PORTFOLIO INSIGHTS

Connecting market and macroeconomic volatility

Multi-asset implications

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MULTI-ASSET SOLUTIONS

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TRENDS IN MARKET VOLATILITY HAVE ATTRACTED CONSIDERABLE ATTENTION OVER THE PAST YEAR. During the second half of 2017, implied and realized market volatility, particularly in equities, ran at extraordinarily low levels by historical standards. This phenomenon raised questions about investor complacency. Subsequently, in early 2018, volatility surged. Market participants then wondered whether the shift occurred at random or was sending signals about the economic cycle.

More broadly, volatility forecasts play a major role in our investment process. Our *Long-Term Capital Market Assumptions* (LTCMAs) include volatility projections for each of the asset classes under consideration, and the resulting Sharpe ratio comparisons help shape our thinking about strategic portfolio benchmarks. In making tactical allocations, we rely on shorter-term volatility forecasts to guide decisions about overall portfolio risk, as well as how this risk is distributed across relative value positions. In both cases, we lean heavily on historical volatility data in setting these projections.

In this paper, we consider the interconnections between macroeconomic volatility and market volatility. We start from an intuitive assumption that market volatility likely relates, in some way, to economic volatility—with shocks to growth or inflation passing through into market fluctuations. By almost any measure, macro volatility has fallen significantly in recent decades. During the same period, though, the average level of realized equity volatility seemingly did not decline. Does that discrepancy invalidate the macro-market connection? We think not.

Basic statistical analysis suggests that declining macroeconomic volatility has indeed pushed down on market volatility. At the same time, we propose that a countervailing force, the rise of leverage in the financial system, boosted market volatility in the 1990s and 2000s. We believe that the secular downtrend in macro volatility will persist. Meanwhile, partly as a result of regulatory change, financial system leverage has now receded. The low market volatility of the past year likely reflects these two factors, at least to some extent, and we expect that average volatility in the coming decade will likely run somewhat below past trends.

At the same time, however, even if this benchmark level of volatility has diminished, its cyclicality has not. Market volatility tends to rise in or near a recession and to fall during expansions. Indeed, in the past two decades, cyclical variations in market volatility may have increased somewhat. The precise connection between economic and volatility cycles remains elusive and difficult to model. We therefore conclude that economic analysis teaches us more about medium-term volatility trends than about month-to-month swings.

J.P.Morgan
Asset Management

In the following pages, we

- present a set of stylized facts about volatility in the near and long terms
- analyze post-World War II trends in macro volatility
- delineate the connections between macro and market volatility
- explore the volatility of inflation and its connection to the term premium
- assess the implications for multi-asset investors

FIVE FACTS ABOUT VOLATILITY

The empirical starting point for our discussion of market volatility is a set of stylized facts about vol in the near and long terms. We will then focus more specifically on the postwar period and the interconnections between macro and market volatility.

Fact #1: It's cyclical

We begin with a familiar fact: Prior to the recent spike, vol had generally been quite low by historical standards (**EXHIBIT 1**). While people tend to fixate on specific measures like the VIX,[1] the observation that vol is low relative to its own history turns out to be common across an array of different measures (implied or realized) and different asset classes (equities or bonds), as well as across different frequencies over which they are measured (daily, monthly or annual). Another familiar feature of these vol measures is that they tend to rise near periods of economic recession and subsequently ease during expansions. Indeed, recessionary periods corresponded to the highest average VIX levels over the past three business cycles, and each recession was followed by a multi-year period of low and falling vol.

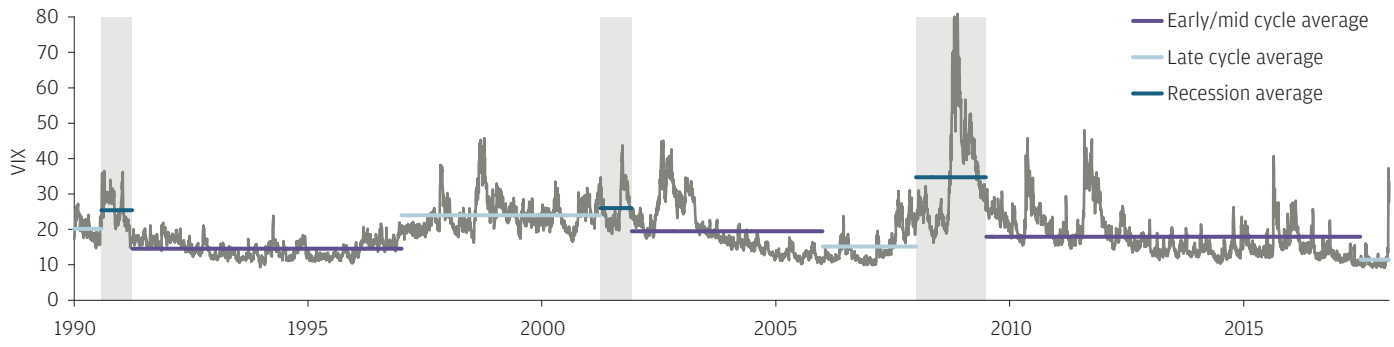
Through this lens, it is tempting to view declines in vol over the past few years as simply reflecting the later stages of a U.S. expansion, one that has been relatively long and flat. However, that would be a simplification and would gloss over the fact that a wide array of market vol outcomes is possible in the late stage of the cycle, which may yet play out in the coming quarters. One possibility is that the current expansion—we estimate that the U.S. economy entered late cycle in mid 2017—ends up looking like the late 1990s. In that instance, market volatility took a step up as the economy entered the late stage of the cycle and then remained high until the recession in 2001. Yet another possibility is that this late cycle looks like the period immediately preceding the global financial crisis, in which volatility stayed generally low in late cycle until taking a step up shortly before the recession.

We have several takeaways from these diverse experiences. While market pricing of a negative growth shock before recession is virtually always a catalyst for significantly higher vol, the timing of those shocks within late cycle determines whether the late phase as a whole is characterized as high vol. The length of the cycle also plays a role, with longer cycles allowing time for a wider array of catalysts to materialize. For example, vol may be driven higher by tightening monetary policy, accelerating inflation, or sources of financial instability, along with concerns about growth.

[1] Ticker symbol of the Chicago Board Options Exchange Volatility Index, which uses implied vol of S&P 500 index options to plot for 30-day market volatility expectations.

Volatility is higher in recession but can go either way, on average, in late cycle

EXHIBIT 1: VIX OVER THE BUSINESS CYCLE (RECESSION, EARLY/MID AND LATE PHASES)



Source: Bloomberg, J.P. Morgan Asset Management Multi-Asset Solutions; data as of March 2018.

50bps real yields have represented a trigger for higher volatility

EXHIBIT 2: VIX SENSITIVITY TO RISING RATES

Source: Bloomberg, J.P. Morgan Asset Management Multi-Asset Solutions; data as of March 2018.

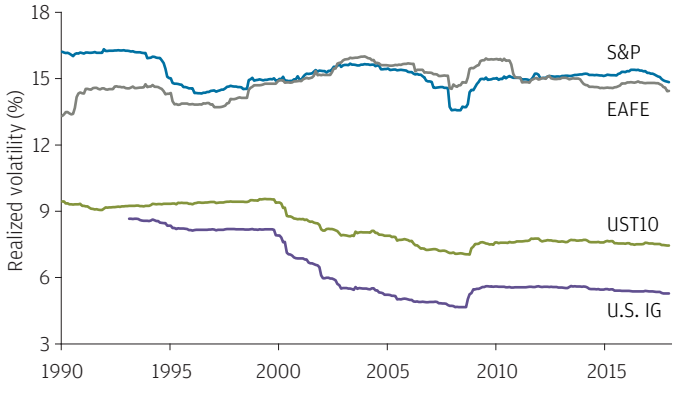
Building on these ideas, the recent re-emergence of vol in February of this year is not an obvious function of growth concerns. Rather, it appears closely related to the fact that real interest rates are rising after a long period of torpor, prompting concern that high equity valuations are more difficult to justify under a higher rate regime. A number of bouts of vol erupted just as real interest rates broke through the 50 basis points (bps) level (**EXHIBIT 2**). Yields pushed up in 2013 post "taper tantrum" and again in 2014 at the end of the Federal Reserve's (Fed's) quantitative easing (QE) program, and in both instances, upswings in vol followed. In 2015, as markets braced for the first Fed rate hike, real yields rose yet again, this time exposing fragility in China's exchange rate regime. Two substantial rounds of vol followed in August 2015 and January 2016. Given this context, it is not terribly surprising that vol re-emerged in 2018 after real yields broke through 50bps in January.[2] In a cycle that will probably linger in its late phase and may continue to be unsettled as interest rates rise, average vol is likely to be higher than it has been over the past few years.

Fact #2: Portfolio vol has trended down, driven by fixed income

Beyond the higher-frequency cyclical dynamics, the trend in market vol has been falling, a phenomenon driven predominantly by declining bond volatility. To measure these lower frequency movements over long periods, and with the intent to abstract from business cycle influences on asset prices, we adjust our lens to consider realized volatility over a 20-year rolling window. Unlike the return profile for stocks and bonds, which trended up during the 1990s and down ever since, the contour of market volatility is generally more stable. For instance, realized equity vol trends for developed market (DM) economies were more or less stable at 15% (annualized) over that period (**EXHIBIT 3**).

A long-term declining trend has been driven exclusively by bonds

EXHIBIT 3: MEASURES OF LONG-TERM REALIZED VOLATILITY (20-YEAR ROLLING STANDARD DEVIATION OF M/M AR)



Source: Bloomberg, J.P. Morgan Asset Management Multi-Asset Solutions; data as of March 2018.

It was notable that equity vol stayed in a relatively tight range even as the level of realized returns went down by a factor of one half. In contrast, bond volatility declined in tandem with bond returns in the 2000s. Realized volatility trends for bond returns were flat in the 1990s at an annualized rate of 8%–9% before taking a step down in the 2000s and eventually leveling off post-financial crisis. All in all, from the perspective of a balanced portfolio, volatility has fallen over recent decades, driven almost entirely by fixed income trends.

[2] The other catalyst cited for the recent outbreak of vol is the rise in inflation breakevens. However, the historical relationship between breakevens and vol is less clear-cut. There are many instances in recent years in which inflation pricing was at current levels without eliciting serious concern about equity pricing.

Fact #3: Economic volatility can account for low frequency trends in market vol

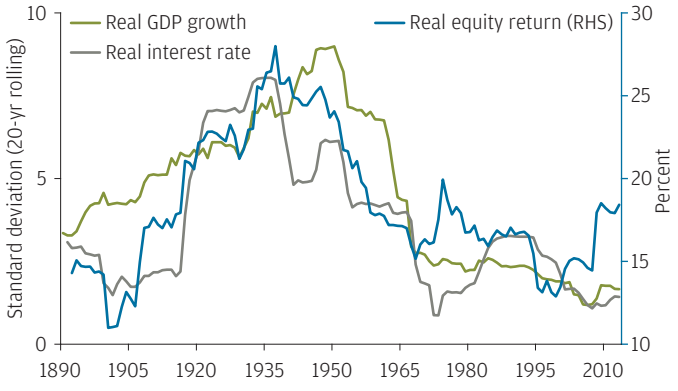
Having established some of the broad contours of market vol at both high and low frequencies, we now begin to suggest linkages with corresponding measures of economic volatility. Here we use a new academic data set of annual GDP, interest rates and equity prices across 17 developed market economies, spanning back to 1870.[3] Analyzing these data, we can construct measures of long-term volatility in a much richer historical context.

We begin with the U.S. and, specifically, the long-term realized vol of real GDP, real interest rates and the real equity return since 1870 (**EXHIBIT 4**). Volatility of all three series toggled between two regimes over the past 150 years: (1) a low volatility regime, not dissimilar to today's, in the late 19th century, and (2) a high-volatility regime in the early- to mid-20th century, during the war years. The serial economic dislocations of World War I, the Great Depression and World War II all contributed to the peak in annualized real GDP volatility of about 9% in the late 1940s, at which point it fell precipitously for much of the next two decades. The most recent period saw a continuation of the decline in economic volatility, which was accompanied (as discussed in Fact #2) by declining fixed income vol and equity vol, around the 15% level.

[3] A full description of the data can be found in: Òscar Jordà, Moritz Schularick and Alan M. Taylor. "Macrofinancial History and the New Business Cycle Facts," in NBER *Macroeconomics Annual 2016*, vol. 31, eds. Martin Eichenbaum and Jonathan A. Parker (Chicago: University of Chicago Press, 2017)

Since 1870, volatility of real GDP, real interest rates and real equity return has toggled between low and high regimes

EXHIBIT 4: VOLATILITY OF U.S. GROWTH AND ASSET PRICES



Source: Òscar Jordà, Moritz Schularick and Alan M. Taylor (2017), J.P. Morgan Asset Management Multi-Asset Solutions; data through 2013.

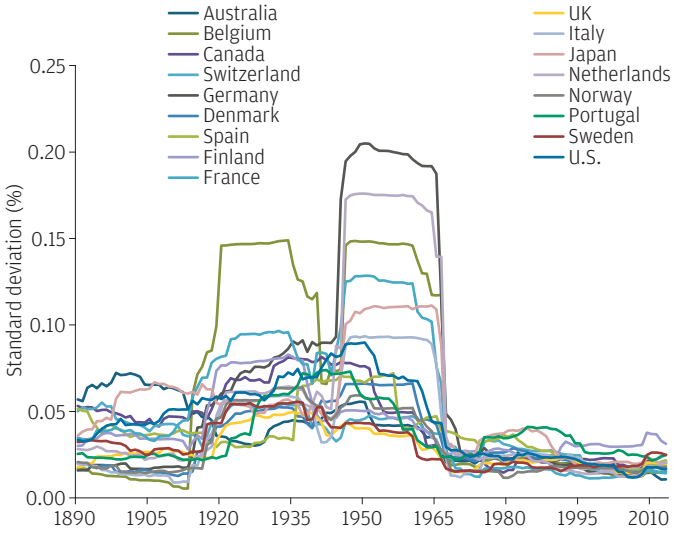
The key takeaway from these long-term trends is that, broadly speaking, volatility regimes for bonds and equities have followed those of the macroeconomy. And, while Exhibit 4 focuses on how real GDP is indicative of overall economic volatility, we note that slow-moving trends in other economic phenomena may also have contributed meaningfully to trends in market vol. For example, the volatility of U.S. loan growth also fell immediately following World War II, but unlike GDP growth, it remained elevated in the 1970s, '80s and '90s. In upcoming sections, we will discuss in greater detail the role leverage plays in driving market volatility.

Fact #4: Links between economic and market volatility are stronger for rates than for equities

While the U.S. example illustrates that both equity and interest rate vol followed the variation in real GDP growth, a broad, global examination of those relationships reveals that the links are much tighter for rates. We see this looking at the 17 countries in the Jordà et al. (2017) data set, where we observe that all 17 economies show a similar Low-High-Low pattern in economic volatility (**EXHIBIT 5**). For obvious reasons, the deviations in economic vol driven by the two world wars were far greater in the European countries relative to the U.S., but the patterns are qualitatively similar.

Volatility today is at levels not unlike the late 19th century

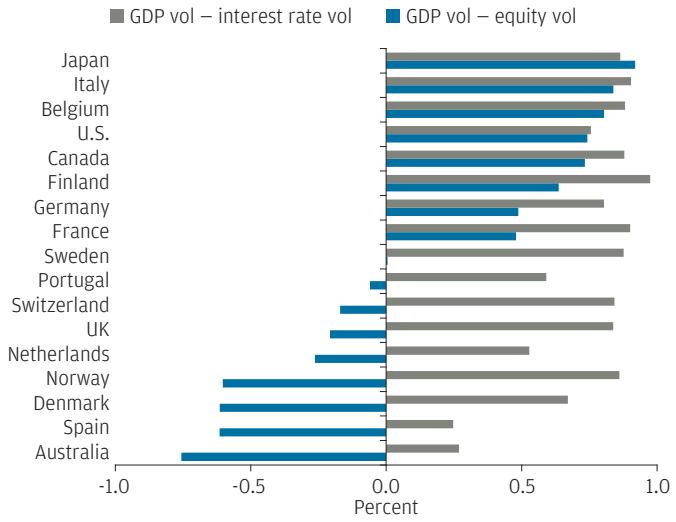
EXHIBIT 5: ECONOMIC VOLATILITY IN DEVELOPED MARKET ECONOMIES (STANDARD DEVIATION OF GDP GROWTH, 20-YR ROLLING)



Source: Òscar Jordà, Moritz Schularick and Alan M. Taylor (2017), J.P. Morgan Asset Management Multi-Asset Solutions; data through 2013.

GDP and bond vol are tightly related; GDP and equities less so

EXHIBIT 6: CORRELATIONS OF ECONOMIC AND MARKET VOLATILITY



Source: Òscar Jordà, Moritz Schularick and Alan M. Taylor (2017), J.P. Morgan Asset Management Multi-Asset Solutions; data through 2013.

The cross-country analysis in **EXHIBIT 6** highlights the robustness of the connections between economic and interest rate volatility, as well as the more variable links with equity vol. Remarkably, the correlation of GDP volatility with real interest rate volatility is positive in every country in the sample, with 15 of 17 countries having a correlation above 0.5. However, that is not a generalizable observation for equity prices, where only eight of 17 countries show a positive correlation of GDP volatility with equity vol. We think of these findings as consistent with the relatively clear-cut theoretical relationship between GDP and interest rates, compared with the more multi-faceted determination of equity return trends. In long-run models of economic growth—dating back to Solow's seminal work in 1956[4]—the risk-free rate in an economy turns out to be exactly equal to the real trend growth rate. As such, it stands to reason that the long-run variance of growth would also bear a close resemblance to that of real rates. Equity prices are a function of long-run growth trends as well, but they are arguably influenced more by other factors than bonds are. Factors such as trends in leverage, the evolution of corporate behavior and the path of interest rates could all conceivably shift long-run equity returns and volatility vs. a path determined purely by growth.

[4] See: Robert M. Solow, 1956. "A Contribution to the Theory of Economic Growth," *The Quarterly Journal of Economics,* Oxford University Press, vol. 701): 65-94.

Fact #5: Falling inflation volatility also helps to explain recent vol trends

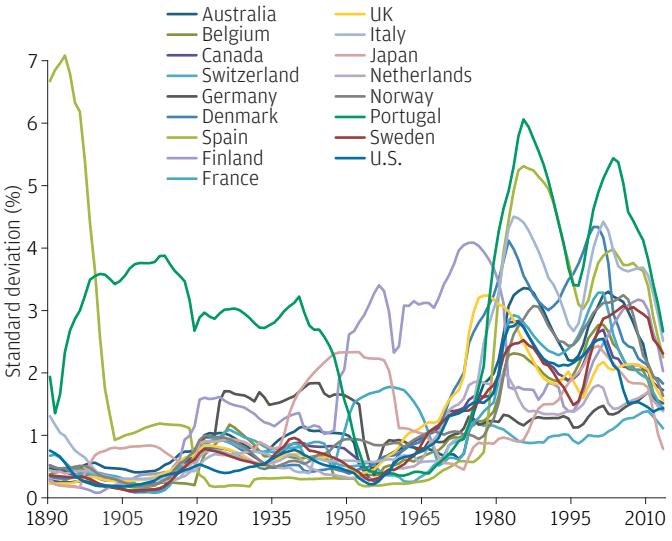
Our final stylized fact highlights inflation volatility as an additional source of market volatility, above and beyond the contribution of growth. We have noted that long-run trends in both growth and real interest rate volatility followed a Low-High-Low pattern over the last 150 years fairly generally across developed market economies. However, when we introduce inflation to the picture and look at the volatility of nominal interest rates—after all, most investors' portfolios are geared to nominal rather than real rates—the pattern looks quite different.

Volatility in nominal rates did, in fact, rise incrementally in the early- to mid-20th century (**EXHIBIT 7**). However, that change was dominated in magnitude by the massive rise in inflation volatility from the late 1960s through the early 1980s, which pushed bond volatility much higher during that period. The shift was driven by several factors: wage and price controls in the U.S.; a series of oil price shocks; and the Federal Reserve's belief, mistaken at the time, that a stable, exploitable relationship existed between unemployment and inflation.[5] Inflation

[5] This belief is mistaken insofar as it does not incorporate economic agents' expectations of future inflation. As policymakers attempt to permanently boost output in exchange for permanently higher inflation, it is reasonable to suppose that participants in product and labor markets will learn to expect higher inflation, which should, in time, increase the inflation rate for each given level of output and unemployment. In other words, people's anticipation of higher inflation offsets the long-run trade-off between output and inflation.

Nominal and real rate vol trends are very different

EXHIBIT 7: LONG-RUN TRENDS IN NOMINAL RATE VOLATILITY (STANDARD DEVIATION OF LONG-TERM RATES, 20-YR ROLLING)



Source: Bloomberg, J.P. Morgan Asset Management Global Multi-Asset Solutions; data through 2013.

volatility had another, smaller bout of volatility in the late 1990s before it fell almost ubiquitously across developed markets over the past decade.

In broad terms, even as postwar volatility in real activity continued to decline, inflation volatility picked up as part of a massive multi-decade cycle. Given that the returns in financial markets are generally nominal returns, we would expect inflation volatility to affect a broad swath of financial market vol measures. Indeed, in subsequent sections we demonstrate that postwar swings in inflation vol had a meaningful effect on risk premia priced into fixed income markets.

ASSESSING POSTWAR TRENDS IN MACRO VOLATILITY

We now narrow our focus to the postwar era, examining trends in macroeconomic volatility during recent decades and attempting to identify their connection with market volatility. Having established that economic volatility has been lower since the 1950s than it was during the turbulent war years and the Great Depression, we ask four questions. First, how has economic volatility changed during this era? Second, do economic and market volatility move together? Third, what might explain the apparent disconnect during the 1990s and 2000s between smoother economic conditions and still-elevated equity volatility? Finally, did the very low level of implied and realized market volatility in 2017 and early 2018 look anomalous, perhaps indicative of investor complacency, or could it be explained by fundamental drivers?

VOLATILITY OUTLOOK IN OUR LONG-TERM CAPITAL MARKET ASSUMPTIONS

Our 2018 Long-Term Capital Market Assumptions volatility projections were unchanged relative to estimates a year ago, despite the low asset volatility environment that prevailed in 2017. While volatility in financial markets ran at historically low levels, particularly for risk assets and most notably for equities, we view this phenomenon as mostly cyclical and potentially vulnerable to the emergence of an asset price bubble.

Volatility in the macroeconomic environment (as measured by changes in real GDP) has been declining for several decades, smoothed by improvements in monetary policy, broader availability of consumer credit and the effects of globalization. However, the likelihood of asset bubbles and financial stress is not necessarily diminished by a smoother macro environment. Despite the downtrend in macro volatility since the 1980s, market volatility has stayed close to its long-run average. In fact, benign macroeconomic volatility could create risks of overvaluation in asset classes, an environment that could lend itself to the creation of asset price bubbles and potentially generate greater volatility, offsetting concurrent low macro volatility. What's more, the extraordinary measures taken by global central banks may be contributing to a more gradual and smooth recovery, but any misstep in their unwinding could result in greater asset volatility.

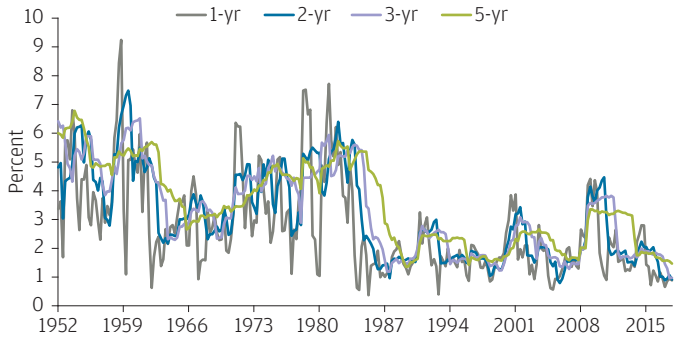
In our view, recent years' reduced asset volatility is consistent with the current economic environment, absent any significant and persistent signs of stress or leverage that could create risks of contagion. Ninety years of history show that asset volatility is typically 6 percentage points lower during expansions—averaging 15%—than during contractions. In addition, we see little evidence that the current low asset volatility regime (as measured by the VIX) has unduly dampened the asset markets' response to events. That is, despite the fact that the VIX has been running at a historically low level, the expected volatility of volatility (as measured by the CBOE VVIX Index—the option-implied volatility of VIX) has remained pronounced and dynamic, responding at the first signs of stress. In short, the recent low asset volatility environment may have edged our long-term forecasts a touch lower for some asset classes, but on balance our broad outlook remains the same.

We have traditionally relied on the most recent 10 years of return data to anchor our forward-looking risk expectations. We chose 10 years as our historical window because that period is recent enough for relevancy and data availability, and long enough to include at least one whole business cycle. However, given the current extended recovery, it is possible that a 10-year window will soon be too short to cover an entire cycle. This means that historical volatility may begin to understate future volatility as periods of contraction (and high volatility, or "stress") roll off and periods of recovery (and low volatility, or "calm") are added on. Expanding the data window helps mitigate this impact, and we have adopted this incremental change in our methodology. Including one additional year of data (i.e., moving from 10 to 11 years) offsets the decline in expected volatility by approximately 0.5 percentage point.

In sum, our projections show Sharpe ratios falling marginally for equities and credit, while increasing for government bonds, in our 10- to 15-year horizon. Despite the decline, credit continues to rank well in expected risk-adjusted returns, closely followed by equities. The risk-adjusted return for government bonds remains considerably below its historical average.

Growth fluctuations have diminished significantly over time

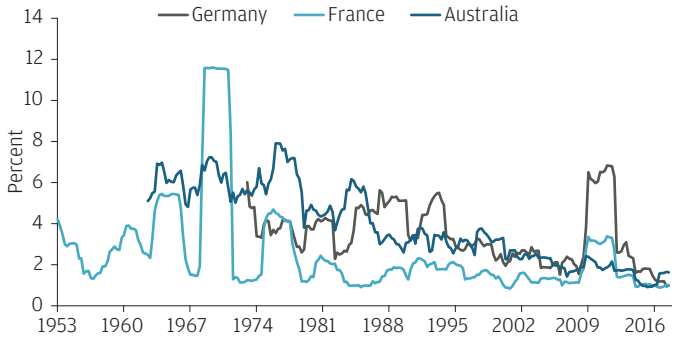
EXHIBIT 8: U.S. STANDARD DEVIATION OF REAL GDP GROWTH (% Q/Q, SAAR)



Source: Haver Analytics, J.P. Morgan Asset Management Multi-Asset Solutions; data as of 4Q17.

Growth volatility has also declined outside the U.S.

EXHIBIT 9: STANDARD DEVIATION OF REAL GDP GROWTH (% Q/Q, SAAR, 3-YEAR WINDOW)



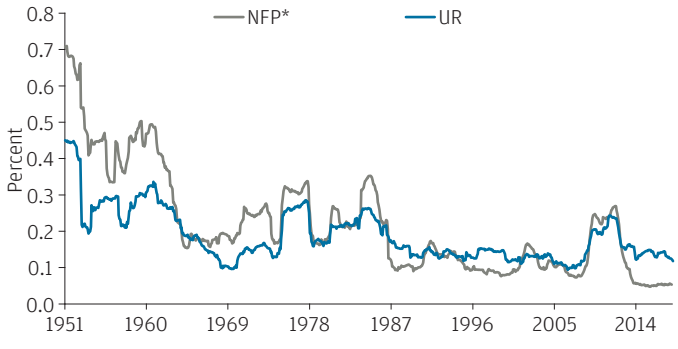
Source: Haver Analytics, J.P. Morgan Asset Management Multi-Asset Solutions; data as of 4Q17.

Macroeconomic volatility appears to have fallen significantly in the past several decades, a finding evident across a broad range of indicators and countries. For example, the volatility of GDP growth in the U.S. dropped sharply around 1990, stayed low for about 25 years and—following a spike related to the financial crisis—may have fallen further during the current expansion (**EXHIBIT 8**). Indeed, the standard deviation of quarterly GDP growth, measured using a three-year window, hit a record low in the third quarter of 2017, with shorter and longer measurement periods showing broadly similar trends. GDP growth volatility also ground lower in other OECD economies during the postwar era, again perhaps reaching new nadirs in the wake of the Great Recession (**EXHIBIT 9**). From this perspective, the so-called Great Moderation, a term coined in the early 2000s to describe the generally calm economic environment of the previous decade or so, remains in place and may have intensified recently. Importantly, the decline in volatility shows through in short enough time frames that the decreased frequency of recessions does not account for it: Instead, lower macro volatility primarily reflects smoother performance during expansions.

Many higher-frequency growth indicators mirror this tendency toward lower volatility. What is perhaps the highest-profile monthly series covering the U.S. economy, the payroll figure, has become significantly more stable over time, as has, to a lesser degree, the unemployment rate (**EXHIBIT 10**). Moreover, even survey data have grown less volatile, as illustrated by the standard deviation of the headline and output measures of the ISM purchasing managers, survey (**EXHIBIT 11**). That development suggests that not only has the economy become less volatile in a measurable sense but that it feels more stable to its participants.

High-frequency data show declining volatility

EXHIBIT 10: U.S. STANDARD DEVIATION OF PAYROLL GROWTH AND JOBLESS RATE (3-YEAR WINDOW)

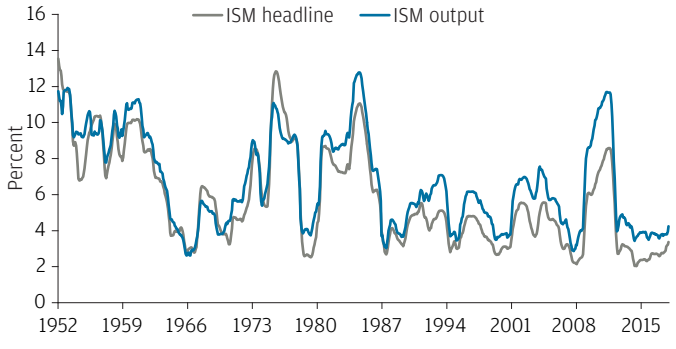


*Non-farm payrolls

Source: Haver Analytics, J.P. Morgan Asset Management Multi-Asset Solutions; data as of February 2018.

Survey data have also become more stable

EXHIBIT 11: U.S. STANDARD DEVIATION OF ISM HEADLINE AND OUTPUT (3-YEAR WINDOW)

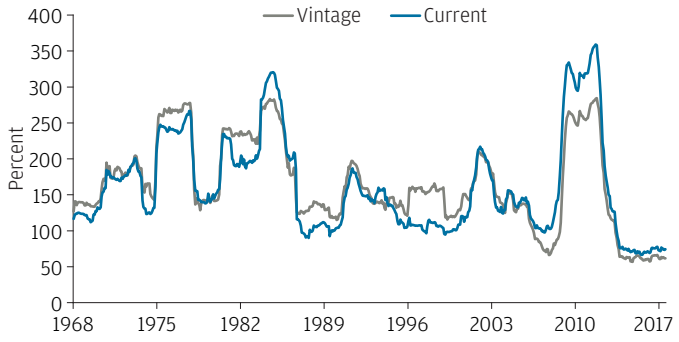


Source: Haver Analytics, J.P. Morgan Asset Management Multi-Asset Solutions; data as of February 2018.

Conceivably, the drop in measured economic volatility—even taking into account the wide variety of indicators that display it—might owe to better data collection. After all, most economic indicators are statistics, estimated from samples. If measurement has improved over time, then the sample variance might have dropped even if there was no decline in the population (i.e., true) variance. While this hypothesis is difficult to disprove entirely, we see significant counterarguments. The final version of the payroll data—after several rounds of revisions—draws on full-population data (for example, from tax returns), not only samples. Despite this difference, the final series displays a virtually identical decline in volatility as the "vintage" (that is, originally reported) series (**EXHIBIT 12**). Meanwhile, volatility in the vintage data held steady in the late 1990s, a period in

Lower volatility does not seem simply to reflect better measurement

EXHIBIT 12: U.S. STANDARD DEVIATION OF PAYROLL GROWTH, ORIGINAL VS. FINAL (3-YEAR WINDOW)



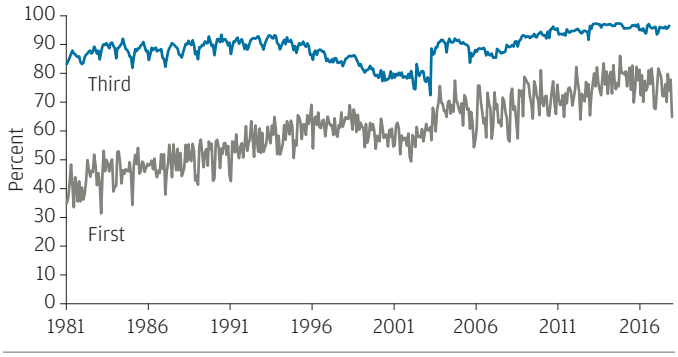
Source: Federal Reserve Bank of Philadelphia, Haver Analytics, J.P. Morgan Asset Management Multi-Asset Solutions; data as of October 2017.

which response rates to the labor market survey were falling (**EXHIBIT 13**). Other things equal, that uptick in missed replies to the survey should have increased the error of the estimates, in turn boosting their volatility. But it didn't. The fact that no obvious increase occurred suggests an ongoing offsetting decline in true volatility.

If we accept that growth volatility has fallen over time, why did it fall, and should we expect it to remain low? Here we consider four possible causes, two of which seem to carry significant explanatory power. First is the greater prevalence of services in the U.S. economy, relative to the inherently more volatile manufacturing sector. This hypothesis does not survive scrutiny,

Measured volatility declined even when measurement was more problematic

EXHIBIT 13: U.S. PAYROLL SURVEY RESPONSE RATES, FIRST AND THIRD PRINTS

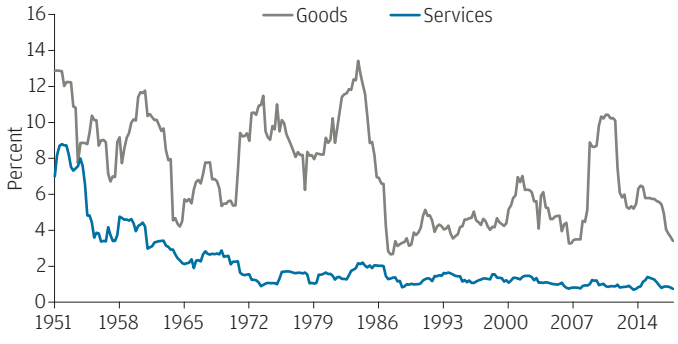


Source: Haver Analytics, J.P. Morgan Asset Management Multi-Asset Solutions; data as of October 2017.

however. For one thing, when looking at real U.S. GDP, the goods share of the economy has not, in fact, declined (although it has slipped in nominal GDP, given that goods prices have fallen over time, relative to services). Volatility has instead dropped for both types of activity (**EXHIBIT 14**). Although the manufacturing share of employment, as distinct from GDP, has dropped sharply, lower volatility in jobs data also reflects the greater stability of both goods and services. A counterfactual exercise, holding goods and services employment shares constant, shows a very similar volatility profile to the raw data,

The goods and services sectors have both become less volatile

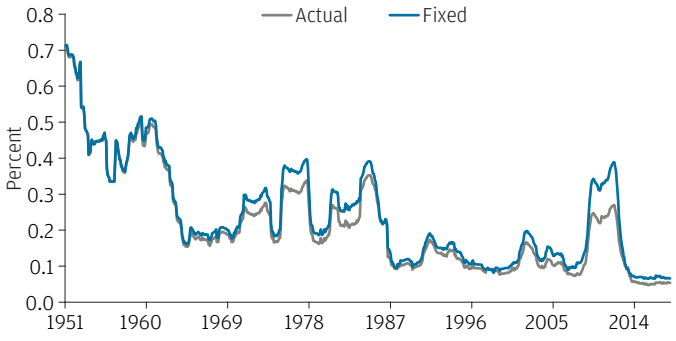
EXHIBIT 14: U.S. REAL GDP GROWTH STANDARD DEVIATION BY TYPE (3-YEAR WINDOW)



Source: Haver Analytics, J.P. Morgan Asset Management Multi-Asset Solutions; data as of 4Q17.

The increased importance of services does not explain lower macro volatility

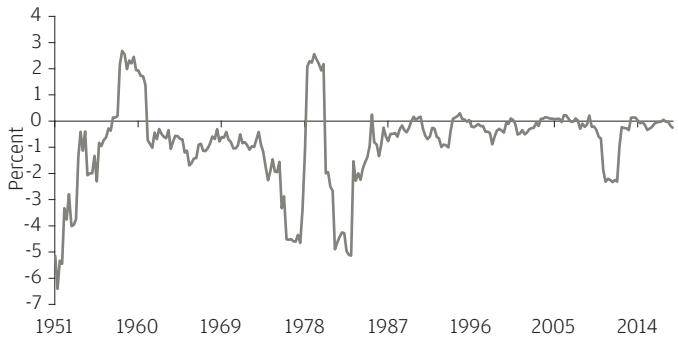
EXHIBIT 15: U.S. NFP CHANGE STANDARD DEVIATION, ACTUAL AND FIXED SHARE



Source: Haver Analytics, J.P. Morgan Asset Management Multi-Asset Solutions; data as of December 2017.

Greater openness does not seem to explain reduced volatility

EXHIBIT 16: U.S. COVARIANCE OF NET TRADE AND DOMESTIC FINAL SALES (3-YEAR WINDOW)



Source: Haver Analytics, J.P. Morgan Asset Management Multi-Asset Solutions; data as of 4Q17.

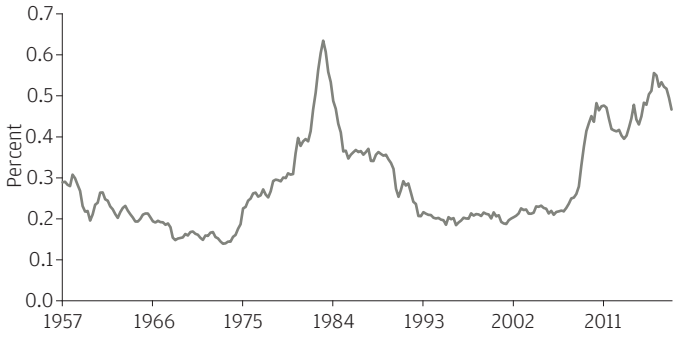
with small gaps occurring only during recessionary periods (**EXHIBIT 15**). Other compositional changes, though, might have played a role. For example, public spending displays a smoother profile than private sector expenditure, so the increased weight over time of government services may have lowered volatility.

What about globalization? The U.S. economy's increasing exposure over time to its foreign counterparts represents a well-known truism. When we combine this fact with an observation from our previous research (see "In search of a global business cycle," J.P. Morgan Asset Management, November 2015, https://am.jpmorgan.com/gi/getdoc/1383284523203—namely, that major economies display a low degree of synchronization during expansions—we form a hypothesis about globalization as a shock absorber. The basic idea is that a temporary shortfall in U.S. demand might be partly countered by a jump in, say, the euro area or Japan, smoothing the overall growth profile over time. But here, too, we find little supporting evidence. In examining the contributions to U.S. GDP growth of the domestic sales and foreign trade components, we find their covariance to have become somewhat less negative over time (**EXHIBIT 16**); if foreign demand were increasingly serving as a buffer for the economy, the opposite should have occurred. True, the size of quarterly trade contributions to GDP growth has picked up somewhat. But this increase seems to be related to recessions, when imports tend to collapse, rather than reflecting trade's gradual pickup over time (**EXHIBIT 17**).

By contrast, one fairly simple change in how the economy functions—more stable inventory management—has reduced growth volatility significantly. Jolts to the economy from inventory surges or cutbacks have diminished steadily. In GDP terms, the standard deviation of the growth contribution from inventory changes has plunged since the early 1950s (**EXHIBIT 18**, next page). The manufacturing sector appears to account for much of this effect, with both the level and the volatility of its inventory-to-sales ratio having dropped (**EXHIBIT 19**, next page). These trends suggest that manufacturers hold leaner inventories than in the past and also display a better ability to plan (for example, via improved software tracking). Other trackable inventory data, from the retail and wholesale sectors, do not show that same

The trade contribution to U.S. growth is important, but mostly in recessions

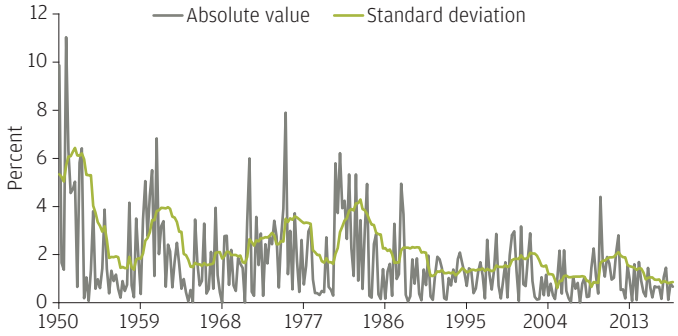
EXHIBIT 17: U.S. ABSOLUTE VALUE OF NET TRADE CONTRIBUTION/GDP GROWTH (10-YEAR)



Source: Haver Analytics, J.P. Morgan Asset Management Multi-Asset Solutions; data as of 4Q17.

Inventory shocks are much smaller now than in the past

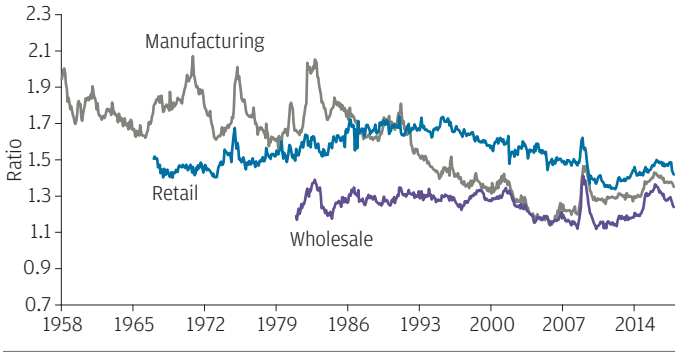
EXHIBIT 18: U.S. INVENTORY CONTRIBUTION TO GDP GROWTH (P.P., Q/Q SAAR)



Source: Haver Analytics, J.P. Morgan Asset Management Multi-Asset Solutions; data as of 3Q17.

Manufacturing inventories are leaner and more stable

EXHIBIT 19: U.S. INVENTORY-TO-SALES RATIOS (X)



Source: Haver Analytics, J.P. Morgan Asset Management Multi-Asset Solutions; data as of November 31, 2017.

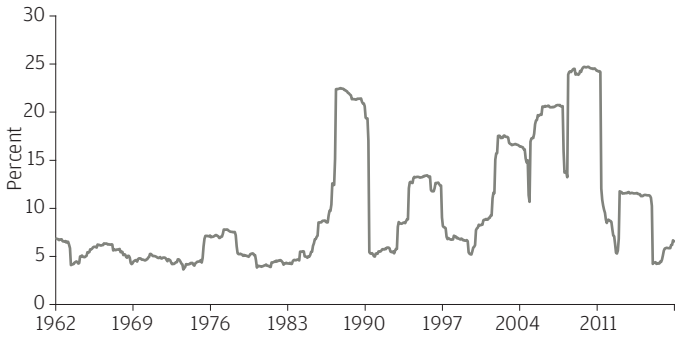
downtrend. Still, narrower fluctuations in manufacturing resulting from smoother inventory management could have contributed to lower volatility in the services sector, some of which depends on demand from industrial companies.

The rise of consumer credit, alongside a greater household wealth cushion, has also served as a growth stabilizer. The ability to borrow allows consumers to smooth spending through fluctuations in real income, stemming from factors like labor market wobbles, gasoline price spikes or tax changes. Indeed, one of the few U.S. data series to show an increase in volatility over time is the personal saving rate (**EXHIBIT 20**)—exactly what one would expect if households are using credit to dampen gyrations in their spending. Correspondingly, fluctuations in consumption have fallen relative to those in disposable personal income (**EXHIBIT 21**), likely representing a major influence on overall macro volatility, given the large weight of household spending in the economy.

Our survey of postwar trends in macro volatility suggests two conclusions. First, growth volatility has declined convincingly in both the U.S. and elsewhere, and may currently be plumbing new lows even relative to the stability observed in the 1990s and mid-2000s. Second, we can identify partial explanations for this trend, which seem likely to persist: Companies will not uninvent just-in-time inventory management, nor will consumer credit vanish from the face of the earth. Of course, other structural changes to the economy could occur that push in the opposite direction. As a working assumption, though, macro volatility seems likely to remain low by historical

The personal saving rate has become more volatile over time

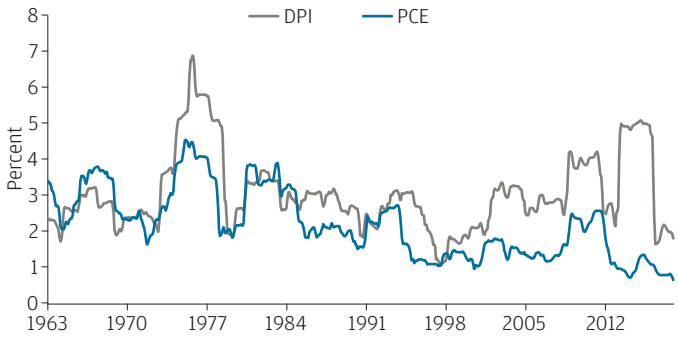
EXHIBIT 20: U.S. PERSONAL SAVING RATE VOLATILITY (3-YEAR WINDOW, % M/M)



Source: Haver Analytics, J.P. Morgan Asset Management Multi-Asset Solutions; data as of September 2017.

Consumption volatility has fallen relative to income fluctuations

EXHIBIT 21: U.S. VOLATILITY OF PERSONAL INCOME AND CONSUMPTION (3-YEAR WINDOW, % 3M/3M)



Source: Haver Analytics, J.P. Morgan Asset Management Multi-Asset Solutions; data as of September 2017.

standards. We believe this state of affairs carries significant implications for the future of market volatility, a topic to which we turn in the next section.

FROM MACRO TO MARKETS: THE VOLATILITY CONNECTION

We see an intuitive connection between economic and market volatility. If markets behave even somewhat rationally, then a major part of securities price fluctuations should reflect incoming news, much of which concerns the economy. Declining macro volatility implies that the news flow from the economy is diminishing, and this force should in turn dampen market volatility. This assertion, though, quickly runs into a major difficulty. Equity market volatility, as measured over extended periods (to abstract from purely cyclical fluctuations), has not trended meaningfully lower (see "Volatility assumptions," 2018 Long-Term Capital Market Assumptions).

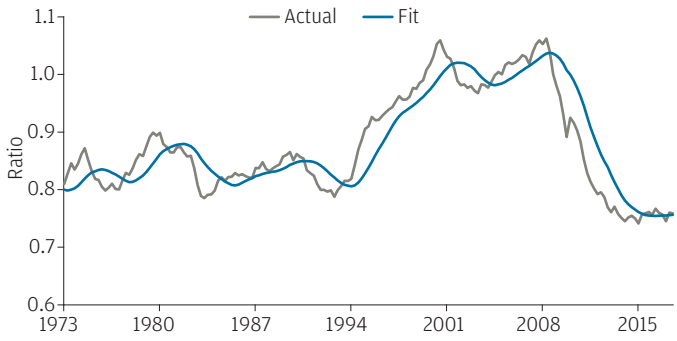
In confronting this truth, we first ask whether macro volatility really matters in this context. Basic statistical analysis suggests that, indeed, macro volatility influences market volatility. When we regress measured (realized) volatility for the S&P 500 at the index level against measures of macro volatility, using quarterly data for both, the coefficient on the latter shows the expected positive sign and a high degree of significance (generally clearing the 99% bar). While for the most part we used three-year windows for both market and macro volatility, this result appears robust to such specification choices. At least statistically speaking, market volatility stems in part from macro volatility, however measured and over whatever time frame.

Has some other slow-moving phenomenon served to push up equity market volatility, even as declining macro volatility was pulling it down? We propose a possible culprit: leverage. Of course, this broad term encompasses many distinct phenomena. What we have in mind relates less to rising debt levels around the economy—at the household, corporate and government levels—and more to behavior within the financial system and financial markets. We surmise that levered holdings of financial assets, for example by banks, market makers or high-frequency traders, will tend to react more violently to incoming news than their unlevered counterparts. The rise of leverage within financial markets, primarily a phenomenon of the past 25 years or so, may thus have amplified the effect of smaller fluctuations in the economy, keeping observed market volatility broadly stable.

Even as we have defined it, though, leverage remains a nebulous concept and one that cannot be easily and directly observed. To test our hypothesis, we need to develop proxies for leverage. We conceived of three such instrumental variables, for which we were able to obtain data on at least a quarterly frequency: (1) the U.S. commercial bank loan-to-deposit ratio; (2) U.S. equity market turnover relative to market capitalization; and (3) repo agreements outstanding. Intriguingly, the loan-to-deposit ratio began climbing in the early 1990s, when macro volatility took a step down, and it remained elevated until the financial crisis, at which point it began to drop sharply (**EXHIBIT 22**). The other variables show broadly similar patterns.

Bank behavior serves as a proxy for overall financial system leverage

EXHIBIT 22: U.S. BANK LOAN-TO-DEPOSIT RATIO (X)



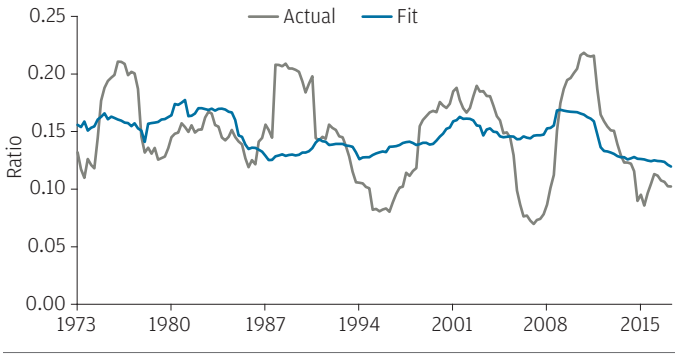
Source: Haver Analytics, J.P. Morgan Asset Management Multi-Asset Solutions; data as of 3Q17.

When we test these instrumental variables in regressions (alongside macro volatility), we generally find that they add notable explanatory power. Both the loan-to-deposit ratio and equity market turnover display the expected (positive) signs, and both appear as significant at the 99% level. The overall explanatory power of the regression, in each case, increases compared with the version that used only macro volatility. Repo volumes also show the expected sign but are only significant at the 10% level. Overall, though, we believe these results provide tentative support for our hypothesis that financial system leverage propped up equity market volatility in the 1990s and 2000s, in the face of declining macro volatility.

A look at the regression fits produced using these instrumental variables and macro volatility reveals that they capture the volatility regime reasonably well—in other words, the average level of volatility through the course of a cycle—but do not

Leverage helps explain the average level of volatility over time …

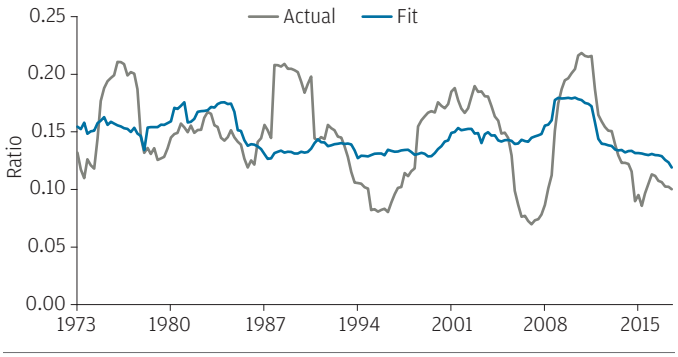
EXHIBIT 23: U.S. LARGE CAP EQUITY VOLATILITY, TEST 1 WITH LOAN-DEPOSIT RATIO



Source: Haver Analytics, J.P. Morgan Asset Management Multi-Asset Solutions; data as of 2Q17.

… but cyclical fluctuations do not reflect slower-moving forces

EXHIBIT 24: U.S. LARGE CAP EQUITY VOLATILITY, TEST 2 WITH EQUITY TURNOVER

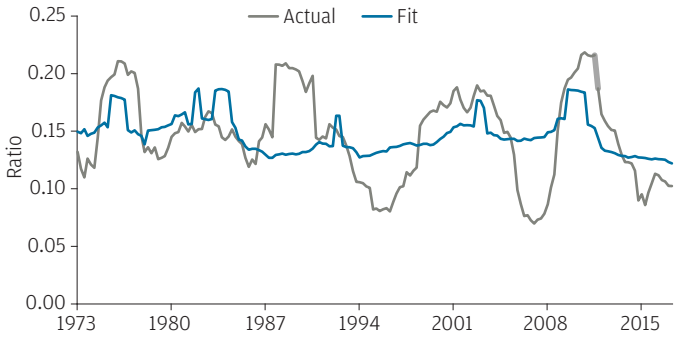


Source: Haver Analytics, J.P. Morgan Asset Management Multi-Asset Solutions; data as of 3Q17.

track cyclical fluctuations in volatility at all closely (**EXHIBITS 23** and **24**). As discussed earlier, realized equity market volatility follows a clear pattern, with spikes during recessions and gradual declines as expansions unfold. Volatility has sometimes, but not always, picked up before the onset of the subsequent recession. When we introduce a recession dummy variable into the regressions, the overall fit improves modestly but not dramatically (**EXHIBIT 25**), and the dummy draws some explanatory power away from the other inputs. Volatility's relationship with the cycle appears more subtle than a simple on-off switch, in particular via the gradual rather than sudden drop following the start of each expansion. Indeed, experimentation with specifications for the recession dummy variable suggests that the cyclical fluctuations in equity volatility may have grown larger in recent decades.

Cyclical volatility is more subtle than an on-off switch

EXHIBIT 25: U.S. LARGE CAP VOLATILITY, TEST 1 WITH LOAN-DEPOSIT RATIO AND CYCLE DUMMY



Source: Haver Analytics, J.P. Morgan Multi-Asset Solutions; data as of 2Q17.

Taking its structural and cyclical drivers into consideration, the record-low levels of implied and realized equity market volatility that prevailed in late 2017 and early 2018 no longer seem very surprising. After all, we have established a connection between market volatility and macro volatility, which itself may have declined to new lows; the leverage cycle that appears to have bolstered equity volatility during the past two decades has essentially unwound; and the current expansion reached its eight year mark in mid-2017, likely generating a large cyclical drag on volatility. To be sure, cyclicality works in both directions, and at the present time volatility appears to be on an upslope as the cycle continues to mature. It will likely surge when the next recession hits, or perhaps slightly before. Its slower-moving fundamental influences, though, suggest that equity market volatility may have entered a new regime, with a through-the-cycle average lower than what generally prevailed in the past.

INFLATION VOLATILITY AND THE TERM PREMIUM

The behavior of the government bond term premium has puzzled many market participants in recent years. The term premium has not only fallen compared with previous norms but has at times turned negative. Can we relate this trend to macroeconomic volatility? In an attempt to do so, we shift from growth volatility to the volatility of inflation.

Conceptually, bond yields consist of two components: the average overnight interest rate expected to prevail during the term of the bond (known as the "risk-neutral rate")—in other words, what an investor would expect to earn by keeping money in the bank for that period—and extra compensation for the risk of lending long and thus taking duration exposure. This latter portion of the yield is known as the term premium, and in the U.S. Treasury market it has averaged about 1.5 percentage points since the 1960s, albeit with wide fluctuations (**EXHIBIT 26**).[1] Roughly speaking, the term premium was quite high in the 1970s and early 1980s and lower both before and after that period.

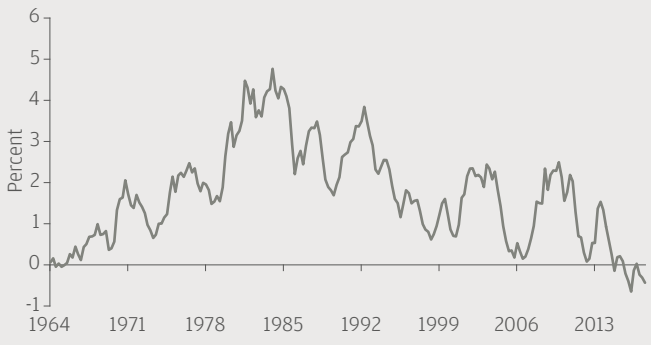
What drives these swings in the term premium? If an investor's forecasts for growth and inflation influence her views about the expected overnight rate, then the term premium, in part, provides compensation for the risk that those projections are incorrect. In turn, this forecast uncertainty likely depends to some degree on macro volatility. Perhaps, then, the low level of the term premium represents another manifestation of macro volatility's decline over time. But tests of the term premium against the growth volatility measures applied elsewhere in this paper generally indicate only a limited and statistically insignificant connection.

The term premium, however, is a nominal concept, for which inflation matters. We thus turn to measures of inflation volatility. Not only has the average level of the inflation rate declined in recent years compared with the experience of the 1960s and 1970s, but inflation has also become significantly more stable (**EXHIBIT 27**). Regression analysis suggests a tie between this development and the behavior of the term premium. The term premium's rise during the 1970s broadly coincided with inflation's increasing instability, and the subsequent drop in inflation volatility tracks the downward shift in the term premium's average level (**EXHIBIT 28**).

[1] We rely here on the ACM model of the term premium, developed by three researchers at the Federal Reserve Bank of New York. Other term premium models give broadly similar results, especially in terms of long-run averages.

The Treasury term premium was high in the 1970s and early 1980s

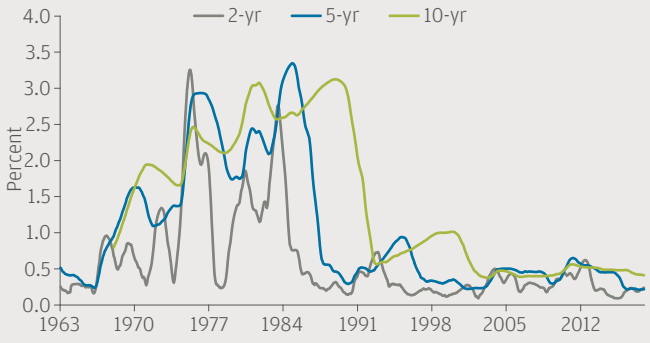
EXHIBIT 26: U.S. TREASURY 10-YEAR TERM PREMIUM (ACM MODEL, %)



Source: Haver Analytics, J.P. Morgan Asset Management Multi-Asset Solutions; data as of 4Q17.

Inflation volatility collapsed in the late 1980s

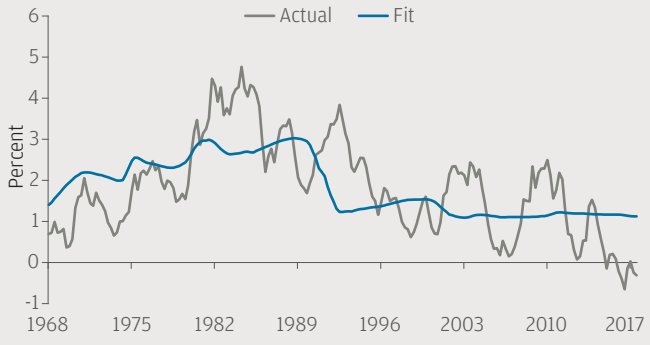
EXHIBIT 27: U.S. STANDARD DEVIATION OF CORE CPI INFLATION (%, VARYING WINDOWS)



Source: Haver Analytics, J.P. Morgan Asset Management Multi-Asset Solutions; data as of 4Q17.

The 1990s decline in the term premium mirrored inflation volatility

EXHIBIT 28: TERM PREMIUM FIT AGAINST 10-YEAR INFLATION VOLATILITY



Source: Haver Analytics, J.P. Morgan Asset Management Multi-Asset Solutions; data as of 3Q17.

INFLATION VOLATILITY AND THE TERM PREMIUM (CONT'D)

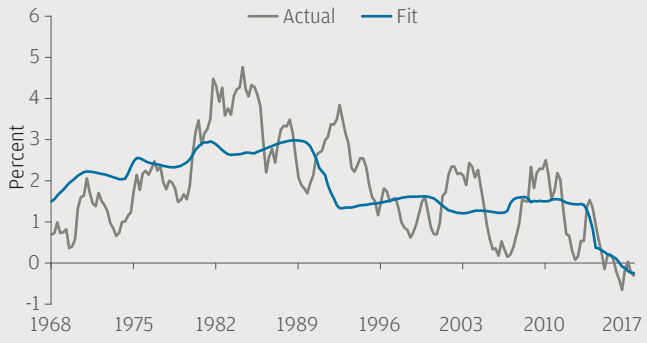
The recent behavior of the term premium, however, suggests that inflation volatility represents only part of the story. Having dropped around 1990, inflation volatility has held steady at a low level since. By contrast, the term premium has moved lower in the past several years, turning negative in early 2015 and remaining below zero much of the time since. What changed? We associate this further compression in the term premium with the advent of central bank quantitative easing, bond purchases meant to decrease the supply of duration available in the market. We generally regard the term premium as being determined globally, as suggested by the high level of correlation across government bond markets, which greatly exceeds the synchronicity in underlying economic performance. It therefore seems likely that the measure of QE relevant to the U.S. term premium is an aggregate global one rather than only the Federal Reserve's purchases of Treasuries.

To test this proposition, we calculate the aggregate developed market central bank balance sheet as a share of total GDP for these economies. We then add this construct to the term premium regression alongside the inflation volatility term. The central bank balance sheet adds statistically significant explanatory power to the regression, and the equation now appears to capture the large decline in the term premium in the wake of the global recession (**EXHIBIT 29**).

What does all this mean for the future of the term premium? We see two major implications. First, with inflation volatility likely to continue running at a low level by historical standards, and far below what was observed in the 1970s, the average term premium will likely also remain below historical averages. Second, the term premium will depend in part on the choices central banks make about balance sheet policy. Taken literally, the regression coefficient implies that QE is currently depressing the U.S. Treasury term premium by about 140bps. In other words, holding other things equal, a complete reversal of QE might raise the term premium from its current level around -40bps to something around 100bps. That development would put much more upward pressure on bond yields than markets currently expect. Still, it seems likely that central banks will maintain persistently larger balance sheets than in the past, and—taking the Federal Reserve's runoff program as an example—will move slowly to reduce their bond holdings. For the time being, then, we would take 100bps as an upper bound for the term premium's plausible range, and instead expect a gradual return to moderately positive territory.

Quantitative easing helps account for the recent plunge in the term premium

EXHIBIT 29: TERM PREMIUM FIT ON INFLATION VOL AND CENTRAL BANK BALANCE SHEETS



Source: Haver Analytics, J.P. Morgan Asset Management Multi-Asset Solutions; data as of 3Q17.

IMPLICATIONS FOR MULTI-ASSET INVESTORS

What emerges from our empirical exploration of macro and market volatility is a better understanding of the current tension between the structural factors pushing vol down and the cyclical, late-cycle factors pushing upward. Given that this economic expansion in the U.S. may, in fact, end up being the longest in postwar history, we expect this tension to continue featuring prominently in investors' asset allocation discussions. From here to the end of the current macro and market cycles, our results suggest that vol will move higher from the unusually low levels observed in 2017, but also that it will ultimately revert to a lower trend level than in prior cycles.

In contemplating the influence on near-term asset allocation of vol edging higher (assuming that the move occurs in the absence of recession), it is important to recognize that the influence will be felt more in position sizing and less in directional views on risk assets. A state of persistently higher volatility can still be consistent with a pro-risk stance and a preference for equities vs. bonds in a portfolio. Indeed, that would be the default allocation amid low recession risk and with a global growth outlook that continues to be supportive. However, higher volatility implies that smaller position sizes would be required to meet volatility targets in portfolios, and hence the absolute size of deviations from a given strategic benchmark allocation would get smaller as vol rose.

A related point is that even as vol picks up, the cross-asset covariance of returns would not necessarily rise. It depends on the nature of the shocks that are sparking the market volatility in the first place. In the bout of vol in February of this year, the root cause of the disturbance was the rapid ascent of bond yields. Amid the market volatility, the correlation between equity and bond returns swung temporarily from negative to positive as both asset classes sold off, and the covariance of stocks and bonds over the course of the month was roughly zero. As markets continue to balance growth concerns (which drive negative stock-bond correlation) with inflation and monetary policy uncertainty (which drive positive correlation), we expect cross-asset covariance to make a somewhat smaller contribution to portfolio volatility, on average, through the remainder of the cycle.

In an environment of higher expected portfolio vol and reduced cross-asset diversification, how can risk be tactically managed? What are appropriate hedging strategies for higher vol? In addition to the mechanical effect on position sizing mentioned above, we also note that higher vol environments shift the focus of tactical asset allocation incrementally away from taking directional bets—on equities, duration, credit and so on—toward relative value opportunities within asset classes.

Options are another way to address tail risk in portfolios, to the extent that the cost-benefit trade-off makes sense. In general, we advocate sticking with the asset allocation that matches our central expectation of outcomes and then overlaying considerations of sizing, relative value bets and more explicit hedges for tail risks.

From a longer-term perspective, a decline in vol is an inherently good thing insofar as it is driven by smoother economic variation over time. The decline in economic volatility that follows from advances in consumers' ability to smooth consumption and businesses' ability to manage inventories is a welcome development. These structural economic trends are persistent in nature and likely imply smoother and longer business cycles in the future. Our study of the Treasury term premium suggests that declining bond yields have been exacerbated by falling inflation volatility (a positive development in that low inflation volatility reduces economic uncertainty in people's lives). And our finding that equity vol is linked to financial system leverage suggests that the deleveraging at the end of the leverage cycle of the '00s may underpin a sustained period of lower trend market vol. All in all, these results imply that long-term volatility forecasts may be overestimating the risk of future volatility based on historical experience.

PORTFOLIO INSIGHTS

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