Macroeconomic Forecasts, 3Q2018

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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
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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
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15. 20-year Treasury yield
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18. Mortgage rate
19. Prime rate
20. US Average Retail Gasoline Price ($/gal; all grades, all formulations)
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25. Dow Jones Total Stock Market Index
26. House Price Index
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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 2Q2018. Most domestic variables are driven by T-bill yields and inflation. Most of these domestic variables are currently expected to move towards stronger positions, with (for example) the 10-year T-bill hitting 3% by YE2018, and becoming solidly entrenched above that level between mid-2019 and 2023.

I. 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. Most of these domestic variables are currently expected to move consistently towards stronger positions over the next 3-5 years.

II. 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 174 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*

III. Analysis of Variables

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

Analysis

Primarily based on the unexpected spike in GDP during 2Q2018, Capitalytics' analysis of the real GDP growth shifts from anticipating steady levels between approximately 2.0% & 2.5% to a damped "sawtooth" pattern that peaks in Q4; based on our quantitative analysis, real GDP growth will finish 2018 with estimates at 3.75% and just under 4.0%, dropping to 3.1% by 3Q2019 and then recovering to 3.4% by year-end. Nominal GDP growth is expected to retreat from 7% during the remainder of 2018 to approximately 5.25% by mid-2021, and firmly entrenching at that level through mid-2023.

Real disposable income growth suddenly retreated from 4.4% during 1Q2018 to around 2.5% during 2Q2018, and is projected gradually rise, but stay between 2.5% and 3%, until mid-2020. The metric's levels appear to converge at about 3% in 2021. Nominal disposable income growth went from 7% in 1Q2018 to 4.4% in 2Q2018, and appears to also be converging to approximately 4% in early 2021 in the absence of other factors.

Inflation dropped sharply Q/Q during 2Q2018 (to 1.5%), but is projected to rebound to 2% by YE2018, and gradually increase to 2.5% over the next 2 to 3 years. Beyond that point, increases are calculated to rise to almost 2.6% within the next 5 years. These notes coincide with Chicago Federal Reserve Bank President Charles Evans' comments (see https://www.reuters.com/article/us-usa-fed-evans/fed-policy-to-turn-mildly-restrictive-in-2019-evans-says-idUSKCN1LU1TK): "The U.S. economy is firing on all cylinders, with strong growth, low unemployment, and inflation approaching our 2 percent symmetric target on a sustained basis …" and, per the article, Evans said that inflation will likely rise "a bit above 2 percent, though not far enough to cause concern."

[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 "*".

Other Commentary

- Kiplinger reports that it believes inflation should drop to 2.5% by YE2018 (see https://www.kiplinger.com/article/business/T019-C000-S010-inflation-rate-forecast.html; Sept 14, 2018)
- The escalating trade war with China has the possibility of wiping out most of the progress made by the economy, particularly if the dispute continues *and* the Fed' continues with its plan to increase interest rates. Increased rates and tariffs will result in increased prices impacting both personal spending and enterprises' budgets, with the latter having the potential to impact hiring and growth plans. (see https://money.cnn.com/2018/08/22/news/economy/federal-reserve-interest-rates-august-minutes/index.html; August 22, 2018)
- The strong GDP data for 2Q2018 is one of the strongest on record, but is being discounted by analyses that claim shipments and sales are trying to "beat the clock" before the White House fuels a looming trade war with China. (see https://www.marketwatch.com/story/get-ready-for-the-gdp-hot-takes-2018-07-25; July 26, 2018)
- OECD speculates 2.5% growth for 2018, and 2.1% for 2019; and Kiplinger estimates 2.9% growth for 2018 (https://www.kiplinger.com/article/business/T019-C000-S010-gdp-growth-rate-and-forecast.html). OECD comparably estimates the nominal GDP at 4.1% growth for 2018 and 4.4% for 2019. (June 28, 2018)

Unemployment Rate

Analysis

While the Federal Reserve considers a ~5% unemployment rate as "full employment"[3], the unemployment rate has remained below that level for two years, and is expected to stay there for the next several years. The unemployment rate was at 3.9% during 2Q2018, and is expected to drop to 3.6% by YE 2018, and steadily continue to drop to almost 3% by 2023.

Most estimates agree with this trend, with differences primarily surrounding (1) how quickly unemployment will continue to drop, and (2) the factors that could derail these drops. For example, Chicago Federal Reserve Bank President Charles Evans' acknowledges that the unemployment rate will likely get to 3.5% by 2020.

Other Commentary

- The Motley Food makes a case for the likely impact of new technology on low- and commodity-skilled workers in the context of this continued period of low unemployment. (see https://www.fool.com/investing/2018/09/03/why-doesnt-the-unemployment-rate-ever-drop-well-be.aspx; Sept 3, 2018)

[3] It should be noted that Capitalytics has not found a reference to any study that re-evaluates the validity of the 5% U3 rate since the passage of the ACA in 2014. The costs and regulatory requirements that the ACA imposes on individuals will have a non-negligible impact on their willingness to maintain employment where that is a consideration.

- A recent academic paper (https://www.ecb.europa.eu/pub/conferences/shared/pdf/20180618_ecb_forum_on_central_banking/Stock_James_Paper.pdf) authored by faculty from Harvard University and Princeton University suggests not only that unemployment is being mis-measured and/or understated nationally and globally "… because of special features of the financial crisis recession and the long recovery", but also that domestic (US) inflation is increasing in sectors that experience strongest *local* pricing pressures (e.g., food service, hospitality, etc.) and are "historically cyclically sensitive". (June 26, 2018)

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

Analysis

Based on the Federal Reserve's published projection of raising rates several times over the next several years (as part of winding down the central bank's balance sheet), economic forecasts are generally positive. Capitalytics believes that the expected market growth of the next few years will cause, e.g., the 1-month T-bill yield to experience steady growth from the current 1.7% rate to almost 2.5% within 24 months. Other maturities show similar yields rising to approximately 2.5% for maturities less than 1 year, and a 10-year yield rate approaching 3.15%.

However, there are several points which indicate the possibility of an inversion in the yield curve coming as soon as the end of 2018, and anywhere before YE2020, that could signal a strong recessionary trend. Our forecasts show the yields for, e.g., 5 year T-bill's rate exceeding the 10-year yield during 2020 and beyond.

The issues driving the potential for a recession are (i) that the unwinding of the Central Bank's balance sheet, and (ii) the prevalence of "cheap money" over the past several years is coming to an end; the resulting change in economic policies will result in the way that banks, borrowers, and the economy as a whole needing to adjust expectations as new rates ripple through the system. On the other hand (and as we will discuss later in this report), the Federal Reserve has already been found to be willing to occasionally adjust some of its announced decisions regarding the management of its MBS.

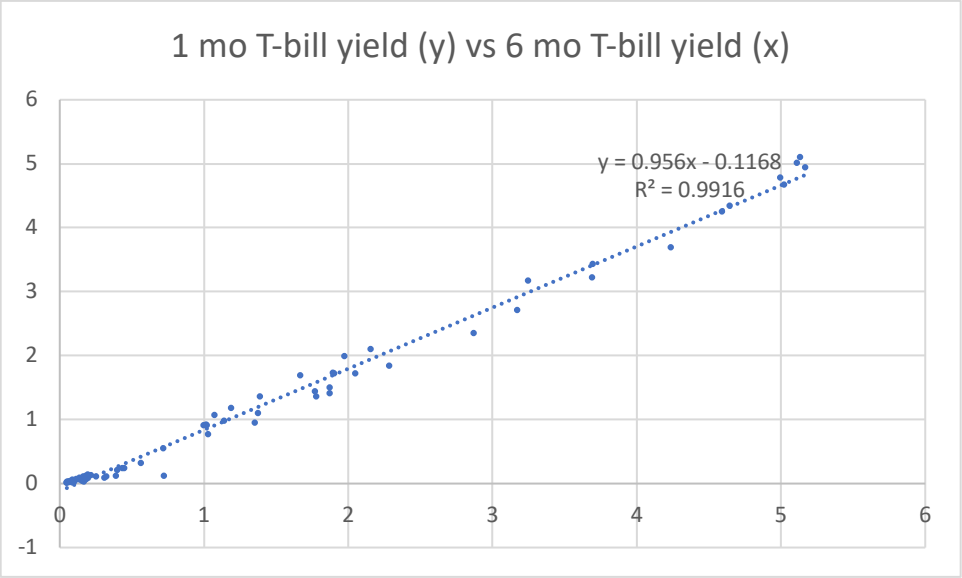
The following charts serve to illustrate the correlation between T-bill yields over as much as the past 40 years. As is also discussed later in this report, Capitalytics leverages these correlations (where they are significant enough) in order to adapt its analyses and provide better forecasts.

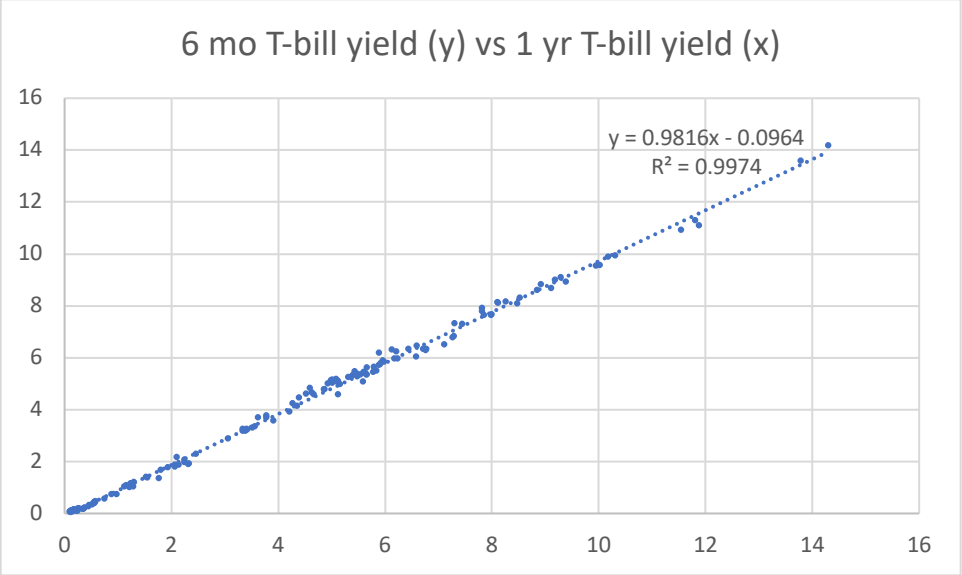
Other Commentary

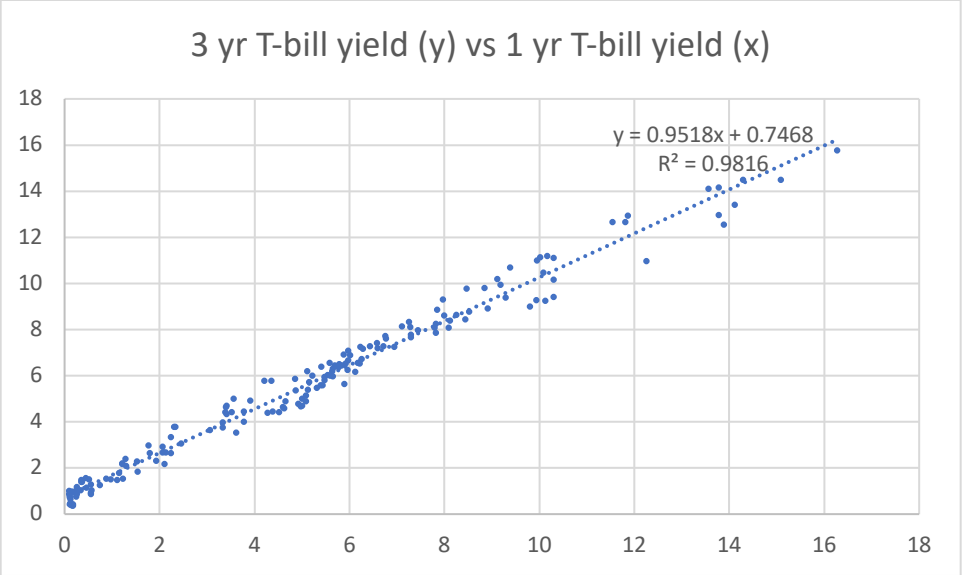
- The Fed' and FOMC insist that they are "deeply committed" to the plan to continue to gradually raise rates through 2019 (with two hikes planned for 3Q & 4Q2018, and 3 increases targeted during 2019) and remain objective and politically independent. (See https://money.cnn.com/2018/08/22/news/economy/federal-reserve-interest-rates-august-minutes/index.html; Aug 22, 2018)
- Kiplinger asserts that 10Y T-bills will end 2018 at 3.2% (see https://www.kiplinger.com/article/business/T019-C000-S010-interest-rate-forecast.html,

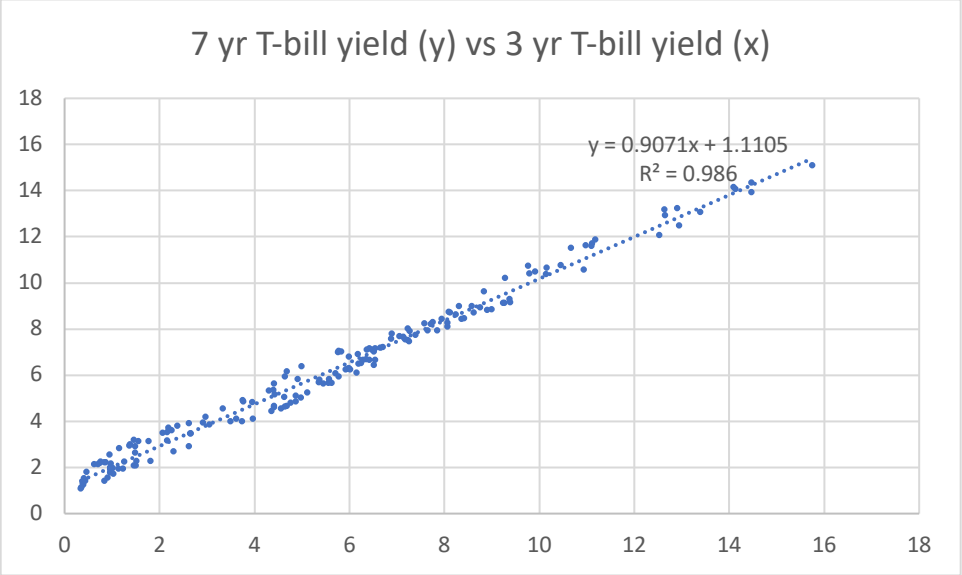
Aug 16, 2018), mentioning that the Fed' could easily issue more long-term bonds, as necessary, in order to prevent the inversion of the yield curve.

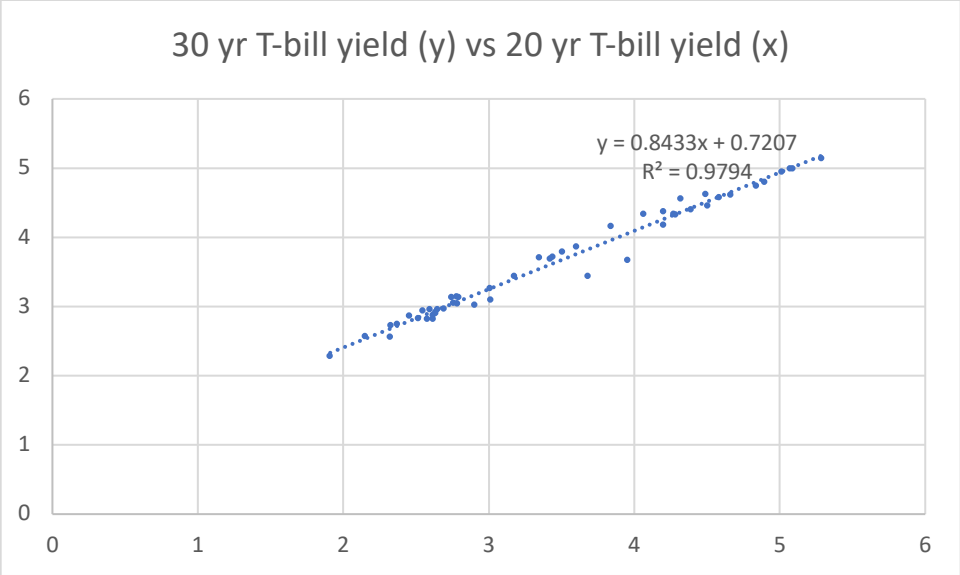
- The Fed's returns on the MBS portfolio that it is attempting to unwind are running below its expected thresholds, resulting in the difference in monies not being re-invested as intended (see https://www.cnbc.com/2018/07/05/fed-balance-sheet-runoff-hits-another-snag.html). (July 5, 2018)









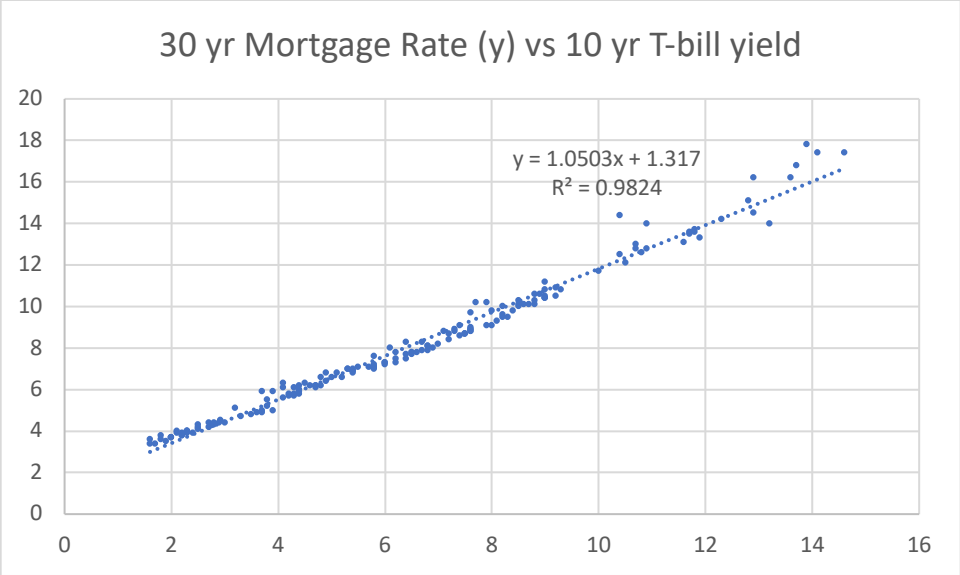


30-year Mortgage Rate

Analysis

Driven by the rising bond yields, we expect the 30-year mortgage rate to continue to increase beyond 4.7% by mid-2021 and thereafter, paralleling 10-year T-bill yields. The Federal Reserve recently has been reducing its $4.5 trillion asset portfolio, and, while mortgage rates are expected to increase as a result of this portfolio reduction (and interest rates are targeted to increase over the next several years based on targets issued by the Federal Reserve), Capitalytics' analysis of the market does not currently indicate significant movement outside of the 4.6%-4.8% range for the foreseeable period (through 2023).

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 surged 10 basis points to 4.88 percent from 4.78 percent … The average 15-year fixed rate and the average 5/1 adjustable-rate mortgage each climbed 7 basis points to 4.28 percent and 4.27 percent, respectively." (See https://www.bankrate.com/mortgages/analysis/; Sept 20, 2018)
- Mortgage rates are continuing to rise, with 5% easily within striking distance for conforming residential loans, and a return to the 6%-7% rates of the 2007-era appearing very possible. (See https://seekingalpha.com/article/4207272-mortgage-rates-head-6-percent-10-year-yield-4-percent-yield-curve-fails-invert-fed-keeps; Sept 20, 2018)

Moody's AAA & BAA Rates

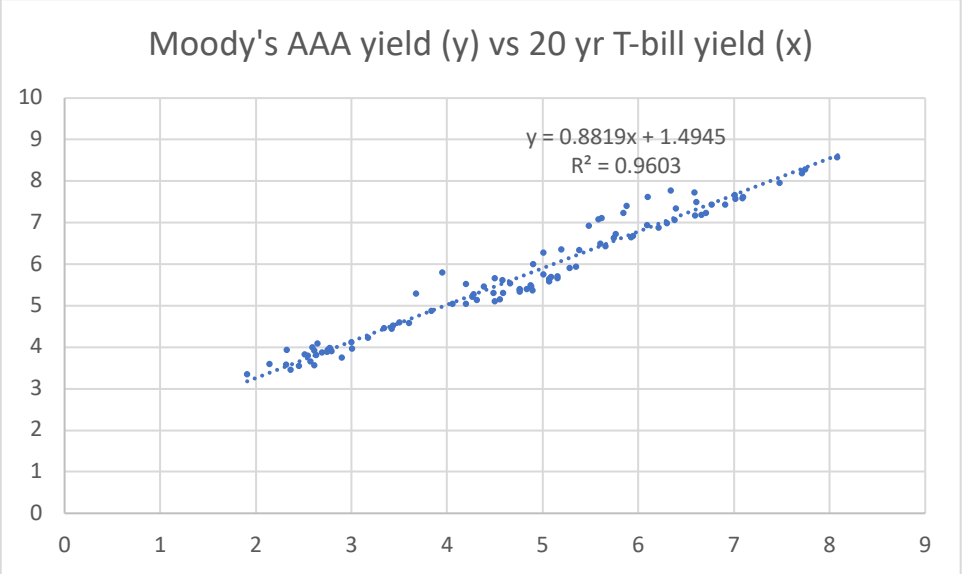
Analysis

Moody's AAA bond rates tend to track in conjunction with mid-duration T-bill yields (i.e., 10- and 20-year maturities). Given our analysis, we see AAA rates – currently at around 3.95% -- gradually peaking at almost 4.0% by YE2018 and then dropping back to between 3.90% and 3.95% through 2022.

Moody's BAA rates tend to be higher, and more volatile, than AAA rates. They reported at 4.27% as of YE 2017, but then spiked unexpectedly in 2Q2018 at about 4.78% and are projected to remain between 4.66% and 4.75% through 2022.

The latest published quarterly rates for Moody's AAA bonds and Moody's BAA bonds are 3.952% and 4.779%, resulting in a current "quality spread" of 0.827%. This spread should drop to 0.764% by YE2018, and then drop to around 0.74% through mid-2021, before it rises to 0.77% (first) in 3Q2022 and (again) in 2Q2023.

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



Other Commentary

- https://www.forecasts.org/aaabonds.htm forecasts Moody's AAA bonds peaking at 3.92% in September 2018, and then retreating to 3.77% by February 2019. (Sept. 26, 2018)

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. The yield spiked to 4.3% during 2Q2018, and Capitalytics generally sees these instruments as stagnating at between 4.3% & 4.4% for the foreseeable future (through mid-2023).

Other Commentary

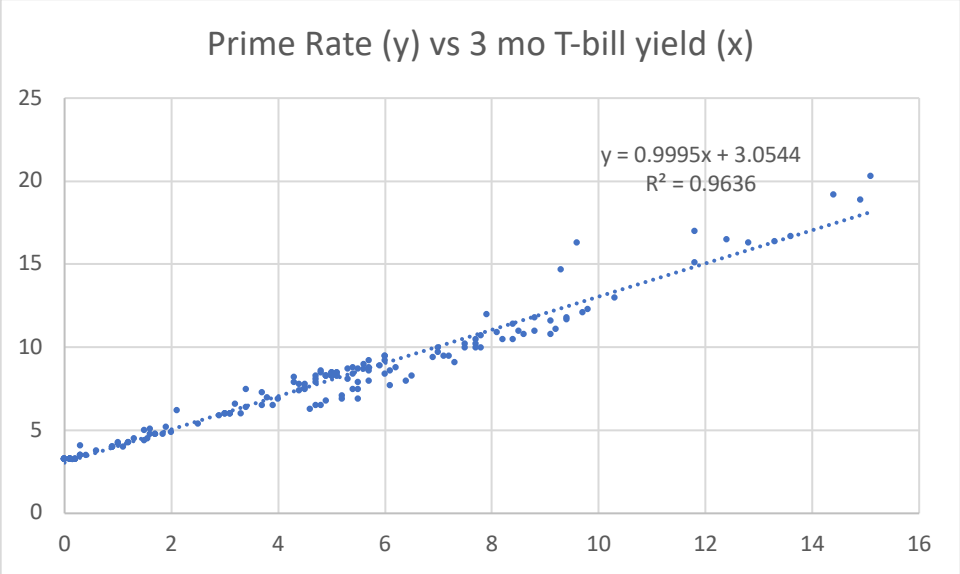
- Year over year, the amount of private corporate debt has dramatically increased by over 40%, primarily due to investment-grade corporate debt. Further, the composition of the investment-grade corporate bond market has shifted towards BBB corporate bonds, due to the availability of inexpensive money in the market and the ease of issuing long-term notes. (See https://www.schwab.com/resource-center/insights/content/corporate-bond-bubble-risks-are-brewing-but-market-has-near-term-positives, Aug 28, 2018; and https://seekingalpha.com/news/3343011-bbb-rated-corporate-bonds-outstanding-quadrupled-last-decade, Apr 2, 2018)

Prime Rate

Analysis

The Prime Rate is historically very tightly coupled to very short-term Treasury Bills (specifically, 3-month yields). The Prime Rate stagnated at 3.3% from 2009 through 2015. Since that time, both the Prime Rate and the short-term T-Bills have consistently tracked very closely to one another. Capitalytics' analysis shows the Prime Rate rising to 5% before YE 2018, reaching 5.75% in mid-2021, and then peaking at around 5.8% in mid-2022. In fact, one of Capitalytics' individual forecasts shows a possibility of the Prime Rate crossing above 6% in 2Q2022. Along with this expectation, we still expect continued political pressure(whether effective or otherwise) to be exerted to quell increasing interest rates prior to the next election cycle.

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



Other Commentary

- Per https://www.cnbc.com/2018/09/25/fed-expected-to-raise-interest-rates-and-signal-more-hikes-are-coming.html, "The Fed is expected to sound more confident about the economy, raising its forecast for growth and removing language form its statement that described its policy as easy." (Sept 25, 2018)
- Trump has recently aimed his ire at the Federal Reserve, stating that the Fed's expected interest rate hikes are hurting the economy; he will "… have the opportunity to fashion the central bank in the image he would like as he has four vacancies to fill on the board of governors" per https://www.cnbc.com/2018/07/20/trump-poised-to-take-control-of-the-federal-reserve.html (Jul 20, 2018)

US Average Retail Gasoline Price

Analysis

Capitalytics is expecting a decrease of about 10% Y/Y (down to as low as $2.70/gal) until the summer season of 2019, at which point retail prices will jump back to current day levels (about $2.90/gal). The summer increases are due to increased demand as the US public typically drives several hundred additional miles during the summer months for vacations. This position is always subject to the potential impact of weather, OPEC's agenda, geopolitical tensions, and other expected factors.

It should be noted that, if the current White House administration continues with its current direction potentially imposing sanctions on Iran, as well as withdrawing from the Iran Nuclear Deal, crude exports from the region will likely negatively impact the US fuel supply, inflating the risk of rising oil prices (for both retail gasoline and heating oil).

Other Commentary

- AAA's public statement have positioned "Cheaper-to-produce gasoline and relatively stable crude oil prices in August, combined with an anticipated drop in consumer gasoline demand post-Labor Day, means consumers will see savings when they fill-up at the pump this fall, …" (https://newsroom.aaa.com/2018/08/fall-2018-gas-price-forecast/; Aug 29, 2018)

Primary Credit Rate

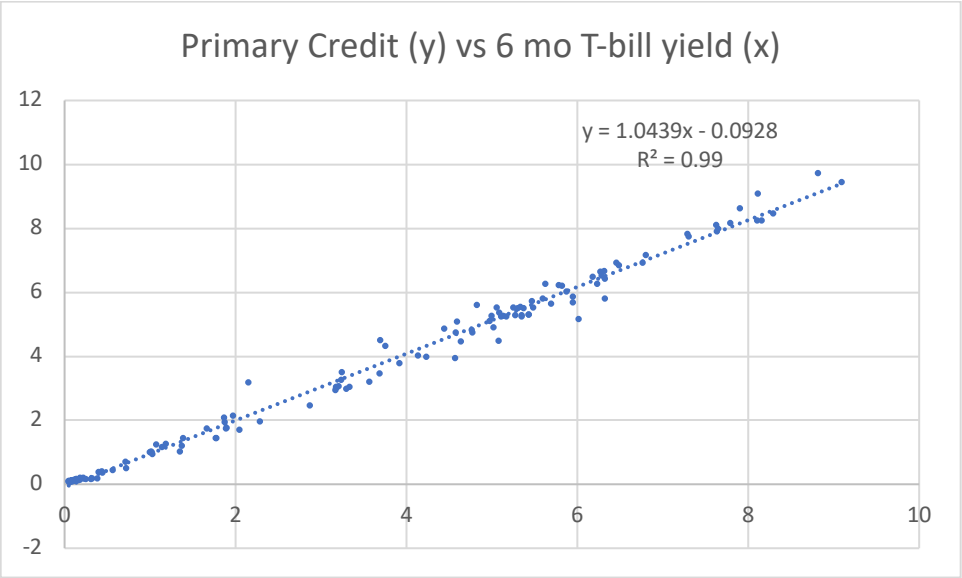
Analysis

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.

While our computational analysis dictates that (a) the Primary Credit Rate is closely related to the 6-month T-bill yield; and (b) the Primary Credit Rate will rise from 1.7% to 2.8% by mid-2020, and then fluctuate between 2.6% and 2.8% for the next two years, we are cautious about the impact of the exact composition of Board of Governors of the Federal Reserve. Capitalytics does believe that the Rate will rise significantly over the next several years, but again feels that political influences, including the changes in the composition of the Board of Governors, will affect whether rates will continue to rise at this speed. The White House has already nominated

Richard Clarida, Michelle Bowman, Marvin Goodfriend, and Nellie Liang to ascend to the Federal Reserve Board; with two candidates already confirmed, and two more who are generally viewed as conservative and well-vetted, many of the concerns expressed by some members of Congress are disappearing.

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



Other Commentary

- The Fed' is expected to approve another 0.25%-0.5% increase in the overnight borrowing rate (see https://www.cnbc.com/2018/09/24/a-handful-of-traders-actually-think-the-fed-could-hike-a-half-point-this-week.html). (Sept 24, 2018)
- Trump has recently aimed his ire at the Federal Reserve, stating that the Fed's expected interest rate hikes are hurting the economy; he will "… have the opportunity to fashion the central bank in the image he would like as he has four vacancies to fill on the board of governors" per https://www.cnbc.com/2018/07/20/trump-poised-to-take-control-of-the-federal-reserve.html (Jul 20, 2018)

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

Analysis

Given the business- and investor-friendly administration that is currently installed in the United States, we expect continued moderate growth of the Dow-Jones and S&P500 indexes through 2018, with some slowing 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 30,000 within the next 5 years. Our analysis shows growth stagnating at 29,300 in two years' time. We do still forecast the continued growth of the S&P500, and it growing by 40-60 points per quarter to over 3,500 by YE2022. If the Republican party does not retain control of the White House, and even if they install a different specific leader, we expect that growth will be dampened to some degree[4].

House and Commercial Real Estate Price Indexes

Analysis

National home and commercial real estate price indexes are seen to be closely connected at this time, but the effects of the 2007-2009 housing crisis prevent us from statistically tying the two together. Over the past year, both residential and commercial real estate have seen dramatic increases in pricing across the US, with both indexes growing sharply over the past 6 to 9 months.

We expect both commercial and residential real estate prices (and these indexes) to push their bounds consistently over the next several years, limited primarily by inventory and key lending rates. Our analyses show that, if not constrained by recessionary forces that we have previously alluded to, both the residential home price index and commercial real estate index will consistently increase at between 3.25%-3.75% per year, resulting in a 20% growth rate over the next five years.

Commercial real estate needs will be driven by low unemployment, industry growth, real estate availability, and market strength. Unemployment and market strength are projected to continue through 2019, after which point they will be subject to the impact of the US election cycle. Financial markets will be affected by the policies of the Federal Reserve and the FOMC, though it appears that the current nationalistic tone in the US will not become pervasive within the Fed' (as some have feared). New real estate development is still concentrated in the current business centers around the US (see our previous comments about development concentrations in New York, Washington, San Francisco, Dallas, and Seattle). As a result, while a national view is one of strong growth, that growth will be localized and focused around current population/talent centers.

Along the lines of those conclusions, residential real estate is becoming an opportunistic game in which bi-modal distributions are painting an increasingly worrisome and deceptive picture in many cities. While average housing prices and numbers of units on the market are approaching or surpassing pre-2007 levels in many areas, a disproportionate percentage of these (appreciation) dollars and homes are at overly affluent levels. The past several years of "home flipping" hobbyists have turned the population of "starter homes" in many cities into high-priced

[4] Between 2009 and 2015, Q/Q growth of the Dow-Jones (quarter end) index ranged between -15% and 12%, with an average of 3% growth. For the same period, growth of the S&P500 was between -18% and 16%, with an average of 2.8% growth.

"retreats" or "villas" that can only be afforded by a more elite clientele … and those homeowners, in turn, also want to resell their investments for a profit in a few years. Experts are generally stating that there are no market forces on the horizon to compel re-adjustment of prices in these localized areas, and it is unclear how the national effects of inflation will play out in these situations (or in areas where these phenomena are not playing out).

Other Commentary

- Business Insider reports that "Only 20% of the 1.2 million homes on the market are entry-level, … compared to 51% of for-sale homes priced in the most expensive tier … mini-housing bubbles are forming in cities all over the US" (see http://www.businessinsider.com/us-housing-markets-are-overvalued-2018-5). (May 9, 2018)

Market Volatility Index

Analysis

Q1 of 2018 was an unexpected period of increased churn in the market. Based on its influence on our analysis, Capitalytics is calling for the Market Volatility Index to generally remain steady over the next five years: starting at 14.0 and gradually dropping by as much as 5% before mid-2023. 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 22.5 was recorded in Q4 of 2016.

Other Commentary

- Robert Shiller is quoted as saying that "Investors are no longer skeptical enough about corporate earnings …" and that – at the same time -- "… the market could still go up for years …" (see https://www.cnbc.com/2018/09/25/nobel-winner-robert-shiller-says-this-is-a-risky-time-in-the-market.html). (Sept 25, 2018)

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[5]
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).

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

Mortgage rate	Quarterly average of weekly series for the interest rate of a conventional, conforming, 30-year fixed-rate 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[6].

[6] 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) 2Q2018.

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) 2Q2018.

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.

I. 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[7] "forecast" package[8]; specifically, the "ets" function (see p.39 of https://cran.r-project.org/web/packages/forecast/forecast.pdf)[9] 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)[10], and the determined parameters. While fitting forecasts to previous values,

[7] As of this writing, v.3.5.0 of the "R" language is available at https://cran.r-project.org/ .
[8] As of this writing, v.8.4 of the forecast package is available at https://CRAN.R-project.org/package=forecast .
[9] 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.
[10] 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

- "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)[11].

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:

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.

[11] At the risk of stating the obvious, it bears noting that a lower value for the "score" indicates better accuracy of an algorithm.

- the slope of the "best fitting" line (based on minimizing the total absolute error) using the immediately preceding 2 years of values[12];
- the same slope using the immediately preceding 4 years of values; and,
- 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[13].

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 quantified "goodness of fit" coefficient (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

[12] 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.
[13] See the SP500 metric's analysis.

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.

II. 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	Seasonal: A	Seasonal: 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
BBB Corporate Yield	Commercial Real Estate Price Index	-0.725422
BBB Corporate Yield	Dow Jones Total Stock Market Index	-0.820548
BBB Corporate Yield	3-month Treasury yield	0.739841
BBB Corporate Yield	House Price Index	-0.747467
BBB Corporate Yield	Prime Rate	0.716991
BBB Corporate Yield	US Average Retail Gasoline Price	0.623021
BBB Corporate Yield	10-year Treasury yield	0.903101
BBB Corporate Yield	20-year Treasury yield	-0.832639
BBB Corporate Yield	Mortgage Rate	0.92341
BBB Corporate Yield	30-year Treasury yield	-0.687709
BBB Corporate Yield	3-year Treasury yield	-0.639719
BBB Corporate Yield	5-year Treasury yield	0.855189
BBB Corporate Yield	7-year Treasury yield	-0.727635
Commercial Real Estate Price Index	6-month Treasury yield	0.755979
Commercial Real Estate Price Index	US Average Retail Gasoline Price	-0.711095
Commercial Real Estate Price Index	10-year Treasury yield	-0.806561
Commercial Real Estate Price Index	1-year Treasury yield	0.766674
Commercial Real Estate Price Index	20-year Treasury yield	0.873451
Commercial Real Estate Price Index	3-year Treasury yield	0.833706
Commercial Real Estate Price Index	5-year Treasury yield	-0.737375
Commercial Real Estate Price Index	7-year Treasury yield	0.890853
Primary Credit	Commercial Real Estate Price Index	0.744296
Primary Credit	Dow Jones Total Stock Market Index	0.681105
Primary Credit	**1-month Treasury yield**	**0.993376**
Primary Credit	**6-month Treasury yield**	**0.994092**
Primary Credit	Moody's AAA Rate	0.820146

Primary Credit	Moody's BAA Rate	0.749069
Primary Credit	House Price Index	0.664384
Primary Credit	US Average Retail Gasoline Price	-0.637464
Primary Credit	10-year Treasury yield	-0.703493
Primary Credit	**1-year Treasury yield**	**0.987561**
Primary Credit	20-year Treasury yield	0.813925
Primary Credit	Mortgage Rate	-0.671176
Primary Credit	30-year Treasury yield	0.642021
Primary Credit	**3-year Treasury yield**	**0.956758**
Primary Credit	5-year Treasury yield	-0.697128
Primary Credit	7-year Treasury yield	0.900576
Dow Jones Total Stock Market Index	Commercial Real Estate Price Index	0.896542
Dow Jones Total Stock Market Index	6-month Treasury yield	0.690652
Dow Jones Total Stock Market Index	House Price Index	0.823783
Dow Jones Total Stock Market Index	10-year Treasury yield	-0.801496
Dow Jones Total Stock Market Index	1-year Treasury yield	0.703623
Dow Jones Total Stock Market Index	20-year Treasury yield	0.813383
Dow Jones Total Stock Market Index	30-year Treasury yield	0.86659
Dow Jones Total Stock Market Index	3-year Treasury yield	0.773957
Dow Jones Total Stock Market Index	5-year Treasury yield	-0.710831
Dow Jones Total Stock Market Index	7-year Treasury yield	0.852785
1-month Treasury yield	**6-month Treasury yield**	**0.995768**
1-month Treasury yield	**1-year Treasury yield**	**0.990164**
1-month Treasury yield	3-year Treasury yield	0.942275
1-month Treasury yield	5-year Treasury yield	-0.617901
1-month Treasury yield	7-year Treasury yield	0.817613
3-month Treasury yield	6-month Treasury yield	-0.628428
3-month Treasury yield	1-year Treasury yield	-0.64847
3-month Treasury yield	3-year Treasury yield	-0.702314
3-month Treasury yield	5-year Treasury yield	0.940199
6-month Treasury yield	**1-year Treasury yield**	**0.998138**
6-month Treasury yield	**3-year Treasury yield**	**0.975253**
Moody's AAA Rate	BBB Corporate Yield	-0.780654
Moody's AAA Rate	Commercial Real Estate Price Index	0.932987

Moody's AAA Rate	Dow Jones Total Stock Market Index	0.909142
Moody's AAA Rate	3-month Treasury yield	-0.689875
Moody's AAA Rate	6-month Treasury yield	0.83493
Moody's AAA Rate	**Moody's BAA Rate**	**0.971495**
Moody's AAA Rate	House Price Index	0.866982
Moody's AAA Rate	Prime Rate	-0.651397
Moody's AAA Rate	US Average Retail Gasoline Price	-0.779943
Moody's AAA Rate	10-year Treasury yield	-0.874297
Moody's AAA Rate	1-year Treasury yield	0.850493
Moody's AAA Rate	**20-year Treasury yield**	**0.979952**
Moody's AAA Rate	Mortgage Rate	-0.856857
Moody's AAA Rate	30-year Treasury yield	0.936886
Moody's AAA Rate	3-year Treasury yield	0.913215
Moody's AAA Rate	5-year Treasury yield	-0.825996
Moody's AAA Rate	**7-year Treasury yield**	**0.967299**
Moody's BAA Rate	BBB Corporate Yield	-0.75376
Moody's BAA Rate	Commercial Real Estate Price Index	0.903663
Moody's BAA Rate	Dow Jones Total Stock Market Index	0.915932
Moody's BAA Rate	3-month Treasury yield	-0.616123
Moody's BAA Rate	6-month Treasury yield	0.761697
Moody's BAA Rate	House Price Index	0.842668
Moody's BAA Rate	US Average Retail Gasoline Price	-0.723116
Moody's BAA Rate	10-year Treasury yield	-0.82817
Moody's BAA Rate	1-year Treasury yield	0.777512
Moody's BAA Rate	20-year Treasury yield	0.910055
Moody's BAA Rate	Mortgage Rate	-0.809859
Moody's BAA Rate	30-year Treasury yield	0.716711
Moody's BAA Rate	3-year Treasury yield	0.843355
Moody's BAA Rate	5-year Treasury yield	-0.765607
Moody's BAA Rate	7-year Treasury yield	0.906292
House Price Index	Commercial Real Estate Price Index	0.942815
House Price Index	6-month Treasury yield	0.671974
House Price Index	US Average Retail Gasoline Price	-0.617974
House Price Index	10-year Treasury yield	-0.786474
House Price Index	1-year Treasury yield	0.683809
House Price Index	20-year Treasury yield	0.820123
House Price Index	3-year Treasury yield	0.751553

House Price Index	5-year Treasury yield	-0.723695
House Price Index	7-year Treasury yield	0.812702
Prime Rate	**3-month Treasury yield**	**0.991849**
Prime Rate	US Average Retail Gasoline Price	0.682352
Prime Rate	10-year Treasury yield	0.847466
Prime Rate	1-year Treasury yield	-0.615709
Prime Rate	20-year Treasury yield	-0.783899
Prime Rate	3-year Treasury yield	-0.672332
Prime Rate	5-year Treasury yield	0.911851
Prime Rate	7-year Treasury yield	-0.697677
Real disposable income growth	Nominal disposable income growth	0.916244
Real GDP growth	Nominal GDP growth	0.934402
US Average Retail Gasoline Price	3-month Treasury yield	0.697366
US Average Retail Gasoline Price	6-month Treasury yield	-0.661453
US Average Retail Gasoline Price	10-year Treasury yield	0.766616
US Average Retail Gasoline Price	1-year Treasury yield	-0.684449
US Average Retail Gasoline Price	20-year Treasury yield	-0.762602
US Average Retail Gasoline Price	3-year Treasury yield	-0.750406
US Average Retail Gasoline Price	5-year Treasury yield	0.757235
US Average Retail Gasoline Price	7-year Treasury yield	-0.784238
S&P 500 Stock Price Index	BBB Corporate Yield	0.76337
S&P 500 Stock Price Index	Commercial Real Estate Price Index	-0.746533
S&P 500 Stock Price Index	Dow Jones Total Stock Market Index	-0.930171
S&P 500 Stock Price Index	Moody's AAA Rate	-0.738985
S&P 500 Stock Price Index	Moody's BAA Rate	-0.755401
S&P 500 Stock Price Index	House Price Index	-0.839631
S&P 500 Stock Price Index	Unemployment rate	0.730017
S&P 500 Stock Price Index	Market Volatiity Index	0.649154
S&P 500 Stock Price Index	10-year Treasury yield	0.616361
S&P 500 Stock Price Index	20-year Treasury yield	-0.699121

S&P 500 Stock Price Index	Mortgage Rate	0.676023
S&P 500 Stock Price Index	30-year Treasury yield	-0.703817
10-year Treasury yield	1-month Treasury yield	-0.641215
10-year Treasury yield	3-month Treasury yield	0.879822
10-year Treasury yield	6-month Treasury yield	-0.725225
10-year Treasury yield	1-year Treasury yield	-0.741807
10-year Treasury yield	3-year Treasury yield	-0.807401
10-year Treasury yield	**5-year Treasury yield**	**0.983156**
10-year Treasury yield	7-year Treasury yield	-0.861572
20-year Treasury yield	1-month Treasury yield	0.611081
20-year Treasury yield	3-month Treasury yield	-0.796347
20-year Treasury yield	6-month Treasury yield	0.835769
20-year Treasury yield	10-year Treasury yield	-0.925414
20-year Treasury yield	1-year Treasury yield	0.85709
20-year Treasury yield	3-year Treasury yield	0.914265
20-year Treasury yield	5-year Treasury yield	-0.883358
20-year Treasury yield	**7-year Treasury yield**	**0.972126**
Mortgage Rate	Commercial Real Estate Price Index	-0.783083
Mortgage Rate	Dow Jones Total Stock Market Index	-0.794033
Mortgage Rate	1-month Treasury yield	-0.617691
Mortgage Rate	3-month Treasury yield	0.889689
Mortgage Rate	6-month Treasury yield	-0.692957
Mortgage Rate	House Price Index	-0.773517
Mortgage Rate	Prime Rate	0.862079
Mortgage Rate	US Average Retail Gasoline Price	0.773172
Mortgage Rate	**10-year Treasury yield**	**0.993399**
Mortgage Rate	1-year Treasury yield	-0.710408
Mortgage Rate	20-year Treasury yield	-0.924863
Mortgage Rate	30-year Treasury yield	-0.605835
Mortgage Rate	3-year Treasury yield	-0.77971
Mortgage Rate	**5-year Treasury yield**	**0.97979**
Mortgage Rate	7-year Treasury yield	-0.839108
30-year Treasury yield	1-month Treasury yield	0.630116
30-year Treasury yield	6-month Treasury yield	0.624927
30-year Treasury yield	1-year Treasury yield	0.623538
30-year Treasury yield	**20-year Treasury yield**	**0.989656**
30-year Treasury yield	3-year Treasury yield	0.689391

30-year Treasury yield	7-year Treasury yield	0.867671
3-year Treasury yield	**1-year Treasury yield**	**0.984802**
5-year Treasury yield	6-month Treasury yield	-0.724393
5-year Treasury yield	1-year Treasury yield	-0.742758
5-year Treasury yield	3-year Treasury yield	-0.800991
7-year Treasury yield	3-month Treasury yield	-0.727676
7-year Treasury yield	6-month Treasury yield	0.921294
7-year Treasury yield	1-year Treasury yield	0.935801
7-year Treasury yield	**3-year Treasury yield**	**0.980112**
7-year Treasury yield	5-year Treasury yield	-0.837355

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