Macroeconomic Forecasts, 2Q2019

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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 following¹:

- 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. Regressions are performed per the procedure in Section III of Appendix B for all variables.
- 5. 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 macroeconomic variables using data up to, and including, that for 1Q2019. 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 macroeconomic 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, albeit slowing.

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 135 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 I 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

US GDP growth slowed dramatically to 0.75% in 1Q2019, and Capitalytics expects it to very slowly rebound, first to 1.5% through 2019 and thereafter. We anticipate real GDP growth to hit 2.25% by 3Q2021, and it will stabilize around 2.1% thereafter. This drop from 3% in 2018 is a result of the impending trade war that the White House's economic policy is pressing.

If the Fed' perceives inflation as having stabilized around its target of 2%, it is more likely to temper its deployment of rate increases. However, recent public confrontations between the White House and the Fed' is imposing pressure on the latter to lower rates. Capitalytics sees that inflation will stay below 1% until 2Q2020, and will only return to 1.25% by the end of 2022.

Disposable income unexpectedly dropped to 0.5% during 1Q2019, but it is projected to return to 2.4% by mid-2020, 2.75% by mid-2021, and 3% near the end of 2022.

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)
- ITR Economics anticipates a GDP growth rate of 2.7% by 2020. (see https://www.bizjournals.com/kansascity/news/2019/01/11/economist-expect-gdp-to-dramatically-slow-in-2019.html; Jan 11, 2019)

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 "*".

Unemployment Rate

Analysis

Unemployment shows no sign of breaking from its historic sub-4% low levels in the foreseeable future, likely staying below 4% through 2023. 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. A significant portion of the unemployed population has been out of work so long that they will never be able to recover to earn their previous income.

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

For the past several months, the US' yield rates have toyed with long-term rates dropping below short-term rates, i.e., a "yield curve inversion". Now, in mid-August 2019, it has occurred not once, but twice, providing a justification for concern of an impending recession. The concern is not uniformly held, however.

Capitalytics anticipates the 3-month Treasury yield to fairly steadily climb to 2.6% by the end of 2020. We expect that 5-year Treasury yield rates reach the same point by mid-2020, at which point we project the 10-year Treasury yield rates to rise to 2.75%. We also project rates to stabilize in 2021 & 2022. Because of these forecasts, we do think that recession is a realistic possibility.

Other Commentary

- "[Robert Shiller] chalks it up to analysts "data-mining" to find any indicator that holds up. While the yield curve has preceded each of the seven recessions since the 1950s, with only one false positive, it's a fairly small data set to be really conclusive." (<u>https://www.cnbc.com/2019/08/22/robert-shiller-says-recession-fears-may-make-it-a-reality.html</u>; Aug 22, 2019)
- "Fears of an economic slowdown ... [resurfaced] ... when the release of the Federal Reserve's July meeting minutes reiterated officials' belief that its July rate cut was just a

"mid-cycle adjustment." (see <u>https://www.cnbc.com/2019/08/21/us-bonds-fed-meeting-minutes-in-focus-ahead-of-g7-summit.html</u>; Aug 21, 2019)

• "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-idUSKCN10X1QV; Jan 3, 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". Even in our preceding reports, Capitalytics has discussed the possibility of a slowdown. At this point, though, we are now anticipating a short-term rise in rates from their current 4.3% rate by another 20 bps before withdrawing. (Our current models show rates dropping to 3.5% by 2023.)

However, we are concerned about the current White House administration's attempts to influence interest rates (which are closely tied to the mortgage rate), and the expectation that this influence will continue for the next 12-18 months. If successful, we would not be surprised if rates dip as low as 4% before the next election.

Analysis

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



Other Commentary

• "The average rate on a 30-year mortgage, after peaking at 4.87% in November, fell more than one percentage point to 3.75% in June. ... The S&P CoreLogic Case-Shiller National Home Price Index rose 3.4% in May from a year ago, down from 3.5% growth in the previous month. Home-price growth has declined on a year-to-year basis for 14

consecutive months. Double-digit price gains have vanished across the nation, after being the norm in many coastal cities just a couple of years ago." (see https://www.kiplinger.com/article/business/T019-C000-S003-housing-market-forecast-housing-starts-home-sales.html; Aug 1, 2019)

• "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 <u>https://www.bankrate.com/mortgages/analysis/;</u> Jan 3, 2019)

Moody's AAA & BAA Rates

Analysis

Moody's AAA bond rates tend to track in conjunction with mid-duration T-bill yields (i.e., 10and 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 (through 2022) at between 3.75% and 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 4.9% and 4.95% in the near term (through mid-2020), with rates gradually eroding over the next several years (to as low as 4.88%).

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



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.

Given the recent turn in returns, Capitalytics sees returns on BBB investments sinking to 2% before 2022.

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 <u>https://seekingalpha.com/article/4224172-outlook-investment-grade-corporate-bonds;</u> 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% through 2023, potentially even peaking momentarily around 5.6%.

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. For the foreseeable future, gasoline is expected to stay at around \$2.50/year, sporadically wandering by as much as 4% from this target.

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 Primary Credit rate is currently at 2.4%, and Capitalytics is projecting it to rise to 2.6% by year-end, and almost 3.0% by 2024. The accompanying chart serves to illustrate the relationship between the Primary Credit rate and the 6-month T-bill yield.



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 stabilize at around 30,000 within the next 18 months, and remain at that point. We also anticipate stagnation of the S&P500 starting in the very near-term.

House and Commercial Real Estate Price Indexes

New home-construction and home sales (both new- and existing-home sales) have dropped dramatically since the end of 2018. 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 0.4% 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 290 to 302 over the next 60 months.

Other Commentary

- The S&P CoreLogic Case-Shiller National Home Price Index rose 3.4% in May from a year ago, down from 3.5% growth in the previous month. Home-price growth has declined on a year-to-year basis for 14 consecutive months. Double-digit price gains have vanished across the nation, after being the norm in many coastal cities just a couple of years ago. (see https://www.kiplinger.com/article/business/T019-C000-S003-housing-market-forecast-housing-starts-home-sales.html; Aug 1, 2019)
- "The National Association of Realtors said on Tuesday existing home sales dropped 1.7% to a seasonally adjusted annual rate of 5.27 million units last month. The median existing house price increased 4.3% from a year ago to an all-time high of \$285,700 in June. ... 'Meager inventory levels, especially in the entry-level segment, and still-rising prices continue to limit the selection of homes available to more budget-conscious buyers,' said Matthew Speakman, an economist at Zillow." (see <u>https://www.reuters.com/article/us-usa-economy-housing/u-s-home-sales-tumble-asprices-race-to-record-high-idUSKCN1UI1T3</u>; Jul 23, 2019)

Market Volatility Index

Analysis

Capitalytics is calling for the Market Volatility Index to very gradually increase over the next five years: starting at 25 and rising to 27 over the next five years. 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)

Regression Analyses

Real & Nominal GDP Growth

Real GDP Growth Residuals: 10 Median 30 Min Max -3.2083 -0.9298 -0.1780 1.0248 2.8454 Coefficients: Estimate Std. Error t value Pr(>|t|)(Intercept) 1.2634786 0.8209085 1.539 0.132 0.238 sp500 0.0005281 0.0004408 1.198 Residual standard error: 1.56 on 38 degrees of freedom Multiple R-squared: 0.03639, Adjusted R-squared: 0.01103 F-statistic: 1.435 on 1 and 38 DF, p-value: 0.2383 _____ Nominal GDP Growth Residuals: Min 1Q Median 30 Max -4.0792 -0.5192 0.0866 0.5412 2.8292 Coefficients: Estimate Std. Error t value Pr(>|t|) (Intercept) -95.231251 29.779801 -3.198 0.003518 ** sp5000.0174030.0050513.4450.001879**moodys_baa-4.0039381.386797-2.8870.007562** unemployment_rate 7.600286 1.851324 4.105 0.000335 *** bbb5.8317241.2681994.1050.000335***y30mort-7.9882313.479844-2.2960.029695*comm_re_index0.1586140.0591892.6800.012397*y30tbill22.0011617.9185182.7780.009817**y20tbill-26.2093408.494054-3.0860.004653**y10tbill5.6380222.5969042.1710.000453** 5.638022 2.596894 2.171 0.038886 * y10tbill 27.858109 9.596181 2.903 0.007277 ** m6tbill 8.125089 3.779845 2.150 0.040708 * y3tbill yltbill -34.054642 11.427198 -2.980 0.006032 ** Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 Residual standard error: 1.456 on 27 degrees of freedom Multiple R-squared: 0.6498, Adjusted R-squared: 0.4942 F-statistic: 4.175 on 12 and 27 DF, p-value: 0.0009916

Real & Nominal Disposable Income Growth

Real Disposable Income Growth Residuals: Min 1Q Median 3Q Max -17.3012 -0.8911 0.0860 1.9041 9.3133 Coefficients: Estimate Std. Error t value Pr(>|t|) (Intercept) 3.3165 2.1045 1.576 0.123 unemployment_rate -0.1448 0.3014 -0.481 0.634 Residual standard error: 3.974 on 38 degrees of freedom Multiple R-squared: 0.006041, Adjusted R-squared: -0.02012 F-statistic: 0.231 on 1 and 38 DF, p-value: 0.6336 _____ Nominal Disposable Income Growth Residuals: 1Q Median 3Q Max Min -17.3580 -0.8717 -0.0681 1.4405 10.7905 Coefficients: Estimate Std. Error t value Pr(>|t|) (Intercept) 2.046 2.754 0.743 0.462 0.743 1.040 0.715 0.479 y10tbill Residual standard error: 4.11 on 38 degrees of freedom Multiple R-squared: 0.01326, Adjusted R-squared: -0.01271 F-statistic: 0.5105 on 1 and 38 DF, p-value: 0.4793 **CPI Inflation Rate** Residuals: 1Q Median 3Q Max Min -0.9849 -0.2388 0.0315 0.2714 0.7018 Coefficients: Estimate Std. Error t value Pr(>|t|) (Intercept) -0.11564 0.12441 -0.929 0.359 real_disposable_income_growth -1.26744 0.06219 -20.379 <2e-16 *** nominal_disposable_income_growth 1.22989 0.05991 20.529 <2e-16 *** ___ Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 Residual standard error: 0.4238 on 37 degrees of freedom Multiple R-squared: 0.9203, Adjusted R-squared: 0.916 F-statistic: 213.5 on 2 and 37 DF, p-value: < 2.2e-16

Unemployment Rate

Residuals: Min 10 Median 30 Max -0.130222 -0.065515 0.009653 0.040582 0.219789 Coefficients: Estimate Std. Error t value Pr(>|t|)1.642e+01 5.824e-01 28.190 < 2e-16 *** 1.203e+00 4.459e-01 2.698 0.012095 * 4.047e-01 8.738e-02 4.632 8.88e-05 *** (Intercept) cost of funds moodys baa nominal_gdp_growth 3.223e-02 9.535e-03 3.381 0.002295 ** bbb -4.176e-01 6.530e-02 -6.395 8.96e-07 *** dow jones total -1.098e-04 1.762e-05 -6.231 1.36e-06 *** national home price index -2.360e-02 5.224e-03 -4.518 0.000120 *** comm_re_index -2.168e-02 2.779e-03 -7.800 2.83e-08 *** -2.467e+00 5.097e-01 -4.840 5.12e-05 *** y30tbill 2.935e+00 5.126e-01 5.725 5.01e-06 *** y20tbill -8.346e-01 2.592e-01 -3.220 0.003432 ** m3tbill -2.274e+00 8.022e-01 -2.835 0.008758 ** -8.257e-01 2.255e-01 -3.662 0.001122 ** m6tbill v3tbill 2.736e+00 6.623e-01 4.131 0.000332 *** y1tbill ___ Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.09988 on 26 degrees of freedom Multiple R-squared: 0.9985, Adjusted R-squared: 0.9978 F-statistic: 1338 on 13 and 26 DF, p-value: < 2.2e-16

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

1-month Treasury Yield Residuals: Min 10 Median 30 Max -0.14759 -0.04582 -0.01179 0.05904 0.16417 Coefficients: Estimate Std. Error t value Pr(>|t|)(Intercept) 0.29796 0.09043 3.295 0.00222 ** moodys_baa -0.11922 0.03556 -3.353 0.00189 ** bbb 0.06944 0.02867 2.422 0.02058 * 1.05812 0.01749 60.496 < 2e-16 *** m3tbill ___ Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 Residual standard error: 0.07059 on 36 degrees of freedom Multiple R-squared: 0.9913, Adjusted R-squared: 0.9906 F-statistic: 1367 on 3 and 36 DF, p-value: < 2.2e-16

```
3-month Treasury Yield
Residuals:
Min 10 Median 30 Max
-0.10737 -0.03627 0.01314 0.03437 0.09232
Coefficients:
                     Estimate Std. Error t value Pr(>|t|)
(Intercept)2.0457390.8154992.5090.01797 *moodys_baa0.1755780.0463583.7870.00071 ***
unemployment_rate -0.137304 0.053920 -2.546 0.01645 *
                   -0.118374 0.037418 -3.164 0.00364 **
bbb
DDD-0.1183/40.03/418-3.1640.00364**comm_re_index-0.0057530.002359-2.4390.02108*y30tbill-0.7981940.306952-2.6000.01450*y20tbill0.8608120.3203882.6870.01182*m1tbill1.2827970.2534795.0612.14e-05***m6tbill-1.3239520.610557-2.1680.03847*y3tbill-0.3826140.139296-2.7470.01023*y1tbill1.2398510.4878112.5420.01664*
___
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
Residual standard error: 0.05978 on 29 degrees of freedom
Multiple R-squared: 0.9942, Adjusted R-squared: 0.9922
F-statistic: 496.9 on 10 and 29 DF, p-value: < 2.2e-16
 _____
6-month Treasury Yield
Residuals:
                   10 Median 30
       Min
                                                     Max
-0.171701 -0.051776 -0.007609 0.031666 0.192142
Coefficients:
                     Estimate Std. Error t value Pr(>|t|)
(Intercept) -2.532300 0.935004 -2.708 0.010509 *
moodys_baa -0.192620 0.055978 -3.441 0.001553 **
unemployment_rate 0.145433 0.058820 2.473 0.018577 *
               0.144250 0.039151 3.684 0.000792 ***
bbb
comm_re_index0.0093850.0028053.3450.002014**m3tbill0.9667200.03943624.514< 2e-16</td>***
___
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
Residual standard error: 0.09511 on 34 degrees of freedom
Multiple R-squared: 0.9869, Adjusted R-squared: 0.985
F-statistic: 513.1 on 5 and 34 DF, p-value: < 2.2e-16
```

1-year Treasury Yield Residuals: Min 1Q Median 3Q Max -0.182362 -0.045040 0.001532 0.040254 0.168914 Coefficients: Estimate Std. Error t value Pr(>|t|)(Intercept) -2.129e+00 8.525e-01 -2.498 0.018200 * moodys baa -1.725e-01 7.048e-02 -2.447 0.020482 * unemployment rate 2.244e-01 6.253e-02 3.589 0.001164 ** 3.793e-02 1.241e-02 3.057 0.004666 ** inflation rate 2.580e-01 4.627e-02 5.575 4.59e-06 *** bbb bbb2.380e-014.027e-023.3734.39e-064.44y30mort-2.417e-019.254e-02-2.6120.013932*dow_jones_total1.090e-042.633e-054.1410.000259***vix7.337e-032.913e-032.5190.017345*retail_gasoline-2.326e-014.821e-02-4.8253.82e-05*** m3tbill 9.185e-01 5.165e-02 17.783 < 2e-16 *** ____ Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 Residual standard error: 0.1003 on 30 degrees of freedom Multiple R-squared: 0.9875, Adjusted R-squared: 0.9838 F-statistic: 264.3 on 9 and 30 DF, p-value: < 2.2e-16 3-year Treasury Yield Residuals: Min 10 Median 30 Max -0.37827 -0.07950 0.01199 0.10243 0.22083 Coefficients: Estimate Std. Error t value Pr(>|t|)(Intercept) -5.799e+00 1.249e+00 -4.644 5.95e-05 *** unemployment_rate 3.234e-01 1.069e-01 3.025 0.004962 ** bbb 3.447e-01 6.631e-02 5.198 1.22e-05 *** y30mort -3.308e-01 1.298e-01 -2.549 0.015971 * dow jones total 2.059e-04 4.021e-05 5.120 1.52e-05 *** 1.182e-02 4.510e-03 2.620 0.013484 * vix retail_gasoline -3.058e-01 7.257e-02 -4.214 0.000201 *** y30tbill 3.431e-01 9.755e-02 3.517 0.001368 ** 4.083e-01 7.749e-02 5.270 9.91e-06 *** m3tbill Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 Residual standard error: 0.1551 on 31 degrees of freedom

Multiple R-squared: 0.9593, Adjusted R-squared: 0.9488 F-statistic: 91.3 on 8 and 31 DF, p-value: < 2.2e-16

```
5-year Treasury Yield
Residuals:
Min 1Q Median 3Q Max
-0.52615 -0.17013 0.00476 0.14058 0.54991
Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) -3.539410 0.787934 -4.492 7.75e-05 ***
sp5000.0019760.0003815.1879.83e-06***moodys_baa0.8658060.1061948.1531.65e-09***
comm_re_index -0.014405 0.003704 -3.889 0.000444 ***
m6tbill -1.735309 0.629821 -2.755 0.009355 **
y1tbill
            2.034003 0.636126 3.197 0.002994 **
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
Residual standard error: 0.2358 on 34 degrees of freedom
Multiple R-squared: 0.8677, Adjusted R-squared: 0.8483
F-statistic: 44.61 on 5 and 34 DF, p-value: 5.572e-14
_____
7-year Treasury Yield
Residuals:
    Min 1Q Median 3Q Max
-0.50439 -0.24485 -0.06816 0.25025 0.51673
Coefficients:
                 Estimate Std. Error t value Pr(>|t|)
(Intercept) -8.0464866 1.2659143 -6.356 2.63e-07 ***
sp500
                0.0026295 0.0003524 7.462 9.77e-09 ***
unemployment_rate 0.5544841 0.1018128 5.446 4.15e-06 ***
                0.5708323 0.0791189 7.215 2.02e-08 ***
bbb
retail_gasoline -0.2873142 0.1303716 -2.204 0.0342 *
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
Residual standard error: 0.3003 on 35 degrees of freedom
Multiple R-squared: 0.7562, Adjusted R-squared: 0.7284
```

F-statistic: 27.15 on 4 and 35 DF, p-value: 2.662e-10

```
10-year Treasury Yield
Residuals:
Min 1Q Median 3Q Max
-0.58057 -0.17297 0.04081 0.21212 0.56105
Coefficients:
                  Estimate Std. Error t value Pr(>|t|)
(Intercept) -4.843e+00 1.540e+00 -3.144 0.00345 **
unemployment rate 3.719e-01 1.615e-01 2.303 0.02754 *
dow_jones_total 1.486e-04 4.786e-05 3.106 0.00382 **
vix 2.117e-02 6.352e-03 3.333 0.00208 **
retail_gasoline -3.397e-01 1.349e-01 -2.519 0.01664 *
y30tbill 7.854e-01 1.503e-01 5.227 8.71e-06 ***
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
Residual standard error: 0.3013 on 34 degrees of freedom
Multiple R-squared: 0.8024, Adjusted R-squared: 0.7734
F-statistic: 27.62 on 5 and 34 DF, p-value: 4.574e-11
_____
20-year Treasury Yield
Residuals:
    Min 1Q Median 3Q Max
-0.63888 -0.20379 0.00939 0.23794 0.50475
Coefficients:
                   Estimate Std. Error t value Pr(>|t|)
(Intercept) -7.5411070 1.3255771 -5.689 2.18e-06 ***
sp500
                  0.0023281 0.0003689 6.311 3.41e-07 ***
nominal gdp growth -0.0583635 0.0264239 -2.209 0.0340 *
unemployment_rate 0.6696813 0.0931591 7.189 2.58e-08 ***
bbb 0.5420552 0.0728338 7.442 1.24e-08 ***
                  -0.0124666 0.0061315 -2.033 0.0499 *
vix
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
Residual standard error: 0.2949 on 34 degrees of freedom
Multiple R-squared: 0.8264, Adjusted R-squared: 0.8008
F-statistic: 32.36 on 5 and 34 DF, p-value: 5.311e-12
```

30-year Treasury Yield Residuals: Min 1Q Median 3Q Max -0.40378 -0.11233 -0.02131 0.11254 0.38748 Coefficients: Estimate Std. Error t value Pr(>|t|) (Intercept) 0.754963 0.195985 3.852 0.000494 *** unemployment rate 0.142749 0.050912 2.804 0.008285 ** -0.009871 0.004332 -2.279 0.029094 * vix y10tbill 1.059837 0.253262 4.185 0.000190 *** -0.929788 0.317522 -2.928 0.006044 ** y5tbill 0.591445 0.144820 4.084 0.000254 *** y3tbill Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.2105 on 34 degrees of freedom Multiple R-squared: 0.8973, Adjusted R-squared: 0.8822 F-statistic: 59.43 on 5 and 34 DF, p-value: 7.869e-16

30-year Mortgage Rate

Residuals: Min 10 Median 30 Max -0.42342 -0.08534 0.02206 0.07386 0.34108

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)			
(Intercept)	0.9971492	0.6549257	1.523	0.13686			
sp500	0.0014876	0.0002957	5.030	1.46e-05	* * *		
moodys baa	0.7186693	0.0965460	7.444	1.03e-08	* * *		
comm re index	-0.0158969	0.0026652	-5.965	8.59e-07	* * *		
y3tbill	0.2463707	0.0893135	2.758	0.00917	**		
Signif. codes:	0 '***' (0.001 '**' 0	0.01 '*'	0.05 '.'	0.1	. ,	' 1

Residual standard error: 0.1789 on 35 degrees of freedom Multiple R-squared: 0.8746, Adjusted R-squared: 0.8603 F-statistic: 61.05 on 4 and 35 DF, p-value: 2.691e-15

Moody's AAA & BAA Rates

Moody's AAA Residuals: 1Q Median 3Q Min Max -0.53782 -0.17073 0.00506 0.17422 0.64479 Coefficients: Estimate Std. Error t value Pr(>|t|)(Intercept) -1.7110503 1.1448992 -1.494 0.14376 0.0009510 0.0003048 3.120 0.00356 ** sp500 unemployment_rate 0.3096160 0.0778024 3.980 0.00032 *** bbb 0.4605235 0.0639460 7.202 1.79e-08 *** ___ Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 Residual standard error: 0.2716 on 36 degrees of freedom Multiple R-squared: 0.7981, Adjusted R-squared: 0.7813 F-statistic: 47.44 on 3 and 36 DF, p-value: 1.363e-12 Moody's BAA Residuals: Min 10 Median 3Q Max -0.44081 -0.08606 0.00531 0.08732 0.28156 Coefficients: Estimate Std. Error t value Pr(>|t|)8.4755542 0.8159351 10.388 6.19e-12 *** (Intercept) sp500 -0.0024791 0.0002369 -10.466 5.12e-12 *** unemployment_rate -0.4906462 0.0614305 -7.987 3.26e-09 *** y30mort 0.8083009 0.1033913 7.818 5.21e-09 *** y30tbill 0.2847005 0.0949005 3.000 0.00511 ** mltbill -0.9394524 0.4098704 -2.292 0.02842 * m3tbill 1.1839698 0.4100982 2.887 0.00681 ** ___ Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 Residual standard error: 0.1733 on 33 degrees of freedom Multiple R-squared: 0.9554, Adjusted R-squared: 0.9473 F-statistic: 117.8 on 6 and 33 DF, p-value: < 2.2e-16

BBB Corporate Yield

Residuals:					
Min 1Q	Median	3Q	Max		
-0.42307 -0.09225 -	-0.01762 0.	10023 0.49	9392		
Coefficients:					
	Estimate	Std. Error	t value	Pr(> t)	
(Intercept)	17.3022788	3.1769337	5.446	8.20e-06	* * *
sp500	-0.0019031	0.0004899	-3.884	0.000572	* * *
moodys_baa	0.8900436	0.1317414	6.756	2.46e-07	***
nominal gdp growth	0.0770904	0.0198061	3.892	0.000561	* * *
unemployment_rate	-1.0884629	0.2027164	-5.369	1.01e-05	***
comm re index	-0.0296249	0.0075155	-3.942	0.000491	* * *
y30tbill	-4.9830346	0.9320684	-5.346	1.08e-05	* * *
y20tbill	5.4957465	0.9770216	5.625	5.04e-06	* * *
m3tbill	-0.8930252	0.4296387	-2.079	0.046939	*
m6tbill	-2.9308377	1.2056895	-2.431	0.021721	*
y3tbill	-1.7193972	0.4396114	-3.911	0.000533	* * *
yltbill	4.9700308	1.1499484	4.322	0.000176	* * *
Signif. codes: 0	'***' 0.001	'**' 0.01	'*' 0.05	·. · 0.1 ·	'' 1
-					

Residual standard error: 0.2035 on 28 degrees of freedom Multiple R-squared: 0.9662, Adjusted R-squared: 0.9529 F-statistic: 72.79 on 11 and 28 DF, p-value: < 2.2e-16

Prime Rate

Residuals: Min 1Q Median 3Q Max -0.159078 -0.023942 0.006525 0.035056 0.186610 Coefficients: Estimate Std. Error t value Pr(>|t|) (Intercept) 3.37329 0.12009 28.091 < 2e-16 *** moodys_baa 0.10978 0.04132 2.657 0.01206 * bbb -0.07691 0.03216 -2.391 0.02264 * y30tbill -0.23587 0.07818 -3.017 0.00489 ** m1tbill 1.01695 0.06467 15.725 < 2e-16 *** y7tbill 0.41560 0.14075 2.953 0.00576 ** y3tbill -0.45108 0.14211 -3.174 0.00325 ** ---Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.06759 on 33 degrees of freedom Multiple R-squared: 0.9895, Adjusted R-squared: 0.9876 F-statistic: 518 on 6 and 33 DF, p-value: < 2.2e-16

US Average Retail Gasoline Price

Residuals: 10 Median 3Q Max Min -0.48257 -0.16349 0.00911 0.13009 0.51751 Coefficients: Estimate Std. Error t value Pr(>|t|)(Intercept) 8.782e+00 7.811e-01 11.243 7.96e-13 *** real disposable income growth -8.947e-02 3.898e-02 -2.295 0.028205 * nominal_disposable_income_growth 8.914e-02 3.767e-02 2.366 0.024012 * 1.687e-04 2.768e-05 6.092 7.36e-07 *** dow jones total -5.534e-02 7.861e-03 -7.040 4.69e-08 *** 2.793e+00 6.272e-01 4.453 9.14e-05 *** national home price index m6tbill -2.554e+00 6.456e-01 -3.956 0.000381 *** y1tbill ___ Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.2374 on 33 degrees of freedom Multiple R-squared: 0.833, Adjusted R-squared: 0.8026 F-statistic: 27.43 on 6 and 33 DF, p-value: 1.719e-11

Primary Credit Rate

Residuals: Min 10 Median 3Q Max -0.115392 -0.034589 -0.007339 0.024805 0.135636 Coefficients: Estimate Std. Error t value Pr(>|t|)(Intercept) -0.1384806 0.1917129 -0.722 0.475029 sp500 -0.0003720 0.0001381 -2.694 0.010876 * sp500 moodys_baa -0.1783121 0.0535823 -3.328 0.002112 ** y30mort 0.1756086 0.0532918 3.295 0.002306 ** comm re index 0.0050949 0.0012660 4.024 0.000302 *** m3tbill 0.9413265 0.0273737 34.388 < 2e-16 *** ___ Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.06128 on 34 degrees of freedom Multiple R-squared: 0.9935, Adjusted R-squared: 0.9925 F-statistic: 1032 on 5 and 34 DF, p-value: < 2.2e-16

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

Dow Jones Total Stock Market Index Residuals: Min 1Q Median 3Q Max -2085.81 -331.46 -90.15 479.11 1426.22 Coefficients: Estimate Std. Error t value Pr(>|t|)(Intercept)26977.671473.3618.310< 2e-16</td>***unemployment_rate-2544.71145.86-17.446< 2e-16</td>***prime_rate1496.11354.774.2170.000173***vix-80.8316.39-4.9322.1e-05***retail_gasoline1052.11331.533.1730.003191**y10tbill971.39285.883.3980.001746** ___ Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 Residual standard error: 775.2 on 34 degrees of freedom Multiple R-squared: 0.9849, Adjusted R-squared: 0.9827 F-statistic: 443.7 on 5 and 34 DF, p-value: < 2.2e-16 _____ S&P 500 Residuals: Min 1Q Median 3Q Max -137.711 -43.203 4.863 44.282 209.721 Coefficients:

COCTITOTORICI						
	Estimate S	td. Error	t value	Pr(> t)		
(Intercept)	2928.697	343.139	8.535	1.60e-09	* * *	
moodys aaa	569.859	215.874	2.640	0.013036	*	
moodys baa	-394.542	67.653	-5.832	2.23e-06	* * *	
vix	-5.306	1.915	-2.771	0.009511	**	
y20tbill	-829.287	133.304	-6.221	7.53e-07	* * *	
y10tbill	-662.648	209.332	-3.166	0.003539	**	
y7tbill	1385.527	266.557	5.198	1.33e-05	***	
y5tbill	441.458	145.548	3.033	0.004959	**	
m6tbill	607.816	105.134	5.781	2.57e-06	* * *	
y3tbill	-982.088	261.476	-3.756	0.000743	***	
Signif. code	es: 0 '***	′ 0.001 ′	**′ 0.01	'*' 0.05	'.' 0.1	L''1

Residual standard error: 83.42 on 30 degrees of freedom Multiple R-squared: 0.9833, Adjusted R-squared: 0.9783 F-statistic: 196.7 on 9 and 30 DF, p-value: < 2.2e-16

House and Commercial Real Estate Price Indexes

National Home Price Index Residuals: Min 1Q Median 3Q Max -4.9008 -1.3886 0.3075 1.6386 4.1347 Coefficients: Estimate Std. Error t value Pr(>|t|) EstimateStd. EfforC valueFI(-|C|)(Intercept)218.64013.141669.595< 2e-16</td>cost_of_funds8.69220.856010.1555.67e-12unemployment_rate-9.91090.4436-22.342< 2e-16</td>retail_gasoline-4.43610.8891-4.9891.66e-05y30tbill5.71941.05885.4024.75e-06 ___ Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 Residual standard error: 2.441 on 35 degrees of freedom Multiple R-squared: 0.9913, Adjusted R-squared: 0.9903 F-statistic: 999.3 on 4 and 35 DF, p-value: < 2.2e-16 _____ Commercial Real Estate Price Index Residuals: 1Q Median 3Q Max Min -9.3489 -3.7340 0.7424 2.8487 8.5269 Coefficients: Estimate Std. Error t value Pr(>|t|)(Intercept)338.97666.265054.107< 2e-16</th>***cost_of_funds8.63671.70705.0601.34e-05***unemployment_rate-19.71070.8846-22.281< 2e-16</td>***retail_gasoline-4.35881.7730-2.4580.0190*y30tbill6.08612.11142.8820.0067** ___ Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 Residual standard error: 4.867 on 35 degrees of freedom Multiple R-squared: 0.9895, Adjusted R-squared: 0.9883

F-statistic: 827.1 on 4 and 35 DF, p-value: < 2.2e-16

Market Volatility Index

Residuals: Min 10 Median 30 Max -6.965 -3.101 -0.696 3.334 9.890

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)	
(Intercept)	539.620975	106.354439	5.074	2.27e-05	***
real disposable income growth	1.649357	0.804501	2.050	0.049817	*
nominal_disposable_income_growth	-1.769519	0.786412	-2.250	0.032485	*
unemployment rate	-20.732834	5.234429	-3.961	0.000467	***
bbb	-8.570907	2.663513	-3.218	0.003254	* *
dow_jones_total	-0.007169	0.001169	-6.134	1.28e-06	***
national home price index	-1.334811	0.376615	-3.544	0.001405	* *
y20tbill	-45.739486	12.880114	-3.551	0.001380	**
y10tbill	9.402873	3.442003	2.732	0.010781	*
y7tbill	82.154704	24.100297	3.409	0.001996	* *
y3tbill	-60.817713	20.836679	-2.919	0.006861	* *
yltbill	48.673657	11.404717	4.268	0.000204	***
Signif. codes: 0 '***' 0.001 '**	*' 0.01 '*'	0.05 '.' 0.	1 ' ' 1		

Residual standard error: 4.835 on 28 degrees of freedom Multiple R-squared: 0.8017, Adjusted R-squared: 0.7238 F-statistic: 10.29 on 11 and 28 DF, p-value: 3.518e-07

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 "2019 Supervisory Scenarios for Annual Stress Tests Required under the Dodd-Frank Act Stress Testing Rules and the Capital Plan Rule" (found at

<u>https://www.federalreserve.gov/newsevents/pressreleases/files/bcreg20190213a1.pdf</u>) 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 LNS1400000)
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).

³ Per https://www.federalreserve.gov/newsevents/pressreleases/files/bcreg20190213a1.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	End-of-quarter rates from the H.10 Release, Foreign
exchange rate (F/USD, index)	Exchange Rates, Federal Reserve Board.
Japan Beal GDP Growth	Percent change in gross domestic product at an
	annualized rate, Cabinet Office via Haver.
	Percent change in the quarterly average of the
lanan Inflation	consumer price index at an annualized rate, staff
bapar initation	calculations based on Ministry of Internal Affairs and
	Communications via Haver.
Japan Bilateral Dollar Exchange	End-of-quarter rates from the H.10 Release, Foreign
Rate (Yen/USD)	Exchange Rates, Federal Reserve Board.
	Percent change in gross domestic product at an
UK Real GDP Growth	annualized rate, Office for National Statistics via
	Haver.
	Percent change in the quarterly average of the
UK Inflation	consumer price index at an annualized rate, staff
ONIMATION	calculations based on Office for National Statistics via
	Haver.
UK Bilateral Dollar Exchange Rate	End-of-quarter rates from the H.10 Release, Foreign
(USD/Pound)	Exchange Rates, Federal Reserve Board.

The above dataset from the Federal Reserve can be downloaded manually or automatically. Manual downloads are available at <u>https://www.federalreserve.gov/supervisionreg/ccar-</u> <u>2019.htm</u> (shown below, as of June 2019) by clicking the link marked "Historical data (ZIP)". Alternatively, downloading the file at <u>https://www.federalreserve.gov/supervisionreg/files/2019-</u> <u>historical-data.zip</u> 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 basis⁴.

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 4Q2018 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) 2Q2019.

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 <u>https://www.federalreserve.gov/supervisoryreg/files/2019-historical-data.zip</u>, 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) 2Q2019.

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.

Section 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's⁵ "forecast" package⁶; specifically, the "ets" function (see p.39 of <u>https://cran.r-project.org/web/packages/forecast/forecast.pdf</u>)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)</pre>

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+1st 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.3.6.1 of the "R" language is available at <u>https://cran.r-project.org/</u>.

⁶ As of this writing, v.8.8 of the forecast package is available at <u>https://CRAN.R-project.org/package=forecast</u>.

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

- "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,</pre>
       1041.372826, ... )
       > sp_ts<-ts(sp,freq=4,end=c(2017,4))</pre>
       > sp_ts
         Qtr1
                    Qtr2
                              Qtr3
                                         Qtr4
               130.6591 1250.5201 998.4077
2008
2009 812.0470 799.5264 927.5045 1041.3728
       > m<-ets(sp_ts,model='ZZZ',opt.crit=c('mae'),additive.only=TRUE)</pre>
       > dsp ts<-diff(sp ts)</pre>
       > dsp_ts
            Qtr1
                        Qtr2
                                    Qtr3
                                                 0tr4
                             1119.860980 -252.112424
2008
2009 -186.360685 -12.520593 127.978126 113.868293
       > m<-ets(dsp_ts,model='ZZZ',opt.crit=c('mae'),additive.only=TRUE</pre>
```

- 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. ⁹ 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 values¹⁰;
- 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 slopes¹¹.

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

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.

¹¹ 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.

Section 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 $0 \le \alpha \le 1$, 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.

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

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.

Section III: Regression Construction

Capitalytics also generates a regression to estimate future values of the variables that we track in terms of current-day values. By using R's "lm" function, we estimate the next quarter's values for each variable in terms of the preceding set of variables' values. These regressions are built using the immediately preceding 40 sets of variables' values.

Each output variable is considered in turn as the response variable, with all other variables as possibilities for the control (independent) variables *excluding* any variables that have an 80% correlation with the response variable. Successive linear regressions are built; if any of the control variables' p-values exceed 5%, or if the model's p-value exceeds 5% and the number of considered control variables is greater than one, the most offensive control variable is dropped, and the regression is re-run.

Trend	Ν	Seasonal A	М
Ν	$\hat{y}_{t+h t} = \ell_t$ $\ell_t = \alpha y_t + (1-\alpha)\ell_{t-1}$	$\begin{aligned} \hat{y}_{t+h t} &= \ell_t + s_{t-m+h_m^+} \\ \ell_t &= \alpha(y_t - s_{t-m}) + (1-\alpha)\ell_{t-1} \\ s_t &= \gamma(y_t - \ell_{t-1}) + (1-\gamma)s_{t-m} \end{aligned}$	$\begin{aligned} \hat{y}_{t+h t} &= \ell_t s_{t-m+h_m^+} \\ \ell_t &= \alpha(y_t/s_{t-m}) + (1-\alpha)\ell_{t-1} \\ s_t &= \gamma(y_t/\ell_{t-1}) + (1-\gamma)s_{t-m} \end{aligned}$
Α	$\begin{split} \hat{y}_{t+h t} &= \ell_t + hb_t \\ \ell_t &= \alpha y_t + (1-\alpha)(\ell_{t-1} + b_{t-1}) \\ b_t &= \beta^*(\ell_t - \ell_{t-1}) + (1-\beta^*)b_{t-1} \end{split}$	$\begin{split} \hat{y}_{t+h t} &= \ell_t + hb_t + s_{t-m+h_m^+} \\ \ell_t &= \alpha(y_t - s_{t-m}) + (1-\alpha)(\ell_{t-1} + b_{t-1}) \\ b_t &= \beta^*(\ell_t - \ell_{t-1}) + (1-\beta^*)b_{t-1} \\ s_t &= \gamma(y_t - \ell_{t-1} - b_{t-1}) + (1-\gamma)s_{t-m} \end{split}$	$\begin{aligned} \hat{y}_{t+h t} &= (\ell_t + hb_t)s_{t-m+h_m^+} \\ \ell_t &= \alpha(y_t/s_{t-m}) + (1-\alpha)(\ell_{t-1} + b_{t-1}) \\ b_t &= \beta^*(\ell_t - \ell_{t-1}) + (1-\beta^*)b_{t-1} \\ s_t &= \gamma(y_t/(\ell_{t-1} + b_{t-1})) + (1-\gamma)s_{t-m} \end{aligned}$
\mathbf{A}_{d}	$\hat{y}_{t+h t} = \ell_t + \phi_h b_t$ $\ell_t = lpha y_t + (1-lpha)(\ell_{t-1} + \phi b_{t-1})$ $b_t = eta^*(\ell_t - \ell_{t-1}) + (1-eta^*)\phi b_{t-1}$	$\begin{split} \hat{y}_{t+h t} &= \ell_t + \phi_h b_t + s_{t-m+h_m^+} \\ \ell_t &= \alpha(y_t - s_{t-m}) + (1-\alpha)(\ell_{t-1} + \phi b_{t-1}) \\ b_t &= \beta^*(\ell_t - \ell_{t-1}) + (1-\beta^*)\phi b_{t-1} \\ s_t &= \gamma(y_t - \ell_{t-1} - \phi b_{t-1}) + (1-\gamma)s_{t-m} \end{split}$	$\begin{split} \hat{y}_{t+h t} &= (\ell_t + \phi_h b_t) s_{t-m+h_m^+} \\ \ell_t &= \alpha(y_t/s_{t-m}) + (1-\alpha)(\ell_{t-1} + \phi b_{t-1}) \\ b_t &= \beta^*(\ell_t - \ell_{t-1}) + (1-\beta^*)\phi b_{t-1} \\ s_t &= \gamma(y_t/(\ell_{t-1} + \phi b_{t-1})) + (1-\gamma)s_{t-m} \end{split}$
М	$egin{aligned} \hat{y}_{t+h t} &= \ell_t b_t^h \ \ell_t &= lpha y_t + (1-lpha) \ell_{t-1} b_{t-1} \ b_t &= eta^* (\ell_t / \ell_{t-1}) + (1-eta^*) b_{t-1} \end{aligned}$	$\begin{aligned} \hat{y}_{t+h t} &= \ell_t b_t^h + s_{t-m+h_m^+} \\ \ell_t &= \alpha(y_t - s_{t-m}) + (1-\alpha)\ell_{t-1}b_{t-1} \\ b_t &= \beta^*(\ell_t/\ell_{t-1}) + (1-\beta^*)b_{t-1} \\ s_t &= \gamma(y_t - \ell_{t-1}b_{t-1}) + (1-\gamma)s_{t-m} \end{aligned}$	$\begin{split} \hat{y}_{t+h t} &= \ell_t b_t^h s_{t-m+h_m^+} \\ \ell_t &= \alpha(y_t/s_{t-m}) + (1-\alpha)\ell_{t-1}b_{t-1} \\ b_t &= \beta^*(\ell_t/\ell_{t-1}) + (1-\beta^*)b_{t-1} \\ s_t &= \gamma(y_t/(\ell_{t-1}b_{t-1})) + (1-\gamma)s_{t-m} \end{split}$
M_d	$\begin{split} \hat{y}_{t+h t} &= \ell_t b_t^{\phi_h} \\ \ell_t &= \alpha y_t + (1-\alpha) \ell_{t-1} b_{t-1}^{\phi} \\ b_t &= \beta^* (\ell_t / \ell_{t-1}) + (1-\beta^*) b_{t-1}^{\phi} \end{split}$	$\begin{split} \hat{y}_{t+h t} &= \ell_t b_t^{\phi_h} + s_{t-m+h_m^+} \\ \ell_t &= \alpha(y_t - s_{t-m}) + (1-\alpha)\ell_{t-1}b_{t-1}^{\phi} \\ b_t &= \beta^*(\ell_t/\ell_{t-1}) + (1-\beta^*)b_{t-1}^{\phi} \\ s_t &= \gamma(y_t - \ell_{t-1}b_{t-1}^{\phi}) + (1-\gamma)s_{t-m} \end{split}$	$\begin{aligned} \hat{y}_{t+h t} &= \ell_t b_t^{\phi_h} s_{t-m+h_m^+} \\ \ell_t &= \alpha(y_t/s_{t-m}) + (1-\alpha)\ell_{t-1}b_{t-1}^{\phi} \\ b_t &= \beta^*(\ell_t/\ell_{t-1}) + (1-\beta^*)b_{t-1}^{\phi} \\ s_t &= \gamma(y_t/(\ell_{t-1}b_{t-1}^{\phi})) + (1-\gamma)s_{t-m} \end{aligned}$

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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	0.737168
S&P 500 Stock Price Index	ndex Unemployment Rate	
S&P 500 Stock Price Index	BBB Corporate Yield	0.763964
S&P 500 Stock Price Index	Prime Rate	-0.751538
S&P 500 Stock Price Index	Dow Jones Total Stock Market Index	-0.938617
S&P 500 Stock Price Index	House Price Index	-0.925759
S&P 500 Stock Price Index	Commercial Real Estate Price Index	-0.941898
S&P 500 Stock Price Index	30-year Treasury yield	-0.657606
S&P 500 Stock Price Index	1-month Treasury yield	0.718515
S&P 500 Stock Price Index	3-month Treasury yield	-0.726434
S&P 500 Stock Price Index	6-month Treasury yield	0.728232
S&P 500 Stock Price Index	1-year Treasury yield	0.720723
Primary Credit	Mortgage Rate	-0.694866
Primary Credit	Prime Rate	-0.724931
Primary Credit	House Price Index	0.611436
Primary Credit	Commercial Real Estate Price Index	0.673185
Primary Credit	US Average Retail Gasoline Price	-0.628575
Primary Credit	20-year Treasury yield	0.79886
Primary Credit	10-year Treasury yield	-0.719481
Primary Credit	1-month Treasury yield	0.992903
Primary Credit	7-year Treasury yield	0.896113
Primary Credit	3-month Treasury yield	-0.729456
Primary Credit	5-year Treasury yield	-0.753268
Primary Credit 6-month Treasury yield		0.993992
Primary Credit	3-year Treasury yield	0.955794
Primary Credit	1-year Treasury yield	0.987376
Real GDP Growth Rate	Nominal GDP Growth Rate	0.932223
Real Disposable Income Growth Rate	Nominal Disposable Income Growth Rate	0.908843
BBB Corporate Yield	Mortgage Rate	0.914071
BBB Corporate Yield	Prime Rate	0.691511
BBB Corporate Yield	Dow Jones Total Stock Market Index	-0.827576
BBB Corporate Yield	House Price Index	-0.761606
BBB Corporate Yield	Commercial Real Estate Price Index	-0.737902
BBB Corporate Yield	US Average Retail Gasoline Price	0.669951
BBB Corporate Yield	30-year Treasury yield	-0.673048
BBB Corporate Yield	20-year Treasury yield	-0.798992
BBB Corporate Yield	10-year Treasury yield	0.895915
BBB Corporate Yield	7-year Treasury yield	-0.73071
BBB Corporate Yield	rporate Yield 3-month Treasury yield	
BBB Corporate Yield	Corporate Yield 5-year Treasury yield	
BBB Corporate Yield	3-year Treasury yield	-0.649887
Mortgage Rate	Prime Rate	0.856347
Mortgage Rate	Dow Jones Total Stock Market Index	-0.78184
Mortgage Rate	House Price Index	-0.777961

Mortgage Rate	Commercial Real Estate Price Index	-0.779392
Mortgage Rate	US Average Retail Gasoline Price	0.786474
Mortgage Rate	20-year Treasury yield	-0.885562
Mortgage Rate	10-year Treasury yield	0.993504
Mortgage Rate	7-year Treasury yield	-0.844911
Mortgage Rate	3-month Treasury yield	0.882526
Mortgage Rate	5-year Treasury yield	0.979149
Mortgage Rate	6-month Treasury vield	-0.711516
Mortgage Rate	3-year Treasury yield	-0.791442
Mortgage Rate	1-year Treasury yield	-0.729589
Prime Rate	US Average Retail Gasoline Price	0.692341
Prime Rate	20-year Treasury vield	-0.728785
Prime Rate	10-year Treasury yield	0.841057
Prime Rate	7-year Treasury yield	-0.743624
Prime Rate	3-month Treasury vield	0.991801
Prime Rate	5-vear Treasury vield	0.90949
Prime Rate	6-month Treasury vield	-0.745749
Prime Rate	3-year Treasury yield	-0.76855
Prime Rate	1-year Treasury vield	-0.75471
Dow Jones Total Stock Market Index	House Price Index	0.837862
Dow Jones Total Stock Market Index	Commercial Real Estate Price Index	0.902875
Dow Jones Total Stock Market Index	US Average Retail Gasoline Price	-0.609915
Dow Jones Total Stock Market Index	30-year Treasury yield	0.892476
Dow Jones Total Stock Market Index	20-year Treasury yield	0.83001
Dow Jones Total Stock Market Index	10-vear Treasury yield	-0 791097
Dow Jones Total Stock Market Index	7-year Treasury yield	0.824038
Dow Jones Total Stock Market Index	5-year Treasury yield	-0.692527
Dow Jones Total Stock Market Index	6-month Treasury yield	0.610428
Dow Jones Total Stock Market Index	3-year Treasury yield	0 721494
Dow Jones Total Stock Market Index	1-year Treasury yield	0.629737
House Price Index	Commercial Real Estate Price Index	0.949863
House Price Index	30-year Treasury yield	0.648973
House Price Index	20-year Treasury yield	0.842888
House Price Index	10-vear Treasury yield	-0 791863
House Price Index	7-year Treasury yield	0.802892
House Price Index	5-year Treasury yield	-0 722487
House Price Index	6-month Treasury yield	0.722407
House Price Index	3-year Treasury yield	0.721541
House Price Index	1-year Treasury yield	0.639956
Commercial Real Estate Price Index	US Average Retail Gasoline Price	-0.678044
Commercial Real Estate Price Index	30-year Treasury yield	0.711463
Commercial Real Estate Price Index	20-year Treasury yield	0.885187
Commercial Real Estate Price Index	10-year Treasury yield	_0.803107
Commercial Real Estate Price Index	7-year Treasury yield	0.8630/9
Commercial Real Estate Price Index	5-year Treasury yield	-0 72710/
Commercial Real Estate Price Index	6-month Treasury yield	0.684400
Commercial Real Estate Drice Index	3 year Treasury yield	0.004409
Commercial Real Estate Price Index	1-year Treasury yield	0.702903
US Average Retail Casoling Price	20 year Treasury yield	-0.756572
US Average Retail Gasoline Price	10 year Treasury yield	-0.750575
US Average Retail Gasoline Price	7 year Treasury yield	0.709033
US Average Retail Gasoline Price	2 month Treasury yield	-0./03/4
US Average Retail Gasoline Price	5-year Treasury yield	0.702113
US Average Retail Gasonine Flice	J-year rieasury yreiu	0./5010/

US Average Retail Gasoline Price	6-month Treasury yield	-0.651812
US Average Retail Gasoline Price	3-year Treasury yield	-0.746017
US Average Retail Gasoline Price	1-year Treasury yield	-0.675375
30-year Treasury yield	20-year Treasury yield	0.989045
30-year Treasury yield	7-year Treasury yield	0.842654
30-year Treasury yield	3-year Treasury yield	0.627642
20-year Treasury yield	10-year Treasury yield	-0.884452
20-year Treasury yield	7-year Treasury yield	0.969392
20-year Treasury yield	3-month Treasury yield	-0.725943
20-year Treasury yield	5-year Treasury yield	-0.829616
20-year Treasury yield	6-month Treasury yield	0.817722
20-year Treasury yield	3-year Treasury yield	0.903405
20-year Treasury yield	1-year Treasury yield	0.839657
10-year Treasury yield	7-year Treasury yield	-0.859752
10-year Treasury yield	3-month Treasury yield	0.871784
10-year Treasury yield	5-year Treasury yield	0.981972 ^(*)
10-year Treasury yield	6-month Treasury yield	-0.733671
10-year Treasury yield	3-year Treasury yield	-0.808659
10-year Treasury yield	1-year Treasury yield	-0.750075
1-month Treasury yield	7-year Treasury yield	0.793126
1-month Treasury yield	6-month Treasury yield	0.995637
1-month Treasury yield	3-year Treasury yield	0.937796
1-month Treasury yield	1-year Treasury yield	0.989624
7-year Treasury yield	3-month Treasury yield	-0.754476
7-year Treasury yield	5-year Treasury yield	-0.841083
7-year Treasury yield	6-month Treasury yield	0.915658
7-year Treasury yield	3-year Treasury yield	0.978236
7-year Treasury yield	1-year Treasury yield	0.930683
3-month Treasury yield	5-year Treasury yield	0.936962
3-month Treasury yield	6-month Treasury yield	-0.746421
3-month Treasury yield	3-year Treasury yield	-0.771386
3-month Treasury yield	1-year Treasury yield	-0.755118
5-year Treasury yield	6-month Treasury yield	-0.766015
5-year Treasury yield	3-year Treasury yield	-0.818721
5-year Treasury yield	1-year Treasury yield	-0.779179
6-month Treasury yield	3-year Treasury yield	0.974027
6-month Treasury yield	1-year Treasury yield	0.998089
3-year Treasury yield	1-year Treasury yield	0.983905

* While the 10-year Treasury yield appears to be highly correlated to the 5-year yield, this correlation has not been seen in previous analyses; as such, we will not include this connection in this study, but will do so if the connection becomes consistent.

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