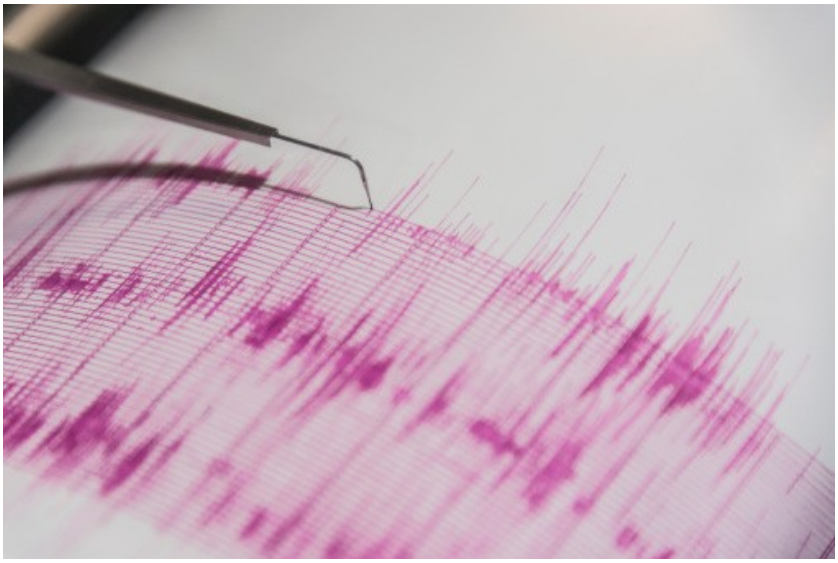
July 15, 2014

## US Economics

# Introducing the Morgan Stanley Recession Risk Model

White Paper: The Morgan Stanley Recession Risk Model (MSRISK) provides a timely and definitive warning of a downturn in the US business cycle.



*Source: Getty Images*

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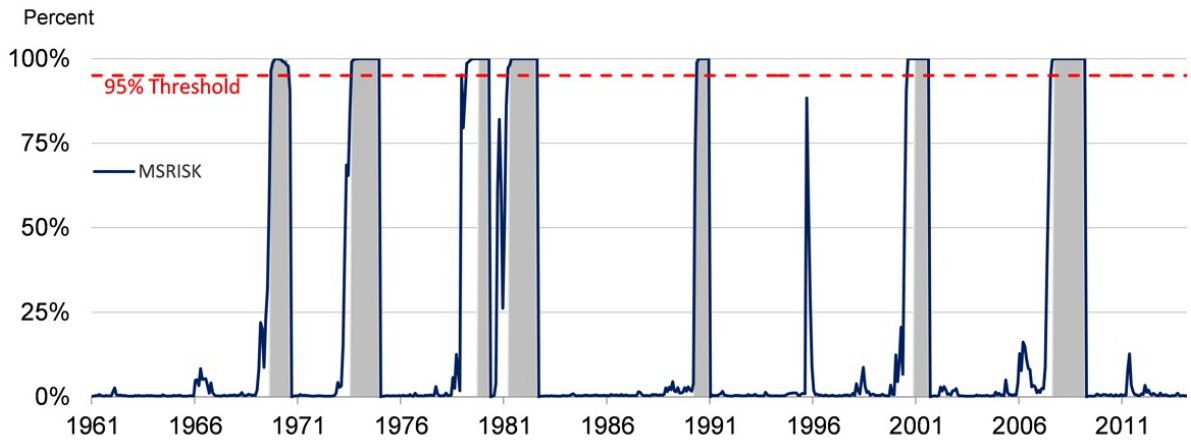
## The Morgan Stanley US Recession Risk Model

The ability to accurately anticipate downturns in the US business cycle is critical to Main Street, Wall Street, and policymakers alike. And while there's no shortage of recession probability models, we find they fall short of being able to give a **definitive signal** of whether the US economy is indeed headed into recession. Moreover, official business cycle dating tends to lag the onset of recession, oftentimes by a full year or more. **The Morgan Stanley Recession Risk Model (MSRISK)** does not produce a difficult-to-interpret probability; instead - as we discuss in this White Paper - the MSRISK is based on a regime-switching framework whose high risk/low risk signals provide virtually a "yes/no" answer as to whether the US economy is heading towards imminent recession. Currently, the MSRISK indicates a very low risk of recession in the next month, but that won't always be the case.

**Since 1961, the US has experienced 7 recessions, of which the MSRISK would have accurately provided a "high risk" signal, on average, one month ahead of the retrospectively determined start month (Exhibit 1).** The bar for signaling the onset of recession in our model is set particularly high. Only when the MSRISK breaches the 95% confidence threshold (level) do we definitively conclude the US is transitioning into a downturn. The high threshold for signaling has also ensured the MSRISK would have never falsely indicated the onset of recession.

As we will discuss in further detail, volatility in the MSRISK has also provided an average 5-month lead to its recession signal. Using the two measures together (level and volatility) ensures that **we not only get a sufficient "heads-up" that the probability of recession is rising, but we also get a definitive signal that a downturn in the economy is imminent.**

**Exhibit 1:** Historical Performance of the MSRISK




Note: Areas of gray represent recession dating as determined by the National Bureau of Economic Research. Source: Morgan Stanley Research

## The MSRISK: a Regime-Switching Model

### *Model Construction*

The MSRISK is based on a regime-switching scheme anchored to The Conference Board's Composite Index of Leading Economic Indicators (LEI). We choose the LEI as our target data series for two reasons: the LEI is compiled using indicators that each independently have proven to anticipate turning points in the business cycle, and the LEI is released monthly with only minor revisions.

Regime-switching is particularly useful in modeling non-linear phenomena because sudden and sharp changes in economic activity are not common. James Hamilton, a leading econometrician at University of California San

Diego, notes "*... of particular interest to economists is the apparent tendency of many economic variables to behave quite differently during economic downturns, when underutilization of factors of production rather than their long-run tendency to grow governs economic dynamics.*" [1]

Rather than modeling a simple linear relationship with continuous regressors we allow two separate regimes to co-exist. Our parameterization leads to one regime of recessions and one of expansions.[2]

This construction allows two schemes of coefficients, each representing a regime, which then generates the respective probabilities of the period ahead as a recession or expansion.

More specifically, we assume the probability of switching between regimes (i.e., from expansion to recession) is dependent on past values of switching that internalize the demarcations of the National Bureau of Economic Research's Business Cycle Dating Committee. Further, by finding the likelihood of transition between regimes as well as within regimes (i.e., the probability to stay in recession, the probability to transition from recession to expansion, *et cetera*) we can create an unconditional probability the next month is a recession.[3]

Further, our estimators are actively updated for each period as new data is released.[4] This is called smoothing as initial spikes are smoothed when more data becomes available. Because there are limited observations of recession over the past 60 years, incorporating the entirety of the series' movements maximizes the ability to accurately identify a recession in real time.

## *LEI: The Anchor*

Every third week of the month, the Conference Board publishes its **Composite Index of Leading Economic Indicators**, also called the Leading Economic Index (LEI). The LEI provides a monthly view of the business cycle through its compilation of ten high frequency data series (**Exhibit 2**). According to The Conference Board, the composite index is "constructed to summarize and reveal common turning point patterns in economic data in a clearer and more convincing manner than any individual component." Historically, the LEI has led turning points in the business cycle by about 3 to 6 months.

**Exhibit 2:** LEI Components

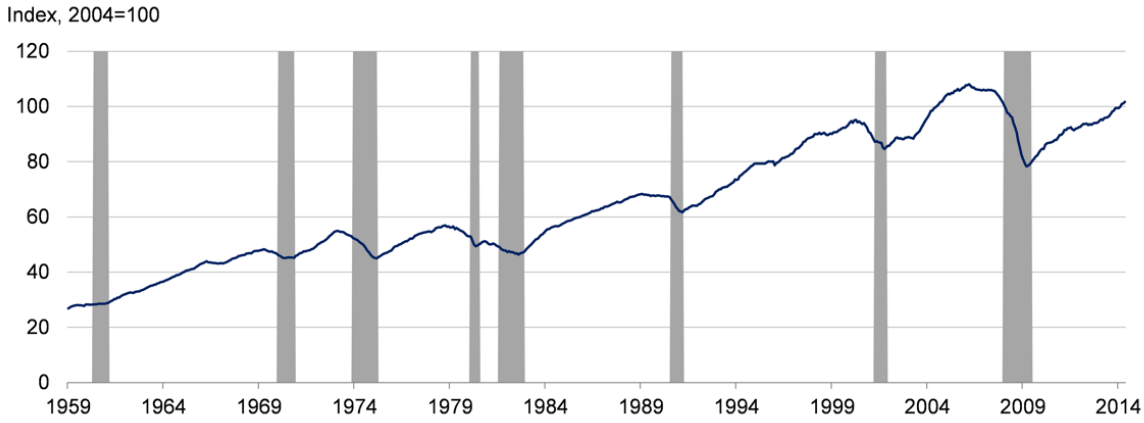
| SERIES | FACTOR* |
|---|---|
| Average Weekly Hours, Manufacturing Production Workers | 0.2713 |
| Average Weekly Initial Claims, State Unemployment Insurance | 0.0336 |
| Manufacturers' New Orders: Consumer Goods & Materials | 0.0830 |
| ISM New Orders Diffusion Index | 0.1606 |
| Manufacturers' New Orders: Nondefense Capital Goods excluding Aircraft | 0.0409 |
| Building Permits: New Private Housing Units | 0.0312 |
| Stock Price Index: S&P Composite | 0.0392 |
| Interest Rate Spread: 10 Year Treasury Bond and Federal Funds | 0.1102 |
| Average Consumer Expectation on Business and Economic Conditions | 0.1468 |
| Leading Credit Index | 0.0832 |

*Factors are used to equalize volatility of the contribution of each series. They are computed as inversely related to the standard deviation of MoM changes.

Source: The Conference Board

As **Exhibit 3** shows, movements in the LEI indeed appear to lead turning points in the business cycle, but as a recession signal, a common rule is that the LEI must decline for three consecutive months.[5] However, the rule fails to capture the more complex movements of the indicator.

**Exhibit 3:** Composite Index of Leading Economic Indicators



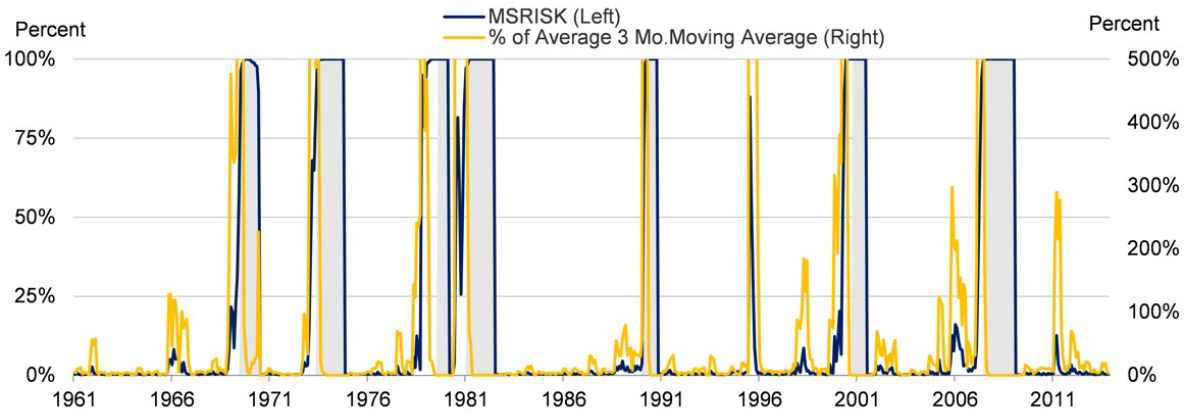

Note: Areas of gray represent recession dating as determined by the National Bureau of Economic Research. Source: The Conference Board, Morgan Stanley Research

Morgan Stanley's Recession Risk Model examines changes in the LEI and compares those changes to historical patterns at different stages of the business cycle. While the causes of a recession vary across time and geography, the fallout behaves similarly from recession to recession. This phenomenon is what underpins the MSRISK's ability to calculate short-term risks with historical data.

## *Volatility*

While the output of the model is a value between 0 and 100%, it does not move along a continuous spectrum. Looking at **the performance of the MSRISK over time reveals that any nonzero value has often indicated a recession is approaching**, with the exception of the mid-cycle growth correction in early 1996, which we will address later. Because of this non-linear behavior, **it can be useful to consider the volatility of our indicator**, which represents the underlying turmoil in the economy, as a complement to the level of the MSRISK (**Exhibit 4**).

**Exhibit 4:** Including Variance as an Indication of Turmoil




Source: Note: Areas of gray represent recession dating as determined by the National Bureau of Economic Research. Source: The Conference Board, Morgan Stanley Research

While the level of the MSRISK provides the definitive signal of an imminent recession, volatility in the MSRISK provides a consistent lead time to that signal. Volatility greater than 3 times the normal 3-month moving average has provided, on average, a 5-month lead time (**Exhibit 7**).

**Exhibit 5:** Volatility Can Extend Lead Time of MSRISK

| RECESSION START | VOLATILITY SPIKE* |
|---|---|
| December-69 | June-69 |
| November-73 | June-73 |
| January-80 | March-79 |
| July-81 | December-80 |
| July-90 | July-90 |
| March-01 | July-00 |
| December-07 | August-07 |

*Greater than 3 times normal 3-month moving average

Source: National Bureau of Economic Research, Morgan Stanley Research

**Mapping the volatility of the recession signal makes it possible to see the severity of economic events even when they produce only a negligible change in our overall recession risk value.** For example, 2011 shows only a minor blip in the increased risk of recession in September (the blue line in Exhibit 4 above), but volatility jumped to nearly 2.5 times its normal 3-month moving average (represented by the yellow line). Digging further, a perfect storm stemming from Congress's inability to find compromise over the debt ceiling and the subsequent downgrade of the US debt rating by S&P thrashed consumer confidence and raised financial market jitters. These jitters were enough to raise the risk level of recession from trivial values, but the MSRISK remained well below the 95% confidence threshold needed to confirm the onset of recession. Nevertheless, September 2011 provides a handy example of how **looking at *both* the level and the volatility in the MSRISK can help identify when potential recessionary events are underway.**

In early 1996, several broad measures of economic activity moved suddenly in the direction of a recession. For example, average weekly hours dropped suddenly and briefly, as did manufacturers' new orders. Given that these are two of the largest drivers of the LEI, such movements pushed the MSRISK to worrying levels while the volatility skyrocketed. All told, the MSRISK reached 88% - still below but dangerously close to our threshold - while the volatility jumped to more than 11 times its normal 3-month moving average. In retrospect, the US was experiencing a mid-cycle growth correction. This is **a lesson in using both the level of the indicator along with volatility in the indicator itself to gain full perspective on distress in the real economy**.

## Traditional Measures of Recession Lag

Traditional measures of the business cycle are slow to interpret downturns, primarily because data can be subject to nontrivial revisions with long lags. For example, while the Bureau of Economic Analysis (BEA) provides GDP estimates within one month past quarter end, annual benchmark revisions in July of each year can be significant, particularly around turning points in the business cycle. GDP was originally reported to have expanded at a pace of 0.6% (annualized rate) in Q1 2008, the first full quarter of the Great Recession, only to ultimately be revised to a deep drop of -2.7% nearly five years later.

Because it relies on GDP data in its determination of business cycle dates, the National Bureau of Economic Research's (NBER) Business Cycle Dating Committee, the accepted arbiter of business cycle dating, has taken between 6 and 21 months to declare turning points in the business cycle. The Committee has to wait long enough for data revisions to ensure an inflection point exists and the exact month it occurred is clear. This cautious decision making process has resulted in no revision to business cycle dates since 1978, but it also means investors must wait for what seems an interminable period for official dating.

Part of the difficulty in business cycle dating also stems from the definition of a recession. Plain definitions do exist, most notably the rule of "two quarters," where declining real GDP growth for two consecutive quarters is thought to indicate a recession. But a quick comparison between this rule and the NBER's recession dating reveals a flaw: in the post-war period the NBER has identified 41 quarters of recession, but the two-quarter rule

would have only indicated 14. The problem with such a simple metric is that any non-negative growth, however meager, would prevent the identification of a recession.

Instead, the NBER uses a broader definition of recession which *"examines and compares the behavior of various measures of broad activity: real GDP measured on the product and income sides, economy-wide employment, and real income.... [They] also may consider indicators that do not cover the entire economy, such as real sales and the Federal Reserve's index of industrial production."* Identifying a recession must, therefore, consider a wider variety of data than just GDP.

## How Do We Compare?

Given the number and variety of existing recession indicators, it's important to see how the MSRISK performs in comparison. Other recession probability indicators fall into a handful of categories: rules of thumb, GDP forecasting, probit regression, and regime-switching models anchored to different underlying data. Rules of thumb are not wholly reliable ways to predict recessions, while GDP models work off too narrow a definition of recession. An overarching concern with probit models is that probabilities are difficult to interpret with regards to recession. How should one internalize a 30% likelihood of recession compared with a 60% likelihood? In many cases, a 60% probability has not been followed by recession. Instead, our model is parameterized in a way that it generally remains at one of the two extremes – low or high risk - with volatility as an indication of underlying distress. In other words, **the MSRISK is unique in that it is designed to give virtually a "yes" or "no" answer as to whether the US is entering recession.**

### *Rules of Thumb*

Rules of thumb have an intuitive appeal. For example, the most common rule of thumb is that a decline in GDP for two consecutive quarters indicates a recession. In reality, however, such simple rules do not perform particularly well. As we noted above, the problem with such a simple metric is that any non-negative growth, however mediocre, can prevent the identification of a recession.

Another common rule of thumb is a decline in the LEI for three consecutive months. Though we find this to be a better indicator of recession than the GDP rule, it still performs poorly - signaling recession when there was none four times since 1961 (**Exhibit 7**).

### *GDP Forecasting Models*

GDP forecasting models are popular because economists can use any estimating techniques they prefer, as long as the model produces GDP estimates. These models are often some sort of vector autogression model, and the likelihood of recession is based on the chance these GDP forecasting models predict two quarters of consecutive GDP declines.

The biggest downfall of such a technique is the underlying assumption of what defines a recession. As we discussed previously, the simple two-quarter rule of thumb is too narrow a definition to capture the wide variety of metrics the NBER considers when dating a recession. Further, the model provides an unpleasant choice between allowing sufficient lead time and providing accuracy; it is difficult to balance the two.

### *Probit Regression Models*

Probit regression models, such as the one published **here** by the New York Federal Reserve Bank (NYFRB), codify the belief that the yield curve can accurately forecast recession.[6] In recent years, this assumption has been challenged.

The slope of the yield curve reflects market expectations of the future path of interest rates, making it ideal as a

leading indicator of the business cycle. In normal times, the prospect of steady economic growth implies a flat to slightly rising yield curve. But when conditions point to slower growth ahead, investors expect lower interest rates in the future, sending long-term yields below short-term yields, inverting the yield curve.

An inversion of the yield curve has not always signaled an approaching recession, but it has preceded each of the last seven recessions. This makes the yield curve an important leading indicator in business cycle and recession-risk modeling. The NYFRB bases its recession risk model solely on the spread between the 10-year Treasury bond and the 3-month Treasury bill. Unfortunately, when short-term and long-term yields remain at very low levels, such as today under the Fed's promise to keep the Federal Funds rate low for a considerable period, **the efficacy of the yield curve as a leading indicator of the business cycle breaks down because an inversion becomes virtually impossible**.

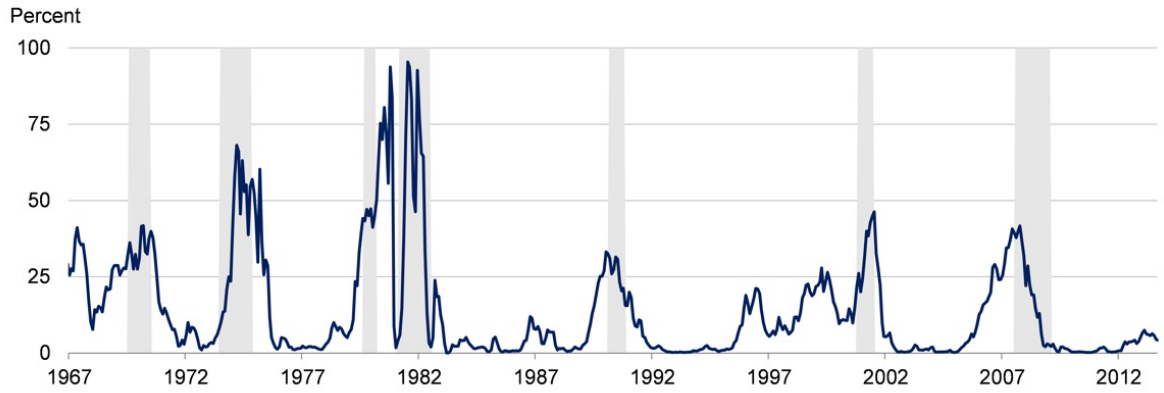
The LEI includes the spread between the rate on the 10-year Treasury bond and the Federal Funds rate. Yet as just one of the 10 components, the spread drives roughly 11% of the LEI's month-to-month movements. This provides the MSRISK a degree of insulation from possible distortion due to the yield curve during periods of extraordinary monetary policy accommodation.

An additional drawback to probit models is their vulnerability to overfitting the data. With a large dataset, the probit based regression model can sometimes include spurious relationships with no true predictive power. When these inconsequential variables move, a probit model will erroneously predict a recession.

Moreover, a probit model is sensitive to assumptions about the forecast horizon. Because the lead time to recession has varied greatly when compared to movements in the yield curve, a probit model attempts to include the entirety of these peculiar lead times. In doing so, its accuracy can be diminished either by predicting a recession too far ahead only to see the underlying economy skirt recession, or by missing a recession entirely. Over longer horizons, however, a probit model tends to perform better than other models. Despite this seeming advantage, we prefer to have a definitive signal one month ahead rather than chance a false recession signal as much as 12 months ahead.

Even more, the probabilities that probit models produce can be difficult to interpret. To be sure, a reading over 50% implies a greater likelihood of recession than not, but it is unclear at what point the probability is definitive (**Exhibit 6**). Though a 50% threshold for the NYFRB probit model is intuitive, it provides poor results compared with a lower threshold of 25% (**Exhibit 7**).

**Exhibit 6:** NYFRB Probit Model (12 Month Horizon)




Note: Areas of gray represent recession dating as determined by the National Bureau of Economic Research. Source: New York Federal Reserve, Morgan Stanley Research

## *Other Regime-Switching Models*

Other regime-switching models differ in their choice of the underlying data source. For example, other models have used industrial production, payroll employment, and real personal income as underlying data sources.[7] We prefer to use The Conference Board's LEI, particularly because the LEI captures trends in a wider variety of markets, both financial and nonfinancial.

### *Table of Comparison*

An important consideration in comparing the MSRISK to other available models is **the balance of accuracy against lead time**. Some methods, such as the LEI rule of thumb, can provide a longer lead time but at the cost of frequent false signals. A great advantage of the MSRISK is that it would have never given a false signal, nor missed signaling a recession, since 1961.

**Exhibit 7:** Lead Time: How Do We Compare?

| RECESSION START | MSRISK | NYFRB 25%* | NYFRB 50%* | OTHER REGIME SWITCHING** | LEI*** |
|---|---|---|---|---|---|
| Dec-69 | 0 | 9 | Missed | 2 | 1 |
| Nov-73 | 0 | -4 | -7 | -7 | 4 |
| Jan-80 | 7 | 3 | Missed | -1 | 6 |
| Jul-81 | 1 | -2 | -3 | -1 | 1 |
| Jul-90 | -1 | 5 | Missed | -2 | -1 |
| Mar-01 | 4 | 0 | Missed | 0 | 4 |
| Dec-07 | 1 | 7 | Missed | -2 | 5 |
| False Signals | 0 | 3 | 0 | 0 | 4 |

* New York Fed Probit model with 25% or 50% threshold

** Based Chauvet and Piger "Smooth Recession Probabilities," with 50% threshold

*** 3 consecutive declines

Note: A negative number indicates lagging the official start.

Source: New York Federal Reserve Bank, FRED, The Conference Board, National Bureau of Economic Research, Morgan Stanley Research

## Conclusion

Recession risk modeling is fairly new in historical terms. Only within the last 40 years have regime-switching models been introduced to the field of economics and been used to study the behavior of economic time series over the business cycle. More recently, it was former Fed Chairman Alan Greenspan, when he cited the "probability of recession" during Congressional testimony in the late 1980s, who boosted the popularity of recession risk modeling.

The Morgan Stanley Recession Risk Model (MSRISK) provides a timely indication of the short-term risk of recession and has demonstrated a high degree of accuracy since 1961. Furthermore, to tease out a longer lead time, the MSRISK can be complemented by examining the volatility of the series. Currently, the MSRISK indicates a very low risk of recession in the next month, alongside low volatility, but that won't always be the case. Whenever MSRISK or its volatility concerns us, we will report what we see. As the business cycle stretches on, interest in recession models will grow, and having one that is comparatively advantaged will prove valuable indeed.

## Other US Economics Research

**US Economics: That 70s Show (11 Jul 2014)**

**US Economics: Uncertainty About Slack (02 Jul 2014)**

**US Economics: Business Conditions: A Jump in June (30 Jun 2014)**

**US Economics: Yellen's Conundrum: Slow Wage Growth, Higher Prices (27 Jun 2014)**

**US Economics: The Impact of Higher Oil Prices (20 Jun 2014)**

**US Economics Outlook: Bygones Are Bygones (09 Jun 2014)**

## Endnotes

[1] See Hamilton (2005). "Regime-switching Models."

[2] In doing so, our functional form becomes the autoregressive: $y_t=\beta_{0,s}+\varphi_{t-1}+\varepsilon_t$ where s denotes the state of the model.

[3] This could be a generous assumption; formalized, it implies that our regimes are ergodic over the series, which allows the derivation of unconditional probabilities from conditionals. The likelihood of a recession or expansion in the period ahead is not independent from the current state, however. It is possible to estimate this value itself instead via a maximum likelihood method, but the results it generates are a marginal improvement at the cost of increased complexity. Our results are proof to the rationale of such an assumption. Further, the probability of recession given that the current period is an expansion is $\Pr(s_e= i \mid s_r )=P_{e,r}$ where subscript e denotes expansion and r recession. Consider: $\Pr(s_r= i \mid s_r )=1$ , which implies a recession would persist indefinitely, and therefore it must be the case that both $\Pr(s_r= i \mid s_r )<1$ and $\Pr(s_e= i \mid s_e )<1$.

[4] Our estimates use data releases lagged by 6 months. Doing this attenuates our estimates over time as patterns from decades earlier will impact the unconditional probabilities as they present themselves in various ways in the underlying data. However, we choose such a system for two primary reasons: we fundamentally believe the drivers in a recession bear more resemblance to each other than not, and it makes the interpretation of the output more intuitive.

[5] See Filardo (1999). "How Reliable are Recession Prediction Models?"

[6] See Estrella and Trubin (2006). "The Yield Curve as a Leading Indicator: Some Practical Issue."

[7] See, for example, Chauvet and Piger (2008). "A Comparison of the Real-Time Performance of Business Cycle Dating Methods."

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