Recessions, Asset Prices Bubbles, Monetary Cycles and Yield Curve: The One Framework to Rule Them All

Cover page

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"It is the mark of an educated mind to be able to entertain a thought without accepting it."
– Aristotle

Abstract

This paper proposes a new framework that identifies a threshold between the fed funds rate and the 10-year Treasury yield and when the threshold is breached the risk of a recession in the near future is significant. Our framework predicted several recessions before the yield curve inversion point/monetary cycles approach and, therefore, serves as a more effective tool in predicting recessions. Additionally, our framework accurately forecasted peaks in the S&P 500 index and is thereby helpful to predict asset prices bubbles.

The changing nature of the relationship between business cycles and policy actions raises questions about the usefulness of traditional forecasting approaches, such as yield curve/monetary cycles, to predict recessions. That is, one major challenge in this monetary cycle is the fed funds rate's recovery from the lowest level, along with a low inflation environment, may block inversion of the yield curve and reduce effectiveness of the monetary cycles to predict recessions. Therefore, we need a new tool which predict recessions accurately in different economic regimes.

In conclusion, our method has predicted all the recessions since 1954 with an average lead time of 17 months. Moreover, the framework has also predicted all peaks in the S&P 500 index during the same time period and the average lead time is 17 months. Therefore, given the robust performance of our framework, we suggest decision-makers watch for a recession in 2019 along with peaking the S&P 500 index. We believe the 2018 tax cut will not affect these calls and tariffs/trade war may favor the 2019 recession/peaking of the S&P 500 calls.

Key Words: New Framework; Monetary Cycles; Yield Curve; Recession Prediction; Asset Prices Bubbles.
JEL Classification: E32; E43; E44.

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Introduction

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 those 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 2018, which has brought back the inverted yield curve topic (and the impending risk of a near-term recession) 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 paper, 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 1954 with an average lead time of 17 months. Furthermore, our framework predicted several recessions before the yield curve inversion point/monetary cycles approach and, therefore, serves as a more effective tool in predicting recessions. That is, with our framework, we do not have to wait for the yield curve to invert to predict a recession.

[1]For more detail about the effectiveness of the yield curve to predict recession see, Adrian et al. (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 (the 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.

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. They 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 (peaking of the fed funds rate) is a prediction for an upcoming recession. According to the National Bureau of Economic Research (NBER), however, there have been 9 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.

The evolving nature of the economies forces decision-makers to look for new tools and/or re-evaluate the performance of existing methods to design effective policies. For example, the fed funds rate is recovering from the lowest level along with a low inflation environment and these factors may prevent the yield curve inversion similar to the 1954-1965 period. In addition, monetary cycles' method was unable to predict recessions, in real time, in the 1950s and 1960s. 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 the lower inflation/fed funds rate regimes (the 1954-1965 period and the era since the Great Recession, for example), the higher fed funds rate/inflation regime (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 these economic regimes.

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 2.00 percent (June 2018). Furthermore, the fed funds rate, first time in the current monetary cycle, hit 1.50 percent in December 2017 (with the December 2017 rate hike by the FOMC) and thereby crossed 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 (average lead time). Therefore, the chances of a recession in 2019 are elevated.

Summing up, our proposed framework (FFR/10-yr threshold) produced 13 signals since 1954 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 4 signals are connected with changes in the monetary policy stance (moving from rising fed funds to cutting interest rates, for example) 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 watch for a recession during 2019.

Another application of our proposed framework is that the threshold would help to forecast asset prices bubbles. We utilize a peak in the S&P 500 index as a proxy for an asset prices bubble. Our framework has predicted all the peaks in the S&P 500 index during the 1954-2018 period with an average lead time of 17 months. Additionally, with the threshold breaching date of December 2017, we suggest that decision makers should also lookout for a peak in the S&P 500 in 2019.

In addition, we believe the 2018 tax cut will not affect the 2019 recession/peaking of the S&P 500 calls. The major reason is that the tax cut may have (in our view it already had) put the FOMC on a faster rate hike track as there is a high probability of four rate hikes in 2018. The four rate hikes will take the fed funds rate to 2.50 percent by the end of 2018 and some analysts are suggesting that the terminal fed funds rate is around 2.50-2.75 percent rate. Typically, hitting a terminal rate is an indication of an upcoming recession. The tariffs/trade war, on the other hand, would favor the 2019 recession call by potentially disturbing the global supply chains. Therefore, we suggest decision makers carefully monitor the upcoming data in the rest of 2018 and 2019 and watch for a recession/S&P 500 peak in 2019.

The rest of the paper is organized as follows. Section 2 discusses the effectiveness and limitations of the yield curve approach. Section 3 summarizes the monetary cycles' method. Section 4 presents the new framework to predict recessions. Section 5 provides evidence that the new framework is useful to predict asset prices bubbles (peaks in the S&P 500 index) and the concluding remarks of our study are gather in section 6.

2. 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. For instance, Bordo and Haubrich (2004) utilized a longer history (1875-1997) to test the predictive power of the yield curve and concluded that the predictability varies overtime particularly across different monetary regimes. Estrella et al. (2003) concluded that recessions' predictions, based on the yield curve, are stable over the sample period in both the Germany and U.S. Bernard and Gerlach (1996) also provided an evidence of the yield curve's predictive power using data from 8 countries. In sum, literature does suggest that yield curve is a reliable recession predictor. For example, in the case of U.S., 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. 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.[3]

Third, Adrian and Estrella (2009) employed 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 reason, 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

[3]It is notable to mention 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.

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 (from a rising fed funds rate to cutting interest rate stance, for example). 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 rate level because changes in the economic outlook influence both financial market expectations and monetary policy stance.[4]

2.1 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 and 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- June 2018 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).

[4] 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).

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) 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 (1954-2018), 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 the 1954-2018 period. 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 historic low-level of 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.

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).[5] Furthermore, Romer and Romer (2002) concluded that inflation expectations, typically, play a crucial role in setting the monetary policy stance, for more detail see Romer and Romer (2002) and Mayer (1998). Therefore, the economic outlook may influence the fed funds rate in a way to slow any pace of federal funds rate.

2.2 Echoes From the 1950s

In our view, the current economic outlook, in particular the realized and expected inflation, is more in line with the 1954-1965 period than the last seven recessions (1969-2007 period). For example,

[5] For more detail about the relationship between monetary policy stance and economic variables see Taylor (1999).

the FOMC's inflation target is 2 percent (PCE deflator is the preferred inflation measure of the Fed) and the PCE deflator is just 1.29 percent for the May 2012-April 2018 period. Furthermore, the PCE deflator (year-over-year [YoY] percent change) stays below 2 percent for the May 2012 to April 2018 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).[6] 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 occurred 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 et al. (2016) identified low-inflation episodes (where a low-inflation episode is defined as 6 consecutive months of the PCE deflator below 2 percent) using the 1975-2016 time period. Out of 8 total episodes identified between 1975 and 2016, 3 of them occurred in the 2008-2016 period. Between November 2008 and April 2018, the PCE deflator was below 2 percent for the 96 of 114 total months (with an average of just 1.34 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. That is, the unemployment rate dropped to 4.3 percent in May 2017, just below the 4.4 percent rate registered in May 2007.

Traditionally, 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 dollar (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. Furthermore, a lower fed funds rate has prevented the inversion point of the yield curve in the 1954-1965 period,

[6]It is important to note that the average CPI and PCE deflator for the January 1960-Janaury 1966 period is 1.3 percent. Basically both series are highly correlated overtime.

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.

2.3 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 3.[7] The probit model (or any standard econometric model) needs a longer data history for estimation purposes, thereby 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 consume another tool, monetary cycles approach, to try to predict recessions.

3. 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.[8] 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 an indication of an upcoming recession. According to the NBER, however, there have been 9 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 (determine by the NBER) 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 the monetary cycles approach has predicted several recessions (and missed the 1957-1958 and 1980 recessions), the real time effectiveness of the monetary cycles method is a big

[7] For more detail on the probit model and the yield curve's effectiveness see Silvia et al. (2016).
[8] 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 and Estrella (2009).

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 9 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 6 months before to 6 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 6 months (2^{nd} criterion) to confirm whether the fed funds rate has peaked 6 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 6 months (using the 2^{nd} 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, monetary cycle 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 6 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 8 months and that could be considered a miss using the first criterion to define a monetary cycle (at least 9 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 recessions than the other methods discussed so far in this study.

4. 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 the lower inflation/fed funds rate regimes (the 1954-1965 period and the era since the Great Recession, for example), the higher fed funds rate/inflation regime (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 labelled 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 (the 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.[9]

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 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 rate when the economy enters expansion.[10] 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.

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 the 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.

4.1 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

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

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

current expansion is the second longest at the time of this writing, July 2018. Therefore, attempting to predict a recession based upon 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 recessions, 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 fund 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.

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 meet, unlike the monetary cycle method, which is largely backwards looking. Moreover, we can also predict the possible timing of the threshold point by forecasting fed funds/10-year Treasury. 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 (2005) 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.

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.[11] 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.

Now we discuss the accuracy of our proposed method, with the results reported in Table 2. Since 1954, 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. Furthermore, our framework has a better accuracy and lead time to predict recessions than the monetary cycles approach during the sample period of 1954-2018.

4.2 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 notable to mention that our framework is the only approach (discussed in this study) that did not miss any recession since 1954, 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 (August 1984, February 1995 and July 1998) are followed by changes in the monetary policy stance, see Table 3 for details.

[11] 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.

Put differently, four of the 13 calls are associated with a change in the monetary policy stance with an average of 8 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 1954, and 9 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).

4.3 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—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 4. Therefore, two conditions of the threshold framework are accomplished. The current level of the fed funds rate is 2.00 percent (June 2018), which is higher than the 1.36 percent 10-year yield.[12] Moreover, with the December 2017 rate hike by the FOMC, the fed funds hit 1.50 percent and hence the threshold met in December 2017 as the cycle low for the 10-year is 1.36 percent. Therefore, starting December 2017, there is a 69.2 percent chance of a recession during the next 17 months (average lead time). In other words, decision makers should be watching 2019 for a potential recession.

4.4 Can the 2018 Tax cut and Tariffs/Trade War Effect the Threshold's 2019 Recession Calls?

The threshold conditions met in December 2017 and with an average lead time of 17 months, 2019 seems like a potential year for a recession. Are there any major factors which could affect the recession call made by the proposed framework? We live in an evolving world and many factors could affect the recession call and we discuss two major events and both have happened in 2018.

The first major factor is the 2018 tax cut and, usually, tax cuts are good for the economy at least in the short run. We believe the tax cut would produce a dual effect on the recession call. (A) The

[12] It is important to note that we have used monthly 10-year yield (daily average of the month) and 1.36 percent is a daily closing yield of 10-year. However, the average yield of the July 2016 is 1.50 percent which is also the lowest in this cycle and thereby conclusion will remain the same.

tax cut would boost after-tax personal income and that would boost spending at least in the short run. Similarly, corporations would enjoy higher after-tax profits. Therefore, the tax cut may "push" recession further in the future and effect the recession call. (B) However, on the other hand, the tax cut would affect (in our view it already had) the pace of monetary policy. That is, the FOMC had raised rates twice in 2018 with a very high possibility of two more interest rate hikes (total four rates hikes in 2018). The major reason of the FOMC's faster rate hike pace is the potential higher growth from the tax cut and the FOMC may be worry about the "over-heating" and/or inflationary pressure. In addition, with two more rates hike, the fed fund rate will be 2.50 by the end of 2018 and some analyst are suggesting the terminal (or equilibrium) fed funds rate is around 2.50-2.75 percent range. That is, with two more rate hikes the fed funds rate would be close to its peak and peaking of the fed funds rate is another indication of the upcoming recession (see Adrian and Estrella (2009) for more detail). Therefore, the accumulative effect of the tax cut on our recession call is insignificant—call for a 2019 recession still hold.

The other major economic event of 2018 is the tariffs (and fear of a global trade war). That is, the U.S. has implemented tariffs on several countries' products and most of those countries have announced/applied retaliations (tariffs on the U.S. products). The potential effect of these tariffs (in addition to the global trade war fear) is a disruption in the global supply chains and that has potential to effect the overall U.S. economy. In other words, tariffs/trade war may favor the 2019 recession call made by our framework.

Summing up, the threshold suggests an elevated chance of a recession in 2019 and the 2018 tax cut will not affect that call in the sense that the tax cut may not be able to reduce the chances of a potential near-term recession. The tariffs/trade war would favor the 2019 recession call by potentially disturbing the global supply chains. Therefore, we suggest decision makers carefully monitor the upcoming data in the rest of 2018 and 2019 and watch for a recession.

5. Follow the Money: Predicting Asset Prices Bubbles/Peaks in the S&P 500 Index

Another potential application (in addition to recession prediction) of our proposed framework is that the threshold would help to forecast asset prices bubbles. We utilize a peak in the S&P 500 index as a proxy for an asset prices bubble. The S&P 500 index is a very reliable measure to gauge financial world's sentiments and it also shows large swings which usually represents financial markets participants' excitement/fear of upcoming events such as bubbles/busts. Furthermore, whether we discuss the information technology (the IT) bubble of the late 1990s or the housing bubble of the 2002-2006 period, both bubbles have one thing in common which is the S&P 500 index shows larger (and faster) gains during those time periods. Therefore, we employ the S&P 500 index's peak as a measure of an asset prices bubble. Moreover, we work with the same 1954-2018 period to determine peaks in the S&P 500 index.

The results of the S&P 500 index's peaks along with recessions and the threshold dates are reported in Tables 4a and 4b. The first noticeable observation is that the peak in the S&P 500 index is not a good recession predictor. As several recessions started before the peaking of the S&P 500 and some of those recessions includes 1960-61, 1980, and the 1990-91 recession (Table 4b). Therefore, decision makers should not fully rely on the peaking of the S&P 500 index to predict recession.

The second observation is that our framework has predicted all the peaks in the S&P 500 index with an average lead time of 17 months (Table 4a). That is the FFR/10-yr threshold breached before S&P 500 peaks in the 1954-2018 period. Additionally, with the threshold breaching date of December 2017, we suggest that decision makers should also lookout for a peak in the S&P 500 in 2018-2019. Moreover, similar to the 2018 tax cut and tariffs effects on the recession call, we do not see these factors would affect the S&P 500 peak call.

6. Final Thoughts: Be Mindful of a Recession in 2019

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 1954 with an average lead time of 17 months. Moreover, our framework predicted several recessions before the yield curve inversion point (all recessions before the monetary cycles) and, therefore, serves as a more effective tool in predicting recessions. That is, with our framework, we do not have to wait for the yield curve to invert (or peaking of the fed funds rate) to predict a recession.

Our analysis also show that the proposed framework accurately forecasted asset prices bubbles (peaks in the S&P 500 index as a proxy) since 1954 with an average lead time of 17 months. Likewise, with the threshold breaching date of December 2017, we suggest that decision makers should also lookout for a peak in the S&P 500 in 2019.

We believe the 2018 tax cut will not affect these calls. One major reason is that the tax cut may have "push" the FOMC to a faster fed funds rate hike track. That is, the potential for four rates hikes in 2018 is highly likely. Furthermore, four rate hikes will take the fed funds rate to 2.50 percent by the end of 2018. Some analysts are suggesting that the terminal rate in the current business cycle is around 2.50-2.75 percent rate. Typically, hitting a terminal rate is an indication of an upcoming recession. The tariffs/trade war would favor the 2019 recession call by disturbing the global supply chains. Therefore, we suggest decision makers carefully monitor the upcoming data in 2019 and watch for a recession/S&P 500 peak.

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Table 1: The Monetary Cycles Approach to Predict 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.

Table 2: The New Framework vs. the Inverted Yield Curve

Recession Start Date	Inverted Yield Curve Date/Months before the Recession Start	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.

Table 3: The Exception to the Rule: Recessions vs. Changes 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 untill 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.

Table 4a: The New Framework to Predict Bubbles: Forecasting the S&P 500 Peaks

S&P 500 Peaks and Recessions			
S&P Peak Date	Recession	S&P Peak to Recession*	FFR/10-yr to S&P Peak*
Jul. 1957	Aug. 1957 - Apr. 1958	1.0	15.0
Jan. 1961	Apr. 1960 - Feb. 1961	-9.0	17.0
Jun. 1969	Dec. 1969 - Nov. 1970	6.0	14.0
Oct. 1973	Nov. 1973 - Mar. 1975	1.0	9.0
Feb. 1980	Jan. 1980 - Jul. 1980	-1.0	22.0
Apr. 1981	Jul. 1981 - Nov. 1982	3.0	6.0
Feb. 1991	Jul. 1990 - Mar. 1991	-7.0	41.0
Sep. 2000	Mar. 2001 - Nov. 2001	6.0	7.0
Oct. 2007	Dec. 2007 - Jun. 2009	2.0	22.0

*In number of months

Table 4b: The New Framework to Predict Bubbles: Forecasting the S&P 500 Peaks

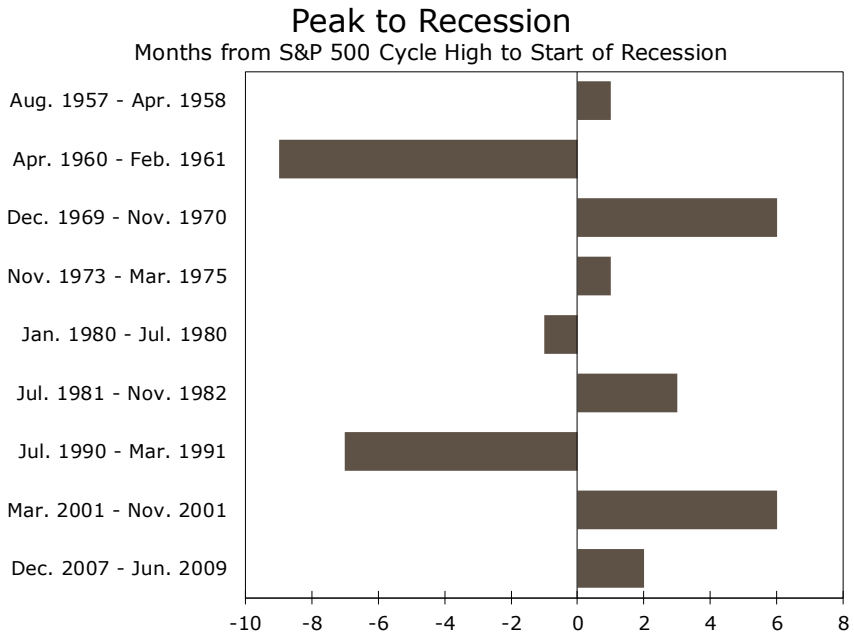

Figure 1: The Yield Spread: 10-Year minus Fed Funds Rates

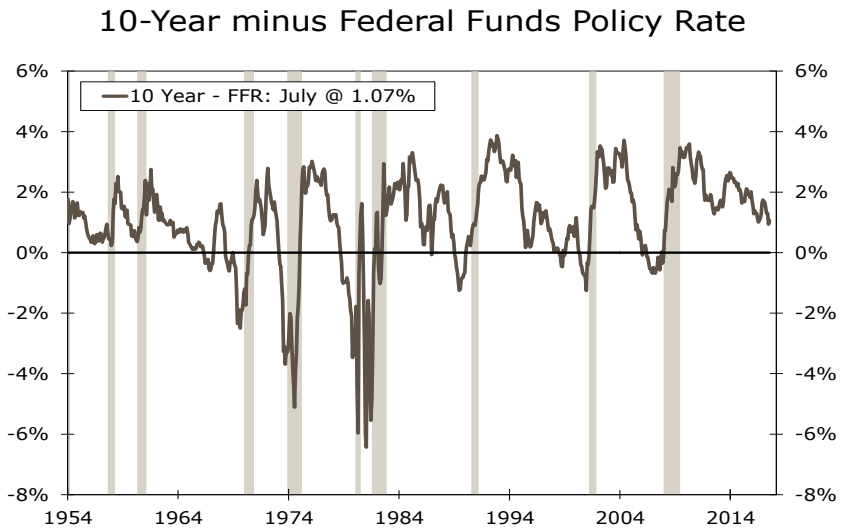

Figure 2: 10-Year vs. Fed Funds Rates

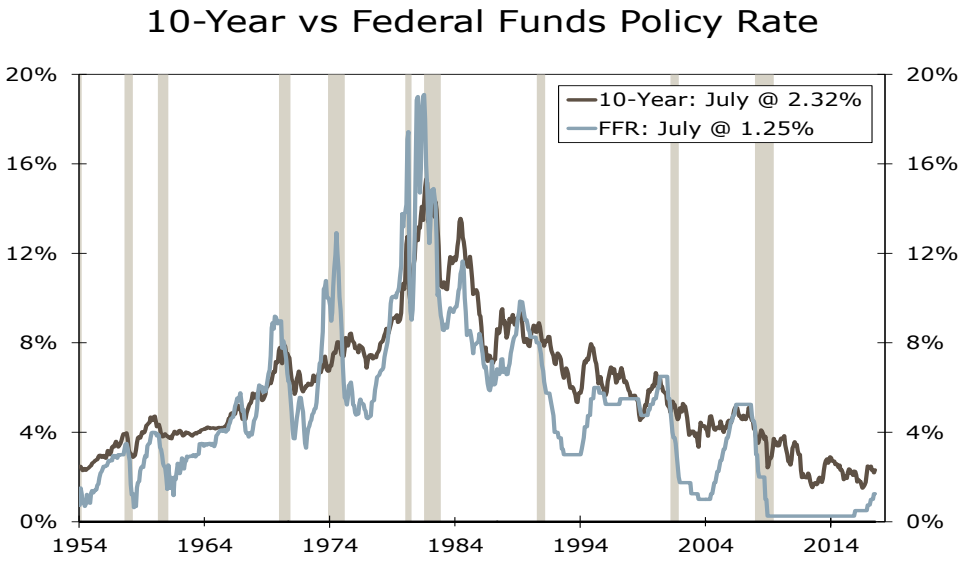

Figure 3: The Probit Model with the Yield Curve as a Predictor

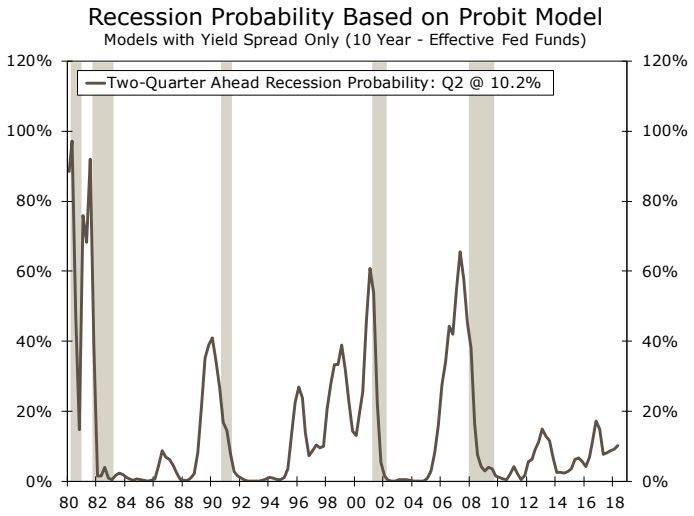

Figure 4: The Threshold Breaching Point of the December 2017