Macroeconomic Forecasts, 4Q2018

Prepared for BancorpSouth
Tupelo, MS

Prepared by: Capitalytics, LLC
P. O. Box 381162
Birmingham, AL 35242

Table of Contents

Introduction

Capitalytics performs a rigorous analysis of every variable that is included in our quarterly macroeconomic study. These variables include the following[1]:

1. Real GDP growth
2. Nominal GDP growth
3. Real disposable income growth
4. Nominal disposable income growth
5. Unemployment rate
6. CPI inflation rate
7. 1-month Treasury yield
8. 3-month Treasury yield
9. 6-month Treasury yield
10. 1-year Treasury yield
11. 3-year Treasury yield
12. 5-year Treasury yield
13. 7-year Treasury yield
14. 10-year Treasury yield
15. 20-year Treasury yield
16. 30-year Treasury yield
17. BBB corporate yield
18. Mortgage rate
19. Prime rate
20. US Average Retail Gasoline Price ($/gal; all grades, all formulations)
21. S&P 500 Stock Price Index
22. Primary Credit Rate
23. Moody's AAA Rate
24. Moody's BAA Rate
25. Dow Jones Total Stock Market Index
26. House Price Index
27. Commercial Real Estate Price Index
28. Market Volatility Index (VIX)

Our procedure is as follows:

1. Data is collected per the information in Appendix A, "Data sources".

2. Correlations between variables are identified to determine which variables are may be considered as "dependent" (upon other variables, i.e., highly correlated with other variables as part of their nature).

[1] This study is motivated by the Federal Reserve Board's Dodd-Frank Act, which includes requirements to consider various international factors; however, those factors will not be discussed extensively in this particular report based on the target use and audience of this report.

3. Multiple forecast analyses are performed per the procedure in Section I of Appendix B for all variables, with the results of corresponding forecasts aggregated.

4. The rationale for these analyses, modifications, and the conclusions thereto are documented in the following section of this report, "Data Series Conclusions".

Data Series Conclusions

This report documents Capitalytics' forecasts and analyses for approximately 28 macro-economic variables using data up to, and including, that for 3Q2018. Most domestic variables are driven by T-bill yields and inflation.

- Overview

As part of the Dodd-Frank Act, larger banking institutions in the United States are required to use government specified variables, and approved proprietary processes, to determine if they are adequately prepared for unexpected "systemic failures". Some banking institutions are also incorporating portions or components of their forecasting processes to estimate future profitability; in order to do so, however, realistic forecasts (as opposed to extremes) are required.

While arguments could be made about the variables included in this study, as stated in Jiang, et al., "… a conclusion that can be made for … US data is that there is little to no improvement in forecast accuracy when the number of predictors is expanded beyond 20-40 variables."

This report documents Capitalytics' forecasts and analyses for the domestically focused macro-economic values specified. Most domestic variables are driven by T-bill yields, which drive mortgages & real estate, borrowing rates, and credit rates, and indirectly impact GDP, inflation & unemployment. We continue to see economic growth, now tempered by rising interest rates and housing prices. The current news of scuffles between Congress and the White House is foreshadowed in our results, and should be a concern going forward.

- Correlations

Part of Capitalytics' analysis of macro-economic variables entails computing the correlation between variables, in order to establish the existence and level of interdependence of variables.

In Appendix C of this document, we document the 145 pairs of variables that showed absolute correlation values greater than or equal to 0.6. As part of this portion of the study, Capitalytics identified the following sets of strong dependencies (correlations with magnitudes greater than 0.95) between variables that were subsequently validated as significant, long-term, recurring correlations as part of the nature of the variables; these pairings of variables are viewed as extremely significant based on the respective definitions of the variables and will be leveraged as discussed in Section II of Appendix B.

Regression (Dependent) Variable		Independent Variable[2]
6-month Treasury yield		1-year Treasury yield
Prime rate		3-month Treasury yield
1-month Treasury yield		6-month Treasury yield*
3-year Treasury yield	… depends on …	1-year Treasury yield
7-year Treasury yield		3-year Treasury yield*
30-year Mortgage rate		10-year Treasury yield
Moody's AAA Rate		20-year Treasury yield
30-year Treasury yield		20-year Treasury yield
Primary Credit rate		6-month Treasury yield*

- Analysis of Variables

Real & Nominal GDP Growth, Real & Nominal Disposable Income Growth, and CPI Inflation Rate

Analysis

While US GDP growth was at 3.5% in 3Q2018, Capitalytics expects it to gradually slow to 3% through 2019 and thereafter. This is slightly more aggressive than the FOMC is predicting at this time, with their prediction being that real GDP will drop to 2.3% during 2019, and even slower thereafter. The main concern at this time, and the main bellweather for the economy as a whole, seems to be the actions that the Fed' takes with regard to interest rates in light of the White House's current diplomatic actions regarding trade with other specific countries: if the Fed' stays its course, now expected to entail only two rate increases during 2019, interest rates are expected to hit 3.1%; but, if they adjust their strategy for any reason, they will be perceived as having succumbed to pressure from the White House.

However, inflation is the other side of the proverbial "double-edged sword": if the Fed' perceives inflation as having stabilized around its target of 2%, it is more likely to temper its deployment of rate increases, and recent comments from the Fed' suggest that such a pause is increasingly likely. Spending and fiscal policy by the Congress and President seem to be weighing heavy on the decisions. Given the White House's readiness to directly intervene in every aspect of monetary policy (from tense overseas trade negotiations, to domestic fiscal policy, to government spending, to tax lawmaking, etc.), it is difficult to have any sense of which way the markets and market forces will respond. Crude oil prices appear to have been a significant force in tempering inflation, and is expected to continue into the first half of 2019. Capitalytics sees that inflation will rebound after YE2018 from around 2.25% to approximately 2.3% by YE2019; during 2020 through 2022, inflation will wobble and gradually rise towards 2.5%.

Disposable income has grown in the US, again helped by the recently drop in crude oil prices. Further, some of the spending seems to have outstripped wage increases, and is expected to be corrected in the coming months. Capitalytics views aggregates spending on the decline in the

[2] It should be immediately apparent that some of the variables that are listed as "independent" are, in fact, dependent on other variables; these "independent" variables that actually have dependencies are noted by a trailing "*".

coming years, with overall spending rates dropping by 0.25% per year by 2023 to an annualized rate of 2.2%.

Other Commentary

- Kiplinger reports that it believes inflation should average 2.3% during 2019 (see https://www.kiplinger.com/article/business/T019-C000-S010-inflation-rate-forecast.html; Dec 12, 2018)
- "The timing of a downturn may be in dispute, but many economists agree that the headwinds facing the U.S. economy are growing stronger and more numerous: Interest rates keep rising, making borrowing costs more expensive for consumers and companies alike; trade tariffs are increasing, thanks in good part to Trump's aggressive trade policies; and Wall Street analysts are growing concerned that earnings growth has peaked as the bull market enters its tenth year, especially in the overpriced tech sector." (see http://fortune.com/2018/11/21/us-economy-slow-2019-recession-2020-economist-forecast/; Nov 21, 2018)
- "… [C]onsumer spending has been brisk and appreciably stronger than real after-tax incomes. At some point, though, the growth of consumer spending is likely to slow to more closely match income growth. (see https://www.stlouisfed.org/publications/regional-economist/fourth-quarter-2018/forecasters-gdp-growth-2019)

Unemployment Rate

Analysis

Unemployment shows no sign of breaking from its historic sub-4% low levels in the foreseeable future, likely staying near and just below 3.7% through 2019, and slowly dropping to 3.5% during subsequent years. The issues with this phenomena are become more social than anything – specifically, what happens when a substantial portion of the population has essentially gives up and becomes "unemployable" (or unwilling to maintain a traditional schedule) as a mindset. While the economy is trending towards more contractor-assigned tasks, particularly in urban areas where there is an increasing demand for delivery services and other independent task-oriented & transactional positions, the wages and requirements for that type of lifestyle will become increasingly stringent as time continues.

Other Commentary

- The unemployment rate—at 3.7% in October—sits near a 50-year low. When unemployment gets so low, it has tended to be a sign that economic resources are running tight. In the 1960s, low unemployment was followed by a decade-long run toward double-digit inflation. In the 1990s, low unemployment came with an epoch of asset bubbles that ended badly. (see https://www.wsj.com/articles/the-economic-forecast-for-2019-less-growth-and-more-uncertainty-1543892700; Jan 7, 2019)

Treasury Yields (1, 3, & 6-month; 1, 3, 5, 7, 10, 20, & 30-year series)

Analysis

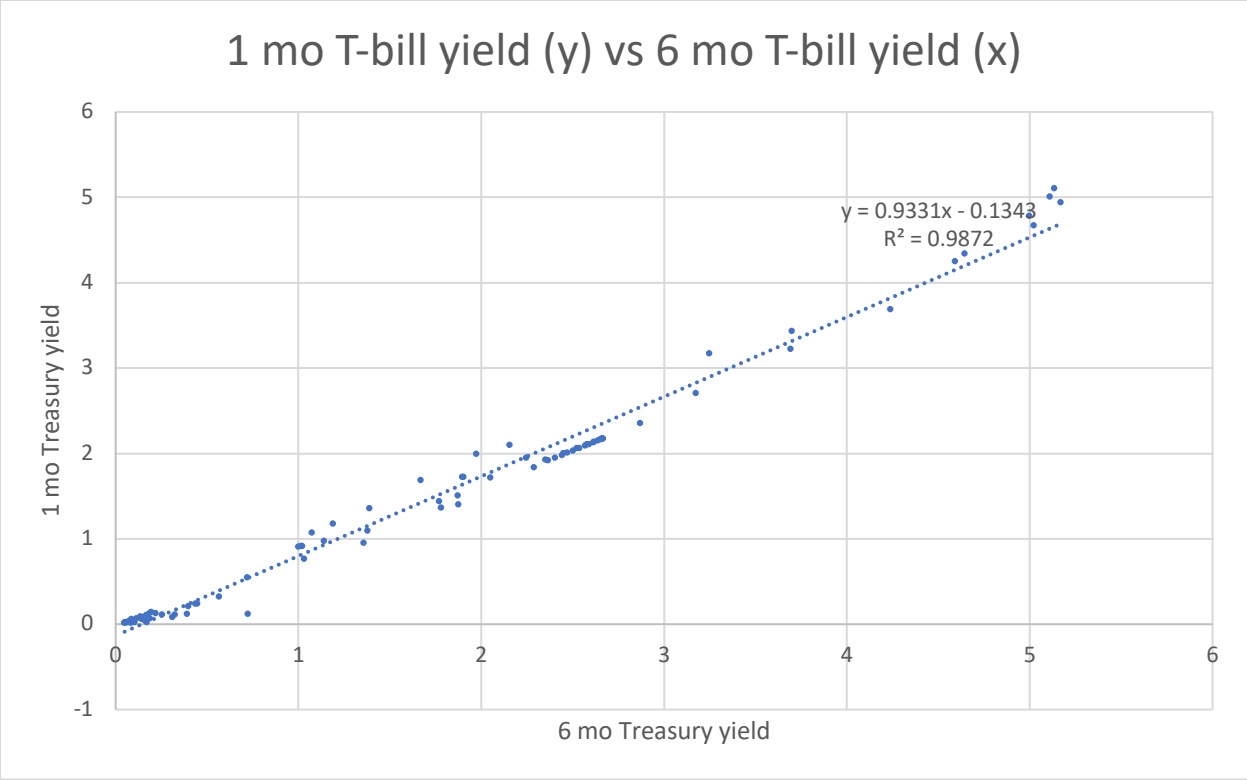
Capitalytics anticipates the 3-month Treasury yield to fairly steadily climb towards 2.75% by mid-2023. We expect that 5-year Treasury yield rates to be more volatile, but to reach 3.25% by late 2022. Additionally, the 10-year Treasury yield rates will reach 3.25% by late 2023. Data acquired directly from the Federal Reserve Economic Research website is more conservative than CCAR data, showing generally lower yields.

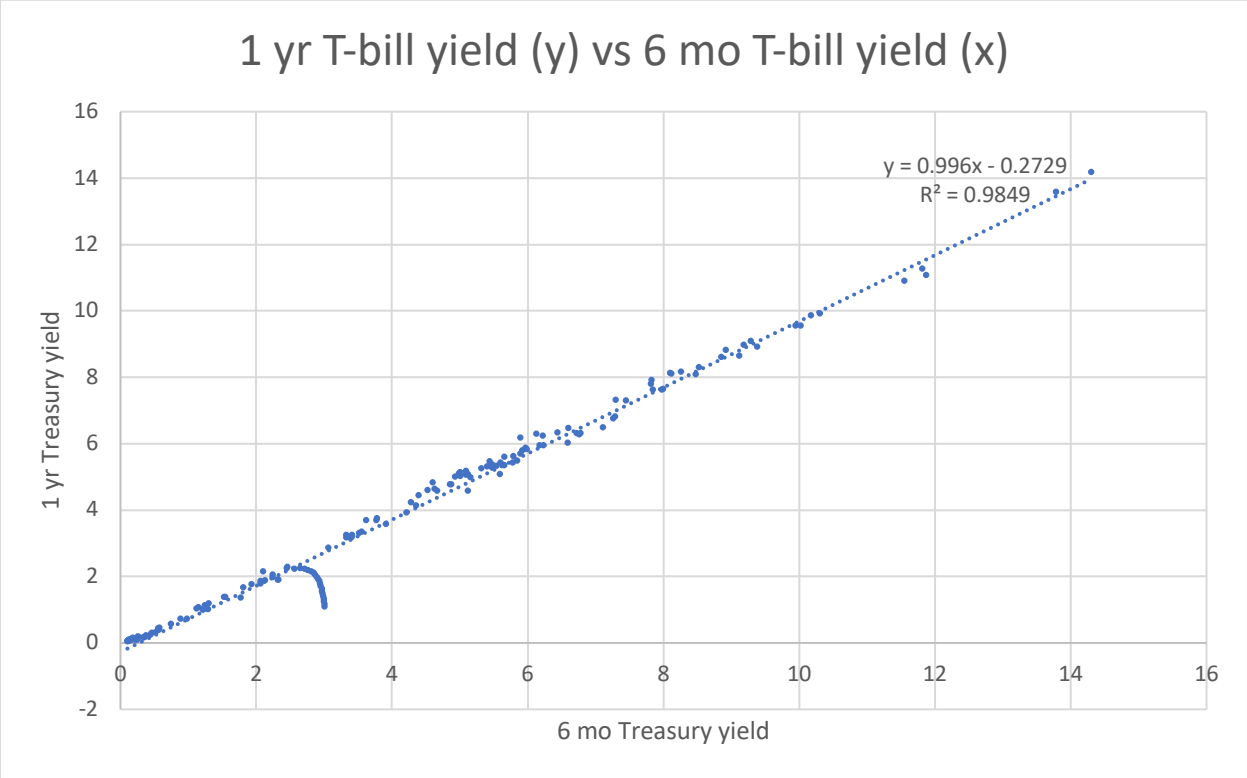
Like many others, Capitalytics is seeing a flattening of the yield curve, with the possibility of inversion as the 10- and 20-year yields cross the 3% and 3.1% levels. (It should be noted that inversions for short periods of time are not unprecedented and are not necessarily *directly* related to any immediate, specific outcome.) The Fed' is insistent that it will manage the US' money supply in order to ensure that an inversion does not lead to either a recession or a depression.

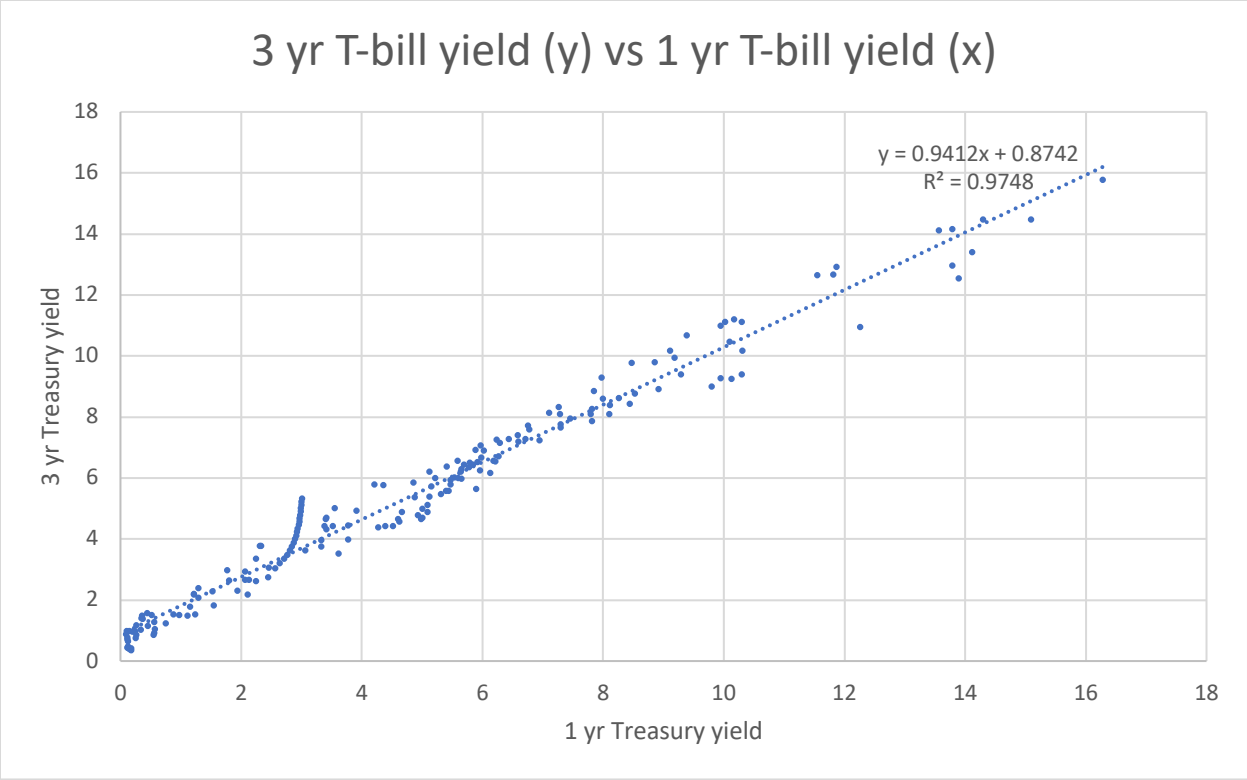
Because of Capitalytics aggressive long-term forecast for the 10-yield Treasury yield, we do think that yield curve inversion is a realistic possibility. Even only looking at CCAR data provided by the Federal Reserve, we anticipate the 5-year Treasury yield sporadically exceeding that of the 10-year during late 2021 and 2023.

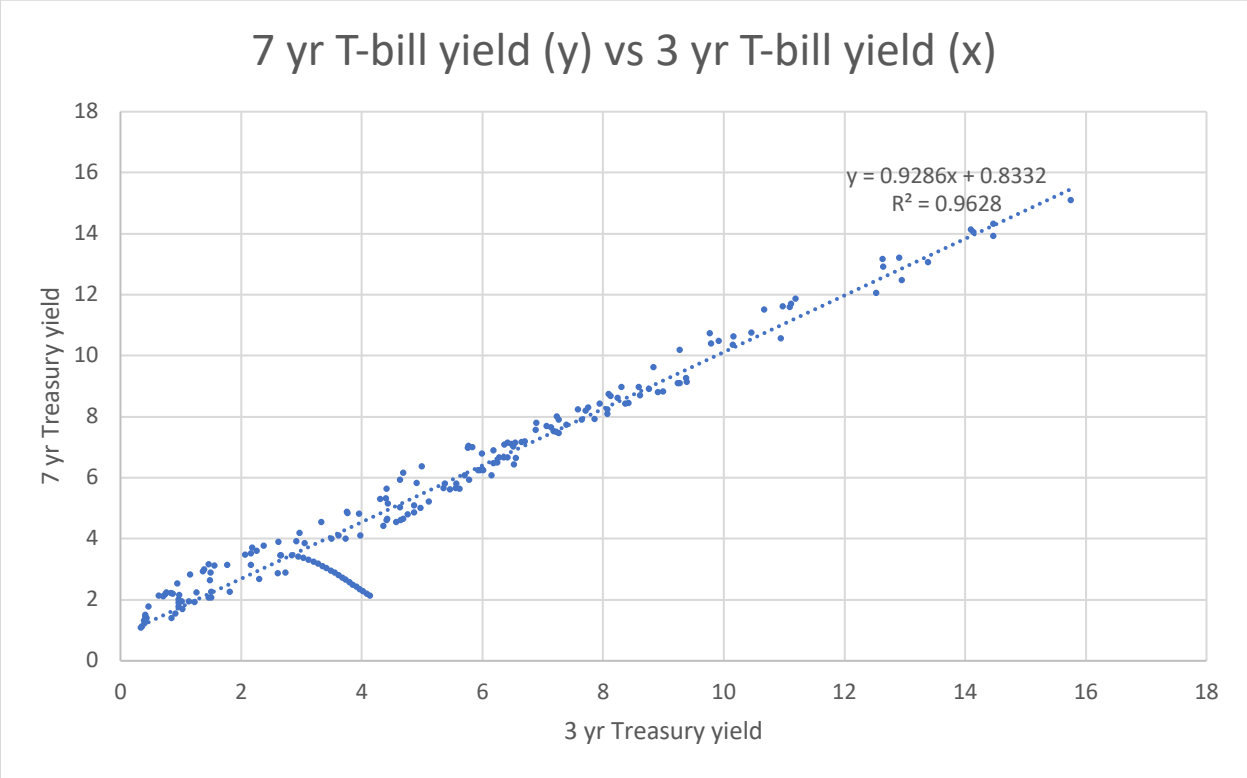
Other Commentary

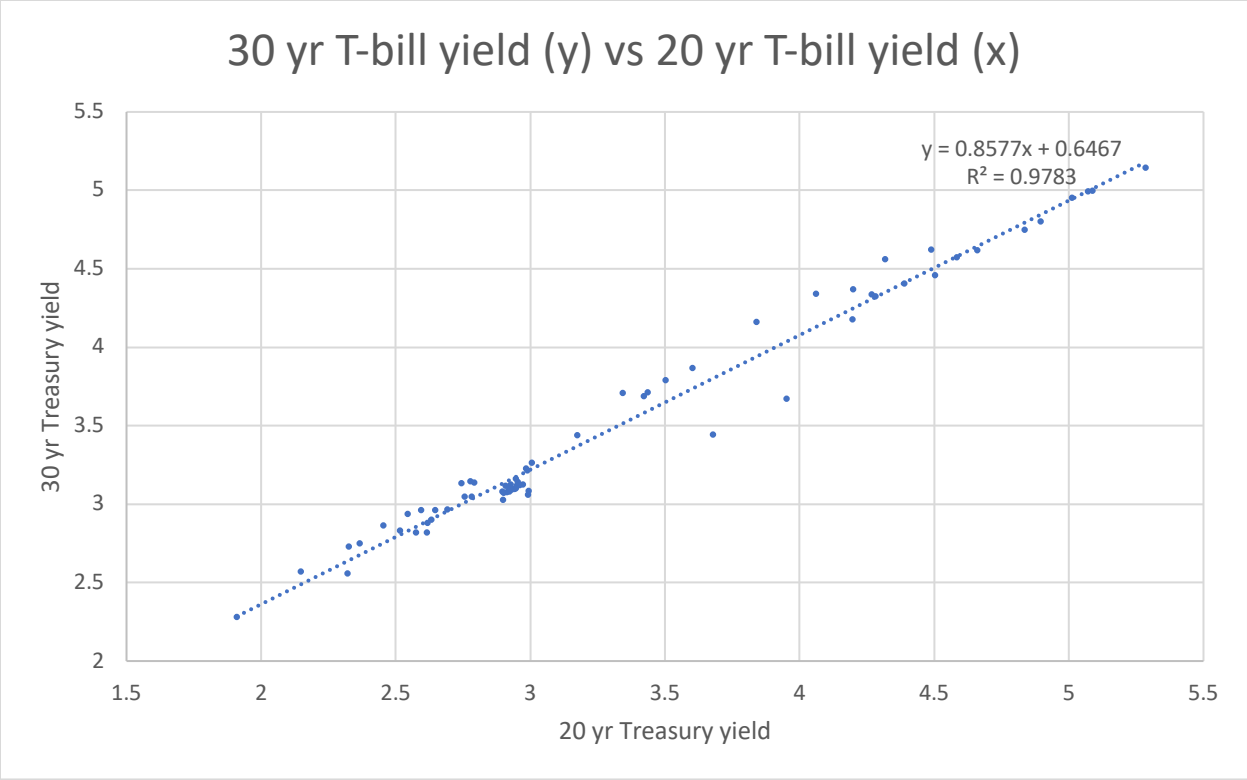
- "The market is effectively saying that at some point in the next 24 months, the Fed is going to have to not only stop hiking, but actively start easing." (see https://www.reuters.com/article/us-usa-bonds/two-year-yield-dips-below-key-fed-rate-for-first-time-since-2008-idUSKCN1OX1QV; Jan 3, 2019)
- Kiplinger asserts that 10Y T-bills will end 2019 at 3.6% (see https://www.kiplinger.com/article/business/T019-C000-S010-interest-rate-forecast.html, Dec 21 , 2018), given a lack of confidence in the Fed's current plan to continue to increase interest rates three to four times during 2019.









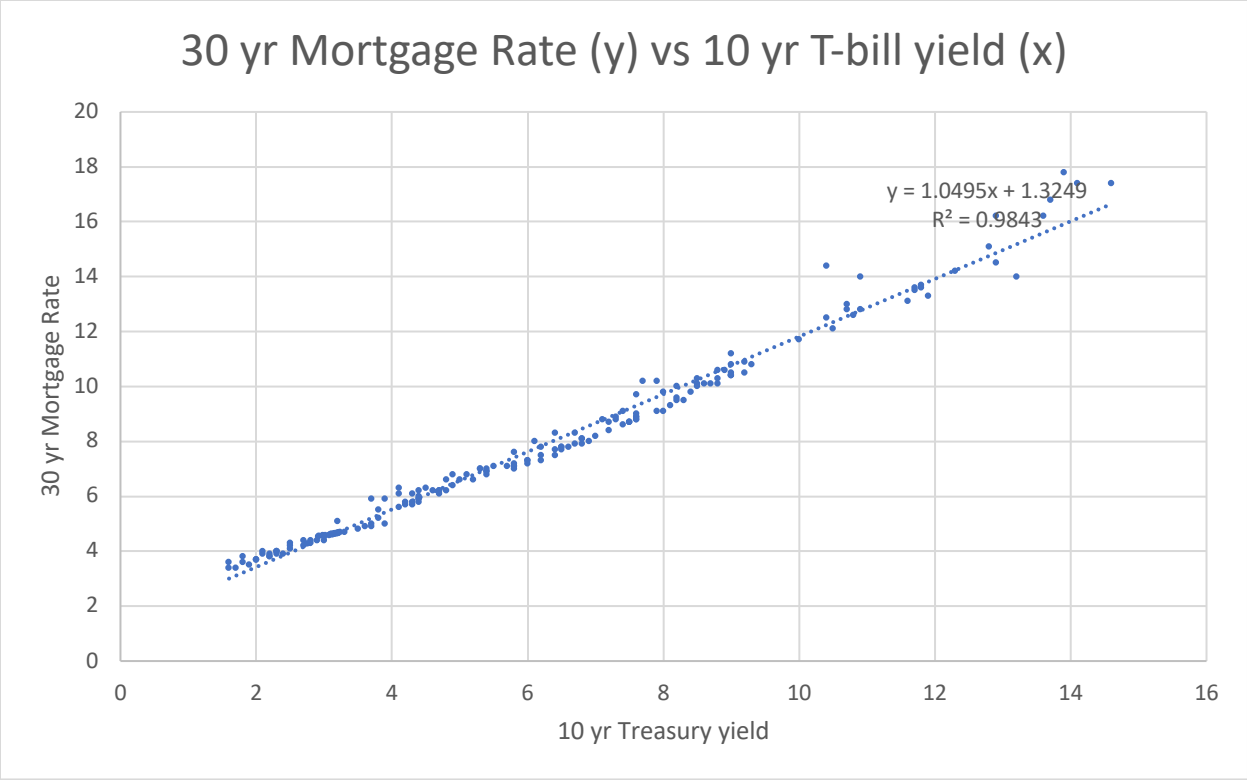


30-year Mortgage Rate

Over the past year, an anticipated economic slowdown and reduction in the housing market has been continuously rumored as being "right around the corner". With the recent increases in interest rates from the Fed' acting as a damper on home prices, though, this slowdown may actually occur. With that slowdown, Capitalytics anticipates interest rates rising to at least 4.7% by 2021, and possibly higher given its relationship with the 10-year Treasury yield.

Analysis

The following chart serves to illustrate the strong connection between mortgage rates and the 10-year T-bill.



Other Commentary

- "The benchmark 30-year fixed [mortgage rate] topped 5 percent just over a month ago. While rates are retreating, it's a much different story when it comes to home prices, which continue to edge higher, although at a slowing pace." (See https://www.bankrate.com/mortgages/analysis/; Jan 3, 2019)
- Extreme stresses in the housing market, particularly in the west, are coming to roost in the form of peaking housing prices and a realization that deflation is occurring today in some markets: "Home prices have shot up for years, even while wages ticked up at much slower rates. At some point, the market is going to run out of people with median incomes who are willing to stretch to the limit to buy a starter shack, and the market is going to run out of people with high incomes who are willing to stretch to the limit to buy a median house." (See https://seekingalpha.com/article/4230676-u-s-housing-market-get-uglier-near-future; Dec 30, 2018)
- "… the Fed's most recent comments indicate that it will continue to raise rates perhaps twice or more in 2019, which will push the average 30-year fixed mortgage rate up to about 5.5 percent by the end of [2019]. This increase … would mean about a $100 increase in monthly mortgage payments on a $300,000 home by the end of 2019. … Lenders will also feel the effects of rising rates, which will increase their costs of lending and dampen demand for their services. This will motivate lenders to expand their customer base to low-income borrowers and first-time homebuyers." (see https://www.redfin.com/blog/2018/12/redfins-2019-housing-market-predictions.html; Dec 19, 2018)

- Kiplinger reports that it believes mortgage rates will rise to 5.3% during 2019 (see https://www.kiplinger.com/article/business/T019-C000-S003-housing-market-forecast-housing-starts-home-sales.html; Nov 30, 2018)

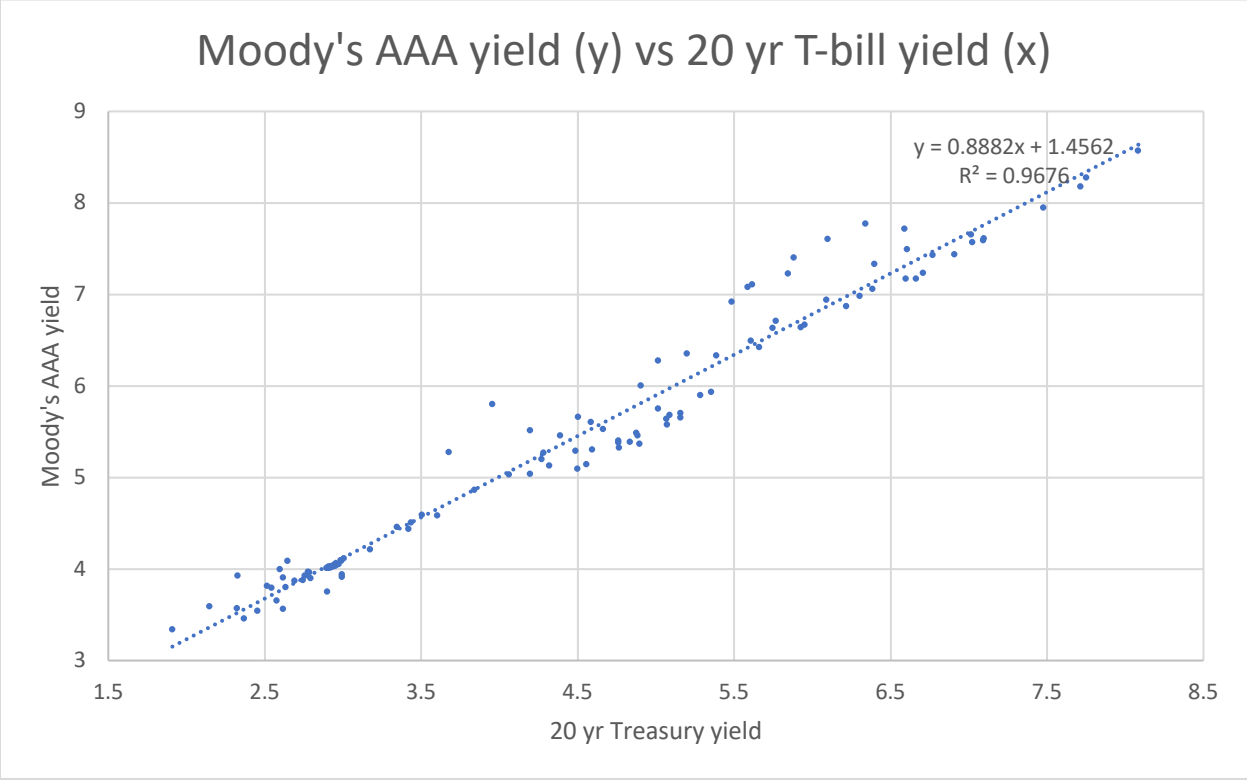
Moody's AAA & BAA Rates

Analysis

Moody's AAA bond rates tend to track in conjunction with mid-duration T-bill yields (i.e., 10- and 20-year maturities). Moody's BAA rates tend to be higher, and more volatile, than AAA rates.

Capitalytics sees AAA rates being relatively stable over the next several years at just below 4% yields; given the projected climate, and the connection between these bonds and the 10- and 20-year Treasury yields, these values are not surprising. BAA rates will fluctuate between 4.7% and 4.8% in the near term, with rates gradually eroding over the next several years.

The following chart illustrates the strong historical relationship between Moody's AAA rate and the 20-year T-bill yield.



Other Commentary

BBB Corporate Yield

Analysis

The BBB Corporate Yield is generally tied to Moody's indices (particularly the Moody's BAA bond yield), and the 30-year Mortgage Rate, even though these bonds are generally 10 years in duration. Over the past few years, the volume of bonds that are rated generally in the BBB range has grown dramatically, to take up a significant portion of the investment grade market. This aggregation implies that this slab of the market is all within one to three grades of "junk bond" status, and could be easily downgraded if the ability of the market to absorb defaults is hampered in a down cycle. This point has not been lost on the Fed', but the market is still remarkably open to investing in these instruments individually, and as part of index funds.

Capitalytics sees returns on BBB investments rising to 4.5% provided that dramatic changes in the market can be held off by the Fed'.

Other Commentary

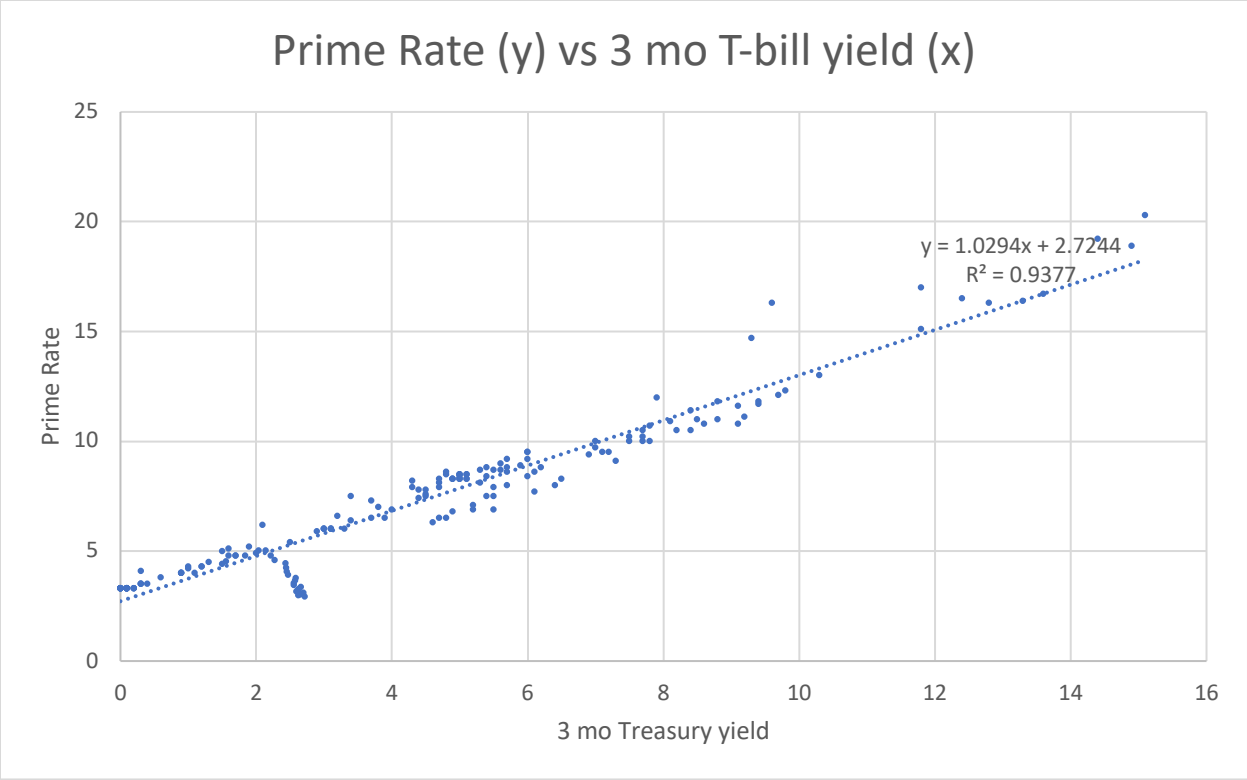
- "BBB-rated bonds have a much larger weighting in the investment-grade bond market than prior to the crisis, which is a bearish sign." (see https://seekingalpha.com/article/4224172-outlook-investment-grade-corporate-bonds; Nov 23, 2018)
- "Companies have had little reason to keep their credit ratings high during a decade of easy money, as investors worldwide shifted trillions of dollars into riskier bonds in search of higher yields. A company that was looking to borrow debt for seven years would pay just 0.5 extra percentage point in interest annually if it were rated in the BBB tier instead of the A tier, according to Bloomberg data. That amounts to just $5 million more a year for every additional $1 billion the company borrows. … The result has been a surge in debt issuance in the lowest rungs of investment-grade—the biggest share of it driven by corporate acquisitions. There's now about $2.47 trillion of U.S. corporate debt rated in the BBB tier, more than triple the level at the end of 2008. It now makes up a record 49 percent of the investment-grade bond market ..." (see https://www.bloomberg.com/graphics/2018-almost-junk-credit-ratings/; Oct 11, 2018)

Prime Rate

Analysis

The Prime Rate is historically very tightly coupled to very short-term Treasury Bills (specifically, 3-month yields). Capitalytics expects the Prime Rate to continue at 5% to 5.5% and gradually decline to 4.5% over the next several years.

The accompanying chart shows the tight relationship that has existed historically between the Prime Rate and the 3-month T-bill yield.



US Average Retail Gasoline Price

Analysis

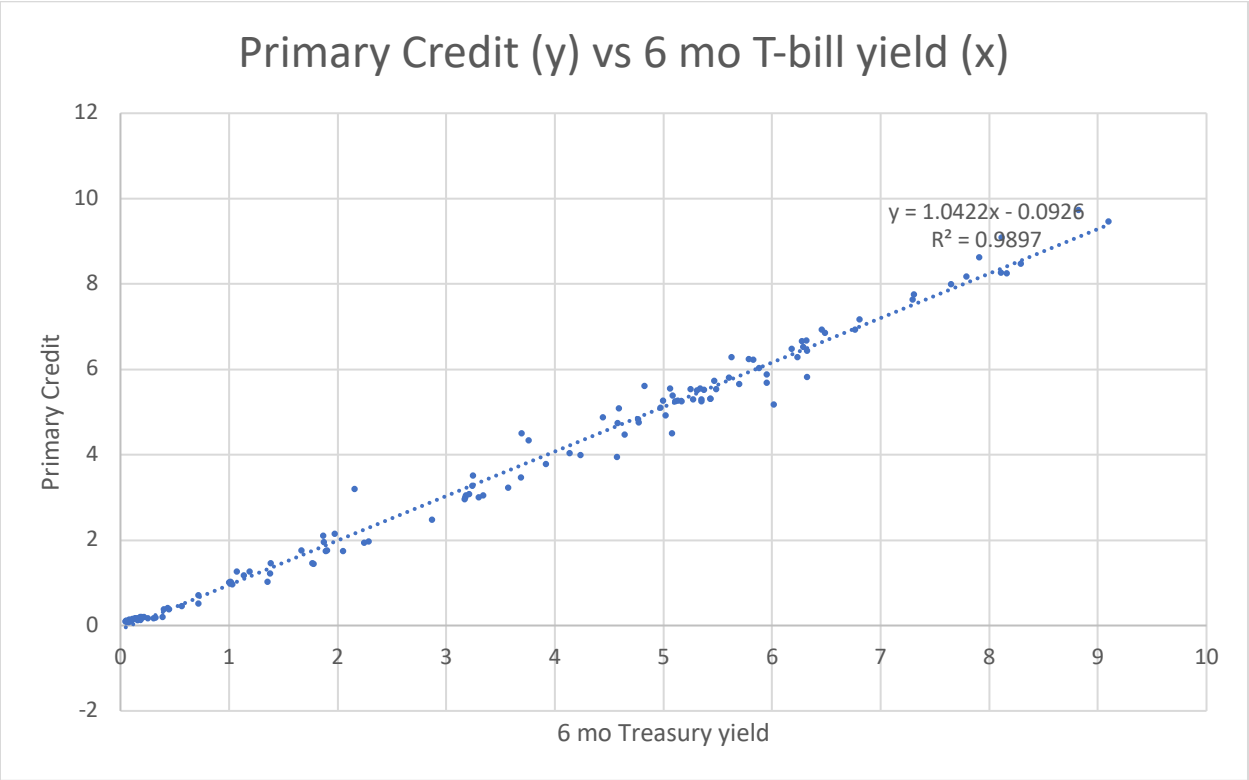
Gasoline prices are expected to remain relatively stable over the next several years, with typically expected fluctuations occurring during the summer and winter months. During the course of a CY2019, gasoline is expected to stay at around $2.90/year on average with single cent increases (on average) each year thereafter.

Primary Credit Rate

Analysis

When a depository institution has a shortfall and need for liquidity, it may borrow funds on a short-term basis from the Federal Reserve. The “discount rate” is the interest rate charged to commercial banks and other depository institutions on loans they receive from their regional Federal Reserve Bank's “discount window”. The Federal Reserve Banks offer three discount window programs to depository institutions: Primary Credit, Secondary Credit, and Seasonal Credit, each with its own interest rate. Under the Primary Credit program, loans are extended for a very short term (usually overnight) to depository institutions in generally sound financial condition. (Secondary Credit & Seasonal Credit may be available to institutions that do not meet the “sound financial condition” criteria.) The discount rate charged for primary credit (the primary credit rate) is set above the usual level of short-term market interest rates.

The accompanying chart serves to illustrate the relationship between the Primary Credit rate and the 6-month T-bill yield.



Other Commentary

Dow Jones Total Stock Market Index (end-of-quarter) and S&P 500 (quarterly average)

Given the business- and investor-friendly administration that is currently installed in the United States, we expect decreasing growth occurring in 2019 and 2020 in concert with the next round of legislative elections.

Based on our current research (and no significant changes to the legislative composition in the federal government), Capitalytics sees the Dow-Jones index' growth slowing below what we've previously published, so that the Dow will have a hard time breaking 32,000 within the next 5 years. Our analysis shows growth stagnating at 31,700 in three years' time. We also anticipate stagnation of the S&P500, and it becoming very difficult to reach 3,000 by mid-2023.

House and Commercial Real Estate Price Indexes

Pending home sales have dropped dramatically since the end of 3Q2018, with the West coast and Southern US most strongly hit. Home prices in these areas have been increasing faster than wages for years, and, recently, the recoiling of prices have begun based on buyers realizing that rising interest rates and continuing declines would likely undermine a decision to buy. The Case-Shiller home price index has shown drops in housing of the largest magnitude in almost 10 years in many sought after areas along the Western coast (specifically, Portland, San Francisco, San Diego, and Los Angeles), as well as further inland (e.g., Las Vegas and Denver). In conjunction with the continued rhetoric regarding interest rates, the perception is that the country is on one-side-or-the-other of an apex on market prices, implying that many buyers are walking away from current inventory in order to take stock of the direction of prices and rates. Smaller markets, and markets further from these areas will lag in this trend, with some (e.g., Greensboro) still showing increases in prices; these increases, with the accompanying rates, though, will squeeze buyers' desires and selling prices to varying degrees. These trends will be reflected in the Home Real Estate Price Index as it may grow by as much as 1% per quarter nationally over the next several quarters, while still being driven by the aforementioned trends.

The Commercial Real Estate Price index is currently projected to grow at between 0.1% and 1% per quarter. As has been previously discussed, residential and commercial trends ideally parallel each other, and that has been the case for the past 24-36 months. The Commercial Real Estate Price index is expected to slowly grow from 285 to 296 over the next 60 months.

Market Volatility Index

Analysis

Capitalytics is calling for the Market Volatility Index to gradually increase over the next five years: starting at 17.8 and rising to 18.5 during the summer/fall time frame of the next few years before cyclically falling to around 18.0 again. We again caveat the statement as we did last quarter, saying that we find "stability" to be fairly unlikely for next few years, and would caution our clients in relying on this information. It should be noted that a value of 40.7 was recorded in Q3 of 2015 (immediately prior to the last US Presidential election), and a value of 37.32 was recorded in Q1 of 2018.

Other Commentary

- "S&P Volatility Index is expected to trade around 27 by the end of this quarter, according to Trading Economics global macro models and analysts expectations. Looking forward, we estimate it to trade around 26 in 12 months time." (see https://tradingeconomics.com/vix:ind/forecast, downloaded on Jan 11, 2019)

Appendix A: Data Sources

The following table lists the attributes provided by Capitalytics as part of its macro-economic forecast service. The sources for data that are defined by the document "2018 Supervisory Scenarios for Annual Stress Tests Required under the Dodd-Frank Act Stress Testing Rules and the Capital Plan Rule" (found at https://www.federalreserve.gov/supervisionreg/files/bcreg20180201a1.pdf) are listed. Please note that shaded attributes are not discussed within this report.

Attribute	Referenced Source[3]
Real GDP growth	Bureau of Economic Analysis (NIPA table 1.1.6, line 1)
Nominal GDP growth	Bureau of Economic Analysis (NIPA table 1.1.5, line 1)
Real disposable income growth	Bureau of Economic Analysis (NIPA table 2.1, line 27, and NIPA table 1.1.4, line 2)
Nominal disposable income growth	Bureau of Economic Analysis (NIPA table 2.1, line 27)
Unemployment rate	Bureau of Labor Statistics (series LNS14000000)
CPI inflation rate	Bureau of Labor Statistics (series CUSR0000SA0)
3-month Treasury yield	Quarterly average of 3-month Treasury bill secondary market rate on a discount basis, H.15 Release, Selected Interest Rates, Federal Reserve Board (series RIFSGFSM03_N.B)
5-year Treasury yield	Quarterly average of the yield on 5-year U.S. Treasury bonds, constructed for the FRB/U.S. model by Federal Reserve staff based on the Svensson smoothed term structure model; see Lars E. O. Svensson (1995), "Estimating Forward Interest Rates with the Extended Nelson-Siegel Method," Quarterly Review, no. 3, Sveriges Riksbank, pp. 13–26
10-year Treasury yield	Quarterly average of the yield on 10-year U.S. Treasury bonds, constructed for the FRB/U.S. model by Federal Reserve staff based on the Svensson smoothed term structure model; see Lars E. O. Svensson (1995), "Estimating Forward Interest Rates with the Extended Nelson-Siegel Method," Quarterly Review, no. 3, Sveriges Riksbank, pp. 13–26
BBB corporate yield	Merrill Lynch 10-year BBB corporate bond yield, Z.1 Release (Financial Accounts of the United States), Federal Reserve Board (series FL073163013.Q).
Mortgage rate	Quarterly average of weekly series for the interest rate of a conventional, conforming, 30-year fixed-rate

[3] Per https://www.federalreserve.gov/supervisionreg/files/bcreg20180201a1.pdf

	mortgage, obtained from the Primary Mortgage Market Survey of the Federal Home Loan Mortgage Corporation.
Prime rate	Quarterly average of monthly series, H.15 Release, Selected Interest Rates, Federal Reserve Board (series RIFSPBLP_N.M).
Dow Jones Total Stock Market Index (end-of-qtr value)	Dow-Jones
House Price Index	Price Index for Owner-Occupied Real Estate, CoreLogic National, Z.1 Release (Financial Accounts of the United States), Federal Reserve Board (series FL075035243.Q).
Commercial Real Estate Price Index	Commercial Real Estate Price Index, Z.1 Release (Financial Accounts of the United States), Federal Reserve Board (series FL075035503.Q divided by 1000).
Market Volatility Index (VIX)	VIX converted to quarterly frequency using the maximum close-of-day value in any quarter, Chicago Board Options Exchange.
Euro Area Real GDP Growth	Percent change in real gross domestic product at an annualized rate, staff calculations based on Statistical Office of the European Communities via Haver, extended back using ECB Area Wide Model dataset (ECB Working Paper series no. 42).
Euro Area Inflation	Percent change in the quarterly average of the harmonized index of consumer prices 16 Federal Reserve Supervisory Scenarios at an annualized rate, staff calculations based on Statistical Office of the European Communities via Haver.
Euro Area Bilateral Dollar Exchange Rate (USD/Euro)	End-of-quarter rates from the H.10 Release, Foreign Exchange Rates, Federal Reserve Board.
Developing Asia Real GDP Growth	Percent change in real gross domestic product at an annualized rate, staff calculations based on Bank of Korea via Haver; Chinese National Bureau of Statistics via CEIC; Indian Central Statistical Organization via CEIC; Census and Statistics Department of Hong Kong via CEIC; and Taiwan Directorate-General of Budget, Accounting, and Statistics via CEIC.
Developing Asia Inflation	Percent change in the quarterly average of the consumer price index, or local equivalent, at an annualized rate, staff calculations based on Chinese National Bureau of Statistics via CEIC; Indian Ministry of Statistics and Programme Implementation via Haver; Labour Bureau of India via CEIC; National Statistical Office of Korea via CEIC; Census and Statistic Department of Hong Kong via CEIC; and Taiwan Directorate General of Budget, Accounting, and Statistics via CEIC.

Developing Asia bilateral dollar exchange rate (F/USD, index)	End-of-quarter rates from the H.10 Release, Foreign Exchange Rates, Federal Reserve Board.
Japan Real GDP Growth	Percent change in gross domestic product at an annualized rate, Cabinet Office via Haver.
Japan Inflation	Percent change in the quarterly average of the consumer price index at an annualized rate, staff calculations based on Ministry of Internal Affairs and Communications via Haver.
Japan Bilateral Dollar Exchange Rate (Yen/USD)	End-of-quarter rates from the H.10 Release, Foreign Exchange Rates, Federal Reserve Board.
UK Real GDP Growth	Percent change in gross domestic product at an annualized rate, Office for National Statistics via Haver.
UK Inflation	Percent change in the quarterly average of the consumer price index at an annualized rate, staff calculations based on Office for National Statistics via Haver.
UK Bilateral Dollar Exchange Rate (USD/Pound)	End-of-quarter rates from the H.10 Release, Foreign Exchange Rates, Federal Reserve Board.

The above dataset from the Federal Reserve can be downloaded manually or automatically. Manual downloads are available at https://www.federalreserve.gov/supervisionreg/ccar-2018.htm (shown below, as of June 2018) by clicking the link marked "Historical data (ZIP)". Alternatively, downloading the file at https://www.federalreserve.gov/econres/files/2018-historical-data.zip using HTTP client software will also download the official dataset.

Decompressing the zip-file will provide two files in CVS format: one containing US domestic data elements on a quarterly basis, and the other containing international data elements on a quarterly basis[4].

[4] Again, due to the requirements of this client, international data elements are not being discussed in this document.

Since the CCAR dataset is only released annually (through 4Q2017 as of this writing), and Capitalytics provides quarterly updates to its forecasts, the CCAR dataset is supplemented by the data sources shown below on a quarterly basis. All datasets discussed herein are supplemented with data through (including) 3Q2018.

Attribute	Supplementary Data Source
Real GDP growth	Bureau of Economic Analysis (NIPA table 1.1.6, line 1)
Nominal GDP growth	Bureau of Economic Analysis (NIPA table 1.1.5, line 1)
Real disposable income growth	Bureau of Economic Analysis (NIPA table 2.1, line 27, and NIPA table 1.1.4, line 2)
Nominal disposable income growth	Bureau of Economic Analysis (NIPA table 2.1, line 27)
Unemployment rate	Bureau of Labor Statistics (series LNS14000000)
CPI inflation rate	Bureau of Labor Statistics (series CUSR0000SA0)
3-month Treasury yield	Quarterly average of 3-month Treasury bill secondary market rate on a discount basis, H.15 Release
5-year Treasury yield	Federal Reserve Economic Research website (https://fred.stlouisfed.org/series/GS5), with “Quarterly” frequency and “Average” aggregation method
10-year Treasury yield	Federal Reserve Economic Research website (https://fred.stlouisfed.org/series/GS10), with “Quarterly” frequency and “Average” aggregation method
BBB corporate yield	Federal Reserve Economic Research website (https://fred.stlouisfed.org/series/BAMLC0A4CBBBEY),

	with "Quarterly" frequency and "Average" aggregation method
Mortgage rate	Federal Reserve Economic Research website (https://fred.stlouisfed.org/series/MORTGAGE30US), with "Quarterly" frequency and "Average" aggregation method
Prime rate	Federal Reserve Economic Research website (https://fred.stlouisfed.org/series/MPRIME), with "Quarterly" frequency and "Average" aggregation method
Dow Jones Total Stock Market Index (end-of-qtr value)	Dow-Jones as provided by the Wall Street Journal (https://quotes.wsj.com/index/DWCF/advanced-chart)
House Price Index	CoreLogic, index level (end-of-quarter)
Commercial Real Estate Price Index	From the Financial Accounts of the United States, Federal Reserve Board (Z.1 release); the series corresponds to the data for price indexes: Commercial Real Estate Price Index (series FL075035503.Q, divided by 1000). Series FL075035503.Q is also available at https://www.quandl.com/data/FED/FL075035503_Q-Interest-rates-and-price-indexes-commercial-real-estate-price-index-Quarterly-Levels-NSA
Market Volatility Index (VIX)	Federal Reserve Economic Research website (https://fred.stlouisfed.org/series/VIXCLS), with "Quarterly" frequency and "Average" aggregation method
Euro Area Real GDP Growth	Quarterly series for "European Union GDP Annual Growth Rate" per tradingeconomics.com
Euro Area Inflation	Quarterly average of monthly series for "European Union Inflation Rate" per tradingeconomics.com
Euro Area Bilateral Dollar Exchange Rate (USD/Euro)	End-of-quarter rates from the H.10 Release, Foreign Exchange Rates, Federal Reserve Board.
Developing Asia Real GDP Growth	The nominal GDP-weighted aggregate of the Real GDP growth for China, India, South Korea, Hong Kong Special Administrative Region, and Taiwan per OECD
Developing Asia Inflation	The nominal GDP-weighted aggregate of the inflation rate for China, India, South Korea, Hong Kong Special Administrative Region, and Taiwan per OECD
Developing Asia bilateral dollar exchange rate (F/USD, index)	End-of-quarter rates from the H.10 Release, Foreign Exchange Rates, Federal Reserve Board.
Japan Real GDP Growth	Quarterly average of monthly series for "Japan GDP Growth Rate" per tradingeconomics.com
Japan Inflation	Quarterly average of monthly series for "Japan Inflation Rate" per tradingeconomics.com
Japan Bilateral Dollar Exchange Rate (Yen/USD)	End-of-quarter rates from the H.10 Release, Foreign Exchange Rates, Federal Reserve Board.
UK Real GDP Growth	Quarterly average of monthly series for "United Kingdom GDP Growth Rate" per tradingeconomics.com

UK Inflation	Quarterly average of monthly series for "United Kingdom Inflation Rate" per tradingeconomics.com
UK Bilateral Dollar Exchange Rate (USD/Pound)	End-of-quarter rates from the H.10 Release, Foreign Exchange Rates, Federal Reserve Board.

While all data that is required for the Annual Stress Tests is available from https://www.federalreserve.gov/econres/files/2017-historical-data.zip, Capitalytics provides 13 additional metrics per the information in the following table. These values are available from the point at which they are collected (which varies from metric to metric) through (and including) 3Q2018.

Attribute	Capitalytics Source
1-month Treasury yield	https://fred.stlouisfed.org/series/dgs1mo
6-month Treasury yield	https://fred.stlouisfed.org/series/dgs6mo
1-year Treasury yield	https://fred.stlouisfed.org/series/dgs1
3-year Treasury yield	https://fred.stlouisfed.org/series/dgs3
7-year Treasury yield	https://fred.stlouisfed.org/series/dgs7
20-year Treasury yield	https://fred.stlouisfed.org/series/dgs20
30-year Treasury yield	https://fred.stlouisfed.org/series/dgs30
US Average Retail Gasoline Price ($/gal; all grades, all formulations)	https://fred.stlouisfed.org/series/gasallm
S&P 500 Stock Price Index	https://fred.stlouisfed.org/series/S&P 500 Stock Price Index
Primary Credit	https://fred.stlouisfed.org/series/FEDFUNDS
Moody's AAA Rate	https://fred.stlouisfed.org/series/aaa
Moody's BAA Rate	https://fred.stlouisfed.org/series/baa
Dow Jones Total Industrial Average	https://fred.stlouisfed.org/series/djia

Appendix B: Methodologies

Capitalytics uses non-structured macroeconomic forecasting techniques in order to prepare its clients for what trends and relationships drive certain metrics, and what values those metrics may take on in the coming months.

- General Forecasting Methodology

Generally, the most effective overall forecasting techniques have been found to be a hybridization of multiple other techniques. Capitalytics uses several forecasting schemes, and aggregates the results, as part of its analysis methodology. This section describes the process that is executed for generating these results.

For each metric, four distinct forecasts are produced.

1. The first forecast uses the full quarterly history of the metric as an input to an additive exponential smoothing representation. The process that is executed is that provided by R's[5] "forecast" package[6]; specifically, the "ets" function (see p.39 of https://cran.r-project.org/web/packages/forecast/forecast.pdf)[7] is designed to automatically determine the best fitting representation out of the "Generic 'ETS' Methodology" (discussed later in this section), including optimal parameters thereto, given a sequence of values. In our work, we have restricted our study to only "additive" forms (i.e., we set "`additive.only=TRUE`" in our calls), and our optimization criteria is set to the mean of absolute residuals (i.e., "`opt.crit=mae`"). Therefore, calls to generate our estimates through this procedure look something like the following command, where "`s`" is an appropriately populated array, vector, time series, or similar object.

```
> m<-ets(s, model='ZZZ', opt.crit=c('mae'), additive.only=TRUE)
```

   The results of this call are shown above each dataset, including the representation type returned (as described later this section), the initial values that are used by the software, the optimal smoothing parameters estimated, and the $n+1^{st}$ forecasted value given the first n values of the metric's sequence (the "fitted" values)[8], and the determined parameters. While fitting forecasts to previous values,

[5] As of this writing, v.3.5.2 of the "R" language is available at https://cran.r-project.org/.
[6] As of this writing, v.8.4 of the forecast package is available at https://CRAN.R-project.org/package=forecast .
[7] It should be noted that Microsoft's Excel software includes a FORECAST.ETS function which is documented as potentially producing comparable results; however, we have not been able to re-create its output independently, and, given the documentation, flexibility, and source availability of the R packages, Capitalytics has decided that it is a preferable option at this time.
[8] While this procedure does generate fitted values for intermediate samples within a sequence -- and allow for generating a forecasted set of samples to extend a sequence – according to the identified parameter set, it does not directly provide for determining the optimal parameter set of a sub-sequence. Capitalytics is currently codifying the process herein so that we may prescribe a "most likely" long term representation for each forecast, and determine the likely effects of errors in the forecasts by estimating the "recent term" values of dy/dx_i (where y is the metric being estimated and x_i is each of the parameters within the representation) and then compensating for recent quantified errors. We can also consider how "finite" a window to account for in building a set of parameters; these representations are theoretically using all history in building a forecast, but the values for alpha, beta, etc. implicitly give an indication of how much history of a metric is truly impacting a specific value.

- "forecast error" is defined as being actual values less forecasted values,
- "% error" is defined as forecast error divided by actual value, and
- "score" is defined as mean absolute forecast error over an appropriate range (generally the duration of the collected past values, less the first two to four years of collected values)[9].

2. The second forecast uses the differences between successive quarterly values in order to forecast the future quarterly differences. It should be noted that these sequences are (obviously) one data-point shorter than those in the preceding procedure. These values are forecasted using the same procedure as described in the first section, with forecasted values for the actual metric being built using the last known value for the metric and forecasts of incremental changes to the metric provided.

   An edited example for loading the SP500 end-of quarter values, and the differences between successive quarterly values, is shown below.

```
       > sp<-c(130.659129, 1250.520109, 998.4076848, 812.047, 799.5264066, 927.5045326,
       1041.372826, … )
       > sp_ts<-ts(sp,freq=4,end=c(2017,4))
       > sp_ts
          Qtr1      Qtr2      Qtr3      Qtr4
2008             130.6591 1250.5201  998.4077
2009  812.0470  799.5264  927.5045 1041.3728
       …

       > m<-ets(sp_ts,model='ZZZ',opt.crit=c('mae'),additive.only=TRUE)
       > dsp_ts<-diff(sp_ts)
       > dsp_ts
           Qtr1        Qtr2        Qtr3        Qtr4
2008                       1119.860980 -252.112424
2009 -186.360685  -12.520593  127.978126  113.868293
       …

       > m<-ets(dsp_ts,model='ZZZ',opt.crit=c('mae'),additive.only=TRUE
```

3. The third forecast uses the sequence of numbers from the second forecast, but partitions the dataset based on the quarter in which they are incurred. Assuming that the differences between quarters are associated with the ending points of each quarter (i.e., the difference between third and fourth quarter values are associated with a date of December 31st), four sequences of numbers are now created, with annual forecasts now being produced for each sequence using the same procedures as previously outlined. The final sequence appropriately interleaves the forecasted data-points.

4. The fourth forecast builds three sequences of values based the history of the metric to an observed point:

   - the slope of the "best fitting" line (based on minimizing the total absolute error) using the immediately preceding 2 years of values[10];
   - the same slope using the immediately preceding 4 years of values; and,

[9] It bears noting that a lower value for the "score" indicates better accuracy of an algorithm.
[10] The value for this slope is calculated using Microsoft Excel's SLOPE function, with the first argument being the appropriate number of preceding values for the metric, and the second argument being the same number of corresponding "end-of-quarter" dates.

- the same slope using the immediately preceding 8 years of values.

While two years of data would provide for a relatively responsive change in aggregate values to be reflected given a change in the economic conditions, eight years of data (a not unreasonable estimate for an "economic cycle") would allow for a much more slowly moving change in average window for a counterbalance.

Using these datasets independently, we are able to use our previous procedure to generate forecasts for each slope, and then average the results on a quarterly basis. Multiplying the average slope by the duration of the following quarter (in days) provides an estimate for the change in the metric's value during that following quarter, just as in our second forecast.

Obviously, this technique requires at least eight years of data to pass before being able to produce any data. However, in order to err on the side of conservatism, we generally allow a sequence to "mature" for two to four years before believing that its initial transience has become less significant and its results are trustworthy. If a dataset does not have enough data to complete one of these analyses, the analysis is dropped. In other words, if the metric does not have +/-11 years of data available, the 8-year slopes cannot be reliably calculated, and the average slope is only based on the 2- & 4-year slopes[11].

5. In some cases, we may find variables with extremely tight cross-connections that can be justified as part of their nature (treasury bill yield rates, for example, with a magnitude or correlation greater than ~0.95). In these cases, we are able to additionally enhance our forecast by building a forecast that expresses one variable (the "dependent" variable, $y(t)$) in terms of another (the "independent" variable, $x(t)$) with a coefficient of determination (R^2), such that

$$y(t) = m(t) * x(t) + b(t) .$$

Notice that the "slope" and "intercept" terms in this expression are time varying expressions that are re-evaluated with each data-point, not simply constants.

By averaging the results of these distinct forecasts in order to provide an aggregate forecast, the error for which can be characterized and measured, Capitalytics aims to provide a robust dataset that can be used for future business decisions.

It was stated earlier that Capitalytics uses each metric's complete history in order to generate a matching representation and forecast. It should be recognized that we also perform the same analyses for periods starting no more than 100, 80, 60, and 40 quarters prior to the forecasted period. However, we have found the results of all of these analyses are more reactionary and less coherent than that already presented within this report.

[11] See the SP500 metric's analysis.

- Exponentially Smoothed State Space Representations & Generic "ETS" Methodology

Exponential smoothing was proposed in the late 1950s (Brown 1959, Holt 1957 and Winters 1960 are key pioneering works) and has motivated some of the most successful forecasting methods. Forecasts produced using exponential smoothing methods are weighted averages of past observations, with the weights decaying exponentially as the observations get older. In other words, the more recent the observation the higher the associated weight. (See the following equation for one example of this type of equation which requires $0 \leq \alpha \leq 1$, and estimates future values of $\hat{y}$ given a history of values denoted as y_t. The ε_{T+1} term denotes an error term, the *residual*, which determines the value of the forecasting function.) This framework generates reliable forecasts quickly and for a wide spectrum of time series.

$$\hat{y}_{T+1|T} = \alpha y_T + \alpha(1-\alpha)y_{T-1} + \alpha(1-\alpha)^2 y_{T-2} + \cdots + \varepsilon_{T+1}$$

In this study, the relevance of quarterly samples more than 3 years old is eliminated by setting the number of terms in this type of expression to no more than 13.

The challenge with these forecasting techniques is to estimate the value of α such that some criteria is optimized, e.g., minimizing the sum of squared errors (SSE), across all values of a set of historical values.

There are other forms of exponential smoothing methods that may account for any combination of forecasting *levels* (as in the Theta method), *trends* (for which a metric may, for instance, be growing or lessening according to a linear or higher order function), and *seasonality* (for which a metric may have engrained "cycles" on, e.g., a monthly, quarterly, or annual basis).

By considering variations in the combination of the trend and seasonal components, fifteen exponential smoothing methods are possible. Each method is labelled by a pair of letters (T,S) defining the type of 'Trend' and 'Seasonal' components. For example, (A,M) is the method with an additive trend and multiplicative seasonality; (M,N) is the method with multiplicative trend and no seasonality; and so on. Per Section 7.6 of Hyndman & Athanasopoulos, some of these methods are well known per the following table.

Trend & Seasonal Components	Method
(N,N)	simple exponential smoothing
(A,N)	Holts linear method
(M,N)	Exponential trend method
(A_d,N)	additive damped trend method
(M_d,N)	multiplicative damped trend method
(A,A)	additive Holt-Winters method
(A,M)	multiplicative Holt-Winters method
(A_d,M)	Holt-Winters damped method

Additionally, the following table (again from Section 7.6 of Hyndman & Athanasopoulos) gives the recursive formulae for applying all possible fifteen exponential smoothing methods. Each cell includes the forecast equation for generating *h*-step-ahead forecasts and the smoothing equations for applying the method. By recursively applying the appropriate expressions to generate consecutive forecasts, this framework can be an extremely powerful tool.

Trend	Seasonal: N	A	M
N	$\hat{y}_{t+h\|t} = \ell_t$ $\ell_t = \alpha y_t + (1-\alpha)\ell_{t-1}$	$\hat{y}_{t+h\|t} = \ell_t + s_{t-m+h_m^+}$ $\ell_t = \alpha(y_t - s_{t-m}) + (1-\alpha)\ell_{t-1}$ $s_t = \gamma(y_t - \ell_{t-1}) + (1-\gamma)s_{t-m}$	$\hat{y}_{t+h\|t} = \ell_t s_{t-m+h_m^+}$ $\ell_t = \alpha(y_t/s_{t-m}) + (1-\alpha)\ell_{t-1}$ $s_t = \gamma(y_t/\ell_{t-1}) + (1-\gamma)s_{t-m}$
A	$\hat{y}_{t+h\|t} = \ell_t + hb_t$ $\ell_t = \alpha y_t + (1-\alpha)(\ell_{t-1} + b_{t-1})$ $b_t = \beta^*(\ell_t - \ell_{t-1}) + (1-\beta^*)b_{t-1}$	$\hat{y}_{t+h\|t} = \ell_t + hb_t + s_{t-m+h_m^+}$ $\ell_t = \alpha(y_t - s_{t-m}) + (1-\alpha)(\ell_{t-1} + b_{t-1})$ $b_t = \beta^*(\ell_t - \ell_{t-1}) + (1-\beta^*)b_{t-1}$ $s_t = \gamma(y_t - \ell_{t-1} - b_{t-1}) + (1-\gamma)s_{t-m}$	$\hat{y}_{t+h\|t} = (\ell_t + hb_t)s_{t-m+h_m^+}$ $\ell_t = \alpha(y_t/s_{t-m}) + (1-\alpha)(\ell_{t-1} + b_{t-1})$ $b_t = \beta^*(\ell_t - \ell_{t-1}) + (1-\beta^*)b_{t-1}$ $s_t = \gamma(y_t/(\ell_{t-1} + b_{t-1})) + (1-\gamma)s_{t-m}$
A_d	$\hat{y}_{t+h\|t} = \ell_t + \phi_h b_t$ $\ell_t = \alpha y_t + (1-\alpha)(\ell_{t-1} + \phi b_{t-1})$ $b_t = \beta^*(\ell_t - \ell_{t-1}) + (1-\beta^*)\phi b_{t-1}$	$\hat{y}_{t+h\|t} = \ell_t + \phi_h b_t + s_{t-m+h_m^+}$ $\ell_t = \alpha(y_t - s_{t-m}) + (1-\alpha)(\ell_{t-1} + \phi b_{t-1})$ $b_t = \beta^*(\ell_t - \ell_{t-1}) + (1-\beta^*)\phi b_{t-1}$ $s_t = \gamma(y_t - \ell_{t-1} - \phi b_{t-1}) + (1-\gamma)s_{t-m}$	$\hat{y}_{t+h\|t} = (\ell_t + \phi_h b_t)s_{t-m+h_m^+}$ $\ell_t = \alpha(y_t/s_{t-m}) + (1-\alpha)(\ell_{t-1} + \phi b_{t-1})$ $b_t = \beta^*(\ell_t - \ell_{t-1}) + (1-\beta^*)\phi b_{t-1}$ $s_t = \gamma(y_t/(\ell_{t-1} + \phi b_{t-1})) + (1-\gamma)s_{t-m}$
M	$\hat{y}_{t+h\|t} = \ell_t b_t^h$ $\ell_t = \alpha y_t + (1-\alpha)\ell_{t-1}b_{t-1}$ $b_t = \beta^*(\ell_t/\ell_{t-1}) + (1-\beta^*)b_{t-1}$	$\hat{y}_{t+h\|t} = \ell_t b_t^h + s_{t-m+h_m^+}$ $\ell_t = \alpha(y_t - s_{t-m}) + (1-\alpha)\ell_{t-1}b_{t-1}$ $b_t = \beta^*(\ell_t/\ell_{t-1}) + (1-\beta^*)b_{t-1}$ $s_t = \gamma(y_t - \ell_{t-1}b_{t-1}) + (1-\gamma)s_{t-m}$	$\hat{y}_{t+h\|t} = \ell_t b_t^h s_{t-m+h_m^+}$ $\ell_t = \alpha(y_t/s_{t-m}) + (1-\alpha)\ell_{t-1}b_{t-1}$ $b_t = \beta^*(\ell_t/\ell_{t-1}) + (1-\beta^*)b_{t-1}$ $s_t = \gamma(y_t/(\ell_{t-1}b_{t-1})) + (1-\gamma)s_{t-m}$
M_d	$\hat{y}_{t+h\|t} = \ell_t b_t^{\phi_h}$ $\ell_t = \alpha y_t + (1-\alpha)\ell_{t-1}b_{t-1}^{\phi}$ $b_t = \beta^*(\ell_t/\ell_{t-1}) + (1-\beta^*)b_{t-1}^{\phi}$	$\hat{y}_{t+h\|t} = \ell_t b_t^{\phi_h} + s_{t-m+h_m^+}$ $\ell_t = \alpha(y_t - s_{t-m}) + (1-\alpha)\ell_{t-1}b_{t-1}^{\phi}$ $b_t = \beta^*(\ell_t/\ell_{t-1}) + (1-\beta^*)b_{t-1}^{\phi}$ $s_t = \gamma(y_t - \ell_{t-1}b_{t-1}^{\phi}) + (1-\gamma)s_{t-m}$	$\hat{y}_{t+h\|t} = \ell_t b_t^{\phi_h} s_{t-m+h_m^+}$ $\ell_t = \alpha(y_t/s_{t-m}) + (1-\alpha)\ell_{t-1}b_{t-1}^{\phi}$ $b_t = \beta^*(\ell_t/\ell_{t-1}) + (1-\beta^*)b_{t-1}^{\phi}$ $s_t = \gamma(y_t/(\ell_{t-1}b_{t-1}^{\phi})) + (1-\gamma)s_{t-m}$

Appendix C: Variable Correlations

The following table shows the correlation factors between all of the listed variables for which the absolute value of the correlation is greater than 0.6, indicating a noteworthy degree of correlation. As is discussed in Appendix B of this report, correlations greater than 0.95 warrant further investigation as the relationship between variables may be useful for our research.

Variable 1	Variable 2	Correlation
S&P 500 Stock Price Index	Primary Credit	0.657079
S&P 500 Stock Price Index	Moody's AAA Rate	-0.743265
S&P 500 Stock Price Index	Moody's BAA Rate	-0.809784
S&P 500 Stock Price Index	Unemployment rate	0.894941
S&P 500 Stock Price Index	BBB Corporate Yield	0.743222
S&P 500 Stock Price Index	Prime Rate	-0.604913
S&P 500 Stock Price Index	**Dow Jones Total Stock Market Index**	**-0.976513**
S&P 500 Stock Price Index	House Price Index	-0.915959
S&P 500 Stock Price Index	Commercial Real Estate Price Index	-0.871855
S&P 500 Stock Price Index	30-year Treasury yield	-0.628152
S&P 500 Stock Price Index	20-year Treasury yield	-0.636561
S&P 500 Stock Price Index	1-month Treasury yield	0.670142
S&P 500 Stock Price Index	3-month Treasury yield	-0.633317
S&P 500 Stock Price Index	6-month Treasury yield	0.606342
Primary Credit	Moody's AAA Rate	0.818126
Primary Credit	Moody's BAA Rate	0.747375
Primary Credit	Mortgage Rate	-0.675617
Primary Credit	Prime Rate	-0.600547
Primary Credit	Dow Jones Total Stock Market Index	0.659467
Primary Credit	House Price Index	0.648854
Primary Credit	Commercial Real Estate Price Index	0.728695
Primary Credit	US Average Retail Gasoline Price	-0.629897
Primary Credit	30-year Treasury yield	0.62997
Primary Credit	20-year Treasury yield	0.811651
Primary Credit	10-year Treasury yield	-0.707199
Primary Credit	**1-month Treasury yield**	**0.993275**
Primary Credit	7-year Treasury yield	0.900411
Primary Credit	3-month Treasury yield	-0.631079
Primary Credit	5-year Treasury yield	-0.712857
Primary Credit	**6-month Treasury yield**	**0.994046**
Primary Credit	**3-year Treasury yield**	**0.956825**
Primary Credit	1-year Treasury yield	0.987489
Moody's AAA Rate	**Moody's BAA Rate**	**0.971923**
Moody's AAA Rate	BBB Corporate Yield	-0.759288
Moody's AAA Rate	Mortgage Rate	-0.847256
Moody's AAA Rate	Prime Rate	-0.652134
Moody's AAA Rate	Dow Jones Total Stock Market Index	0.902953
Moody's AAA Rate	House Price Index	0.862696
Moody's AAA Rate	Commercial Real Estate Price Index	0.931899
Moody's AAA Rate	US Average Retail Gasoline Price	-0.78426
Moody's AAA Rate	30-year Treasury yield	0.937599
Moody's AAA Rate	**20-year Treasury yield**	**0.98014**
Moody's AAA Rate	10-year Treasury yield	-0.865269
Moody's AAA Rate	**7-year Treasury yield**	**0.966259**
Moody's AAA Rate	3-month Treasury yield	-0.687955
Moody's AAA Rate	5-year Treasury yield	-0.818831

Moody's AAA Rate	6-month Treasury yield	0.831803
Moody's AAA Rate	3-year Treasury yield	0.910333
Moody's AAA Rate	1-year Treasury yield	0.84697
Moody's BAA Rate	BBB Corporate Yield	-0.725839
Moody's BAA Rate	Mortgage Rate	-0.794537
Moody's BAA Rate	Dow Jones Total Stock Market Index	0.913515
Moody's BAA Rate	House Price Index	0.841246
Moody's BAA Rate	Commercial Real Estate Price Index	0.903885
Moody's BAA Rate	US Average Retail Gasoline Price	-0.735783
Moody's BAA Rate	30-year Treasury yield	0.719981
Moody's BAA Rate	20-year Treasury yield	0.911191
Moody's BAA Rate	10-year Treasury yield	-0.813537
Moody's BAA Rate	7-year Treasury yield	0.905668
Moody's BAA Rate	3-month Treasury yield	-0.607141
Moody's BAA Rate	5-year Treasury yield	-0.752635
Moody's BAA Rate	6-month Treasury yield	0.758847
Moody's BAA Rate	3-year Treasury yield	0.840746
Moody's BAA Rate	1-year Treasury yield	0.77424
BBB Corporate Yield	US Average Retail Gasoline Price	0.634726
BBB Corporate Yield	30-year Treasury yield	-0.674499
BBB Corporate Yield	20-year Treasury yield	-0.835922
BBB Corporate Yield	7-year Treasury yield	-0.7119
BBB Corporate Yield	3-year Treasury yield	-0.62721
Mortgage Rate	US Average Retail Gasoline Price	0.78054
Mortgage Rate	20-year Treasury yield	-0.926935
Mortgage Rate	7-year Treasury yield	-0.831455
Mortgage Rate	6-month Treasury yield	-0.693366
Mortgage Rate	3-year Treasury yield	-0.774214
Mortgage Rate	1-year Treasury yield	-0.708945
Prime Rate	US Average Retail Gasoline Price	0.68288
Prime Rate	20-year Treasury yield	-0.779626
Prime Rate	7-year Treasury yield	-0.711266
Prime Rate	6-month Treasury yield	-0.637721
Prime Rate	3-year Treasury yield	-0.700765
Prime Rate	1-year Treasury yield	-0.655777
Dow Jones Total Stock Market Index	US Average Retail Gasoline Price	-0.603843
Dow Jones Total Stock Market Index	30-year Treasury yield	0.884264
Dow Jones Total Stock Market Index	20-year Treasury yield	0.807127
Dow Jones Total Stock Market Index	7-year Treasury yield	0.841025
Dow Jones Total Stock Market Index	6-month Treasury yield	0.669015
Dow Jones Total Stock Market Index	3-year Treasury yield	0.75647
Dow Jones Total Stock Market Index	1-year Treasury yield	0.682694
House Price Index	US Average Retail Gasoline Price	-0.621975
House Price Index	20-year Treasury yield	0.825837
House Price Index	7-year Treasury yield	0.807201
House Price Index	6-month Treasury yield	0.65661
House Price Index	3-year Treasury yield	0.739772
House Price Index	1-year Treasury yield	0.668999
Commercial Real Estate Price Index	US Average Retail Gasoline Price	-0.712777
Commercial Real Estate Price Index	30-year Treasury yield	0.62042
Commercial Real Estate Price Index	20-year Treasury yield	0.879527
Commercial Real Estate Price Index	7-year Treasury yield	0.885527
Commercial Real Estate Price Index	6-month Treasury yield	0.739491
Commercial Real Estate Price Index	3-year Treasury yield	0.821629
Commercial Real Estate Price Index	1-year Treasury yield	0.751018

US Average Retail Gasoline Price	20-year Treasury yield	-0.757402
US Average Retail Gasoline Price	10-year Treasury yield	0.772932
US Average Retail Gasoline Price	7-year Treasury yield	-0.782085
US Average Retail Gasoline Price	3-month Treasury yield	0.697568
US Average Retail Gasoline Price	5-year Treasury yield	0.762047
US Average Retail Gasoline Price	6-month Treasury yield	-0.653769
US Average Retail Gasoline Price	3-year Treasury yield	-0.745128
US Average Retail Gasoline Price	1-year Treasury yield	-0.676766
30-year Treasury yield	**20-year Treasury yield**	**0.98924**
30-year Treasury yield	1-month Treasury yield	0.614891
30-year Treasury yield	7-year Treasury yield	0.857472
30-year Treasury yield	6-month Treasury yield	0.60816
30-year Treasury yield	3-year Treasury yield	0.669117
30-year Treasury yield	1-year Treasury yield	0.604452
20-year Treasury yield	10-year Treasury yield	-0.927889
20-year Treasury yield	1-month Treasury yield	0.601029
20-year Treasury yield	**7-year Treasury yield**	**0.971017**
20-year Treasury yield	3-month Treasury yield	-0.787635
20-year Treasury yield	5-year Treasury yield	-0.880418
20-year Treasury yield	6-month Treasury yield	0.832182
20-year Treasury yield	3-year Treasury yield	0.91089
20-year Treasury yield	1-year Treasury yield	0.853028
10-year Treasury yield	7-year Treasury yield	-0.853846
10-year Treasury yield	6-month Treasury yield	-0.724833
10-year Treasury yield	3-year Treasury yield	-0.801658
10-year Treasury yield	1-year Treasury yield	-0.73975
1-month Treasury yield	7-year Treasury yield	0.815643
1-month Treasury yield	**6-month Treasury yield**	**0.995758**
1-month Treasury yield	3-year Treasury yield	0.942474
1-month Treasury yield	**1-year Treasury yield**	**0.990089**
7-year Treasury yield	3-month Treasury yield	-0.735729
7-year Treasury yield	5-year Treasury yield	-0.833269
7-year Treasury yield	6-month Treasury yield	0.920645
7-year Treasury yield	**3-year Treasury yield**	**0.979647**
7-year Treasury yield	1-year Treasury yield	0.934987
3-month Treasury yield	6-month Treasury yield	-0.664656
3-month Treasury yield	3-year Treasury yield	-0.723575
3-month Treasury yield	1-year Treasury yield	-0.680865
5-year Treasury yield	6-month Treasury yield	-0.735667
5-year Treasury yield	3-year Treasury yield	-0.802547
5-year Treasury yield	1-year Treasury yield	-0.751306
6-month Treasury yield	**3-year Treasury yield**	**0.975238**
6-month Treasury yield	**1-year Treasury yield**	**0.998136**
3-year Treasury yield	**1-year Treasury yield**	**0.984745**

References

Fiorucci, Jose A., Tiago R. Pellegrini, Francisco Louzada, Fotios Petropoulos, Anne B. Koehler, "Models for optimising the theta method and their relationship to state space models", In International Journal of Forecasting, Volume 32, Issue 4, 2016, Pages 1151-1161, ISSN 0169-2070, https://doi.org/10.1016/j.ijforecast.2016.02.005. (http://www.sciencedirect.com/science/article/pii/S0169207016300243)

De Livera, Alysha M. "Automatic forecasting with a modified exponential smoothing state space framework." Monash Econometrics and Business Statistics Working Papers 10, no. 10 (2010).

De Livera, Alysha M., Rob J Hyndman, Ralph D Snyder, "Forecasting time series with complex seasonal patterns using exponential smoothing", Journal of the American Statistical Association, Volume 106, Number 496, pp 1513-1527, (2011)

Hyndman, R.J. and Athanasopoulos, G, Forecasting: principles and practice. OTexts: Melbourne, Australia. http://otexts.org/fpp/. Accessed on December 23, 2017 (2013)

Hyndman, Rob J., Baki Billah, "Unmasking the Theta method", In International Journal of Forecasting, Volume 19, Issue 2, 2003, Pages 287-290, ISSN 0169-2070, https://doi.org/10.1016/S0169-2070(01)00143-1. (http://www.sciencedirect.com/science/article/pii/S0169207001001431)

Jiang, Bin, George Athanasopoulos, Rob J Hyndman, Anastasios Panagiotelis, Farshid Vahid, "Macroeconomic forecasting for Australia using a large number of predictors", Unpublished working paper, http://business.monash.edu/econometrics-and-business-statistics/research/publications/ebs/wp02-17.pdf. Accessed on December 27, 2017 (2017)

