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Street View

EXECUTIVE SUMMARY The return of higher equity volatility has shaken investors, along with their portfolios, and left many reaching back in time for relevant comparisons to today's markets. Broadening this historical exercise to encompass a diverse array of asset class valuations and economic conditions suggests that today's markets appear more like a continuation of the past three years than it may seem at first glance. Relatively sanguine economic conditions with higher-but-stable valuations and moderate volatility also resemble mid- to late-cycle markets of the 1990s and mid-2000s.

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Inside:
Markets in the Rear-View Mirror

"History," writes journalist and historian **Eduardo Galeano**, "never really says goodbye. History says, see you later." Echoing this sentiment, investors and market observers have long used the study of past markets as a way to gauge conditions today and guideposts for the ever-murky future. A wide variety of researchers' scorecards, barometers, and dashboards aim to understand what previous period the current moment most "looks like." It is a common and valid exercise. Without some rigor and breadth, however, many historical comparisons are blunt instruments at best.

With credit spreads near cyclical lows, interest rates beginning to rise again, and the return of equity volatility, this seems like a natural time to look back at market history and see which part of previous market cycles most resemble today's environment. In an effort to build a broad, more rigorous measure, many diverse indicators of the economic and market environment can be used to build a weighted measure of the "distance" between the present and each month since January 1990.

BUILDING A 24-DIMENSIONAL MODEL

For a foray into historical market comparisons, let's start with a diverse panel of U.S. financial environment measures. Figure 1 shows the full array of indicators selected, with a cross-section of valuation and spread measures across key asset classes, as well as inflation, GDP growth, unemployment, and confidence survey measures. For each indicator, one can calculate two sub-indicators: level relative to the long-term history and the rate of change relative to the trailing year. Both measures matter, as for example a market where credit spreads are relatively low and still tightening could represent quite different conditions from one where credit spreads are at identical levels, but have been rising in anticipation of declining credit quality.

To add a bit more structure to the distance metric, one approach is to standardize every indicator to have a historical mean of zero and standard deviation of one[1], then apply reasonable rule-of-thumb weights to the different indicators. Market-driven measures tend to have more timely data and represent forward-looking

FIGURE 1 - Indicator Weights in Distance Metrics			
Category	**Indicator**	**Indicator Weight in Category**	**Category Weight in Total**
Market Indicators	VIX (S&P 500 volatility)	25%	50%
	S&P 500 Forward (Estimated) Earnings Yield	12.5%	
	S&P 500 Trailing-Twelve-Months Earnings Yield	12.5%	
	Investment Grade Credit Option-Adjusted Spread	12.5%	
	High Yield Credit Option-Adjusted Spread	12.5%	
	2-Year Treasury Yields (Short-term interest rate)	12.5%	
	10-Year Minus 2-Year Treasury Yield Spread	12.5%	
Economic Indicators	Real GDP Growth (Quarterly)	33%	25%
	Core CPI Month-on-Month Change (seasonally adj.)	33%	
	Headline Unemployment (seasonally adj. U-3)	33%	
Confidence Indicators	Consumer Confidence Index	50%	25%
	Business Confidence Index	50%	

1 This standardization process aims to ensure that no variable is implicitly overweighted in the overall distance metric due to having a much larger variance than others. As an extra standardization step, logarithmic transformations were applied to the most skewed market indicators (VIX, investment grade bond spreads, and high yield bond spreads) in order to shift their historical distribution of values closer to the Gaussian, or normal, distribution.

views of investors, so it seems reasonable to give market category a 50% weight in the total metric versus 25% each for the economic and confidence survey categories. Within each category, one can equal-weight the various indicators (and their level and rate-of-change sub-measures). The sole exceptions are the level and rate-of-change of the VIX index, which were given double weights, as the VIX index was the sole indicator for the volatility asset class.

With standardized metrics of level and change for each indictor, the result is a 24-dimensional space where every month in the measurement period is represented as a single point. By measuring the weighted Euclidean distance between the April 2018 point and all others, one can estimate how similar or different—relatively— the environment today is to all other periods going back to 1990.

WHAT PREVIOUS PERIODS DOES TODAY MOST LOOK LIKE?

A visualization (Fig. 2) of the results of the analysis shows that overall market, economic, and confidence conditions appear to most closely mirror those of the late 1990s, mid-2000s, and much of the last three years. America's long-running economic expansion has led to fairly steady growth, low unemployment, high confidence for both businesses and consumers, and the relatively higher market valuations that accompany those conditions. Perhaps the larger surprise is that there do not appear to be very close parallels to the 1999-2000 "irrational exuberance" market or the 2008 tumult immediately preceding the Global Financial Crisis.

Indeed, the recent jump in equity market volatility may have been frightening after the deafening silence of 2017, but it's easy to forget that the VIX hit an intraday high of 53 as recently as August 24, 2015 when investors' list of concerns included a potential Chinese economic slowdown and the end of the Fed's quantitative easing. Current valuations and volatility do not appear uncommon for a mid- to late-stage bull market, while rate-of-change metrics and leading indicators like confidence surveys still appear positive (in contrast to their declining levels in 2007-2008). The broad measure of market similarity suggests that today, like so much of the past few years, the market is climbing the "wall of worry" that continually lies ahead even as yesterday's fears diminish.

FIGURE 2 - Distance from April 2018 Market Environment, Total and by Category
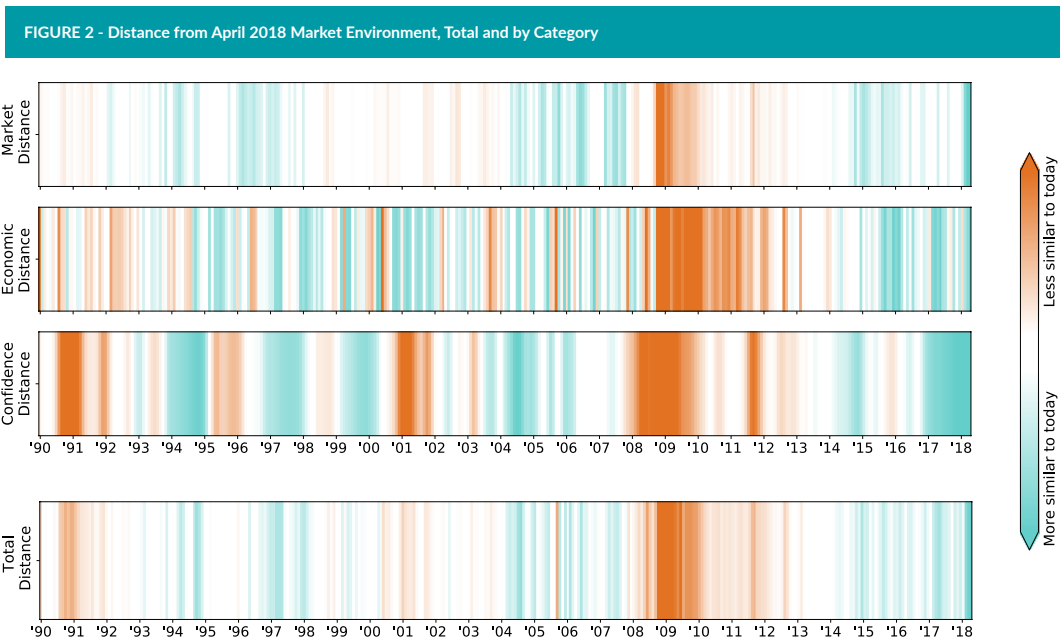
Notes: Heat map representing the "distance" of each historical month from April 2018 based on the level and rate-of-change of the indicators in Figure 1. Months that are closest, or most similar, to April 2018 appear in bright teal, while those furthest away are represented by bright orange.

This comparison with past markets may appear relatively comforting, but markets always have a way of surprising. No analysis is complete without looking for disconfirming evidence, and the Confidence metrics in Figure 2 suggest that one will not always see the troubles ahead. Although businesses and consumers grew wary before the Global Financial Crisis, confidence surveys showed no such foresight in the Tech Bubble; measures remained elevated until the market had already turned the corner and begun a two-year decline. Even if the skies look relatively clear for now, the rains can come at any time.

IMPLICATIONS FOR ALLOCATORS

Although the past never repeats exactly, historical studies may still help investors keep today's events in perspective and prepare for the more likely futures. Statisticians encourage a disciplined approach to this exercise, favoring broad and diverse views of the market environment over focus on isolated data points that might mislead as much as they illuminate. The trick potentially lies in how to combine such broad and sometimes conflicting data into insightful metrics. Statistical approaches to measuring similarity between today's market, economic, and confidence indicators and those of past periods may provide a way for allocators to quantify which types of previous conditions may be ready to "say hello" once again.

APPENDIX

Indicator	Source
VIX Index (from 1990)	Chicago Board Options Exchange; retrieved from http://www.cboe.com/products/vix-index-volatility/vix-options-and-futures/vix-index/vix-historical-data
VXO Index (1989)	Chicago Board Options Exchange; retrieved from http://www.cboe.com/products/vix-index-volatility/vix-options-and-futures/vix-index/vix-historical-data
S&P 500 Forward Price-to-Earnings ratio (inverted)	Bloomberg, Ticker: SPX, Field: INDX_GENERAL_PE_RATIO
S&P 500 Trailing Price-to-Earnings ratio (inverted)	Bloomberg, Ticker: SPX, Field: INDX_GENERAL_EST_PE
Investment Grade Credit Option-Adjusted Spread	Bloomberg, Ticker: LUACOAS
High Yield Credit Option-Adjusted Spread	Bloomberg, Ticker: LF98OAS
2-Year Treasury Yield	Bloomberg, Ticker: USGG2YR
10-Year Treasury Yield	Bloomberg, Ticker: USGG10YR
Real GDP Growth (Quarterly)	OECD (2018), Quarterly GDP (indicator). doi: 10.1787/b86d1fc8-en
Core CPI Month-on-Month Change (seasonally adj.)	U.S. Bureau of Labor Statistics, Consumer Price Index for All Urban Consumers: All Items Less Food and Energy [CPILFESL]; retrieved from https://fred.stlouisfed.org/series/CPILFESL
Headline Unemployment (seasonally adj. U-3)	U.S. Bureau of Labor Statistics, Civilian Unemployment Rate [UNRATE]; retrieved from https://fred.stlouisfed.org/series/UNRATE
Consumer Confidence Index	OECD (2018), Consumer confidence index (CCI) (indicator). doi: 10.1787/46434d78-en
Business Confidence Index	OECD (2018), Business confidence index (BCI) (indicator). doi: 10.1787/3092dc4f-en

Notes: All data retrieved on May 4, 2018

INTERESTING TECHNOLOGY-RELATED ARTICLES

Two Sigma views itself as a technology company that applies a rigorous, scientific method-based approach to investment management. Our technology is inspired by a diverse set of fields including artificial intelligence and distributed computing. Occasionally, we read articles in the popular press that describe applications of technology that we find interesting, thought-provoking, and relevant for people thinking about improving the investment management process. Below is a subset of the articles we read this month. Please do not view the inclusion of these articles as an endorsement by Two Sigma of their viewpoints or the companies discussed therein. Two Sigma welcomes discussions (and contributions) about these and other such technology-related articles.

"Artificial Intelligence Is Cracking Open the Vatican's Secret Archives " by Sam Kean

https://www.theatlantic.com/technology/archive/2018/04/vatican-secret-archives-artificial-intelligence/559205/

The Archivio Segreto Vaticano, or "Secret Vatican Archives," comprises 85km of shelves full of handwritten manuscripts and parchments dating back more than 1,000 years. In an effort to preserve and disseminate the historical information contained within these (not actually secret) documents, a team of researchers based at Roma Tre University developed a novel method based on convolutional neural networks and statistical language models for digital transcription. Their approach is "to govern imprecise character segmentation by considering that correct segments are those that give rise to a sequence of characters that more likely compose a Latin word." To build a training model for this type of complex character recognition software, the team hired students at 24 schools to manually mark whether the algorithm had correctly identified breaks between letters or not. The project is an interesting example of how AI techniques, in combination with astute researchers, can significantly ease the process of knowledge discovery from large, messy, and unorthodox datasets.

"Data Protectionism: The Growing Menace to Global Business" by Alan Beattie

https://www.ft.com/content/6f0f41e4-47de-11e8-8ee8-cae73aab7ccb

A study by the McKinsey Global Institute concludes that the cross-border flow of data added roughly 3 per cent to global gross domestic product between 2005 and 2015, a figure that stands to increase as the world economy becomes more "information-intensive." Yet, according to a recent Financial Times article, significant regulatory discrepancies among major global economies and regions threaten increasingly to hamstring the economic contributions of greater adoption of technology. "Data protectionism"—the regulatory mandate to keep data within borders—has become a sticking point in various multilateral trade negotiations, with little near-term prospect of resolution. The issue, however, promises only to grow in importance over time.

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