Determinants of Cap Rates Across

Multifamily, Industrial, Retail, and Office Asset Classes

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Abstract

This study identifies determining factors in commercial real estate capitalization rates and explores the variation in regressor impact depending on the asset class. Average cap rates were charted from 2000-Q1 2023 from available Greenstreet transaction data. The regression model included three variables: the 10-year treasury yield, the previous year's cap rate, and percent annual expected revenue growth for the asset class. The 10-year treasury had the greatest impact on office cap rates. Expected revenue growth had the greatest impact on retail cap rates with office cap rates as a close second. Past cap rates had the greatest impact on industrial cap rates. Multifamily cap rates appear to be the most consistent; the multifamily cap rate regression achieved the greatest R-squared and no particular regressor impacted multifamily significantly more than any other asset class.

Introduction

Capitalization rates, commonly referred to as cap rates, are used to price an asset in commercial real estate. The cap rate gives the expected return of the asset calculated as net operating income (hereafter, NOI)/purchase price. For example, a property that achieves $5M in NOI and sells for $100M, is trading at a 5% cap ($5,000,000/$100,000,000 =.05%). Since net operating income is well documented, the cap rate is the negotiable factor used to arrive at a final purchase price. Cap rates allow investors to evaluate both risk and potential return of a property. Properties that offer higher cap rates (higher returns) are considered riskier. Low risk assets will sell at lower cap rates (lower returns). Since risk differs across asset classes, cap rates also vary across asset classes.

An important implication of cap rates is that they have the sole power to change a property's value with no changes to the net operating income achieved or the property itself. When cap rates rise, property valuation falls all else equal. Alternatively when cap rates decrease, property valuation increases all else equal. Considering that commercial real estate accounts for $20.7 trillion of wealth in the United States (*Estimating the Size*, 2021), it is important to understand how cap rates change and hence how the value of commercial real estate fluctuates in response to broader economic conditions.

Literature Review

There has been decades of research conducted in order to understand and predict cap rates. One formula for calculating cap rates is derived from Gordon and Shapiro (1956). The Gordon growth model presents that the price of a stock is its dividend payment / required rate of return - growth rate of the dividend. Likewise, the price of an asset can be considered its NOI /

required rate of return - expected growth rate of NOI. Hence, the cap rate is the required rate of return, adjusted for expected growth of said return.

Real estate developers and investors have vested interest in forecasting cap rates for specific properties. These groups will devote significant effort to understanding cap rates in regards to microeconomic factors and granular property characteristics. Sivitanidou and Sivitanides (1999) determined that office cap rates are dependent on location, tenant mix, absorption rates, vacancy rates, etc. This is further supported by Chuangdumrongsomsuk and Fuerst (2016) who concluded office cap rates were highly dependent on location, age, land area, and number of floors.

There have also been studies to determine the relation between broader economic indicators and cap rates. Cap rates have generally been linked to the 10-year treasury yield, which correlates to cap rates better than the three or five year treasury bond (Sivitanides et al., 2001). In exploring the connection between real estate returns and stock market returns, Quan and Titman (1999) found that real estate growth, like the stock market, was strongly correlated to expectation in GDP growth. Duca et al. (2017) found that cap rates are primarily determined in capital markets, as they can stand for the required rate of return of an investment. Larriva (2022), includes GDP and CPI metrics to demonstrate that periods of high inflation present an opportunity for higher rent growth expectations and therefore lower cap rates if the property owner is able to pass increased expenses onto tenants. Other studies question the impact of macroeconomic variables altogether, finding that a regression based on lagged cap rates consistently outperformed one based on macroeconomic variables (Chandrashekaran & Young, 2000).

In the past, many regressions on cap rates have been based on appraisal data from the National Council of Real Estate Investment Fiduciaries (NCREIF), such as that of Sivitanidou and Sivitanides (1999). This study seeks to expand on previous work by making use of increased transparency within real estate and newly available transaction data from Greenstreet, the preeminent data provider in commercial real estate. It also seeks to explain cap rate variation more simply, by using a few metrics that encapsulate a wide number of the nuances previous studies have determined impact cap rates. Furthermore, while there is no doubt cap rates are highly dependent on microeconomic factors and property specific characteristics, only macroeconomic indicators are considered because the aim of this study is to understand how property valuation can change as a result of broader economic conditions, not to predict the cap rate for any specific property.

Methodology

All historical cap rate data was sourced from Greenstreet, the preeminent provider of commercial real estate intelligence in the U.S. The annual average cap rates, based on each year's transaction data from the top 50 U.S. markets, were recorded for each asset class (multifamily, office, industrial, and retail). The cap rate trends were then charted against the annual average 10-year treasury yield as recorded by the Federal Reserve Economic Data (FRED). The correlation between 10-year treasury yield and cap rate trends is visually represented in Figure 1. Figures 2-5 break down Figure 1 further by charting each asset's average spread over the 10-year treasury as well as the spread for each year in the analysis. This preliminary reporting on historical cap rates helped choose variables by considering what

macroeconomic conditions potentially contributed to the expansion/compression of cap rates between 2000-2023.

In order to understand how factors contribute to cap rate determination, cap rates from 2000-2022 were regressed on a number of different variables. Tested variables were chosen based on a theoretical understanding of how cap rates operate in accordance with the Gordon growth model and from variables already proven to be significant from previous studies. These variables were the average annual 10-year treasury yield from FRED (abbreviated to "tr"), the previous year's average cap rate from Greenstreet (abbreviated to "past"), and annual expected revenue percent growth, a Greenstreet metric that combines expected rent growth with expected vacancy (abbreviated to "mrev").

The 10 year-treasury rate contributes to the cap rate by providing a base for the required rate of return for the investment. The expectation was that a higher risk free rate, means that the cap rate must also be higher as the required rate of return would be the risk free rate + the market premium for the additional risk. Annual expected revenue percent growth (mrev) hints at the growth rate of the net operating income as well as the security of the asset. Like the Gordon growth model would predict, it should have a negative correlation to cap rates. Finally, the previous year's average cap rate was included because real estate pricing is largely based on recent transactions. The variables all had at least a 5% statistical significance level.

All regressions were performed with R Studio. The summary regression statistics include coefficients, R-squared, and p-values for the individual variables. Since the data sample was limited (only from 2000-2022), each regression was evaluated with 5-fold cross validation in order to test the model's prediction capabilities for data points not included in the creation of the model. The results of the cross validation including root mean square error (RMSE), mean

average error (MAE), and R-squared are shown in Figures 6-9. Added variable plots were created in order to visually demonstrate the independent impact each test variable has on the cap rate. The variable influence factor (VIF) was calculated for each coefficient in order to quantify the amount of collinearity among the variables. Although there is some collinearity between the predictors, all have a VIF under 5.

Results

Figure 1 is the visual representation of the data collected from averaging the annual cap rates from 2005-2022 for each asset class. While cap rates generally follow the 10-year treasury yield, the spread expands and compresses in accordance with other market factors. This is best understood by considering figures 2-5 in retrospect to the market conditions at the time. For example, rent growth can accelerate during periods of higher inflation, leading to higher expected growth which can offset the higher interest rate (Larriva, 2022). This seems to be the case for multifamily properties; Figure 2 shows that the multifamily cap rate spread over the 10-year treasury significantly decreased from 2020-2021 and has continued to drop below the historical average spread. At the same time, average national rent for multifamily rose 11.3% in 2021 and continued to grow in 2022 (*Multifamily Rent Growth*, 2022). Figure 3 shows that industrial buildings had the greatest compression in cap rates from 2020-2023 as ecommerce sales skyrocketed. There was a 43% increase in ecommerce between 2019 and 2020 as recorded by the U.S. Census annual retail trading survey which continued to grow through the pandemic (*Annual Retail Trade Survey: 2021,* 2022*).*Although these are speculative correlations, they provide insight into what variables should be included in regression analysis to empirically explain the data. Figure 4 shows that retail cap rates rose 500 bp above the 10-year treasury in

2008-2009, after the global financial crisis, and again from 2020-2021 during the Covid-19 pandemic. For the purpose of this study, retail includes only strip centers which have proven much more resilient than traditional malls. Strip centers, "particularly those with essential tenants like grocery and drug strores, have performed consistently better since 2020" while malls "saw an accelerated performance decline" (*JLL Retail Recovery*, 2021). Similarly, Figure 5 shows that office building valuation fell dramatically after the global financial crisis; in 2009 office cap rates rose over 400 basis points above the 10-year treasury. This 400 bp expansion in cap rate spread is seen once again during 2020 perhaps in response to Covid-19 and fear about the obsolescence of offices due to remote work capabilities.

Figure 1: Average Historical Cap Rates for Top 50 U.S. Markets from 2005-2022

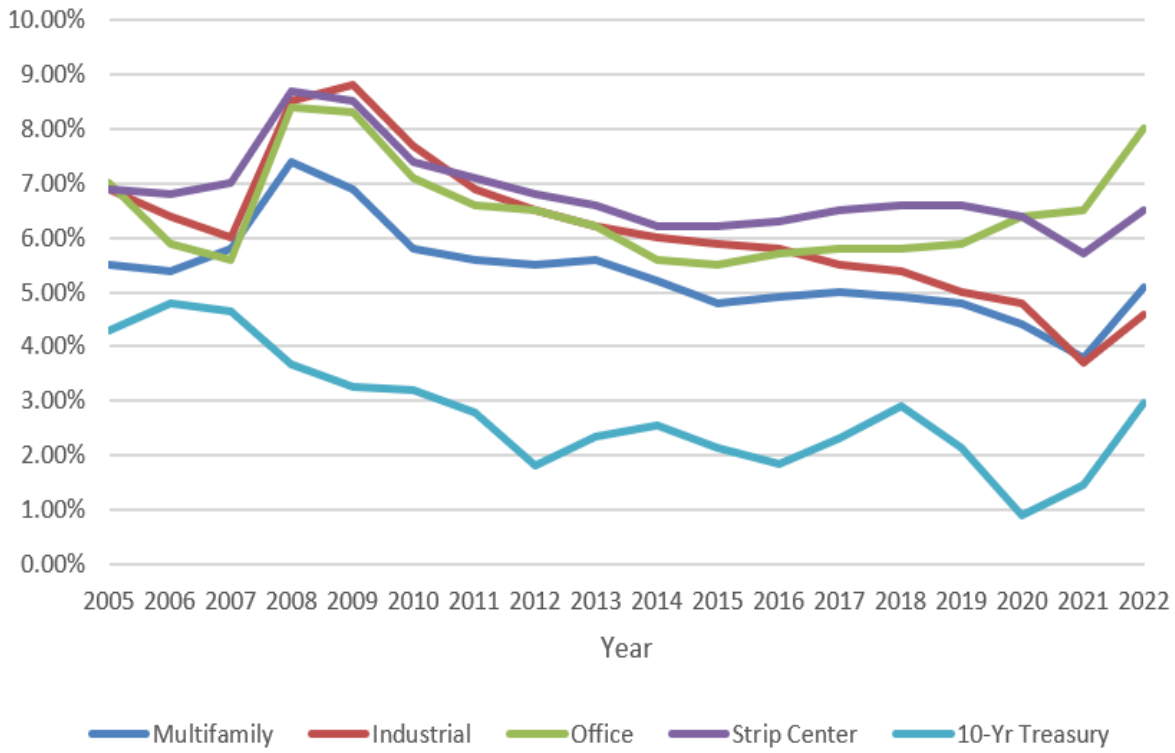


Figure 2: Multifamily Cap Rate Spread Over 10-year Treasury from 2000-Q1 2023

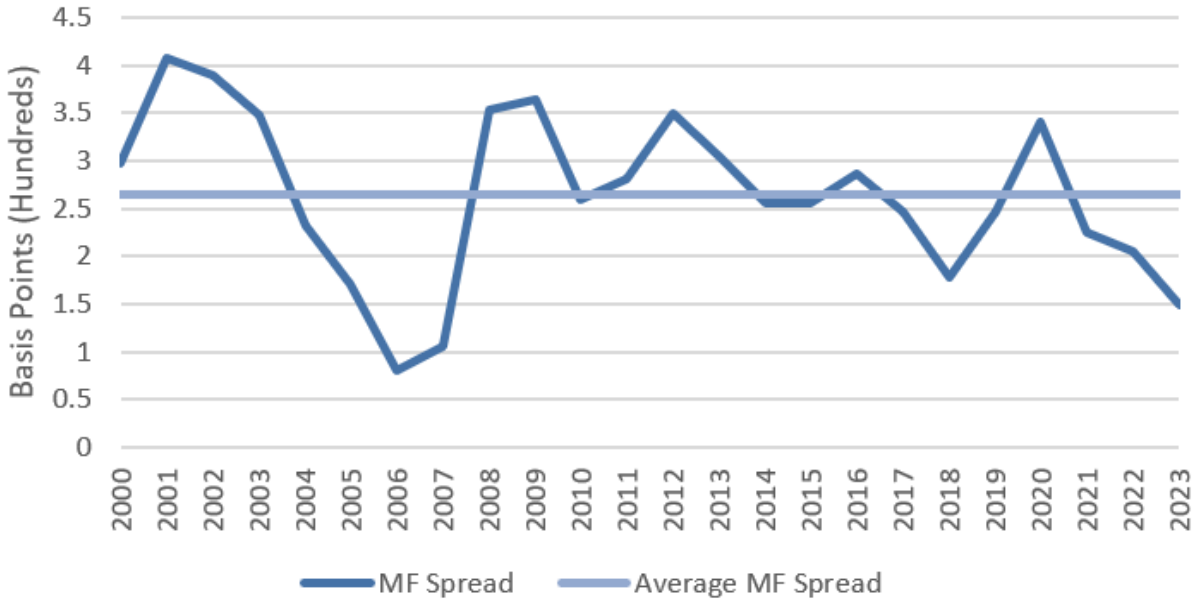


Figure 3: Industrial Cap Rate Spread Over 10-year Treasury from 2000-Q1 2023

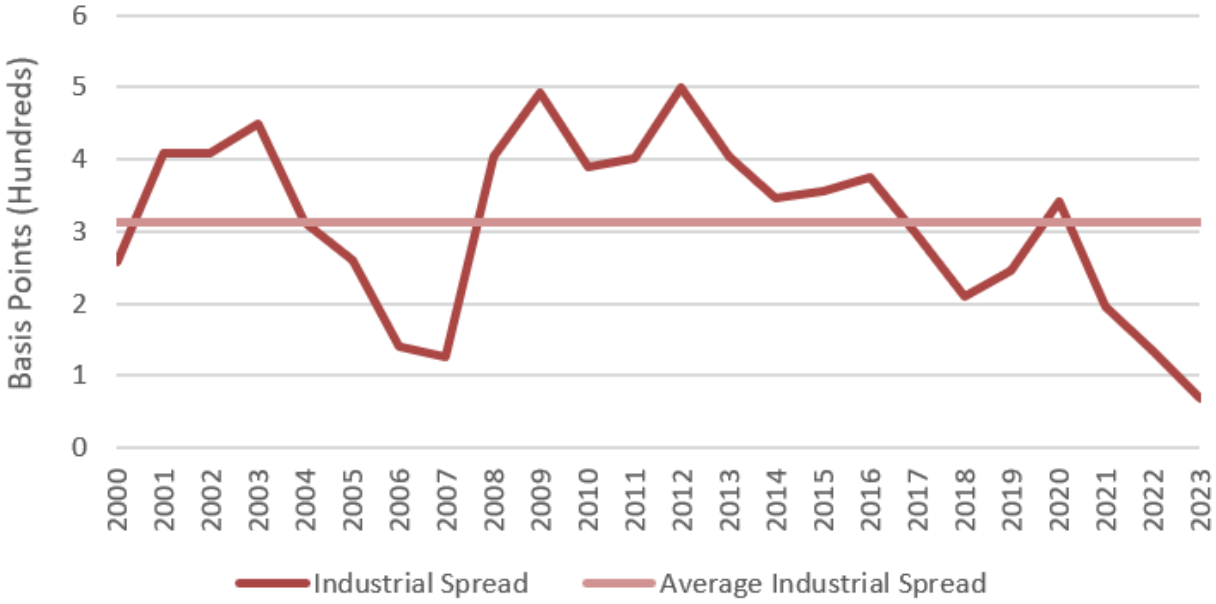
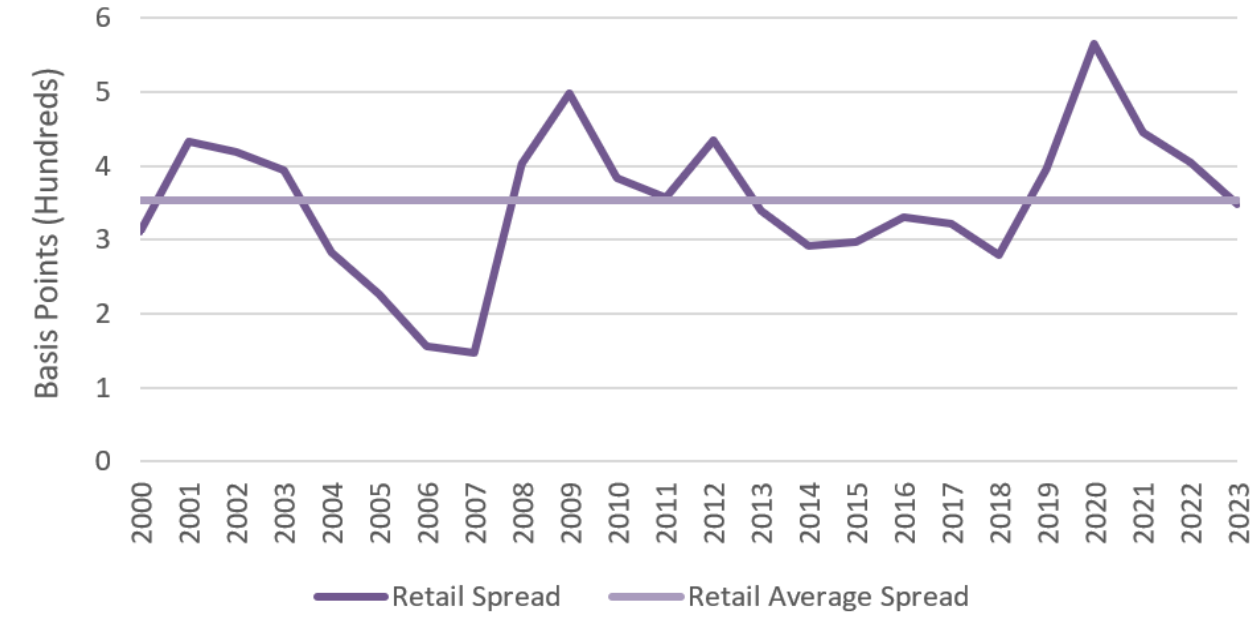
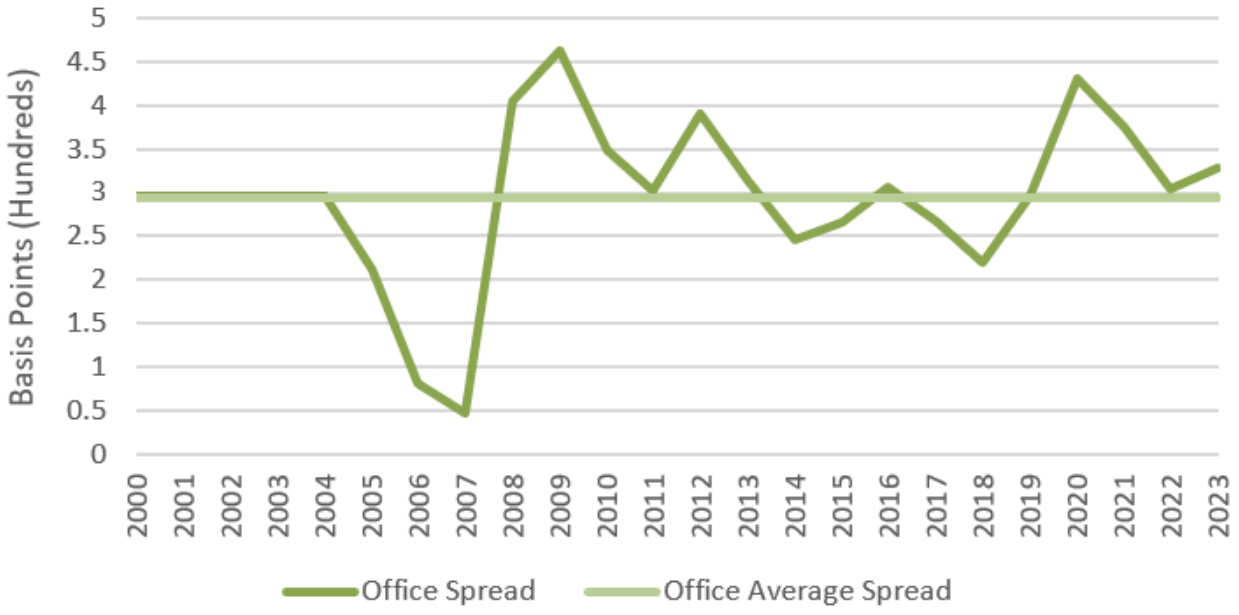


Figure 4 : Retail Cap Rate Spread Over 10-year Treasury from 2000-Q1 2023



*Note that strip centers, not malls, represent retail for this study.

Figure 5: Office Cap Rate Spread Over 10-year Treasury from 2005-Q1 2023



*Note that the Greenstreet data for office cap rates begins in 2005.

Table 1 shows the results from the multifamily regression analysis. Adjusted R-squared was 0.88, and all tested variables: 10-year treasury (tr), the prior year's average multifamily cap rate (past), and expected percent growth in market revenue per available foot (mrev), were considered significant at a .01 level. The individual impact each variable has on the multifamily regression model is displayed in Graph 1. The 10-year treasury had a coefficient of 0.319, meaning a 100 basis point increase in 10-year treasury yield would raise cap rates by 32 basis points. The prior year's cap rate had a coefficient of 0.463, meaning a 100 basis point increase in the prior cap rate, would increase cap rate by 46 basis points. Mrev, the expected percent growth in market revenue per available foot, had a coefficient of -0.077, signifying that a 100 bp increase in expected revenue growth, decreases the cap rate by 7.7 basis points. Chart 1 shows the calculated variable influence factors: 1.863 for tr, 2.236 for past, and 1.284 for mrev.

Table 1: Multifamily Regression Statistics

```
Call:
lm(formula = mfcap ~ tr + past + mrev, data = mfcapr)

Residuals:
    Min      1Q  Median      3Q     Max
-0.4672 -0.2187 -0.1095  0.2222  1.1073

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  2.17538    0.46054   4.724 0.000196 ***
tr           0.31945    0.10762   2.968 0.008615 **
past         0.46291    0.09604   4.820 0.000160 ***
mrev        -0.07730    0.02221  -3.480 0.002865 **
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.3992 on 17 degrees of freedom
Multiple R-squared:  0.9018,    Adjusted R-squared:  0.8845
F-statistic: 52.04 on 3 and 17 DF,  p-value: 8.884e-09
```

Figure 6: Multifamily 5-Fold Cross Validation Results

```
No pre-processing
Resampling: Cross-Validated (5 fold)
Summary of sample sizes: 17, 19, 17, 17, 18
Resampling results:

  RMSE       Rsquared   MAE
  0.4729362  0.8695836  0.3824973
```

Graph 1: Multifamily Added Variable Plots

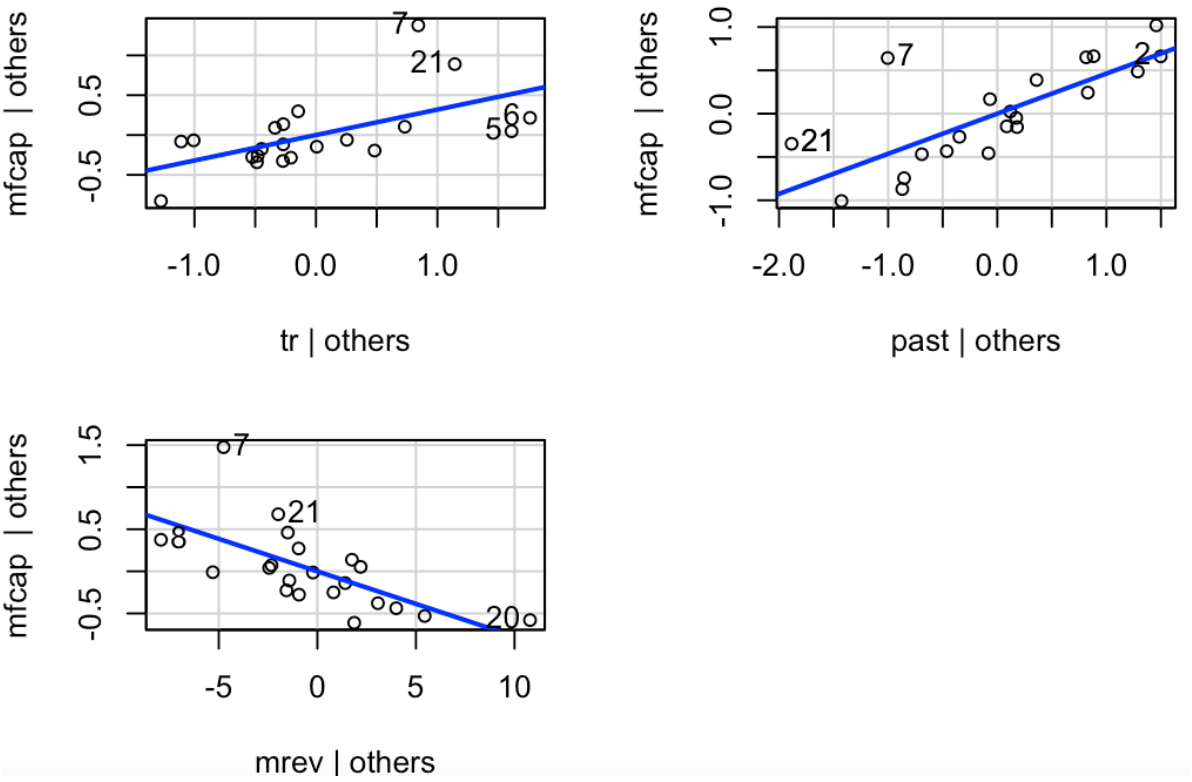


Chart 1: Multifamily Variance Inflation Factor

	VIF
tr	1.8625
past	2.2362
mrev	1.2838

Table 2 shows the results from the industrial regression analysis. Adjusted R-squared was 0.85. Prior cap rate was considered significant at a .01 level, but tr and mrev, were considered significant at a 0.1 level. The individual impact each variable has on the multifamily regression model is displayed in Graph 2. The 10-year treasury had a coefficient of 0.264, meaning a 100 basis point increase in 10-year treasury yield would raise cap rates by 26 basis points. The prior year's cap rate had a coefficient of 0.567, meaning a 100 basis point increase in the prior cap rate, would increase cap rate by 57 basis points. Mrev, the expected percent growth in revenue, had a coefficient of -0.055, signifying that a 100 bp increase in expected revenue growth, decreases the cap rate by 5.5 basis points. Chart 2 displays the calculated variable influence factors: 1.817 for tr, 3.841 for past, and 2.667 for mrev.

Table 2: Industrial Regression Statistics

```
Call:
lm(formula = indcap ~ tr + past + mrev, data = indr)

Residuals:
     Min       1Q   Median       3Q      Max
-0.73417 -0.46045  0.04191  0.32423  1.28647

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  2.01543    0.99157   2.033   0.0571 .
tr           0.26352    0.14816   1.779   0.0922 .
past         0.56696    0.16613   3.413   0.0031 **
mrev        -0.05465    0.02802  -1.950   0.0669 .
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.5976 on 18 degrees of freedom
Multiple R-squared:  0.8708,    Adjusted R-squared:  0.8493
F-statistic: 40.44 on 3 and 18 DF,  p-value: 3.321e-08
```

Figure 7: Industrial 5-Fold Cross Validation Results

```
No pre-processing
Resampling: Cross-Validated (5 fold)
Summary of sample sizes: 17, 19, 16, 17, 19
Resampling results:

  RMSE       Rsquared   MAE
  0.8194378  0.8514679  0.6590416
```

Graph 2: Industrial Added Variable Plots

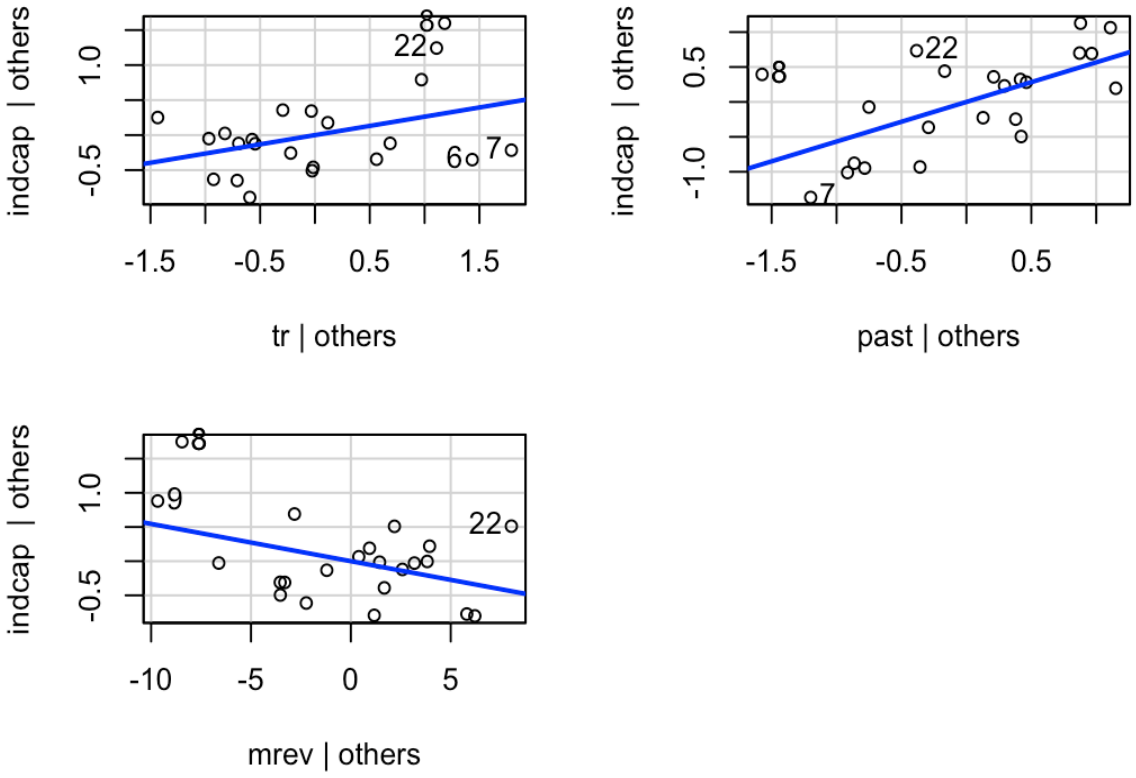


Chart 2: Industrial Variance Inflation Factor

	VIF
tr	1.8167
past	3.8409
mrev	2.6674

Table 3 shows the results from the retail regression analysis. Adjusted R-squared was 0.82. All tested variables were considered significant at a .05 level. The individual impact each variable has on the multifamily regression model is displayed in Graph 3. The 10-year treasury had a coefficient of 0.312, meaning a 100 basis point increase in 10-year treasury yield would raise cap rates by 31 basis points. The prior year's cap rate had a coefficient of 0.551, meaning a 100 basis point increase in the prior cap rate, would increase cap rate by 55 basis points. Mrev, the expected percent growth in market revenue per available foot, had a coefficient of -0.088, signifying that a 100 bp increase in expected revenue growth, decreases the cap rate by 8.8 basis points. Chart 3 shows the calculated variable influence factors: 2.168 for tr, 2.169 for past, and 1.280 for mrev.

Table 3: Retail Regression Statistics

```
Call:
lm(formula = retcap ~ tr + past + mrev, data = stripdatar)

Residuals:
    Min      1Q  Median      3Q     Max
-0.9804 -0.2713 -0.0906  0.2925  0.8328

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  2.03590    0.62661   3.249 0.004454 **
tr           0.31249    0.13254   2.358 0.029902 *
past         0.55082    0.12118   4.545 0.000251 ***
mrev        -0.08805    0.03482  -2.528 0.021032 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.4893 on 18 degrees of freedom
Multiple R-squared:  0.8464,    Adjusted R-squared:  0.8208
F-statistic: 33.05 on 3 and 18 DF,  p-value: 1.56e-07
```

Figure 8: Retail 5-Fold Cross Validation Results

```
No pre-processing
Resampling: Cross-Validated (5 fold)
Summary of sample sizes: 18, 17, 18, 17, 18
Resampling results:

  RMSE       Rsquared   MAE
  0.6298861  0.7264451  0.5057631
```

Graph 3: Retail Added Variable Plots

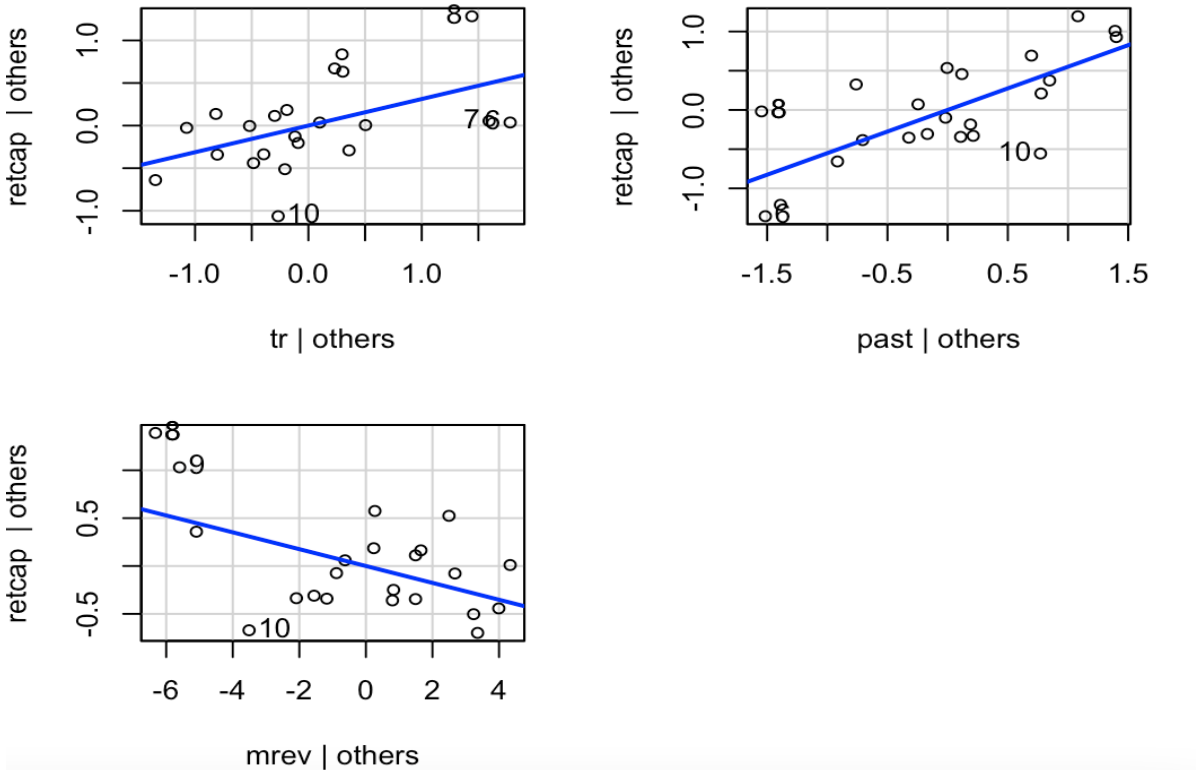


Chart 3: Retail Variance Inflation Factor

	VIF
tr	2.1683
past	2.1685
mrev	1.2799

Table 4 shows the results from the office regression analysis. Adjusted R-squared was 0.69. The past cap rate was not considered statistically significant. The 10-year treasury and mrev were considered significant at a .01 level. The individual impact each variable has on the multifamily regression model is displayed in Graph 4. The 10-year treasury had a coefficient of 0.489, meaning a 100 basis point increase in 10-year treasury yield would raise cap rates by 49 basis points. The prior year's cap rate had a coefficient of 0.236, meaning a 100 basis point increase in the prior cap rate would increase cap rate by 24 basis points. Mrev, the expected percent growth in market revenue per available foot, had a coefficient of -0.085, signifying that a 100 bp increase in expected revenue growth, decreases the cap rate by 8.5 basis points. Chart 4 shows the calculated variable influence factors: 1.614 for tr, 1.468 for past, and 1.434 for mrev.

Table 4: Office Regression Statistics

```
Call:
lm(formula = offcap ~ tr + past + mrev, data = offr)

Residuals:
     Min       1Q   Median       3Q      Max
-0.45289 -0.32086 -0.10612  0.06704  1.41541

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  3.13526    0.82501   3.800 0.002206 **
tr           0.48892    0.16070   3.043 0.009435 **
past         0.23624    0.16685   1.416 0.180325
mrev        -0.08498    0.02011  -4.227 0.000989 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.5225 on 13 degrees of freedom
Multiple R-squared:  0.7461,    Adjusted R-squared:  0.6875
F-statistic: 12.73 on 3 and 13 DF,  p-value: 0.0003623
```

Figure 9: Office 5-Fold Cross Validation Results

```
No pre-processing
Resampling: Cross-Validated (5 fold)
Summary of sample sizes: 13, 13, 14, 14, 14
Resampling results:

  RMSE       Rsquared   MAE
  0.5774973  0.5326596  0.4270852
```

Graph 4: Office Added Variable Plots

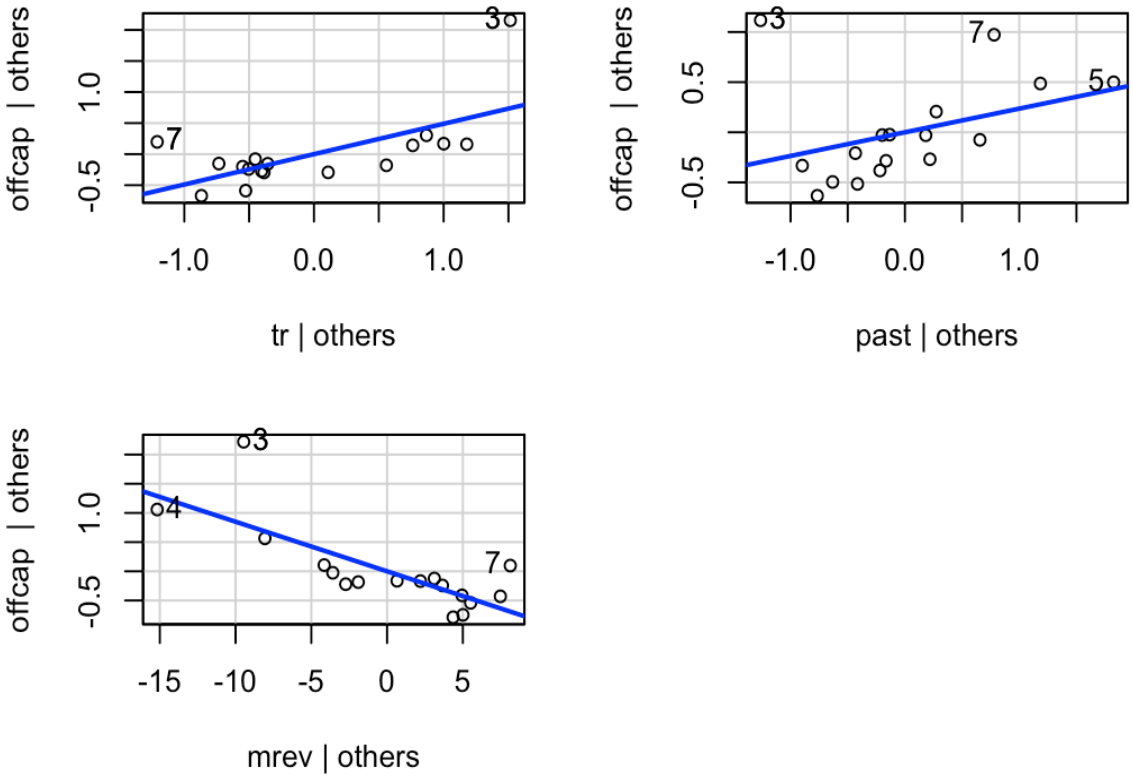


Chart 4: Office Variance Inflation Factor

	VIF
tr	1.6142
past	1.4681
mrev	1.4337

Discussion

This study utilizes the same dependent variables in each regression model in order to understand how the cap rates of different asset classes react differently to broader economic conditions. The chosen variables seem to best represent multifamily properties as that regression model achieved the highest adjusted R-squared at 0.88. However, it should be noted that the Greenstreet data for multifamily properties may be more accurate since 55% of multifamily properties are institutionally owned and it is the largest component of the commercial real estate industry with an estimated worth of $3.8 trillion, compared to $3.2 trillion for office, $2.9 trillion for retail, and $2.4 trillion for industrial (*Estimating the Size*, 2021).

Percent expected revenue growth had the largest impact on retail and office cap rates with rates decreasing 8.8 bps and 8.5 bps respectively for each 100 bp increase in expected revenue growth. The expected growth was less impactful at 7.7 bps for multifamily, and even less at 5.5 for industrial. The 10-year treasury rate had the largest impact on office properties, with cap rates increasing 49 bps for every 100 bps increase in 10-year treasury yield. This reduced to 32 bps for multifamily, 31 bps for retail, and only 26 basis points for industrial. Past cap rates were most impactful for industrial at 57 bps, followed by retail at 55 bps, multifamily at 46 bps and finally office at only 24 bps. The office cap rate regression has the lowest adjusted R-squared at 0.69, but it should be noted that this regression was performed with only 13 degrees of freedom, due to Greenstreet office cap rate reporting beginning in 2005.

To expand on this study and explain greater variance within cap rates, the variables included in the regression could be specifically tailored to the various asset classes. For example, treasury and expected revenue growth had very little impact on industrial cap rates. This may be because the asset class is relatively new and small. It has become especially lucrative only in the

past few years as e-commerce has grown. Therefore, it may make more sense to regress industrial cap rates on the amount of sales in the e-commerce sector. It is found that every $1 billion of growth in the e-commerce sector requires an extra 1.2 million square feet of new warehouse space (*Global E-Commerce Impact on Logistics Real Estate*, 2021). Office and retail were the two asset classes most affected by the expected revenue growth. Retail cap rates could also be regressed on disposable personal income as that may contribute to expected revenue growth for retail. The 10-year treasury had the greatest impact on office cap rates which connects office cap rates to the health of the national economy. It may make sense to add GDP and unemployment metrics as regressors to office cap rates.

Conclusion

The magnitude of each regressor's impact varied depending on the asset class. Out of the four asset classes studied, the expected revenue growth regressor had the greatest effect on office and retail cap rates. The 10-year treasury also had the greatest impact on office cap rates. Past cap rates had the greatest impact on industrial properties, perhaps due to its recent emergence and growth as a lucrative asset class. Multifamily seems to be the most resilient and consistent overall. The three regressors explained 88% of the variation within multifamily cap rates and this asset class has had the lowest historical average spread over the 10-year treasury at just over 250 basis points. Despite the variation in magnitude of regressor impact, the sign remained consistent for each regressor; increases in the 10-year treasury and prior cap rates increased cap rates and increases in expected annual revenue percent growth decreased cap rates.

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