestic product (GDP) by 1986, as figure 3 shows.² The mounting deficit coincided with a strengthening of the dollar, as figure 4 shows, and this became the Fed's new focus.

To stem these developments, in September 1985 the United States gathered finance ministers and central bankers from a group of large nations and agreed to the Plaza Accord. Its aim was to depreciate the dollar, facilitated by other central banks raising their interest rates.³ The Fed commensurately started cutting rates in 1985, not long before the 1987 crisis, and lowered the target federal funds rate from 8% to just below 6% going into 1987.

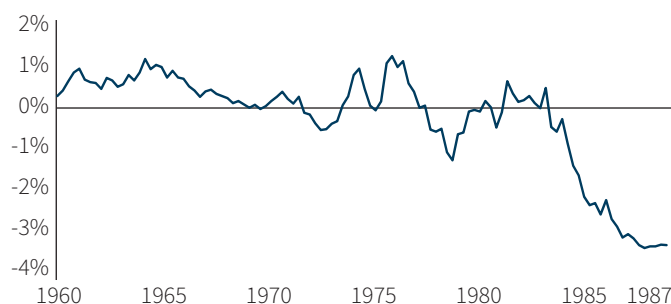
This wave of monetary policy stimulus was short but intense. By February 1987, the dollar had lost 40% of its value and inflation was creeping back up toward 5%. Apparently, this was too much of a good thing. The dollar depreciation prompted another accord in February 1987—the Louvre Accord—which was created to have

Figure 2:
Effective Federal Funds Rate Less Taylor Rule Rate



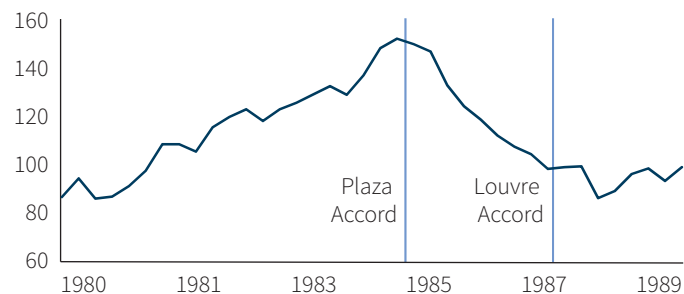
— Rate Smoothing = 0.5, Inflation Differential = 1.5, Output Gap = 0.5
 - - - Rate Smoothing = 0.0, Inflation Differential = 1.0, Output Gap = 0.5
 Source: Federal Reserve Bank of Atlanta, William Blair, as of July 31, 2018.

Figure 3:
Current Account Balance as a Percentage of GDP



Sources: Federal Reserve Bank of St. Louis, William Blair, as of October 1987.

Figure 4:
U.S. Dollar Index



Sources: Bloomberg, William Blair, as of March 1989.

“With the birth of this so-called ‘Greenspan Put,’ the 800-pound gorilla of U.S. monetary policy had unleashed itself on capital markets.”

the opposite effect of the Plaza Accord: that of strengthening the dollar.⁴ Federal Reserve Chairman Paul Volcker and his successor Alan Greenspan increased the Fed’s target rate from 6% to 7.3% in 1987, effectively pulling the punch bowl away from the party.⁵ Figure 5 shows the target federal funds rate during that time.

Between the two accords, as the Fed lowered interest rates, markets rallied on the stimulus, good economic news, and widespread optimism encouraged by the illusion of prosperity the Fed created. Despite being a short-lived period of monetary loosening, the S&P 500 Index performed in a manner that would become familiar to investors. It rose by 85% between February 1985 and August 1987, while producing low volatility.

This optimism did not last long. Having ridden a wave of money-induced euphoria, the system was ripe for a correction. It came with a vengeance, after an already tumultuous September and October in 1987. From October 14 through October 16 of 1987, the Dow Jones Industrial Average (DJIA) declined by 10%. Investors’ moods darkened. The following Monday, October 19, which would be labeled “Black Monday” for being the worst day in market history, the DJIA dropped 508 points—almost 23%—and the S&P 500 Index fell by more than 20%. Over four business days, ending on Black Monday, the S&P 500 Index plunged 29%.

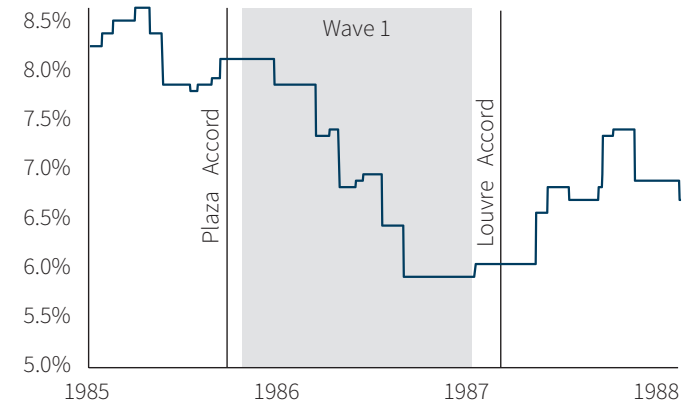
Flush with confidence from its perceived successes in steering the exchange rate, breaking inflation, and ending the 1982 recession, the Fed stepped in to end the Black Monday crash by flooding the system with liquidity. It lent through the discount window, bought Treasuries, encouraged banks to lend to Wall Street, and lowered the federal funds rate.⁶ With the birth of this so-called “Greenspan Put,” the 800-pound gorilla of U.S. monetary policy had unleashed itself on capital markets. With this series of interventions, the markets began to expect the Fed to serve as a financial market backstop.

In addition to the liquidity firehoses, policy makers moved to prevent market crashes and volatility through new regulations. For this purpose, they set up the so-called “Brady Commission” to craft recommendations on how to tame capital markets. These recommendations, in part, institutionalized the circuit breaker, an important control mechanism that we describe in depth later. With the 1987 crash, manipulative central bank policies and circuit breakers were released unto the market—their legacy persists to this day.

The Second Wave

With the 1987 crash in the rear-view mirror, Washington policy makers set out to make subsequent years worry-free. In the late 1980s and early 1990s, the Fed kept interest rates low during a period of economic stability throughout the developed world.⁷ This so-called “Great Moderation” established the idea that central banks had finally abolished business cycles for good. There

Figure 5:
Target Federal Funds Rate



Sources: Bloomberg, William Blair, as of January 29, 2018.

was nothing that well-meaning and seemingly thoughtful public policies couldn’t do.

The new economic stability mirrored similar financial market stability. The story went that the internet and its dot-com byproducts had created a “new economy” in which higher growth and lower volatility were the new “normal.” In the vernacular of the time, Greenspan “got it.” Greenspan “got it” because he bought into a sustainable productivity increase based on the emergence of a new economy built on technology and e-commerce. The era of high economic volatility was over and the Fed stood ready to stem any crash.

In the run-up to the 2000 dot-com crash, unemployment dropped below levels not seen since 1970, bottoming out at about 4% in June 2000. By then, inflation had risen to 3.7%, from 2% a year earlier. Productivity was also increasing rapidly. The economy, in short, was overheating, and the surging stock market was but another sign of this. This warranted increasing interest rates. However, a couple of events came along that stirred the Fed’s worry. In 1997, East Asia suffered a financial crisis and, a year later, Russia defaulted on its debt. Both events shook the U.S. markets. Not only did the Fed avoid rate increases, it increased the growth rate of the monetary base from 4% to 10% between 1996 and 1999, and lowered interest rates on three occasions in 1998, from 5.5% to 4.75%.

The sustained period of low rates helped push stock prices toward the sky in a narrow but large IT-sector bubble. Ignoring the pessimists’ warnings of a tech bubble, the new economy’s high productivity was used to justify higher valuations and, thus, the absence of any cooling measures.⁸ When the Fed finally started raising rates, the bubble was already on the brink of bursting. Between March 24 and May 10 of 2000, the tech-heavy Nasdaq Composite Index fell by almost 30%. The equity market rout continued into the summer of 2002.

“The GFC-induced Fed put became the mother of all Fed puts, extending for the subsequent 10 years and counting.”

The Third Wave

In 2001, the *Financial Times* ran a telling headline: “It’s official. There is a Greenspan put option.” The “Fed put” was again pulled out to do its magic. After the Fed’s initial put-option reactions, it stayed accommodative from 2002 to 2005.⁹ The Fed kept the effective federal funds rate below the Taylor Rule recommendation until early 2008. According to most standard rules for monetary policy, high productivity over this period prescribed interest rates on the higher side.¹⁰ Unnaturally low interest rates drove the cost of capital below equilibrium for several years.¹¹ Almost flooring the federal funds rate was great for the markets, but predictably caused a new bubble.¹²

Just like in the period before the dot-com crash, risk-taking was encouraged by lower market volatility, with years of annual S&P 500 Index volatility at 10%.¹³ In a deceptively safe environment, the risk premia on risky assets declined. This time, investors piled money into the housing sector in search of yield. We can see this by looking at the capitalization rate, a measure of real estate yield that divides net operating income by market value of a property. Figure 6 shows the capitalization rate for multifamily houses in relation to 10-year U.S. government bonds. We can observe a sharp drop in this relationship to unsustainable levels between 2002 and 2007.

Steadily increasing house prices and low volatility again provided the backdrop for another new theory of the economy. This time was different and in the new theory, stock markets were a long-term opportunity that could be ridden to inevitable new highs. In the eyes of the market, housing—being a real asset—could not decline in value, which warranted exceptionally low risk premia. Since real estate prices had never fallen on a national scale, homebuyers were able to secure huge mortgages with little equity coverage and few terms of recourse. These “whole loans” were packaged into ever more leveraged slices of risk exposure and sold as financial products, creating a fragile financial backdrop.

As real estate prices declined and subprime lending began to sour, leverage in the system was quickly withdrawn. The financial system briefly seized, causing equity prices and bond yields to collapse. The equity market decline starting in 2007, again triggered the Fed put, with the target federal funds rate dropping from 5.25% in September 2007 to below 1.0% by October 2008.

The Start of the Fourth Wave

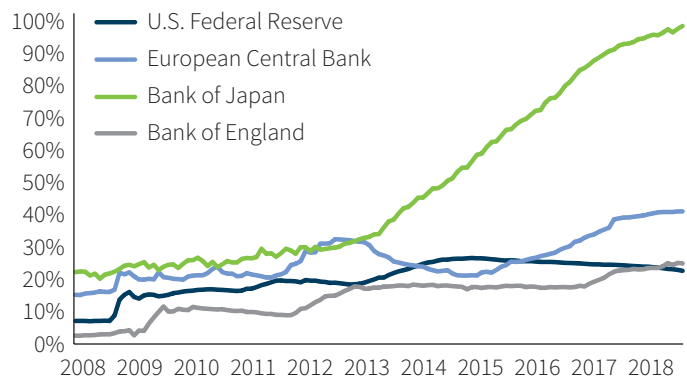
After the GFC, when it seemed as if the Fed could get no more accommodative, it pushed the federal funds rate down further, largely removing any remaining market risk influences. The Fed tagged the effective federal funds rate at 0.25% in November 2008 and then introduced quantitative easing—the mass purchases of government bonds. Low interest rates, together with a massive fiscal stimulus package and a series of bailouts, worked like an opiate on the markets, keeping them calm and happy in the short run but inevitably sick in the end.

Figure 6:
Cap Rate Spread to 10-Year Government Bonds



Sources: Bloomberg, William Blair, as of March 2018.

Figure 7:
Central Bank Balance Sheets as a Percentage of GDP



Source: Bloomberg, William Blair, as of May 2018.

The GFC-induced Fed put became the mother of all Fed puts, extending for the subsequent 10 years and counting. The Fed expanded its balance sheet to an inconceivable 26% of GDP by 2014. The Fed was not alone. The Bank of England (BOE), Bank of Japan (BOJ), and European Central Bank (ECB) also expanded their balance sheets and all but the United States remain at historic peaks. The BOE’s balance sheet has ballooned from 2% of GDP in early 2008 to 24% today, the ECB’s from 15% to 40%, and the BOJ’s from 21% to 98%. The BOJ is reacting to a quarter century of economic stagnation by becoming the world leader in balance sheet expansion. The ECB comes second, after Europe’s dual financial crises. In aggregate, the G4 central banks expanded balance sheet assets from 10% to 37% of GDP, thus breaking the previous record of 12% in 2005. Figure 7 illustrates.

Beyond ultra-easy developed economy monetary policies, the People’s Bank of China (PBOC), through its peg to the U.S. dollar, also implemented a defacto easy-money stance.

There is not just one 800-pound gorilla harassing capital markets; a troop of gorillas has held markets hostage for more than a decade. The effects of these quantitative easing policies and the resulting malinvestment are unknown, but it is hard to see how this latest wave can end well.

“There is not just one 800-pound gorilla harassing capital markets; a troop of gorillas has held markets hostage for more than a decade.”

Capital Market Repercussions

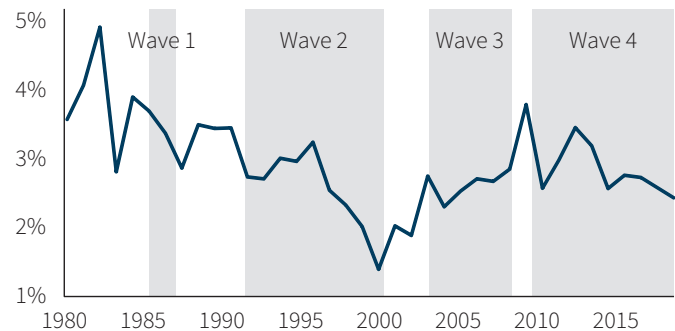
Of utmost concern with the sheer scale of post-GFC policy easing should be its distortionary effects on asset prices and the suppressed growth potential of the real economy. Central banks encourage risk-taking by lowering interest rates and pushing down the market risk premium. Geert Bekaert and co-authors of a *Journal of Monetary Economics* study find that loose monetary policy lowers implied volatility in the stock market after about nine months, and that this effect lasts more than two years.¹⁴ Ben Bernanke and Kenneth Kuttner, in the *Journal of Finance*, similarly conclude that loose monetary policy pushes down the equity risk premium.¹⁵ Central banks thus push prices higher, create a sense of market calm, and set markets up for bigger falls. Figure 8 shows the implied risk premium for the S&P 500 Index using a model based on earnings growth, dividends, and stock prices.¹⁶ We see that the short-term interest rate decline from over 5% in 2006 to effectively 0% in 2008 boosted the implied equity risk premium going into the 2008 stock market crash.

The 1980s wave of monetary easing was brief. The next two waves were longer than the first, and with longer and deeper bear markets. The light blue line in figure 9 shows high or rising returns and the dark blue line low or declining volatility during the second, third, and fourth waves of monetary stimulus. Figure 10 instead shows the Sharpe Ratio, which is the combined effect of return and volatility.

In the 2000s, easy monetary policy resulted in high real estate prices more than high equity market returns, which participated only during the final push of easy money. The GFC market collapse was unique in that prices were relatively close to fundamental values for most non-real estate assets heading into it. The global equity market collapse drove equities globally to unprecedentedly cheap valuations and bonds into extremely expensive bubble territory. Since 2013, three-year rolling S&P 500 Index returns have averaged greater than 10% annually. The most recent wave of easy money has pushed equity prices from cheap to expensive in many, but not all, parts of the world, with the S&P 500 Index generating vast rewards for investors.

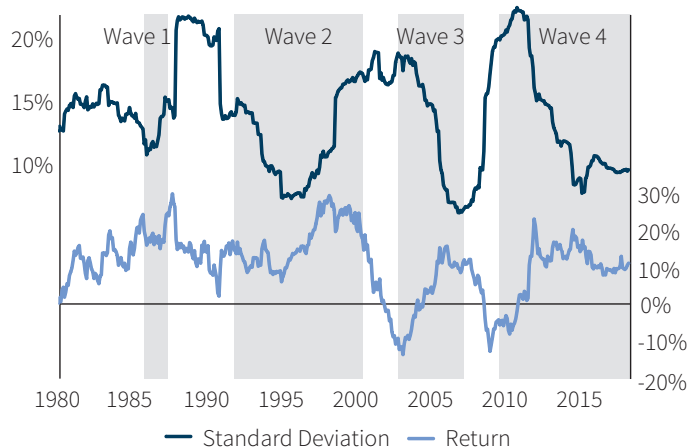
Looking outside the United States, the ECB is pursuing similar monetary actions as the Fed. During ECB President Jean-Claude Trichet's tenure after the GFC, ECB policy was relatively restrictive. By contrast, following the 2011 European Debt Crisis and the appointment of Mario Draghi, its approach has been much more stimulative. As a result, risky asset prices have risen and volatility has remained at low levels, as figure 11 illustrates. Draghi's "do whatever it takes" dictum ranks right up there with Greenspan's "put." Thus, this stimulative environment has expanded beyond the borders of the United States, which is now tentatively shifting away from ultra-easy policy.

Figure 8:
Implied Equity Risk Premium for the S&P 500 Index



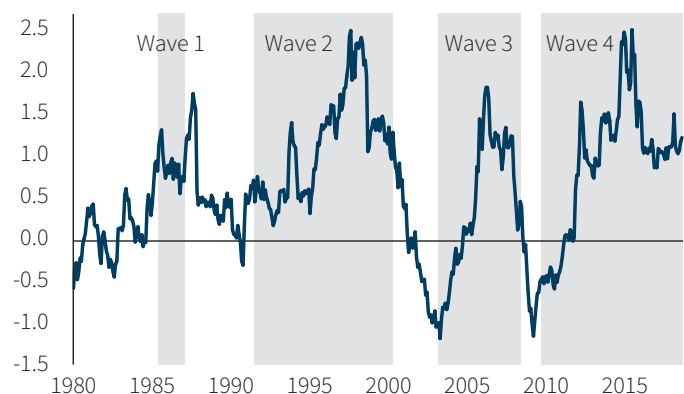
Source: William Blair, as of 2017.

Figure 9:
Rolling 36-Month Return and Volatility, S&P 500 Index



Source: Bloomberg, William Blair, as of July 31, 2018. Past performance is not indicative of future returns.

Figure 10:
Rolling 36-Month Sharpe Ratio, S&P 500 Index



Source: Bloomberg, William Blair, as of July 31, 2018. Past performance is not indicative of future returns.

“For those riding this momentum, it’s a fun party while it lasts. But only the most sophisticated and forward-looking investors are able to deftly navigate the inevitable removal of the punch bowl.”

In addition to raising risky asset prices, the troop of gorillas has overwhelmed fundamentals by encouraging systematic co-movement.

This environment advantages quantitative and factor-based strategies. Persistence of ultra-easy monetary policies reinforces systematic price movement and rewards such strategies, presenting fundamental investors with an uphill battle against price manipulation. The global underperformance of value versus growth, shown in figure 12, brings to light this uphill struggle. For factor investors, value is therefore one factor that does not work in a loose monetary environment.

By manipulating interest rates, central banks become the price-setting investors, precluding fundamentals from exerting enough influence to bring asset prices back toward values. This makes markets more systematic, rewarding persistent exploitation of factors like momentum and low volatility. For those riding this momentum, it’s a fun party while it lasts. But only the most sophisticated and forward-looking investors are able to deftly navigate the inevitable removal of the punch bowl. The rest are left to nurse their self-inflicted wounds.

Why This Time Is Different

As the end of the fourth wave of central bank easing comes to an end, its magnitude and breadth combine with three other dynamics to give us ample reason to believe that the next downturn will be more disruptive than those of the past:

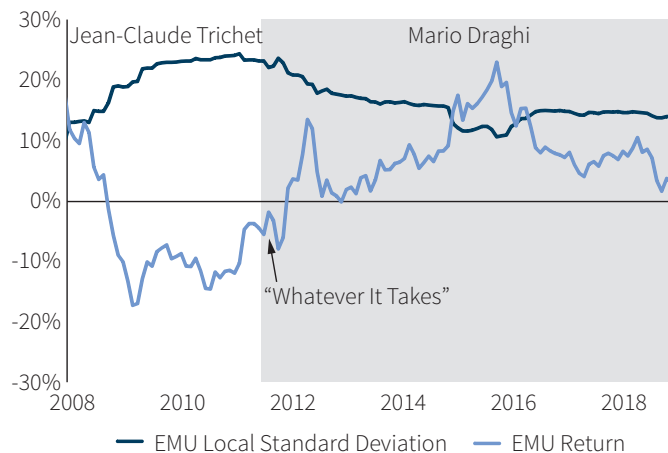
- First, the current market structure is heavily influenced by rules-based and systematic strategies, which have limited if any ability to adapt to new market circumstances.
- Second, the Volcker Rule, introduced after the GFC, is creating a dearth of liquidity that has yet to show its ruthlessness in a bear market.
- Third, circuit breakers, continually contorted after their 1987 introduction, will hinder price discovery and risk spreading market panic when the next crisis hits.

We will discuss these three in turn. When combined with distortionary monetary policy, these factors make the market environment unusually fragile in the face of a crisis.

Rules-Based and Systematic Strategies

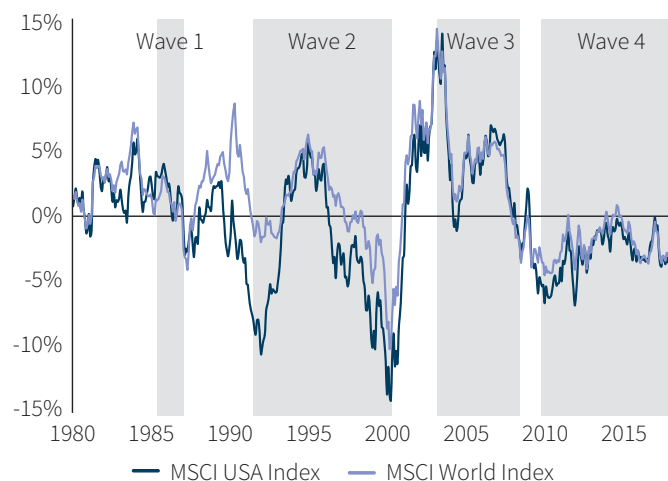
As in the prior three waves, central banks’ current ultra-easy monetary policies have not only pushed volatility down and asset prices up, but also discouraged fundamental-value investing. The age-old dictum, “Don’t fight the Fed,” is even more powerful when several central banks simultaneously triple and quadruple their balance sheets. This has been a good time for systematic strategies, which have seduced investors into believing that simple rules can create superior performance.

Figure 11:
Rolling 36-Month Return and Volatility, Euro Stoxx



Source: William Blair, as of June 29, 2018. Past performance is not indicative of future returns.

Figure 12:
Rolling 36-Month Relative Returns, Value Versus Growth



Source: William Blair, as of July 2018. Past performance is not indicative of future returns. Value and growth style characteristics are as defined by MSCI.

“With more investors doing the same thing, at some point their strategies simply may not work anymore.”

Today’s rules-based strategies include purely passive (index), semi-passive (smart beta), and systematic-quantitative (factor) strategies. Of these three, purely passive strategies should have the least influence on market prices. Most purely passive strategies are well-diversified, market-cap-weighted portfolios mirroring broad indices. Nonetheless, in the chaos of crisis, broad index vehicles are often the immediate go-to source of liquidity and risk mitigation.

Old Rules: Portfolio Insurance

The role of rules-based strategies in a market downturn was originally laid bare in 1987. Black Monday opened in a disorderly fashion, and an hour after the open, 30% of the S&P 500 Index constituents still had not begun trading.¹⁷ As a result, the quotes used to construct market indices were stale and did not sufficiently reflect the market’s decline. Market participants were reacting more to price movements than news—the only real news was that prices were declining.

The painful subplot of Black Monday’s saga began in 1976 when two academics, Hayne Leland and Mark Rubinstein, invented a method of hedging a portfolio of stocks against market declines by dynamically selling stocks and index futures. Their strategy replicated a “long put” return profile, by decreasing market exposure when prices declined. The technique was called “portfolio insurance” and a firm called Leland, O’Brien, Rubinstein (LOR) began selling it in the early 1980s. This strategy worked well during the mid-1980s, a period of rising asset prices and relatively low volatility that kept the costs of the strategy down. When equity prices declined, portfolio insurance strategies contractually prescribed selling in order to reduce market exposure. The more prices declined, the more portfolio insurers sold. They had no discretion and became forced price takers.

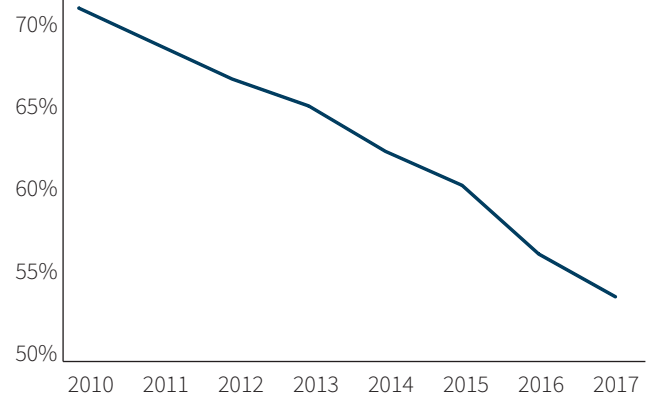
In this state of chaos, real-time information was all but nonexistent. Record margin calls were sucking liquidity out of the market, with clearing house margin calls about 10 times the average size. Intraday margin calls were suddenly required within an hour’s notice, compelling more forced equity liquidation. Portfolio insurers sped up this race by selling all they could.

It is thought that by 1987, LOR had sold some \$60 billion worth of portfolio insurance, representing more than 2.5% of the S&P 500 Index’s market cap.¹⁸ Together with other similar programs, the total portfolio insurance share was about 3% of the market.

New Rules

A generation later, investors armed with faded memories have brought similar rules-based approaches back *en vogue*. Today’s rigid rules are exposed to changes in flows rather than the price fluctuations that directed the behavior of the old portfolio insurance. Research from Morgan Stanley indicates that today’s flavors of rules-based strategies, excluding purely passive index funds, amount to about \$1.7 trillion. Systematic-quantitative and

Figure 13:
Actively Managed U.S. Mutual Funds and ETFs, Share of Assets



Source: Morningstar, as of 2017.

hedge-fund strategies constitute about \$1.2 trillion, and smart beta strategies add about another \$0.5 trillion.¹⁹

Any estimates of magnitude should be taken with a healthy dose of skepticism. BlackRock’s smart beta offering alone reached \$288 billion as of November 2017. Vanguard’s adds another approximately \$150 billion.²⁰ Bloomberg estimated smart beta assets under management (AUM) at \$600 billion in May 2018²¹ and Boston Consulting Group at \$430 billion in July 2018.²²

The transition from discretionary portfolios to semi-passive, systematic-quantitative, and even purely passive strategies involves selling losers and accumulating winners. As long as these rules-based strategies grow, they support market momentum and price moves become detached from fundamental values.

The fundamental motivation for transacting has diminished considerably. The accumulation of assets in rules-based strategies has reduced fundamental discretionary trading volumes to only an estimated 10% of total volume.²³ Figure 13 shows that only 55% of mutual-fund assets are now actively managed. The problem with this is that with more investors doing the same thing, at some point their strategies simply may not work anymore.

Systematic-Quantitative Strategies

The demand for systematic-quantitative, or risk-factor, strategies has surged in recent years, a growth rate that suggests marginal players are getting in on the party. These strategies are often based on a common set of confirmed factors, such as value, momentum, quality, volatility, and yield. Over time, these marginal players data-mine their way to establish rules and correlated outcomes depending on the sensitivity of their algorithms. An example of such a factor-based fund is the iShares Edge MSCI Multifactor USA ETF, which “seeks to maximize exposure to factors that have historically outperformed the broad market.”²⁴ “How likely is it that other funds would have the same factor exposures?” asks

“The current low-inflation environment is unlikely to persist, even if it doesn’t return to a 1970s and 1980s environment.”

Andrew Lo of MIT. “If they use similar quantitative portfolio construction techniques, then more often than not, they will make the same kind of bets.”²⁵ When flows turn the other direction, the virtuous cycle that bolstered past performance can rapidly become vicious.

Of course, not all systematic-factor strategies are structurally identical. Of primary concern are those marginal players that have unwittingly herded into similar exposures as an ultra-easy monetary environment has persisted.

Smart Beta

Smart beta exchange-traded products (ETPs), while smaller in AUM than systematic-quantitative strategies, are notable as the most rigid category of rules-based strategies. While systematic-quantitative strategies constantly run their algorithms based on past data, smart beta strategies select and weight securities based on a fixed set of rules, purportedly capturing the systematic compensation of underlying risk factors to deliver better risk-adjusted returns than active portfolios. Like systematic-quantitative strategies, smart beta rules are predicated on previously observed “systematic” market characteristics.

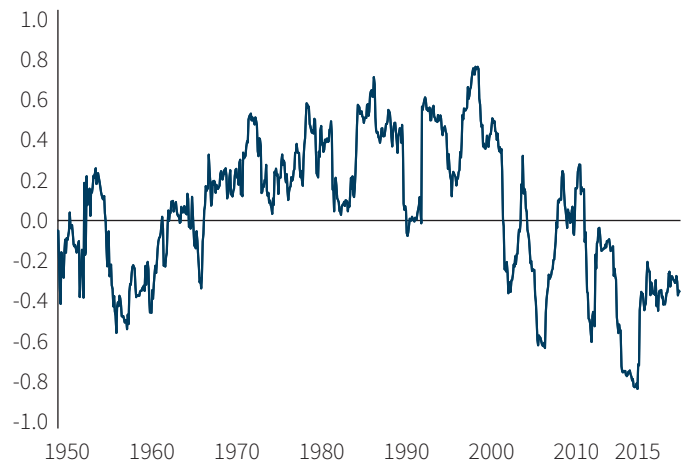
Many smart beta portfolios are packaged as ETPs because passive ETP construction requirements dovetail nicely with rigid smart beta rules. Almost 64% of institutional investors use equity smart beta strategies, up threefold in only two years.²⁶ Europe is the leader in smart beta investing, but in the United States this category is still significant.

Risk Parity

A special case of a rules-based strategy is risk parity, which differs from smart beta and factor strategies by not relying on factors for rebalancing. Risk parity strategies instead rebalance to equilibrate risk across asset classes. They are more diversified and not as tightly rule-bound as smart beta and systematic-quantitative strategies. The main danger of risk parity is deleveraging triggered by a simultaneous increase in asset class volatilities and cross-asset-class correlations. Risk parity strategies are estimated to currently total about \$600 billion in AUM, according to Algebris Investments. A deleveraging of that size would not overwhelm the market, but would certainly contribute to asset price declines in the midst of a correlated rules-based strategy sell-off.

This would likely happen in the event of a correlation increase between stocks and bonds. As an example, Bloomberg estimates that an increase in correlation between the return of the Bloomberg Barclays Global Aggregate Index and the S&P 500 Index from -0.66 to zero would have a material impact on this type of strategy: “a hypothetical risk parity portfolio of just those two assets would cut its leverage by 87 percent.”²⁷ As figure 14 shows, while the global financial crisis brought about a period of negative correlation, zero or even positive correlations between stocks and bonds would in no way be a historical anomaly. The

Figure 14:
Rolling 36-Month Stock-Bond Correlation



Source: William Blair, as of December 2017. **Past performance is not indicative of future returns.** Stocks are represented by the S&P 500 Index; bonds by the 10-year U.S. Treasury.

most recent environment of negative correlations is well below our 0.2 long-term Equilibrium risk model estimate. Our analysis indicates that high and volatile inflation coincides with high stock-bond correlations, and the current low-inflation environment is unlikely to persist, even if it doesn’t return to a 1970s and 1980s environment.

Concavity and Short Volatility

Further compounding the rules-based investment approach are other investment strategies and programs with similar volatility characteristics. Christopher Cole of Artemis Capital Management explores this in a white paper analyzing the vulnerabilities of current market exposure to volatility.²⁸ He defines a short volatility strategy as “any financial strategy that relies on the assumption of market stability to generate returns, while using volatility itself as an input for risk taking.” Per Cole, implicit short volatility strategies (which involve replicating short volatility) and explicit short volatility strategies (which involve directly selling, short volatility) aggregate to \$1.5 trillion, with implicit \$1.4 trillion and explicit around \$0.1 trillion.²⁹

Short volatility strategies, therefore, constitute almost 5% of the (circa 2017) Russell 3000 Index market cap, a much larger share than that of portfolio insurance going into the October 1987 sell-off. If we count only risk parity, volatility control, and explicit short volatility strategies, these still account for 4%. Cole estimates that “as much as a \$600 billion in selling pressure would emerge ... if the market declined just 10% with higher vol[atility].”

The behavior of short volatility strategies may be unintuitive. Explicit short volatility strategies are akin to a direct selling of volatility. They must sell volatility as volatility decreases to maintain their short exposure. Lower volatility thus generates a

“Like snow serenely building on a mountain before the avalanche, the longer volatility remains low, the higher the ultimate risk.”

positive feedback loop, with ever-lower volatility dulling market investors into a numb complacency to risk. Like snow serenely building on a mountain before the avalanche, the longer volatility remains low, the higher the ultimate risk. When the bear market “avalanche” begins, the short volatility strategies’ effective long market exposures increase and losses build up, forcing selling of the underlying market in order to limit losses.

Among implicit volatility strategies, hedged short volatility takes short volatility positions while offsetting the market exposure, similar to selling a put and shorting the underlying stock. These strategies are generally referred to as “concave” and amount to an estimated \$1.5 trillion in AUM. They do well when volatility stays low or mean-reverts, but lose out at an accelerating rate as volatility increases or prices diverge. Hedged short volatility strategies tend to force-sell assets on market falls and buy on market rises. This is because they must hedge growing long positions as asset prices decline and short positions on the upside.³⁰ Think of a short put option: As price declines and the “moneyness,” or delta, increases, the strategy’s exposure gets longer. This is the case with any short option or other short volatility position. To offset these increased exposures and reduce risk in a down market, these strategies must sell to reduce increasing long delta, and buy on the upside to reduce growing short delta.

Unlike Cole, we add credit and illiquid assets to the heap of short volatility strategies growing in the market today. Here, too, investors have effectively sold options. Credit exposes the investor to downside tail risk that requires compensation. With illiquid assets, there is no illiquidity premium “free lunch”—the premium is compensation for an opportunity cost of unknown magnitude, which is the inability to liquidate and invest in emerging superior opportunities for the duration of illiquidity. Credit is the incursion of tail risk and illiquid assets are the opportunity cost of not being able to take advantage of tail risk events.

Prolonged periods of low volatility set the system up for corrections and crashes. They create market fragility. Algorithms that rely on historical volatility numbers acquire ever-larger positions to maintain exposures. Rules-based and short volatility investors have concave portfolios that migrate to higher risk levels as they attempt to maintain strategy volatilities. When this dynamic breaks, it can do so in grandiose fashion. One group of economists looked at the connection between periods of low volatility and found a strong connection to subsequent banking crises. Low and behold, low volatility turns out to be a significant predictor of banking crises. The researchers attribute the connection to excessive lending and increased financial leverage.³¹ This is yet another indication that prolonged periods of low volatility, while deceptively attractive, are dangerous.

Early Cracks

Recently, we have seen examples of how rules-based and short volatility strategies may bear the short-term brunt of such cracks in the system. A small Chinese yuan devaluation on August 11, 2015, sparked fears of slowing Chinese growth, which sent markets lower. This built into a larger sell-off in Asia on Monday, August 24. Europe subsequently followed Asia’s decline and the S&P 500 futures fell by 7% at the cash market open. Trading in S&P 500 Index futures halted. As the market opened, bid/ask spreads widened for individual stocks, delaying opening trades and causing problems with calculating ETP prices. In the first 15 minutes, only half of the S&P 500 Index’s stocks opened and 765 Russell 3000 Index stocks were down more than 10%, triggering 1,278 trading halts. The iShares Core Conservative Allocation ETF dropped about 50%, the \$65 billion iShares Core S&P 500 ETF fell by 25%, and the \$18 billion Vanguard Dividend Appreciation and the SPDR S&P Dividend ETFs plunged by 38%. Ironically, the PowerShares S&P 500 Low Volatility ETF fell 46%. This was all a manifestation of how vulnerable ETPs are in a marketplace deprived of liquidity.

Another crack appeared with short-volatility trading being forced into reverse in late January and early February 2018, as increased implied volatilities drove some short volatility ETPs to collapse. This came as the Fed vowed to raise rates and doubts emerged about the prudence of volatility-selling strategies. The sudden volatility increase augmented the short positions of inverse volatility ETPs, which were forced to buy volatility as a result. Leveraged long-volatility strategies also had to buy volatility to maintain their leverage targets when their long positions increased. Predatory traders took the opportunity to front-run this buying. They, too, bought volatility and pushed it up into the close of the trading day, forcing the VIX even higher and triggering more rebalancing.

Unable to buy relatively illiquid VIX futures, panicked traders sold S&P 500 Index ETPs and futures contracts predicated on a high negative correlation between S&P 500 Index returns and volatility changes. This selling temporarily drove the index down about 7%.

These events exemplify how rules-based strategies are penalized when the momentum from which they benefit is disrupted and their behaviors combine to create destructive feedback loops. The next such exodus will likely follow these examples, and be both sharper and deeper than has been witnessed previously. The Volcker Rule and circuit breakers introduced after the crashes of 2008 and 1987, respectively, are likely to exacerbate the bear market that central banks will have already spawned. We turn to these market-changers next.

The Volcker Rule

After monetary policy and systematic strategies, our main worry is the role played by the Volcker Rule. It was the capstone of the financial industry regulations that came out of the 2008 financial

“The Volcker Rule may be preventing large financial institutions from acting as market makers when this is needed the most.”

crisis, changing the dynamics of the markets for the worse, in our view.

The Volcker Rule came into force in July 2015—just before the aforementioned August 2015 crack—as part of the Dodd-Frank Act. Dodd-Frank added a long list of new regulatory agencies, which imposed a mountain of complicated rules that prompted financial institutions to boost their compliance departments. Together with the new international Basel III framework, it also imposed stringent capital requirements on financial institutions.

The Volcker Rule, Dodd-Frank, and Basel III are all aimed at reducing risk-taking and speculation by financial institutions. Alas, the law of unintended consequences is catching up with these rules faster than most analysts would have predicted. The capital requirements in Dodd-Frank and Basel III are decreasing risk with the side effect of making the system less efficient, as financial institutions pass the costs of higher capital holdings on to their customers. The Volcker Rule restricts proprietary trading, which has affected traditional sell-side participation in providing market liquidity.

During the 2008 crisis, several years before the rule came into force, the Fed mandated all the large investment banks to have access to the Fed’s discount window as a way to prop up the financial system.³² With this “privilege” came the Volcker Rule that subsequently prohibited their proprietary trading, so as not to “gamble” with the Fed’s money.

The Volcker Rule keeps getting revised, and one cannot fault banks for being confused about how to abide by it. As the rule now stands, a trading desk can only hold securities that meet the “reasonably expected near-term demand,” or RENTD, of their clients. This sets limits on a security’s exposure, risk, and the time it may be held by the traders. Too long and it looks too much like proprietary trading. While nobody knows how to measure this “reasonable” demand, consultancies are having a field day offering their advice.

The problem with this approach is that holding inventory of assets that may be demanded in the future is an important role of market makers. Precluded from serving this function, investment banks cannot be counted on to provide the crisis liquidity like they have in the past. The Volcker Rule may be preventing large financial institutions from acting as market makers when this is needed the most.³³

A staff report from the New York Fed finds that the banks hardest hit by the Volcker Rule are providing much less liquidity than before the rule was enacted, which indicates that the law is having an impact.³⁴ A working paper from Fed’s Board of Governors draws similar conclusions and also notes that while institutions not covered by the rule have stepped in to take on a bigger role, this has not been enough to prevent an overall drop in market liquidity.³⁵

Since the Volcker Rule, the bond market has become paper thin. Despite a reasonable amount of trading volume, dealer corporate bond inventories have declined from \$250 billion before the financial crisis to about \$30 billion today.³⁶ This suggests that a severe absence of liquidity in the underlying bonds would greet any forced selling of credit exchange-traded notes (ETNs), especially high-yield vehicles. Credit assets simply do not trade with the same liquidity as their respective listed ETNs. They are not stocks and do not have the liquidity of stocks.

The one area where the Volcker Rule may not pose a problem is in U.S. government, agency, state, and municipal debt, as well as foreign exchange (FX) trading, as these are all exempted. It seems the government wanted to make sure not to hurt its own lending ability with the new regulations.

In the absence of any serious crash since the Volcker Rule came into effect, any backward-looking analysis can look at changes in liquidity only under relatively normal market conditions. Our worry is that in times of stress, this rule will show its real capacity to stifle liquidity and price discovery.

While many banks have lost the incentive and ability to provide liquidity, many intermediary functions are now handled by high-frequency traders (HFTs), or algorithmic traders. This is worrying as HFTs will hardly provide liquidity in the face of chaotic markets. They act in sub-second time frames, exploiting system discrepancies and short-term trading behavior quirks. As Goldman Sachs recently spun Oscar Wilde’s definition of a cynic, “HFTs know the price of everything and the value of nothing.”³⁷ It is simply not in their nature to lean against momentum.

Beyond HFTs, hedge funds and other dynamic investors could provide liquidity in time. We work to position our strategies to avoid illiquidity risk exposures and enable the provision of liquidity when the short-term backstops are contravened.

Circuit Breakers

Trading halts in equity markets were introduced in response to the 1987 crash. The idea was to implement “coherent, coordinated circuit breaker mechanisms,” with the argument that “they facilitate price discovery by providing a ‘time-out’ to pause, evaluate, inhibit panic, and publicize order imbalances to attract value traders to cushion violent movements in the market.”³⁸

Thus 1987 saw the introduction of a one-hour trading halt if the DJIA declined 250 points (down 12%) and a two-hour halt on a 400-point decline (down 20%).³⁹ Circuit breakers have been added to and modified repeatedly since then, typically in response to subsequent crises. Market-wide halts now occur for 15 minutes when the S&P 500 Index drops 7%, another 15 minutes if it declines further to 13%, and for the rest of the day if 20% is breached.

The U.S. landscape of circuit breakers is quite fragmented, with both market-wide and single-stock halts and limits.⁴⁰ On top of

“Market forces are like gravity, both inescapable and irrefutable. Declining prices move like water over a cliff, finding ways around obstacles in its path.”



that are price limits, which are pre-specified ranges within which a single stock must trade. Orders outside of that range are rejected, or trading shifts from a continuous market to a call auction market. Circuit breaker rules are also different between countries, with only 9 out of 29 exchanges coordinated, according to a global survey.⁴¹

Academic research on the effects of circuit breakers is inconclusive, but most studies and practitioner reflections suggest that they exacerbate rather than mitigate market declines.

A *Cornell Law Review* article on regulatory overreach describes one way that circuit breakers increase volatility: “If traders fear that a halt will be called before they can submit their orders, they may choose to submit them earlier than otherwise to increase the probability that they are executed. Greater volatility will therefore result as the price limit attracts orders from rationally fearful traders.”⁴² This mechanism is referred to as the “magnet effect.” An SEC report on the October 27-28, 1997, market decline found that “[v]irtually all of the firms interviewed [the largest buyers and sellers] reported that the ... circuit breaker had a strong magnet effect, making the second triggering virtually inevitable.”

A second unintended consequence of circuit breakers is the “spillover effect.” Market forces are like gravity, both inescapable and irrefutable. Declining prices move like water over a cliff, finding ways around obstacles in its path. When the cataclysm finds a land obstruction, it simply shifts to a downward alternative. Ultimately, the water reaches its new level. Similarly, market forces are only briefly hindered by circuit breakers, shifting execution to the next best alternative. The market may get its desired “time-out,” but trading soon shifts, from market to market, exchange to exchange, and country to country. Prices will reach new levels, even when forced through circuitous routes.

We are concerned that circuit breakers will conceal the prices that HFTs and other algorithmic traders require to continue active trading, further jeopardizing access to liquidity in a

market downturn. There is no reason to believe that restricting price movement facilitates price discovery. While markets are imperfect, they are the most efficient means of price discovery. Still, regulators and exchange providers rely on these market obstacles while complicating the work of market actors.

Where We Go from Here

The past three major market crises played out in similar ways. Loose monetary policies encouraged passive and rules-based strategies, caused resource misallocations, dampened volatility, and facilitated the formation of asset bubbles. The ensuing corrections prompted regulators to try to control the markets with new tools and restrictions. The cycle then started anew, propelled with monetary accommodation and characterized by rising prices, each time with a bit less flexibility and liquidity in the markets.

The fourth and current wave now displays all the symptoms of fragility. The U.S. equity market has had a great ride since the GFC. Asset prices have appreciated, volatility has been low, and the world’s central banks have been extraordinarily accommodative. Investors have ridden the tide with passive and semi-passive strategies, which benefit from positive momentum and low volatility. While this environment can encourage just about anyone to jump on the bandwagon in fear of missing out, we see all these factors as reasons for caution.

We worry that this time policy makers and markets will be unusually ineffective in stemming a market crash. The environment of today is dominated by passive and momentum-following strategies, which are more likely to conspire to exacerbate the next crash than stem it. The Volcker Rule has yet to show its impact in the scenario of a large and sustained market downturn. Circuit breakers have yet to reveal their influence in a market of ETPs in the case of a real crash, as opposed to the mini-crashes we have witnessed recently. Once the crisis is imminent, the Fed “put” has few teeth left to stop it.

“We worry that this time policy makers and markets will be unusually ineffective in stemming a market crash.”

Jerome Powell took over as Fed chairman in February 2018. As markets may discover to their peril and thanks to his investment banking background, he will likely be more tolerant than his predecessors of market volatility. Thus, after this lengthy period of suppressed volatility, markets will yet again have to get used to some fluctuation. While this may be painful, we believe, in our view, it will be a healthy development and markets will become more fundamentally efficient.

Implications

The last wave of loose monetary policy has accumulated a mountain of resource misallocation that will need to be unwound. Many corporate acquisitions and investments, while feasible at low borrowing rates, may be shuttered, remain idle, or be underutilized as rates rise. Misallocated investments will likely experience price declines associated with the realization of lower-than-anticipated value.

The built-up malinvestment has combined with a global bubble in illiquid assets such as private debt, private equity, infrastructure, and real estate. Fundraising in these asset classes set records on an almost quarterly basis. The sheer size of this build-up suggests that the next correction will take an unorthodox path. As the next bear market sets in, the central banks are likely to underestimate the amount of asset-price correction that needs to take place. Ordinary tools, which now include quantitative easing, may not be enough to turn markets, and central banks may contemplate even more innovative measures.

The next bear market is referred to as “the most anticipated bear market in history.” Many large investors are appropriately cautious and building cash to step in. Like the central bankers, these investors will likely underestimate the size of the correction that needs to take place. Therefore, they may step in too early in the down-market, thus temporarily stemming the fall before it again starts to unwind. This may be a repeated pattern as we endure the next bear market.

There is no telling what event will trigger the switch in the market mood. Potential triggers include a U.S.-initiated trade war, slowing Chinese growth, emerging market currency crises, Russia’s disputes with the European Union and the United States, a sudden jump in inflation in the United States or Euro area, a quarter or two of disappointing earnings in the United States, a Tweet ... the list goes on. As we frequently stress, it is not the trigger that matters, but the environment that allows any of a multitude of triggers to begin the asset-price adjustment process.

A prominent component of this environment will be rising rates, as central banks attempt to dampen any market bubbles through slow increases in risk-free rates. The economic corrections that come with rising interest rates have seldom been smooth in the past, and we have no reason to believe that central bankers will succeed in this pursuit this time either. When markets see central

banks are no longer as willing or able to protect price levels, risk premia of long-term debt and other risky assets will likely jump, thus suddenly suppressing prices. Central banks have shown their willingness to act in whatever way possible to minimize market disruptions and rush in to lower short-term interest rates if markets start to shake uncomfortably. This could punctuate the bond market with volatility that has been absent for many years.

Central banks’ long-term objective is to increase rates without prompting spikes in market risk premia. However, central banks have primary influence on the short end of yield curves, while the market primarily controls risk premia. Thus, we might see an environment where longer-term sovereign bond yields vacillate between bearish central bank tightening and bullish safe-haven attraction.

In this environment, investors might consider selling short-duration bonds and buying long-duration bonds. But investors should be careful about shorting bonds across the board, even though they are fundamentally overvalued. If markets start to shake, central banks may rush in to lower interest rates, making short bond positions painfully expensive.

In bonds, equity, and currency, we see large price discrepancies from values, and we are beginning to see moves toward fundamental value on several fronts. Given the nature of our investment philosophy and process, it is to our benefit that some prices are below fundamental value, providing opportunities to be long, while others are above, providing opportunities to be short. Equity is offering great opportunities in long-term value versus price, but we are also keenly aware of the necessity to navigate the waves that we foresee. It is important to be more cautious than average when seeking to exploit these opportunities and be ready to step out of positions if a crisis is imminent. For example, investors might position long and short across assets as they build larger long exposure in attractive equity markets.

Emerging markets generally have a more solid reserve situation now, but there is a widespread worry that their vulnerability can spark pessimism for seemingly no substantial reason. Many emerging markets have increased significantly in value after adopting institutions supportive of wealth creation. We believe it is important to be able to step into these markets during emerging market panic-herding while avoiding or even shorting those that remain institutional laggards.

It is also important to position a portfolio to enable liquidity provision in panic situations, particularly in corporate bonds that are vulnerable to liquidity shocks and packaged in purportedly liquid ETPs. In doing so, an investor becomes prepared to exploit these opportunities as long as they avoid positioning themselves on the wrong side of fundamental values.

Currency, which has historically been uncorrelated with the broad portfolio, has been and will continue to be an important source of potential return. In this environment, its lack of correlation

“As markets normalize, we believe value will likely outperform growth, reversing in some measure its long period of underperformance.”

with markets allows it to be an engine of return that is outside the realm of our market concerns. We, therefore, expect to take bigger risk in this space than in markets until we are able to identify market opportunities.

As markets normalize, we believe value will likely outperform growth, reversing in some measure its long period of underperformance. It is possible to exploit this reversion by positioning a portfolio in value-heavy sectors such as financial, utilities, and energy. ■

Footnotes

1. Federal Reserve Bank of Atlanta. The Taylor Rule is an equation that prescribes a value for the federal funds rate based on the values for inflation and the output gap.
2. Friedman, Benjamin M. “Lessons on Monetary Policy from the 1980s.” *Journal of Economic Perspectives* 2.3 (1988): 51-72.
3. The accord stated that “...some further orderly appreciation of the main non-dollar currencies against the dollar is desirable.”
4. The text concludes with, “Further substantial exchange rate shifts among their currencies could damage growth and adjustment prospects in their countries. In current circumstances, therefore, they agreed to cooperate closely to foster stability of exchange rates around current levels.” No wonder traders were confused.
5. We show the inflation data that policy makers observed at the time rather than the repeatedly revised numbers that current data reveal.
6. Neely, Christopher J. “The Federal Reserve Responds to Crises: September 11th Was Not the First.” *Federal Reserve Bank of St. Louis March* (2004): 27-42.
7. Goodhart, Charles AE. “The Background to the 2007 Financial Crisis.” *International Economics and Economic Policy* 4.4 (2008): 331-346. Bernanke, Ben, and Gertler, Mark. “Monetary Policy and Asset Price Volatility.” *Economic Review* (Federal Reserve Bank of Kansas City) Q IV (1999): 17-51. *New Challenges for Monetary Policy*, a symposium sponsored by the Federal Reserve Bank of Kansas City, Jackson Hole, Wyoming. August 26-28, 1999.
8. Hayford, Marc D., and Malliaris, A. (Tassos) G. “Monetary Policy and the U.S. Stock Market.” *Economic Inquiry* 42 2004: 387-401.
9. Ahrend, Rudiger., Cournède, Boris, and Price, Robert. “Monetary Policy, Market Excesses and Financial Turmoil.” OECD Economics Department Working Papers 597 (2008).
10. Selgin, George, Beckworth, David, and Bahadir, Berrak. “The Productivity Gap: Monetary Policy, the Subprime Boom, and the Post-2001 Productivity Surge.” *Journal of Policy Modeling* 37.2 (2015): 189-207.
11. Lombardi, Marco J., and Sgherri, Silvia. “(Un)Naturally Low? Sequential Monte Carlo Tracking of the US Natural Interest Rate.” *European Central Bank Working Paper Series* 794 (2007).
12. Taylor, John B. “Getting Back on Track Macroeconomic Policy: Lessons from the Financial Crisis.” *Federal Reserve Bank of St. Louis Review* 92.3 (2010): 165-176. Selgin, George, Beckworth, David, and Bahadir, Berrak. “The Productivity Gap: Monetary Policy, the Subprime Boom, and the Post-2001 Productivity Surge.” *Journal of Policy Modeling* 37.2 (2015): 189-207.
13. Between April 2004 and July 2007. Measured on an annual basis.
14. Bekaert, Geert, Hoerova, Marie, and Lo Duca, Marco. “Risk, Uncertainty and Monetary Policy.” *Journal of Monetary Economics* 60.7 (2013): 771-788 Bekaert et al. also find that the component of the VIX explained by lower risk aversion is mostly influenced by monetary policy—less so the part of the VIX they attribute to uncertainty.
15. Bernanke, Ben, and Kuttner, Kenneth. “What Explains the Stock Market’s Reaction to Federal Reserve Policy?” *The Journal of Finance* 60. 3 (2005): 1221-1257. Miller, Marcus, Weller, Paul, and Zhang, Lei. “Moral Hazard and the U.S. Stock Market: Analysing the Greenspan Put.” *The Economic Journal* 112.478 (2002): 171-86. Other academic research confirms that the Fed used lower interest rates, more to boost any financial bubbles than to stem them, between the 1987 and 2000

- crashes: Hayford, Marc D., and Malliaris, A. (Tassos) G. "Monetary Policy and the U.S. Stock Market." *Economic Inquiry* 42 (2004): 387-401.
16. Some studies that find that expansionary monetary policy affects the stock market positively. Thorbecke, Willem. "On Stock Market Returns and Monetary Policy." *Journal of Finance* 52.2 (1997): 635-654.
 Rigobon, Roberto, and Sack, Brian. "The Impact of Monetary Policy on Asset Prices." *Journal of Monetary Economics* 51.8 (2004): 1553-1575.
 Bernanke, Ben, and Kuttner, Kenneth. "What Explains the Stock Market's Reaction to Federal Reserve Policy?" *The Journal of Finance* 60.3 (2005): 1221-1257.
 17. Vigna, Paul. "Crash of '87 Recollections: 'My Singularly Worst-Day Ever.'" *The Wall Street Journal*. October 19, 2012.
 18. Kupfer, Andrew. "Leland, O'Brien, and Rubinstein: The Guys Who Gave Us Portfolio Insurance." *Fortune*. January 4, 1988.
 19. Wigglesworth, Robin. "BlackRock Bets on Algorithms to Beat the Fund Managers." *Financial Times*. March 20, 2018.
 20. Mooney, Attracta. "BlackRock and Vanguard are Smart Beta's Biggest Winners." *Financial Times*. November 26, 2017.
 21. Ponczek, Sarah. "As Smart beta Spreads, Former Fan Wonders If It's Actually Dumb." *Bloomberg*. May 21, 2018.
 22. Boston Consulting Group. "Global Asset Management 2018: The-Digital-Metamorphosis." July 2018.
 23. J.P.Morgan. Other estimates place this percentage higher, up to about 20%.
 24. iShares Edge MSCI Multifactor USA ETF fact sheet, June 30, 2018.
 25. Khandani, Amir E., and Lo, Andrew W. "What Happened to the Quants in August 2007? Evidence from Factors and Transactions Data." *Journal of Financial Markets* 14.1 (2011): 1-46.
 26. Clearpath Analysis. "Sustainable Smart Beta Investing for Institutional Investors." October 2017.
 27. *Bloomberg*. "Latest Quant Armageddon Theory Warns of Risk Parity Correlations." May 12, 2017.
 28. Cole, Christopher R. "Volatility and the Alchemy of Risk: Reflexivity in the Shadows of Black Monday 1987." *Artemis Capital Management*. October 20, 2017.
 29. Cole includes share buybacks in his analysis, but we exclude it because we failed to find empirical justification for the short volatility assertion.
 30. The characteristic of changing exposure based on market price is called "gamma."
 31. Danielsson, Jon, Valenzuela, Marcela, and Zer, Ilknur. "Learning from History: Volatility and Financial Crises." *The Review of Financial Studies* 31.7 (2018): 2774-2805.
 32. Dealbook. "As Goldman and Morgan Shift, a Wall St. Era Ends." September 21, 2008.
 33. Duffie, Darrell. "Market Making Under the Proposed Volcker Rule." *Rock Center for Corporate Governance at Stanford University Working Paper* 106 (2012).
 34. Adrian, Tobias, Fleming, Michael, Shachar, Or, and Vogt, Erik. "Market Liquidity after the Financial Crisis." *Federal Reserve Bank of New York Staff Reports*. 796 (October 2016): 11.
 35. Bao, Jack, O'Hara, Maureen, and Zhou, Alex. "The Volcker Rule and Market-Making in Times of Stress." *Finance and Economics Discussion Series* 2016-102. Washington: Board of Governors of the Federal Reserve System (2016).
 36. McAlvany, David, and Orrick, Kevin. "The Bond Market Is Losing Its Biggest Customer in World History." *McAlvany Weekly Commentary*. May 15, 2018.
 37. Goldman Sachs. "Liquidity as the New Leverage: Will Machines Amplify the Next Downturn?" *Economics Research*. May 22, 2018.
 38. Brady, Nicholas F. et al. 1988. "Report of The Presidential Task Force on Market Mechanisms," January 1988 p.66.
 39. These circuit breakers were triggered not much later when the DJIA dropped on October 27, 1997, by 554 points (7.18%) (SEC "Trading Analysis of October 27 and 28, 1997").
 40. The SEC NASDAQ has established single-stock "limit up-limit down" (LULD) rules, which are similar to trading halts, allegedly to "address extraordinary market volatility in U.S. equity markets." These single-stock halts are predicated not on moves from the prior close, but on price moves that happened over the prior five minutes. A short trading halt occurs if an upper or lower limit is breached for 15 seconds. A NASDAQ summary of the rule can be accessed at https://www.nasdaqtrader.com/content/MarketRegulation/LULD_FAQ.pdf. See also amended Rule 80B: < <http://www.lexis securitiesmosaic.com/gateway/nyse/info-memos/13-6.pdf>>.
 41. Peter Gomber, Benjamin Clapham, Martin Haferkorn, Sven Panz, Paul Jentsch "Circuit Breakers – A Survey among International Trading Venues," World Federation of Exchanges, 2016.
 42. Lawrence Harris, "Dangers of Regulatory Overreaction to the October 1987 Crash". *Cornell Law Review*, Volume 74, Issue 5 July 1989, Article 9, p.937.

About William Blair

William Blair is committed to building enduring relationships with our clients and providing expertise and solutions to meet their evolving needs. We work closely with private and public pension funds, insurance companies, endowments, foundations, sovereign wealth funds, high-net-worth individuals and families, as well as financial advisors. We are 100% active-employee-owned with broad-based ownership. Our investment teams are solely focused on active management and employ disciplined, analytical research processes across a wide range of strategies, including U.S. equity, non-U.S. equity, fixed income, multi-asset, and alternatives. As of September 30, 2018, William Blair manages \$62.2 billion in assets. William Blair is based in Chicago with resources in London, Zurich, and Sydney.

Important Disclosures

This material is provided for information purposes only and is not intended as investment advice, offer or a recommendation to buy or sell any particular security or product. This material is not intended to substitute professional advice on investment in financial products and any investment or strategy mentioned herein may not be suitable for every investor. Before entering into any transaction each investor should consider the suitability of a transaction to his own situation and, if the need be, obtain independent professional advice as to risks and consequences of any investment. William Blair will accept no liability for any direct or consequential loss, damages, costs or prejudices whatsoever arising from the use of this document or its contents.

Any discussion of particular topics is not meant to be complete, accurate, comprehensive or up-to-date and may be subject to change. Data shown does not represent and is not linked to the performance or characteristics of any William Blair product or strategy. Factual information has been taken from sources we believe to be reliable, but its accuracy, completeness or interpretation cannot be guaranteed. Information and opinions expressed are those of the author and may not reflect the opinions of other investment teams within William Blair. Information is current as of the date appearing in this material only and subject to change without notice. This material may include estimates, outlooks, projections and other forward-looking statements. Due to a variety of factors, actual events may differ significantly from those presented.

Past performance is not indicative of future returns. Investing involves risks, including the possible loss of principal. Equity securities may decline in value due to both real and perceived general market, economic, and industry conditions. Investing in foreign denominated and/or domiciled securities may involve heightened risk due to currency fluctuations, and economic and political risks, which may be enhanced in emerging markets. Investing in the bond market is subject to certain risks including market, interest rate, issuer, credit, and inflation risk. Currency transactions are affected by fluctuations in exchange rates; currency exchange rates may fluctuate significantly over short periods of time. Derivatives may involve certain costs and risks such as counterparty, liquidity, interest rate, market, credit, management, and the risk that a position could not be closed when most advantageous. Entering into short sales includes the potential for losses greater than the actual cost of an investment. Any investment or strategy mentioned herein may not be suitable for every investor. Diversification does not ensure against loss.

The **Bloomberg Barclays Global Aggregate Index** is a broad-based measure of the global investment-grade fixed-income markets. The **Dow Jones Industrials Average** is a price-weighted average of 30 significant stocks traded on the NYSE and NASDAQ. The **Euro Stoxx Index** represents large-, small-, and mid-capitalization equity performance across 11 Eurozone countries. The **MSCI USA Index** represents large- and mid-capitalization equity performance in the United States. The **MSCI World Index** represents large- and mid-capitalization equity performance across 23 developed markets. The **NASDAQ Composite Index** is a market-capitalization-weighted index of equities listed on the NASDAQ stock market. The **Russell 3000 Index** measures the performance of the largest 3000 U.S. companies. The **S&P 500 Index** measures the performance of the large-capitalization segment of the U.S. equity market. The **U.S. Dollar Index** is a measure of the value of the dollar relative to a basket of foreign currencies.

Index performance is for illustrative purposes only. Indices are unmanaged, do not incur fees or expenses, and cannot be invested in directly.

Sharpe Ratio is a risk-adjusted measure calculated using standard deviation and excess return to determine reward per unit of risk.

Standard deviation is a statistical measurement of variations from the average.

This material is distributed in the United Kingdom and the European Economic Area (EEA) by William Blair International, Ltd., authorized and regulated by the Financial Conduct Authority (FCA), and is only directed at and is only made available to persons falling within articles 19, 38, 47, and 49 of the Financial Services and Markets Act of 2000 (Financial Promotion) Order 2005 (all such persons being referred to as “relevant persons”). This document is distributed in Australia by William Blair & Company, L.L.C. (“William Blair”), which is exempt from the requirement to hold an Australian financial services license under Australia’s Corporations Act 2001 (Cth) pursuant to ASIC Class Order 03/1100. William Blair is registered as an investment advisor with the U.S. Securities and Exchange Commission (“SEC”) and regulated by the SEC under the U.S. Investment Advisers Act of 1940, which differs from Australian laws. This document is distributed only to wholesale clients as that term is defined under Australia’s Corporations Act 2001 (Cth).

This material is not intended for distribution, publications or use in any jurisdiction where such distribution or publication would be unlawful.

This document is the property of William Blair and is not intended for distribution or dissemination, directly or indirectly, to any other persons than those to which it has been addressed exclusively for their personal use. It is being supplied to you solely for your information and may not be reproduced, modified, forwarded to any other person or published, in whole or in part, for any purpose without the prior written consent of William Blair.