**Exploration of U.S. Economic Growth Leading Indicators:**

**Treasury Yield Spread, Housing Permit Issuance, and Unemployment rate**

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**Abstract**

The relationships between the real GDP growth and economic leading indicators were examined using linear regression analyses. The treasury yield spread and the number of housing permit issuance exhibit statistically significant relationships with economic growth, explaining close to 20 and 14 percent of its variations. In contrast, the unemployment rate, contrary to conclusions drawn by previous studies, shows weak association. Together, these findings suggest that the treasury yield spread best predicts the U.S. economic growth over the past four decades.

*Keywords:* economic growth, leading indicators, federal funds interest rate, GDP

**Introduction**

The U.S. GDP growth is perhaps the most important indicator for global economic health. Economists, investors, business people, and consumers around the globe are all affected by this metric. Thus, people as such seek out leading indicators to predict GDP growth and guide their decision-making. Over the last few decades, the mystery appears to be unraveled as there is increasing agreement in academia and policy circles that the treasury yield spread, number of housing permit issuance, and the unemployment rate are leading indicators for the U.S. real GDP growth. However, the reliability of these measures remain under debate.

Estrella and Hardouvelis (1996) and Seip and Zhang (2021) discussed the accuracy and timing of incorporating the yield spread in forecasting models. They asserted that the metric significantly outperforms other macroeconomic indicators, inclusive of the number of housing permit issuance and unemployment rate, in predicting recessions two to six quarters ahead.

Gete (2014) contended that the measure signals the current demand level for the real estate market and estimates future performance of the construction industry. Service (2017) furthered the analysis and claimed that sustained declines in housing starts, as represented by the

number of housing permits issuance, could slow economic growth and can push the economy into a recession. Likewise, increases in housing activity could trigger economic growth.

Okun's law, named after then-chairman of the Council of Economic Advisors Arthur Melvin Okun (1962), was first put forth in 1962. It states that there exists a strong negative correlation between the unemployment rate and real GDP such that a one-point increase in the former is associated with two percentage points of negative growth in the latter. Andrei, Vasile, and Adrian (2009) conducted empirical research on the same topic in the 21 century and showed that, different from that of the 20th century, a rise of one percentage point of unemployment rate is associated with a decline of roughly half percentage point of real GDP growth.

This study assesses which of the three aforementioned economic leading indicators most strongly correlates with the U.S. GDP growth, using the most up-to-date datasets retrieved from the Federal Reserve.

## Methodology

This research aims to gain insight into the strength of the relationships among the U.S. real GDP growth, the treasury yield spread, the number of housing permit issuance, and the unemployment rate. This chapter further discusses the research method, the data collection method, and the data analysis procedure.

### Location of the study

The dataset used in the study contains six variables: Observation Date, real GDP, real GDP Growth, treasury yield spread, the number of housing permit issuance, and the unemployment rate. These variable datasets were separately retrieved from the Federal Reserve Economic Data (FRED) and the U.S. Census Bureau websites.

### Methods of data collection

Relevant secondary research data at daily, monthly, and quarterly-level were obtained and transformed into annual-level by taking a simple average. First day of each year was recorded as the observation date. Real GDP growth was calculated as the difference of real GDP in current and previous years over the real GDP of previous year. Treasury yield spread was calculated as the spread, or difference, between 10-Year Treasury Constant Maturity and 2-Year Treasury Constant Maturity. All data are seasonally adjusted and aggregated for further analyses.

**Methods of analysis**

In addition to exploratory data analysis for descriptive statistics, the strength of relationships among U.S. real GDP growth and economic leading indicators were tested through performing a series of linear regression. The leading indicator that best predicts U.S. economic growth over the past four decades was identified by comparing the respective r-squared and p-value of each regression model and analyzing the best-fit-line's coefficients.

<div align="center"><b>Results</b></div>

**Data Description**

Treasury yield spread, number of housing permit issuance, and the unemployment rate are all numerical variables, and they were used as the independent variables, while the U.S. real GDP was used as a dependent variable in regression analyses.

**Summary Statistics**
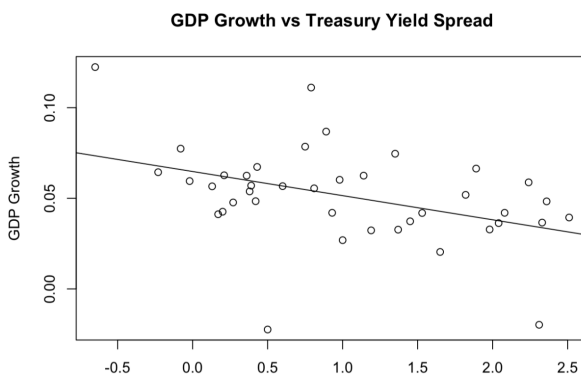


```
Call:
lm(formula = x$`GDPA Growth` ~ x$`Treasury Yield Spread`, data = x)

Residuals:
     Min        1Q    Median        3Q       Max
-0.080552 -0.010520 -0.000721  0.011388  0.056814

Coefficients:
                           Estimate Std. Error t value Pr(>|t|)
(Intercept)                0.064818   0.006125  10.582 6.91e-13 ***
x$`Treasury Yield Spread` -0.013331   0.004695  -2.839  0.00722 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.02445 on 38 degrees of freedom
  (1 observation deleted due to missingness)
Multiple R-squared:  0.175,   Adjusted R-squared:  0.1533
F-statistic: 8.062 on 1 and 38 DF,  p-value: 0.007222
```
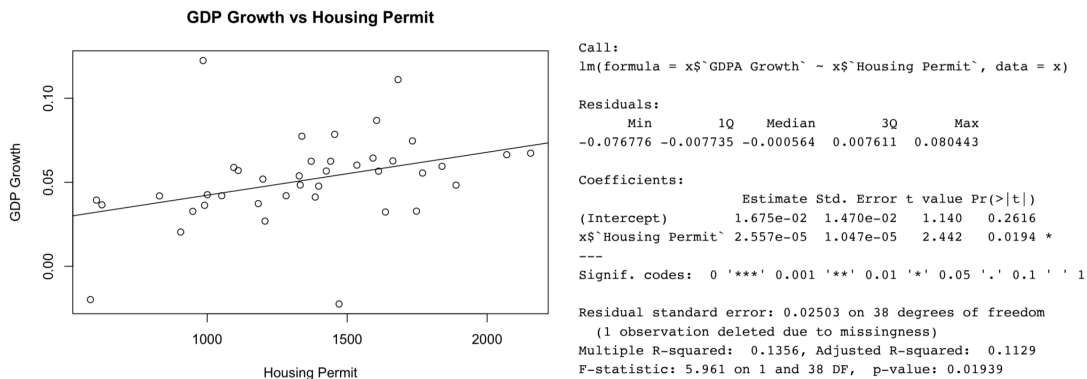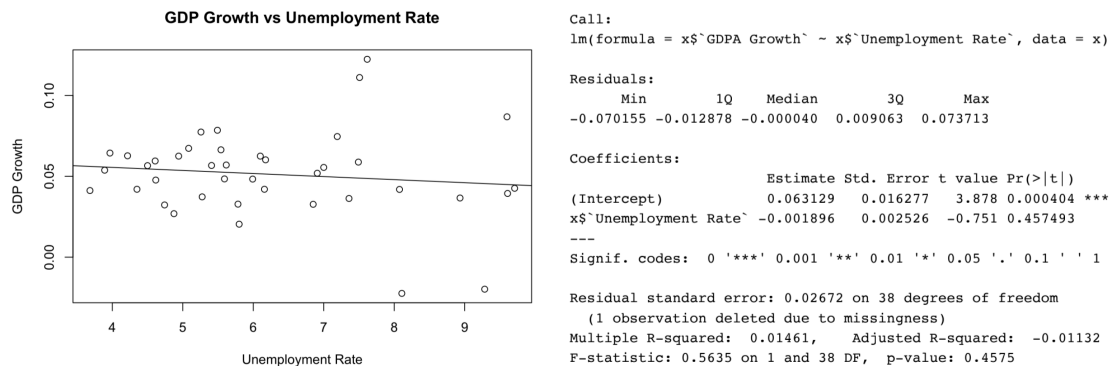
*Figure 1: linear regression fit of GDP growth vs. treasury yield spread and test statistics*

As shown in *Figure-1*, the intercept coefficient is 0.064818 with a standard error of 0.006125. Since the standard coefficient error measures the average amount that the coefficient estimates vary from the actual average value of our dependent variable, in this case, the number of 0.006125 indicates less variation from the population mean. With degree freedom of 38 and f-statistic of 8.062, the p-value of 0.0072 less than 0.05 indicates a significant relationship between the two variables.



```
GDP Growth vs Housing Permit

Call:
lm(formula = x$`GDPA Growth` ~ x$`Housing Permit`, data = x)

Residuals:
     Min        1Q    Median        3Q       Max
-0.076776 -0.007735 -0.000564  0.007611  0.080443

Coefficients:
                   Estimate Std. Error t value Pr(>|t|)
(Intercept)       1.675e-02  1.470e-02   1.140   0.2616
x$`Housing Permit` 2.557e-05  1.047e-05   2.442   0.0194 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.02503 on 38 degrees of freedom
  (1 observation deleted due to missingness)
Multiple R-squared:  0.1356,  Adjusted R-squared:  0.1129
F-statistic: 5.961 on 1 and 38 DF,  p-value: 0.01939
```

*Figure 2: linear regression fit of GDP growth vs. number of housing permits and test statistics*

As shown in *Figure-2*, the linear regression fit coefficient intercept is 0.0675 with a standard error of 0.00147. With degree freedom of 38 and f statistic of 5.961, the p-value of the linear regression test is 0.0194, which is less than 0.05, indicating a significant relationship between GDP growth rate and number of housing permit issuance.



```
GDP Growth vs Unemployment Rate

Call:
lm(formula = x$`GDPA Growth` ~ x$`Unemployment Rate`, data = x)

Residuals:
     Min        1Q    Median        3Q       Max
-0.070155 -0.012878 -0.000040  0.009063  0.073713

Coefficients:
                      Estimate Std. Error t value Pr(>|t|)
(Intercept)           0.063129   0.016277   3.878 0.000404 ***
x$`Unemployment Rate` -0.001896   0.002526  -0.751 0.457493
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.02672 on 38 degrees of freedom
  (1 observation deleted due to missingness)
Multiple R-squared:  0.01461,   Adjusted R-squared:  -0.01132
F-statistic: 0.5635 on 1 and 38 DF,  p-value: 0.4575
```

*Figure 3: linear regression fit of GDP growth vs. unemployment rate and test statistics*

As shown in *Figure-3*, The coefficient intercept of the GDP growth vs. unemployment rate is 0.0631 with a standard error of 0.0163. F statistic is 0.5635 with a degree of freedom of 38. The linear regression test does not show a significant relationship between the two variables with a p-value of 0.3475, greater than the 0.95 significant level.

Compared to housing permits (0.0194) and unemployment rate (0.4575), the treasury yield spread has the smallest p-value of 0.0072, which shows the most significant relationship with the percentage of GDP growth among the three independent variables. While the R-squared value measures the linear relationship between the predictor variable and response variable, the greater the value is, the more the response variable can be explained by the predictor variable. In this case, again, the treasury yield spread yields the most significant value of r-squared of 0.175 compared to 0.1356 for housing permits and 0.0146 for unemployment.

**Measures of Central Tendencies**

```
observation_date                    GDPA          GDPA Growth
Min.   :1980-01-01 00:00:00   Min.   : 2857   Min.   :-0.02240
1st Qu.:1990-01-01 00:00:00   1st Qu.: 5963   1st Qu.: 0.03887
Median :2000-01-01 00:00:00   Median :10251   Median : 0.05285
Mean   :2000-01-01 08:46:49   Mean   :10829   Mean   : 0.05133
3rd Qu.:2010-01-01 00:00:00   3rd Qu.:15049   3rd Qu.: 0.06255
Max.   :2020-01-01 00:00:00   Max.   :21373   Max.   : 0.12240
                                              NA's   :1

Treasury Yield Spread Housing Permit Unemployment Rate
Min.   :-0.6500       Min.   : 583   Min.   :3.683
1st Qu.: 0.3600       1st Qu.:1095   1st Qu.:4.942
Median : 0.8900       Median :1372   Median :5.800
Mean   : 0.9798       Mean   :1348   Mean   :6.246
3rd Qu.: 1.6500       3rd Qu.:1612   3rd Qu.:7.358
Max.   : 2.5100       Max.   :2155   Max.   :9.708
```

*Figure 4: central tendencies of real GDP, real GDP growth, treasured yield spread, housing permit, and unemployment Rate*

**Discussion**

**Main Findings**

The result supports the hypothesis that the 10-year treasury curve rate better predicts, or more strongly correlates with, the U.S. real GDP growth than the unemployment rate and number of housing permits issuance. Specifically, the 0.175 r-squared of the regression analysis of treasury yield and real GDP growth rate suggests that 17.5% of all variations in the U.S. economic growth are completely captured and explained by the leading economic indicator. Considering the breadth of the recorded time span and significance of the U.S. real GDP growth, being able to account for almost one fifth of this measure through a linear regression model is certainly noteworthy.

The result also indicates a statistically significant relationship between the number of housing permit issuance and real GDP growth, while the unemployment rate seems to be a less significant factor in predicting real GDP growth. Since there is a negative relationship between GDP growth and treasury yield spread, a great treasury yield spread will contribute to a lower real GDP growth rate in the following year. The positive slope of the GDP growth vs. housing permit's graph explains that a greater number of issued housing permits will result in a higher GDP growth rate in the following year. Although there is not enough evidence to conclude a significant relationship observed from the unemployment rate with the response variable, a negative slope of the linear regression fit line indicates that a lower unemployment rate might have fewer impacts on a higher GDP growth rate in the following year.

**Connections with Existing Literature**

This research supports the publications put forth by Estrella and Hardouvelis (1996) and Seip and Zhang (2021) that the treasury yield spread significantly outperforms other leading indicators, including the number of house permit issuance and the unemployment rate.

Additionally, this research appears to contradict the assertions made by Okun (1962) and Andrei, Vasile, and Adrian (2009) that there exists such a strong negative correlation between the real GDP growth and the unemployment rate.

## Conclusion

Among all economic leading indicators, the treasury yield spread best predicts the U.S. economic growth, which affirms the conclusions drawn from literature review. The statistical significant relationship shows that a rise of 1.33 percentage point of the spread is associated with a decline of roughly one percentage point of real GDP growth. Close to 20 percent of variations in the U.S. economic growth are completely explained by the leading economic indicator. In comparison, the number of housing permit issuance explains close to 14 percent of variations, while the relationship between real GDP growth and unemployment rate does not appear to be statistically significant, which contradicts with the assertions made by other researchers.

## References

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## Appendices

Harry conducted data collection, background research, and methodology analysis of the study and is responsible for the introduction, methodology, and discussion parts of the report. Diane conducted data collection, data aggregation, and data analysis of the study and is responsible for the results part of the report.