

Economics Group

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Do We Need to Wait for a Yield Curve Inversion to Predict a Recession? No.

“Others have seen what is and asked why. I have seen what could be and asked why not.” – Pablo Picasso

Be Mindful of Elevated Recession Risks in 2018-2019

Predicting recessions is one of the most important elements of decision-making in the public and private sector. As such, a different set of policy tools is needed during a recession than that used for an economic expansion. The yield curve (spread between the 10-year Treasury and federal funds rate, for example), in particular the inversion point of the yield curve, is thought to be a very good predictor of a recession. An inverted yield curve has led all recessions since the 1969-70 recession.¹ Furthermore, the Federal Open Market Committee (FOMC) has raised the federal funds target rate (fed funds rate) twice in 2017, which has brought the inverted yield curve topic (and the impending risk of a near-term recession) back into the spotlight. Other analysts are raising questions surrounding the yield curve’s effectiveness in predicting recessions. Presently, the fed funds rate is “recovering” from a historical low level (zero-lower bound) and, as such, the yield curve may not invert in this cycle as it has in the past. That is, the yield curve stayed in the positive territory (did not invert) during the 1954-1965 period and that era experienced two recessions (1957-1958 and 1960-1961 recessions).²

In this report, we propose a new framework that identifies a threshold between the fed funds rate and the 10-year Treasury yield (we call it FFR/10-year threshold). In a rising fed funds rate environment, the threshold is breached when the fed funds rate touches/crosses the lowest level of the 10-year Treasury yield in that cycle. When this occurs, the risk of a recession in the near future is significant. Our framework has successfully predicted all recessions since 1955 with an average lead time of 17 months. Furthermore, our framework predicted several recessions before the yield curve inversion point and, therefore, serves as a more effective tool in predicting recessions. That is, with our framework, we do not need to wait for the yield curve to invert to predict a recession.

Why is our analysis important for decision-makers? In the current monetary cycle, the lowest 10-year Treasury yield was 1.36 percent (hit on July 5, 2016) and the current fed funds rate is 1.25 percent. We are forecasting one more rate hike by the FOMC (December 2017), and, if we are correct, the fed funds rate will be 1.50 percent, thereby surpassing the lowest level of the 10-year Treasury (1.36 percent) and thus breaching the threshold. Historically, when the threshold is met, there is 69.2 percent chance (average probability) of a recession within the next 17 months

How effective is the yield curve in predicting recessions?

In this report we propose a new framework for predicting recessions.

¹ For more detail about the yield curve’s predictive power see, Adrian, T., Estrella, A. and Shin, H.S. (2010). Monetary Cycles, Financial Cycles, and the Business Cycle. *NY FRB Staff Reports*, No 421, January 2010.

² It is worth mentioning that the U.S. economy was in a recession during the July 1953-May 1954 period but our data (fed funds rate series) only go back to January 1954 and, therefore, we did not include the 1953-54 recession in the analysis. That would have been the third recession “missed” by the inverted yield curve as the yield curve was positive in 1954.



(average lead time). Therefore, in the December rate hike scenario, the chances of a recession in 2018 through mid-2019 are elevated.

Figure 1

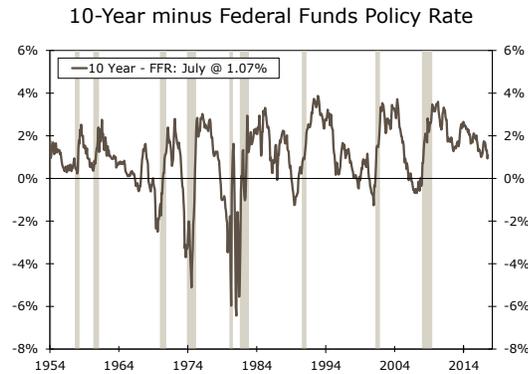
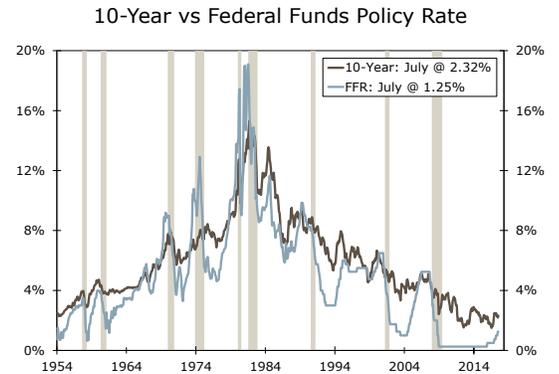


Figure 2



Source: U.S. Department of Labor, Federal Reserve Board and Wells Fargo Securities

Summing up, our proposed framework (FFR/10-yr threshold) produced 13 signals since 1955 and 9 of the 13 signals are associated with recessions (there are only 9 recessions in that time period, thus, we did not miss any recessions) with an average lead time of 17 months. The remaining four signals are connected with changes in the monetary policy stance (moving from rising fed funds to cutting interest rates) with an average lead time of 8 months. Typically, during long economic expansions, monetary policy will shift due to a “mid-cycle softening” and the FOMC will reduce interest rates to boost the economy. This phenomenon occurred in the 1960s, 1980s and 1990s. Therefore, our proposed framework did not produce a single misleading signal (neither false positive or false negative). Given the robust performance of our framework, we suggest decision makers to watch for a recession during 2018 and mid-2019 (17 months from December 2017, in the case of a rate hike).

The Inverted Yield Curve: A Song of Policy Tightening and Recessions

The yield curve (spread between the 10-year Treasury yield and fed funds rate) is one of the most cited recession predictors. In fact, the yield curve is the part of the Conference Board’s index of leading economic indicators (LEI). In particular, the inverted yield curve has led the last seven recessions (all recessions since the 1969-70 recession), Figure 1. That is, the yield curve inverted before each of the last seven recessions (although with a wide range of 8-23 months lead time).

Most studies in the past have utilized the spread between the 10-year Treasury yield and fed funds rate as the yield curve, and we followed that tradition (for more detail see Adrian et al. (2010)). There are several benefits of using the yield curve based on the 10-year Treasury and fed funds rate. First, Bernanke and Blinder (1992) utilized the nominal level of the fed funds rate to measure the monetary policy stance, and thereby we include the policy stance in the yield curve.³ Second, moments in the 10-year yield reflect financial market participants’ expectations about the economic outlook and the monetary policy stance. For example, typically, investors seek higher yield in an inflationary era and take refuge in Treasuries when fears of a recession rise (lower yield), all else equal. Therefore, our measure of the yield curve represents both the policy stance and market expectations.⁴

³ For more detail see, Bernanke, Ben S. and Alan S. Blinder. (1992). The Federal Funds Rate and the Channels of Monetary Transmission. *American Economic Review*, Vol 82(4).

⁴ It is worth mentioning that some analysts utilize the spread between the 10-year and 3-month Treasuries as a measure of yield curve. In our view, that spread represents market expectations mostly and less of a policy stance. Therefore, we did not utilize that spread.

We suggest decision makers watch for a recession during 2018 and mid-2019.

The inverted yield curve has predicted the last seven recessions.

Third, Adrian and Estrella (2009) utilized the fed funds rate to identify monetary cycles, which are good predictors of recessions and another competitor of recession prediction methods. The fourth and final method, our FFR/10-year threshold framework, also utilizes the fed funds rate and 10-year yield to predict recessions. Therefore, all three methods of recession prediction utilize the fed funds rate and 10-year yield and, thereby, we can compare performances of these methods to find which approach is most effective in predicting recessions.

Typically, an inverted yield curve suggests that the financial markets are not very optimistic about the near-term economic outlook and seek “safety” of their investment by buying 10-year Treasuries, which creates higher 10-year Treasury demand and reduces the yield, all else constant. The fed funds rate, on the other hand, is set by the FOMC and, usually, the FOMC takes time (lag effect) to change the stance of monetary policy (transitioning from a dovish tone to hawkish one). The lag response from the FOMC is because the FOMC utilizes realized data along with its forecast to set the monetary policy stance. Therefore, in the case of an inverted yield curve, the 10-year yield drops below the fed funds level because changes in the economic outlook influence both financial market expectations and monetary policy.⁵

Figure 3

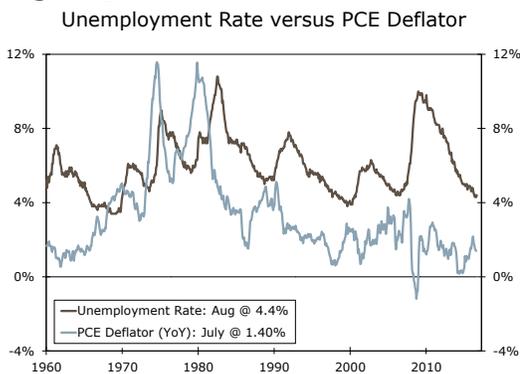
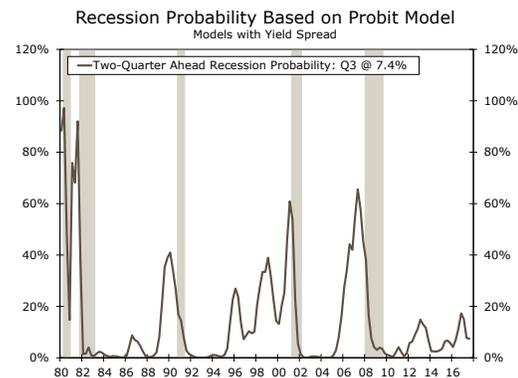


Figure 4



Source: IHS Data Insight, Department of Commerce, Department of Labor and Wells Fargo Securities

Is This Time Different for the Inverted Yield Curve to Predict Recessions?

As mentioned earlier, the inverted yield curve has predicted the last seven recessions but missed the 1957-1958 and 1960-1961 recessions. That is, the yield curve remained positive (did not hit the inversion point) during the 1954-1965 period. Furthermore, the misses associated with the 1957-1958 and 1960-1961 recessions (false negative) raises questions about the yield curve’s effectiveness in predicting the next recession. This begs the questions: are there some potential factors which may prevent the yield curve to invert in this cycle similar to the 1950s/mid-1960s episodes? Likewise, is there an alternative method for recession prediction that is more effective than the yield curve?

We believe that the yield curve’s effectiveness to predict the next recession may be different than the last seven recessions and may repeat the 1957-1958 and 1960-1961 recessions’ experiences. That is, the yield curve may not invert and, thereby, be useless in predicting the next recession. There are several major reasons to support our view. First, the fed funds rate is recovering from the lowest level (from 0-0.25 percent range) in our analysis, which covers the January 1954- July 2017 time period. Furthermore, the fed funds hit the 0-0.25 percent range on December 2008 and that was the lowest level since July 1958 (0.68 percent). In addition, before December 2008 there are only two episodes of below 1 percent fed funds rate and both of them occurred in the 1950s (several months in 1954 and a few months of 1958 observed below 1 percent fed funds rate)

We believe that the yield curve’s effectiveness to predict the next recession may be different than the last seven recessions.

⁵ There are several potential reasons behind the inverted yield curve and we discussed financial world’s expectations and for more detail about the inverted yield curve see, Adrian et al. (2010).

and the yield curve did not invert in the 1950s (1954-1959). Since both the 10-year yield and fed funds rate remained positive in our sample period (1954-2017), a historically lower level of the fed funds rate may pose a hurdle for the yield curve to invert. For instance, the 10-year yield dropped below 2 percent for the first time (in our sample period) on September 2011 (1.98 percent) and never dropped below 1 percent in our analysis. The fed funds rate, on the other hand, hit the zero-lower bound on December 2008. By the same token, in the 1954-1965 period, the lowest fed funds rate was 0.63 percent (May 1958) and the lowest 10-year yield was reported as 2.29 percent (April 1954). It is important to note that, in the pre-December 2008 era, the lowest level of the fed funds rate and 10-year yield were reported in the 1950s and the yield curve did not invert during the 1954-65 period (and missed two recessions). Therefore, the recovery from the historically low-level of the fed funds rate may alter the yield curve's effectiveness in predicting the next recession compared to the last seven recessions—we may not see an inverted yield curve before the next recession.

The recovery from the historically low-level of the fed funds rate may alter the yield curve's effectiveness to predict the next recession.

Second, the current and near-term economic outlook, in particular inflation expectations, may not be ideal for a faster pace of monetary policy tightening (faster fed funds rate hikes, for example). That is, the dual mandate (maximum employment and price stability) of the FOMC dictates that officials consider the labor market/inflation expectations (in addition to other factors) in setting the monetary policy stance. For example, Taylor (1999) suggested that the fed funds rate responds to economic variables (unemployment and inflation rate, for example), even in the periods when the FOMC was targeting some other variables (i.e. money growth and/or reserves targets).⁶ Furthermore, Romer and Romer (2002) concluded that inflation expectations, typically, play a crucial role in setting the monetary policy stance.⁷ Therefore, the economic outlook may influence the fed funds rate in a way to slow any pace of federal funds rate.

Echoes From the 1950s

In our view, the current economic outlook, in particular realized and expected inflation, is more in line with the 1954-1965 period than the last seven recessions (1969-2007 period). For example, the FOMC's inflation target is 2 percent (the PCE deflator is the preferred inflation measure of the Fed) and the PCE deflator is just 1.22 percent for the May 2012-June 2017 period (Figure 3). Furthermore, the PCE deflator (year-over-year [YoY] percent change) stayed below 2 percent for the May 2012 to June 2017 period (with the exception of two months: January/February 2017) and it is the longest stretch in the past 50 years. In addition, before 2012, the last time the PCE deflator stayed below 2 percent for over five years was between January 1960 and January 1966 (slightly more than six years). It is worth mentioning that the PCE deflator series only goes back to 1960, and we utilize CPI (YoY) for the pre-1960 period. The CPI (YoY) was below 2 percent for the November 1952 and July 1956 period (with an average of just 0.41 percent) and between November 1958 and January 1966 (with an average of 1.28 percent).⁸ The possible consequences of the lower inflation of the 1950s and early 1960s is the lower fed funds rate as the rate dropped below 1 percent, the first time ever in our analysis, in 1954 and then in 1958. On the other hand, the PCE deflator hit the 2 percent target on February 1966 and then stayed above the 2 percent line for the next 30 years, and the fed funds rate never dropped below 3 percent during that time period.

Silvia, Iqbal and Bullard (2016) identified low-inflation episodes (where a low-inflation episode is defined as six consecutive months of PCE deflator below 2 percent) using the 1975-2016 time period.⁹ Out of eight total episodes identified between 1975 and 2016, three of them occurred in the 2008-2016 period. Between November 2008 and July 2017 (last data point at the time of this

⁶ For more detail about the relationship between monetary policy stance and economic variables see Taylor, John B. (1999). *A Historical Analysis of Monetary Policy Rules*, in John B. Taylor edited "*Monetary Policy Rules*". University of Chicago Press 1999.

⁷ Romer, Christina and David Romer. (2002). *A Rehabilitation of Monetary Policy in the 1950s*. *American Economic Review*, Vol 92, no 2, May 2002.

⁸ It is worth mentioning that the average CPI and PCE deflator for the January 1960-January 1966 period is 1.3 percent. Basically both series are highly correlated overtime.

⁹ Silvia, John, Azhar Iqbal and Sam Bullard. (2016). *A New Framework to Estimate the Near-Term Path of the Fed Funds Rate*. *Business Economics*, Vol 51, No 4.

writing), the PCE deflator was below 2 percent for 85 of 105 total months (with an average of just 1.33 percent). Therefore, inflation rates since the Great Recession are at historical lows, on average. The unemployment rate, the other focus of the FOMC, took almost nine years to drop below the pre-Great Recession era (Figure 3). That is, the unemployment rate dropped to 4.3 percent in May 2017, just below the 4.4 percent rate registered in May 2007.

Historically low inflation rates, along with a slow decline in the unemployment rate, are associated with a historically low fed funds rate (dropped to zero-lower bound on December 2008 and stayed there for the next six years) and several rounds of quantitative easing, which boosted the Fed’s balance sheet to around \$4.5 trillion (a historically high level). All of these factors, in our view, are supportive of a slower pace of fed funds rate hikes in the near future. The FOMC has also announced its intentions to reduce its balance sheet starting in 2017. Furthermore, a lower fed funds rate was unable to invert the yield curve in the 1954-1965 period, although that period experienced two recessions. Therefore, we need to look for methods, other than the simple yield curve, to accurately predict the possibility of the next recession.

A Probit Model Using the Yield Curve to Predict Recessions

One method that utilizes the yield curve to predict recessions involves building a probit model and employing the yield curve as the predictor variable of the model (Figure 4).¹⁰ The probit model (or any standard econometric model) needs a longer data history for estimation purpose. Therefore, we started forecasting recessions since 1980 (use 1960-79 period for estimation). The probit model has predicted (50 percent probability as a threshold) all recessions since 1980 except the 1990-91 recession. Furthermore, due to the lack of data for the pre-1950 period, we are unable to check the probit model’s accuracy regarding the 1957-1958 and 1960-1961 recessions (these recessions were missed by the traditionally calculated inverted yield curve). Thus, the probit model may not be the answer. Therefore, we move forward to utilize another tool, monetary cycles, to try to predict recessions.

The probit model has predicted (50 percent probability as a threshold) all recessions since 1980 except the 1990-91 recession.

Table 1: Monetary Cycles and Recessions

Recession Start Date*	Monetary Cycle End Date **	Months before/after the Recession Start Date***
August-57	October-57	+2
April-60	November-59	-5
December-69	August-69	-4
November-73	September-73	-2
January-80	April-80	+3
July-81	June-81	-1
July-90	March-89	-16
March-01	July-00	-8
December-07	September-06	-15

* Recession Dates are determined by the National Bureau of Economic Research (NBER)

** Monetary Cycles are determined by Adrian and Estrella (2009)

*** A (+) sign indicates that a recession started before the end of the monetary cycle. A (-) sign shows the monetary cycle ended before the recession start date.

¹⁰ For more detail on the probit model and the yield curve’s effectiveness see our past work, “Recession Talks in the Spotlight: Should We Worry?” The report published on February 24, 2016. The report is available upon request.

The Game of Monetary Cycles: Is Recession Coming?

Adrian and Estrella (2009) identify monetary cycles and suggest that monetary cycles are good predictors of economic activities, as these cycles are typically associated with business cycles.¹¹ Adrian and Estrella (2009) concluded that there have been 14 monetary cycles since 1955 and that a monetary cycle ends when the fed funds rate peaks. Moreover, the end of a monetary cycle is a prediction for an upcoming recession. According to the NBER, however, there have been nine recessions since 1955, which indicates that not all monetary cycles are associated with recessions as there were 14 monetary cycles in the same time period, see Table 1 and 3 for results.

For example, the first monetary cycle ended on October 1957 but the recession start date is August 1957 (missed by two months). Similarly, January 1980 is the recession start date but the monetary cycle end date is April 1980 (missed by three months). Monetary cycles predicted the rest of the recessions with a lead time range of 1-16 months. Although monetary cycles have predicted several recessions (and missed the 1957-1958 and 1980 recessions), the real time effectiveness of the monetary cycles is a big question mark. Why? In our view, the monetary cycle approach to predict recessions is a backward-looking method, and that is because of the way a monetary cycle is defined. For example, Adrian and Estrella (2009) said that a monetary cycle ends when either one of the two criteria is met: (1) the fed funds rate is higher than at any time from the 12 months before to nine months after and is at least 50 bps higher than at the beginning of this period, or (2) the fed funds rate is higher than at any time from six months before to six months after and is 150 bps higher than the average at these endpoints. Basically, the peaking of the fed funds rate is the ending of a monetary cycle; in other words, the peaking of the fed funds rate is a prediction for the upcoming recession.

However, life is not that simple as we have to wait for at least six months (2nd criterion) to confirm whether the fed funds rate has peaked six months ago. Why does that matter? It matters and, to some extent, changes (reduces) the real time effectiveness of monetary cycles to predict recessions completely. For example, the first monetary cycle end date is October 1957 and that cycle missed the recession by two months (the recession start date is August 1957). However, in reality, we have to wait for at least six months (using the 2nd criterion, which has a shorter waiting period) to determine the fed funds rate's peak point. That is, in April 1958 we were able to declare that the October 1957 was the peak month for the fed funds rate (end of a monetary cycle) and then we can make a recession prediction. But, April 1958 is also the end date of the recession, and therefore, in real time analysis, the monetary cycles missed the 1957-1958 recession completely. What we are suggesting is that the monetary cycles method's lead time to predict recessions should be longer than the waiting period of 6-9 months to gain financial benefits (predict recessions) from this approach. For example, using real time analysis, monetary cycles have missed all of the recessions in the 1955-1989 period as the lead time for all these recessions is less than six months (Table 1). Monetary cycles did predict the 1990-1991 and the Great Recession as the lead time was 16 and 15 months, respectively. The lead time for the 2001 recession was eight months and that could be considered a miss using the first criterion to define a monetary cycle (at least nine months are needed to confirm the fed funds rate peak).

Therefore, in our view, monetary cycles are effective recession predictors, but the method is backward-looking. Furthermore, in real time analysis, monetary cycles are only able to predict recessions in the post-1990 era. We need a method that effectively predicts recessions in real time so decision-makers have enough leeway to prepare policies for the upcoming recession. We will now discuss the final method, our proposed method. We believe this approach is more effective in predicting recession than the other methods discussed so far in this study.

¹¹ Adrian and Estrella (2009) suggested that monetary cycles are good predictors of economic activities and for more detail about monetary cycles' definition and their relationship with business cycles see, Adrian, T. and Estrella, A. (2009). Monetary Tightening Cycles and the Predictability of Economic Activity. *NY FRB Staff Reports*, No 397, October 2009.

Not all monetary cycles are associated with recessions.

Monetary cycles are useful in identifying recessions; however that method is backward-looking.

Table 2: The FFR/10-Yr, the Yield Curve and Recessions

Recession Start Date	Inverted Yield Curve Date/Months before Start of Recession	The FFR/10-yr Threshold's Recession Prediction, months in advance	The FFR/10-yr Threshold's Prediction of the Yield curve Inversion, months in advance
August-57	No Inverted Yield Curve	April 1956 (-16)	N/A
April-60	No Inverted Yield Curve	October 1959 (-6)	N/A
December-69	April 1968 (-20)	April 1968 (-20)	Same/zero
November-73	March 1973 (-8)	January 1973 (-10)	-2
January-80	September 1978 (-16)	April 1978 (-21)	-5
July-81	October 1980 (-9)	October 1980 (-9)	Same/zero
July-90	January 1989 (-18)	September 1987 (-34)	-16
March-01	April 2000 (-11)	February 2000 (-13)	-2
December-07	January 2006 (-23)	December 2005 (-24)	-1

*Note: there are some periods which experienced an inverted yield curve but were not followed by recessions, instead another period of inverted yield curve led to the subsequent recession. Those periods are, with the start dates of inverted yield curve, the May 1966 and July 1998. There is just one month which is December 1986 when the yield curve was inverted.

A New Framework to Predict Recessions: The FFR/10-Year Threshold

We have discussed the limitations of the yield curve (inverted yield curve and the probit/yield curve modeling) and monetary cycles' approaches to predict recessions. In addition, one major challenge in this monetary cycle is that the fed funds rate's recovery from the lowest level, along with a low inflation environment, may block inversion of the yield curve similar to the 1954-1965 period. Therefore, we need a framework that is more effective in real time recession forecasting than the yield curve/monetary cycle methods. The framework should also be able to predict recessions accurately in different economic regimes such as lower inflation/fed funds rate regimes (the 1954-1965 period and the era since the Great Recession, for example), higher fed funds rate/inflation (the 1970 to mid-1980s time period) and in the moderate inflation/fed funds rate time periods (the 1990-2007 time period, for instance). We believe our proposed framework would predict recessions accurately in all those economic regimes.

Our framework identifies a threshold between the fed funds rate (FFR) and the 10-year Treasury yield (10-year). The crossing of the threshold is an indicator for an upcoming recession. We labeled the framework as the FFR/10-year threshold to predict recessions. The threshold is best explained by the following description: *in a rising fed funds rate period, when the fed funds rate crosses/touches the lowest level of the 10-year yield in that cycle, then that is a prediction for an upcoming recession.* For example, the Fed started raising the fed funds rate in December 1954 (fed funds rate increased from 0.83 percent to 1.28 percent) and the 10-year yield hit 2.61 percent (lowest level in that cycle) on January 1955. Furthermore, the fed funds rate crossed the lowest level of the 10-year yield on April 1956 (fed funds rate was 2.62 percent) and, thereby, signaled an upcoming recession. The recession start date is August 1957 (a 16-month lead time for our framework's prediction), (Table 2). It is worth mentioning that both the yield curve and monetary cycles' methods were unable to predict the 1957-58 recession.¹²

Before we discuss the effectiveness of the FFR/10-year threshold, we raise a few questions to highlight the intuition behind the threshold method. Why is the rising fed funds rate the starting period for the threshold method? Why is the lowest level of the 10-year Treasury yield in a cycle

An effective recession predicting model should not be backwards looking.

¹² The yield curve approach missed the 1957-58 recession completely. The monetary cycle method missed the recession by 2 months according to Adrian and Estrella (2009) and was a complete miss, in a real time analysis, by our calculation.

matter? Why is the threshold (FFR crossing/touching the lowest 10-yr) approach a good recession predictor? The rising fed funds rate, outside recessions, is a sign of a change in the monetary policy stance and, typically, the Fed starts raising interest rates when the economy enters expansion.¹³ Naturally, a recession comes after an expansion phase and therefore a rising fed funds rate environment is a better policy stance to utilize in recession predictions, which is the objective of the threshold framework. The 1980 recession is an exception as the next recession (the 1981-1982 recession) started within a year of the ending month of the 1980 recession. Therefore, a rising fed funds rate represents a change in the monetary policy stance and the FOMC's expectations about the strength (expansionary phase of a business cycle) of the economy.

Attempting to predict a recession based on an expansion's start date and current length is not a useful exercise.

By the same token, the 10-year yield's lowest level in a cycle serves as an inflection point in the market's expectations about the economic outlook and monetary policy stance. That is, market participants are not looking for a refuge/safety in Treasuries, which reduces the Treasuries' demand and consequently a rise in the yield, all else equal. Furthermore, financial markets are also expecting a better economic outlook (perhaps the beginning of an expansionary phase) and a change in the policy stance (rising fed funds rate) in the near future. Basically, both policy makers and market participants are expecting a better economic outlook/expansion phase and, therefore, the rising fed funds rate and lowest 10-year yield level are inflection points and help to predict recessions.

Looking Beyond the Absolute Length of an Expansion

While it is true that the end of an expansion phase is the beginning of a recession, the length of expansions vary significantly as the longest expansion in our analysis lasted for 10 years. The current expansion is the third longest at the time of this writing, September 2017. Therefore, attempting to predict a recession based on an expansion's start date and current length is not a useful exercise. Moreover, we are looking for a threshold that will help us to predict recession, in real time, in a timely matter. For example, the threshold for the yield curve approach is the inversion point and peaking of the fed funds rate is a benchmark for the monetary cycles. However, the lower fed funds rate along with a low inflation rate may prevent an occurrence of an inversion point in this cycle similar to the 1954-1965 period. We have to wait for 6-9 months to declare a peak month of the fed funds rate to predict recessions in the monetary cycles' analysis and the waiting period reduces the effectiveness to predict recessions significantly, as mentioned earlier. Therefore, our proposed threshold of FFR crossing/touching the lowest 10-year point is effective in real time recession prediction. There are several reasons for this unique ability that will be discussed.

Our method does not incorporate an inversion point in predicting recessions.

First, a lower fed funds rate may prevent a yield curve to invert, but our method does not incorporate an inversion point in predicting recessions. Second, there is no waiting period to declare whether the threshold has been met, unlike the monetary cycle method, which is largely backwards looking. Moreover, we can also predict the possible timing of the threshold point, which we show in a latter part of the study. Third, we do not impose a specific value of the 10-year yield as a benchmark (2 percent 10-year as a threshold, for example) because different economic regimes (higher or lower inflation and/or stronger or weaker recoveries, for instance) would produce different lows/highs of fed funds rates and 10-year yields in a business cycle. Therefore, using the cycle low yield for the 10-year, accounts for the heterogeneity of business cycles. Another reason for not using a fixed level for either the 10-year yield or the fed funds rate as a threshold is that the effect of a rising fed funds rate on 10-year yield varies depending on the cycles. For example, the FOMC raised the fed funds rate from 1.00 percent to 5.25 percent during the June 2004-June 2006 period and the 10-year increased only by 37 bps (from 4.73 percent to 5.11 percent) during the same time period; Greenspan labeled it as "interest rate conundrum." In sum, the accuracy of our proposed framework would not be affected by the fact that the fed funds rate is recovering from the zero-lower bound, or by a low inflation environment or by the fact that the relationship between the fed funds rate and 10-year has changed overtime.

¹³ The 1973-75 and 1980 recessions are the only two exceptions when the Fed raised the fed funds rates during a recession.

The final and fourth reason is that the FOMC can raise the fed funds rate up to a certain level and, typically, when the fed funds rate peaks, that is an indication that the expansion is close to its peak, and a recession is in the neighborhood.¹⁴ Furthermore, historically, (Table 2 and 3) when the fed funds rate crosses/touches the lowest level of the 10-year, in a monetary cycle, that is an indication that fed funds rate's peak is approaching. Therefore, meeting the threshold is a prediction for the upcoming recession.

Table 3: The Exceptions to the Rule: No Recession But Change in the Monetary Policy Stance

Monetary Cycle End Date *	Inverted Yield Curve Dates**	The FFR/10-yr Threshold's Date, months in advance***	Change in the Monetary Policy Stance Date****
November-66	No Inverted Yield Curve before the 1957-58 recession	12/1/1964 (-24)	Dec 66 (Reduced interest rate from 5.76% to 3.79% between Nov 66 and Jul 67)
August-71	No Inverted Yield Curve before the 1960-61 recession	8/1/1984 (-1)	Sep 84 (from 11.65% to 7.51% between Aug 84 and Jun85)
7/1/1974 (within a Recession)	May-66	2/1/1995 (-5)	Jul 95 (from 6.00% to 5.25% between Jun 95 and Jan 96, and maintain that stance until Feb97)
August-84	December 1986 (just one month of inverted yield)	7/1/1998 (-2)	Sep 98 (from 5.50% to 4.75% between Aug 98 and Nov 98, and maintain that stance until May 99)
April-95	July-98	N/A	N/A

*These monetary cycles are not followed by recessions

** These inverted yield curves did not lead to recessions

*** These predictions are not associated with recessions

****We consider a change in the monetary policy stance if the FOMC started cutting the Fed funds rate instead keeping it unchanged. Furthermore, the FOMC reduced interest rates more than once in 6 months and kept that stance for more than a few months.

Now we discuss the accuracy of our proposed method, with the results reported in Table 2. Since 1955, our framework predicted all recessions with an average lead time of 17 months, with a range of 6-34 months. It is important to note that our method is the only approach discussed in this study that did not miss any recessions in the sample period. This means that it is more effective than the yield curve and monetary cycle approaches. Furthermore, our framework has a better lead time than the yield curve to predict recessions for all recessions except the 1969-1970 and 1981-1982 recessions where both approaches have the same lead time, Table 2.

Our method is the only approach discussed in this study that did not miss any recessions in the sample period.

The Exception to the Rule: Recessions versus Changes in the Monetary Policy Stance

Sometimes there is an exception to the rule, and thereby our framework produces four calls that are not associated with recessions. It is worth mentioning that our framework is the only approach (discussed in this study) that did not miss any recession since 1955, whereas the yield curve missed two recessions and produced three calls, which were not related with recessions, Table 2 and 3. Similarly, the monetary cycle method missed two recessions and five of its signals are without a recession, Table 1 and 3. Does that mean that our framework produces false positives? In our view, the answer is no. Although four of the 13 calls are not associated with recessions, those four calls are connected with changes in the monetary policy stance (from raising/unchanged fed funds rate to cutting interest rates). For example, the framework produced a recession call on December 1964 (threshold met) and the Fed started reducing the fed funds rate on December 1966 (24-month lead time). The Fed reduced the rate from 5.76 percent to 3.79 percent between November 1966 and July 1967, Table 3. Similarly, the remaining three calls

¹⁴ Adrian et al. (2010) showed the relationship between monetary cycles and business cycles and they suggested that the peaking in the fed funds rate was associated with recessions most of the time since 1955.

We are forecasting one more rate hike by the FOMC in 2017, at the December meeting.

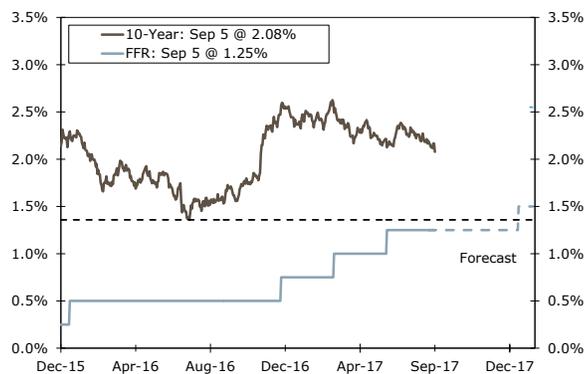
(August 1984, February 1995 and July 1998) are followed by changes in the monetary policy stance, see Table 3 for details.

Put differently, four of the 13 calls are associated with a change in the monetary policy stance with an average of eight months lead time—with a range of 1-24 months. Another reason not to declare these four calls as false positives is that, during long economic expansions, the Fed has reduced interest rates to “boost” the economy from a “mid-cycle slowdown.” Furthermore, the 1960s, 1980s and 1990s experienced some of the longest expansions on record and, thereby, changes of monetary policy stance during those expansions.

Summing up, our framework has produced 13 recession calls since 1955, and nine of those are associated with recessions. Therefore, whenever our framework produced a recession call, there was a 69.2 percent (9/13) chance of a recession within the next 17 months (average lead time).

Figure 5

10-Year and Federal Funds Rate



Source: IHS Global Insight, FRB and Wells Fargo Securities

Why Our Analysis Matters for Decision-Makers?

The FOMC raised the fed funds rate on December 2015, the first time in the post-Great Recession era, so the first condition of our framework is fulfilled—in a rising fed funds rate environment. The 10-year yield hit 1.36 percent on July 5, 2016, which is the lowest level in this cycle, Figure 5. Therefore, two conditions of the threshold framework are accomplished. The current level of the fed funds rate is 1.25 percent, which is lower than the 1.36 percent 10-year yield.¹⁵ As mentioned earlier, our proposed framework is not only good in a real time analysis but also is a forward-looking approach. That is, we are forecasting one more rate hike by the FOMC in 2017 (December), and, if that happens, then the fed funds rate will be 1.50 percent in December 2017. Therefore, in the case of one more rate hike, the threshold will be met in December 2017 as the cycle low for the 10-year is 1.36 percent (lowest daily closing yield on July 5, 2016, and 1.50 percent for the monthly average of July 2016, still the lowest level in this cycle). Therefore, starting in December 2017, again in the case of a rate hike, there will be a 69.2 percent chance of a recession during the next 17 months (average lead time).

Final Thoughts: Be Mindful of Elevated Recession Risks

We have proposed a new framework using the fed funds rate and the 10-year yield to predict recessions. Our framework has predicted all recessions since 1955 with an average lead time of 17 months. Furthermore, we are forecasting one more rate hike in 2017 (December), and, in the case of a rate hike, the threshold will be met. Therefore, starting December 2017, there is an increasingly elevated probability of a recession in the coming years. It is important to note that, at

¹⁵ It is worth mentioning that we have used monthly 10-year yield (daily average of the month) and 1.36 percent is a daily-low-closing yield of the 10-year. However, the average yield of the July 2016 period is 1.50 percent, which is also the lowest in this cycle and thereby conclusion will remain the same.

present, our official call is for continuously moderate growth in 2018-2019 (around 2.5 percent GDP growth rate) and this framework suggests a downside risk to our forecast. Therefore, we are not making an official call for a recession over the two-year forecast horizon. Instead, decision-makers may want to watch 2018 through mid-2019 for potential slowdown/recession. But, be mindful of the analysis we have performed in this report, we will be watching incoming data closely to determine whether conditions that could lead to a recession/slowdown starting late 2018 are developing. We would encourage decision-makers to do so as well.

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