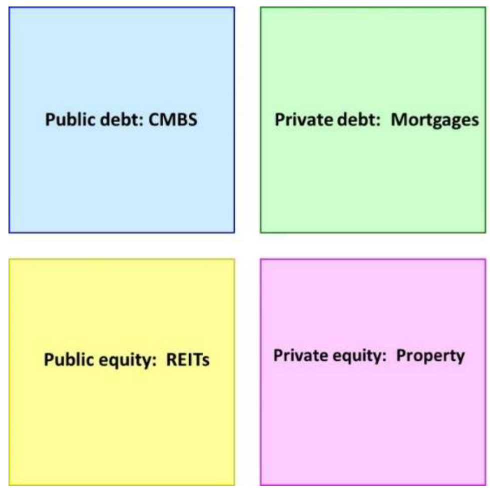
A Pragmatic Approach to
Real Estate Quadrants
Intriguing, Interdependent and Complex



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Prepared for CBRE Econometric Advisors

May 6, 2024

Contents

I. Introduction[1]: The Tactile and the Intangible

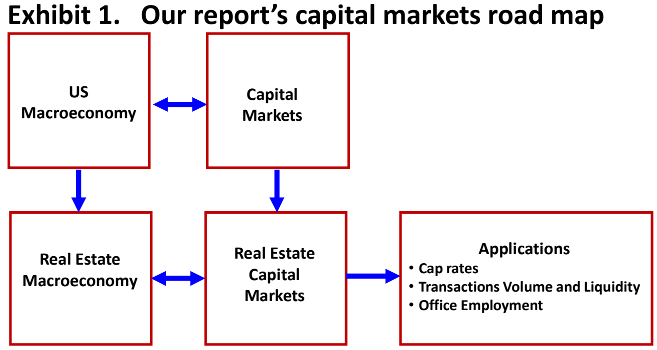
Why entitle this report, "A Pragmatic Approach to Real Estate Quadrants—Intriguingly Interdependent and Complex"? Most references to "quadrants" use the term to indicate a classification scheme; they even include "theory" to lend it respectability, but usually there is little theory. People often use the term "four quadrants", but that seems redundant like "round circles". This report asks, is there a quantifiable theory lurking within and between the quadrants? I believe there is, but dissecting the quadrants is like solving a puzzle. An important finding is that capital market variables already discount macroeconomic conditions and consequently analysts should include these variables in their models.

The relationships between quadrants are complex and highly interdependent. Therein lies one of our deepest and most important insights. I consider these relationships very intriguing. Importantly, even the most skeptical investors will find the results compelling and eminently pragmatic. (See Appendix D for sources and notes for exhibits.)

Investors like to think of property as bricks and mortar ("Bricks"), or something that is tangible or even tactile. Investing in property involves buying financial instruments collateralized by income flowing from property. While the certificates of ownership are tangible, the associated risks and expected returns are intangible. The Bricks may be spatially fixed, but capital is global, mobile, and, in bad times, fleeting. More complex and no less intangible are packages of mortgages called commercial mortgage-backed securities (CMBS). I show that the capital markets price risk and that, in equilibrium—a big assumption—risk adjusted returns equilibrate globally through capital flows. Real estate—property, mortgages, CMBS and REITs—is embedded within the overall economy. The demand for property is a derived demand. Feedbacks, lags, and expectations complicate the pricing system. Importantly, real estate is a hybrid asset consisting of debt- and options-like components, such as leveraged equity. Other embedded options include the options to lease, to abandon or to develop.

Who should read this report? Certainly, investors and operators should. This report covers new ground; it focuses on the intersection between private and public markets and the evaluation and forecasting or returns, risk and value across the quadrants. Our research fills an important gap. If you are interested in risk management or asset allocation, this paper is for you.

Exhibit 1. Our report's capital markets road map



[1] CBRE-Econometric Advisors invited Dr. Randall Zisler prepare this paper on the real estate quadrants. His approach reflects a multifaceted career as a finance and economics professor Princeton University, Wall Street research director at Goldman Sachs & Co. and Nomura Securities International, pension fund consultant partner and Pension Consulting Alliance, and head of investment banking at Jones Lang LaSalle. CBRE-EA is serializing this paper, which will be sent to CBRE's global mailing list.

II. Executive summary

1. **Linking real estate operations to value, returns and risks.** This report presents a comprehensive quantitative framework for the analysis of real estate capital markets through the lens of the real estate quadrants. My goal is to econometrically analyze the function of each quadrant and the linkages between the quadrants. I conclude that the capital markets are an integral part of the real estate economy and macro models should explicitly include capital markets variables.

2. **The quadrants—more a classification scheme than a theory**. The quadrants are distinct but interdependent. Understanding one quadrant requires an appreciation of all quadrants.

3. **Return smoothing and data intricacies**. Public and private return processes differ and the statistical characteristics of their respective returns reflect these differences. Private returns at times should be corrected statistically for serial correlation, which is an indicator of illiquidity. (See pages 8 - 11, "The Challenges of Public and Private Market Data".) I introduce the quadrants along with an analysis of information flow between quadrants. (See page 13, Exhibit 13.)

4. **Quadrant 1 CMBS returns**. BBB-rated CMBS total returns are a function of the high yield corporate bond yield, current leveraged and one-quarter lagged unleveraged property returns. (Page 14)

5. **Quadrant 2 Mortgage returns**. Mortgage returns reflect BBB CMBS returns, the BBB-rated corporate bond return, the BAA corporate bond return and the bond default premium. (Page 20)

6. **Quadrant 3 REIT returns**. REITs total returns are a function of small cap stock returns and unleveraged property returns (current and lagged). (Page 23)

7. **Quadrant 4 Property returns**. Leverage property returns reflect BBB-rated CMBS, equity REIT returns, the NOI growth rate lagged four quarters, the spread between current and four quarter lagged sales transactions volume, and leveraged property returns lagged a quarter. (Page 25)

8. **Where the rubber meets the road—Three applications**. Theory is great but what about practice? I apply my findings to an analysis of the capital markets determinants of cap rates, transactions volume, and office employment. Transactions volume helps explain property returns. (Page 36)

9. **The right tool for the job**. Our findings, which provide a better appreciation of risk, are pragmatic. For example, I advocate using Monte Carlo, not traditional deterministic, analysis when pricing complex investments with embedded options. Deals are replete with embedded options—the options to default, renew leases, redevelop, and escalate rents. These options are call options, the values of which increase with volatility. Using the wrong tools leaves value on the table and causes investors—LPs and GPs—to incur uncompensated, often hidden, risks.

III. Preliminary considerations

I often hear to my chagrin terms such as "four quadrants" or "four quadrant theory". The former is redundant; the latter makes no sense. The quadrants represent a construct or classification, not a theory. Nothing inherent in "quadrant" suggests testable hypotheses or predictive modeling, which, if empirically valid, might support a theory.

This semantic excursion does not discredit in any way the importance of our topic, nor does it minimize the value of rigorously dissecting the quadrants in search of enduring relationships that truly matter.

What drives quadrant performance? This paper solves a long-standing and largely ignored puzzle by unlocking the stylized facts lurking within and between the quadrants themselves. The analysis, which straddles real estate and the capital markets, clarifies the relationships between public and private, equity and debt. Our approach is as eminently pragmatic as it is compelling.

A. The quadrants are distinct but interdependent—more than a classification scheme. The quadrants categorize real estate financial instruments; while property is just one component (or quadrant) of real estate, it is the feed stock of the other quadrants. The other quadrants represent alternative ways to package, price and trade property. Exhibit 2 reports the most recent estimated outstanding capitalizations provided by the Pension Real Estate Association.

Exhibit 2. The real estate quadrants: $8.4 trillion as of 2023:II

	Public	Private
Debt	**Quadrant 1: Public debt** Size*: $1.745 trillion	**Quadrant 2: Mortgages** Size*: $3.781 trillion
Equity	**Quadrant 3: REITs** Size*: $1.086 trillion	**Quadrant 4: Property** Size*: $1.813 trillion

The quadrants are neither homogeneous nor are they independent; they are inseparably bound. Property, which comprises the fourth quadrant, is often, but not always, leveraged with senior and sometimes mezzanine debt. The second quadrant includes only private debt, primarily senior mortgages. Commercial mortgages, which populate the first quadrant, collateralize CMBS, senior and subordinate tranches. The value of mortgage-backed securities depends on the priority with which losses and income are assigned to the various tranches or classes. The more senior is the class, the less risky are its returns. To the extent that property markets weaken or loan-to-value ratios change, for example, the performance of all quadrants, not just one, change.

Total quadrant capitalization was $8.4 trillion by 2023.II, according to the Pension Real Estate Association. Mortgage debt comprised $3.8 trillion and property (equity) was 1.8 trillion, which implies leverage of 68%. REITS account for $1.1 trillion and public debt was about $1.8 trillion.

B. The data Tower of Babel: Which cap rate is most appropriate? The Tower of Babel is a metaphor or symbol of disunity and chaotic communication, a state of affairs that resembles the proliferation of real estate data; this cacophony seems at times conflicting, if not confusing. Cap rates are an example. Proponents of technologically-enabled global real estate capital markets should eschew a Tower of Babel; consistency and transparency should be the norm. A related issue is that real estate data lack sufficient granularity, especially at the levels of MSAs and their submarkets. Another problem, which we do not pursue, is that customary analytic practices may not be up to the challenges imposed by the data and the complexity of markets. For example, traditional deterministic methods are not an adequate substitute for Monte Carlo analysis of real estate risk.

Many capital market times series reflect the longer-term proliferation of new capital markets instruments including derivatives. By comparison, the evolution of real estate capital markets has been slower, but the real estate capital markets are evolving and with this evolution we witness a significant increase in the number of real estate capital markets data series. Collection methodologies vary and many may not be rigorous.

Exhibit 3. Office cap rates: RCA, NPI appraisal equity weighted, and NPI value weighted

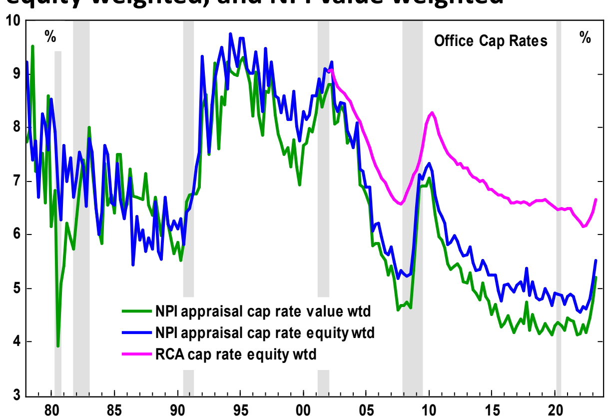
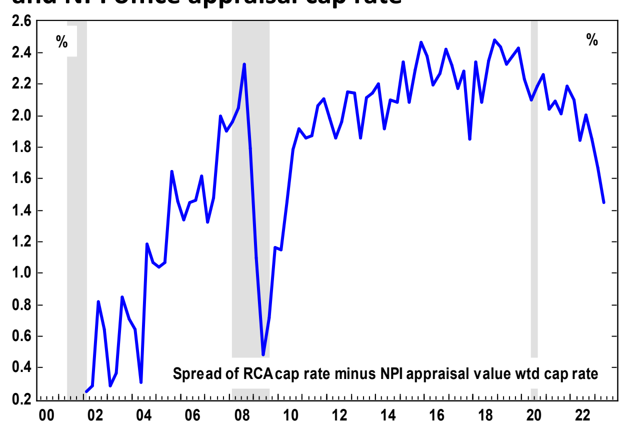


Exhibit 4. Spread between RCA office cap rate and NPI office appraisal cap rate



There are often several versions of the similar variables, such as cap rates[2], which have recently diverged, as shown in Exhibits 3 and 4. Which cap rate is most appropriate and for whom? The investors? The brokers? The academics?

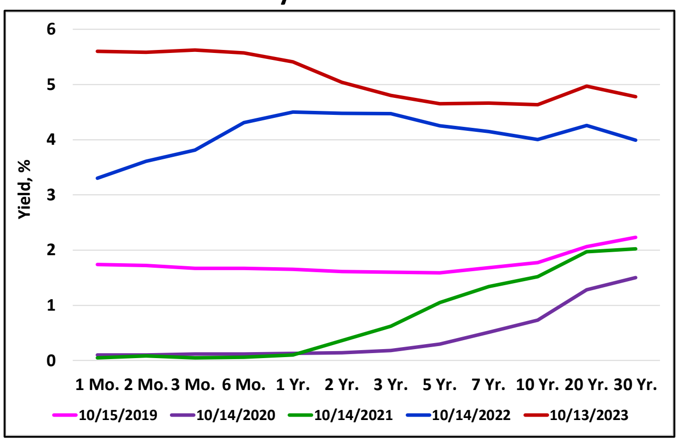
[2] Many investors, especially pension funds and their advisors, prefer the NCREIF ODCE performance index. However, they may not realize that the ODCE index is very similar statistically to the NPI unleveraged property return index, as shown below. The

C. Capital markets: Equity and fixed income. I now introduce some of the more important general capital markets determinants of real estate value, return and risk. These variables are prominently featured in the econometric models that follow.

The curve, as shown in Exhibit 5, is relatively flat as of October 14, 2023. The one-month Treasury yield is 5.60% whereas the 30-year Treasury yield is 4.78. On October 14, 2021, the short- and long-horizon yields were 0.05% and 2.02%.

The yield curve affects the capital markets in a multiplicity of ways. Investors price securities, private and public, either directly or indirectly, based on the yield curve. I show that seemingly unrelated bond yields and total returns are important factors in explaining the total returns of CMBS, mortgages, REITs, and property. Baa-rated bond yields, an important predictor of property yields, are more volatile than AAA-rated bonds, as shown in Exhibit 6. Small cap stock and S&P 500 total returns are highly correlated and small cap stocks have similar volatility. (See Exhibits 7.) I show later in this report that small cap stock returns help explain equity REIT returns.

Exhibit 5. 2019 – 2023 yield curves



ODCE performance return index, NPIODCE, is highly correlated with the leveraged NPI and especially with the NPI unleveraged return indices. With regard to the regression of ODCE on the unleveraged index, the adjusted R^2 is 0.989 and the coefficient on the unleveraged NPI return is close to unity. Investors should not use ODCE as a benchmark for value-add or opportunistic deals; this index is more appropriate for core-like assets and portfolios.

$$NPIODCE_t = 0.368 + 0.648 * NPILEV_t \quad (1)$$

(4.383) (28.590)

Adjusted R^2 = 0.952
DW = 0.760
Mean dependent variable = 1.898
S.D. dependent var = 1.921
S.E. of regression = 0.420

$$NPIODCE_t = -0.194 + 1.070 * NPIUNLEV_t \quad (2)$$

(-4.282) (62.123)

Adjusted R^2 = 0.989
DW = 1.805
Mean dependent variable = 1.898
S.D. dependent var = 1.921
S.E. of regression = 0.197

Exhibit 6. AAA- and Baa-rated bond returns are important in explaining real estate returns and yields.

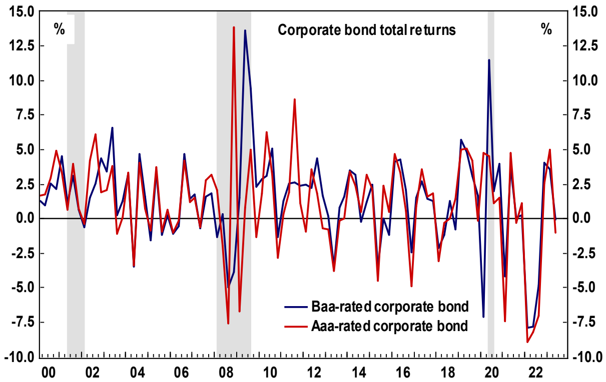
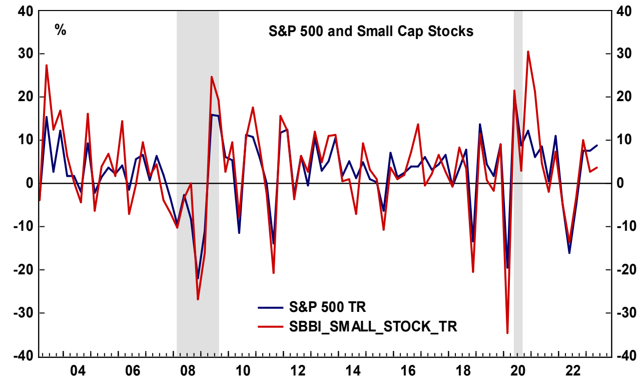


Exhibit 7. Small cap and S&P 500 stocks are highly correlated, but small cap stocks are more volatile. REITS and small cap stocks have similar coefficients of variation.



D. The challenges of public and private market data: A comparative analysis. The characteristics of private market and public market return data differ in important and material ways that affect risk and public-private analyses. Private assets do not trade in continuous auction markets as do publicly traded stocks (such as REITs) and some fixed income securities. Private market pricing is backward-looking due to appraisal and other pricing methodologies; these markets react with a lag to public market shocks. That is why the public markets, as we shall show, help us predict private asset performance. Moreover, since property returns exhibit serial correlation or smoothing, past property returns can predict to some degree future returns; such is not the case with heavily traded stocks like the S&P 500 or public REITs, which exhibit little, if any, serial correlation.

Public markets are more transparent and more liquid; by contrast, private markets are illiquid and transactions costs are higher. Private returns are serially correlated or smoothed because they are backward-looking. Public market prices, which impound information almost instantaneously, are forward looking; they exhibit near random fluctuations, as theory would suggest. The randomness of public prices does not mean, however, that public markets defy or lack causality. Quite the contrary. Public markets are just more efficient at impounding news; prices fluctuate as if they are random.

The degree to which serial correlation affects returns is an important distinction between private real estate and public real estate markets because it poses some empirical challenges, especially if we compare the risk-return performance of, say, REITs with property, or if we want to determine the optimal asset allocation in a portfolio of widely traded stocks, bonds as well as property and mortgages. Serial correlation masks risk; investors incorrectly believe that property is less risky than stocks. It is not.

Correcting for serial correlation shows that property's true return volatility is similar to that of traded equity REITs. I compare past and current total quarterly returns of traded public shares—S&P 500 (SP) and all equity REITs (REIT)—with leveraged property (the NCREIF all-property leveraged index).

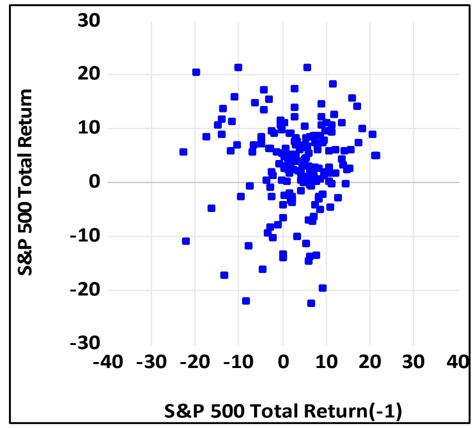
Past S&P 500 returns do not predict current returns, which is a characteristic of an efficient market. The coefficients on the lagged-dependent variables are not significantly different from zero:

$$SP_t = 3.218 + 0.021 * SP_{t-1} + 0.003 * SP_{t-2} - 0.051 * SP_{t-3} \quad (3)$$

(4.428) (0.274) (0.046) (-0.676)

Adjusted R^2 = -0.014
DW = 1.988
Mean dependent variable = 3.137
S.D. dependent var = 8.038
S.E. of regression = 8.095

Exhibit 8. Past S&P 500 returns do not predict current S&P returns.



A scatter of the public assets, S&P 500 and equity REITs, indicates that there is no statistically significant relationship between past and current returns. (See Exhibits 8 and 9.) T-statistics in parentheses and adjusted R^2 are insignificant. The coefficient on each variable, lagged one quarter, is essentially zero statistically.

$$REIT_t = 3.417 + 0.088 * REIT_{t-1} - 0.112 * REIT_{t-2}$$

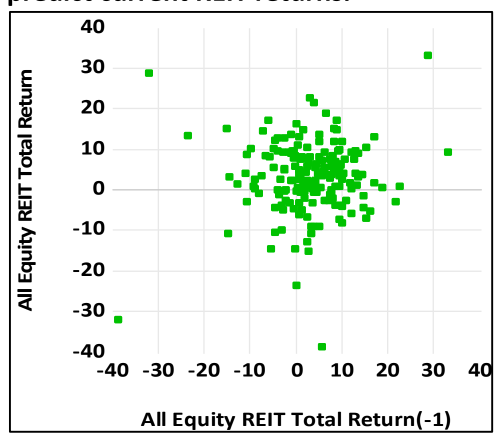
(4.397) (1.174) (-1.484)

$$-0.058 * REIT_{t-3} \quad (4)$$

(-0.773)

Adjusted R^2 = 0.008
DW = 2.000
Mean dependent variable = 3.159
S.D. dependent var = 8.901
S.E. of regression = 8.867

Exhibit 9. Past REIT returns do not predict current REIT returns.



Leverage property exhibits serial correlation as indicated by the linear scatter in Exhibit 10 and the following regression. The coefficients on the lagged variables are significant.

$$NPILEV_t = 0.588 + 0.721 * NPILEV_{t-1} + 0.340 * NPILEV_{t-2}$$

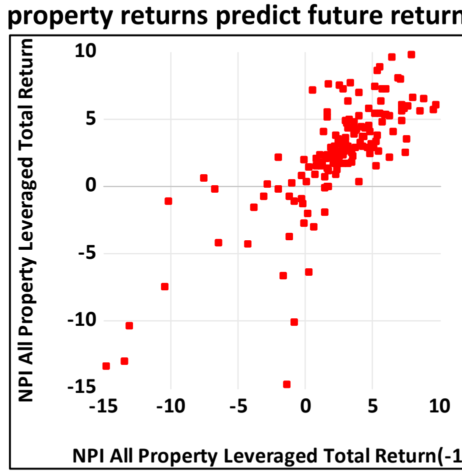
(2.525) (9.452) (3.697)

$$-0.316 NPILEV_{t-3} \quad (5)$$

(-4.072)

Adjusted R^2 = 0.641
DW = 1.967
Mean dependent variable = 2.387
S.D. dependent var = 4.006
S.E. of regression = 2.401

Exhibit 10. Past serially correlated property returns predict future returns.



The coefficients on past values of NPI are statistically significant, as indicated by the high t-statistics. The past three quarters explains about 64% of the variation in current leveraged property returns. When comparing property and REIT returns, for example, then one must correct for serial correlation.

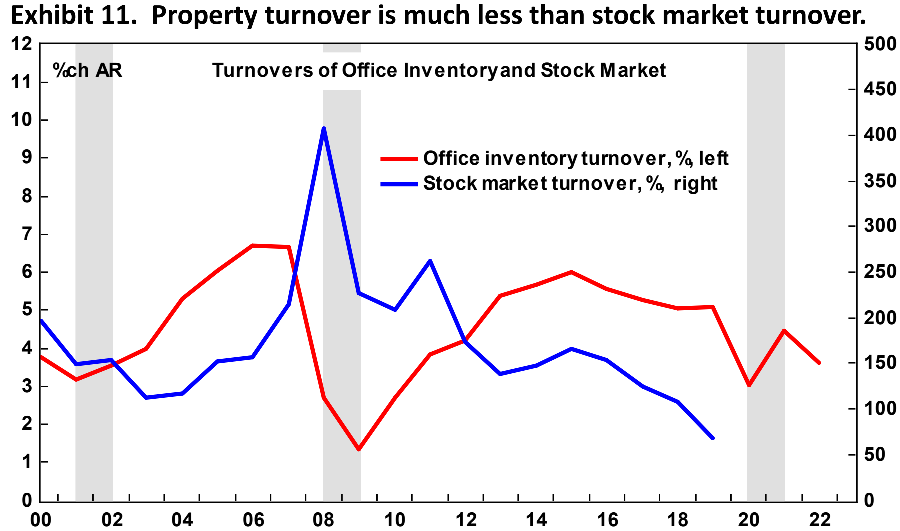
E. Turnover and liquidity. The trade ratio—the value of trades divided by capitalization—affects property returns and, in turn, capital markets factors affect turnover, as we show in "Application 2. Transactions volume and liquidity" (See page 42.)

Turnover ratios differ according to type of security, MSA, and other characteristics. For example, the speed with which prices impound new information differs, often in dramatic ways, between the stock and property markets. The trade ratio is also a measure of liquidity. If news arrives with a lag or if valuations are backward-looking, as they are in the case of appraisals, then investors hesitate until clarity improves and conviction increases.

In Application 2, we explore transactions volume, or turnover, in greater detail and show that, due to illiquidity or imperfections in information flow within the property market, property turnover is significantly lower than turnover in the stock market. During deep recessions, transactions volume craters and liquidity practically vanishes, e.g., during the GFC. Illiquidity, low turnover, and serially correlated, or smoothed, returns are an indication that property markets at their deepest level differ from continuous auction markets, such as the stock market.

Exhibit 11 shows that office property (OFFICETURN) and stock market turnover (STOCKTURN) percentages were 2.7% and 407.6%, respectively, at the onset of the GFC. The property turnover rate is now 3.6%, a small fraction of stock market turnover. Investors who are accustomed to vastly greater liquidity in the stock market should not take comfort that measured or unadjusted property returns have lower (naively) measured volatility than do stocks. Appropriate de-smoothing produces an unbiased standard deviation or property return risk measure that is comparable to that of equity REIT returns. Publicly traded REIT and property returns exhibit similar risks!

Exhibit 11. Property turnover is much less than stock market turnover.



What is the relationship between stock market and office property turnover (or liquidity), for example? Exhibit 11, and the following regression shows that the turnover in stocks leads the turnover in property markets by one year. The model says, if stock turnover increased last year, then property turnover will decrease this year. My model explains 32% of property turnover variable. Note that the coefficient on stock turnover lagged one period is relatively small.

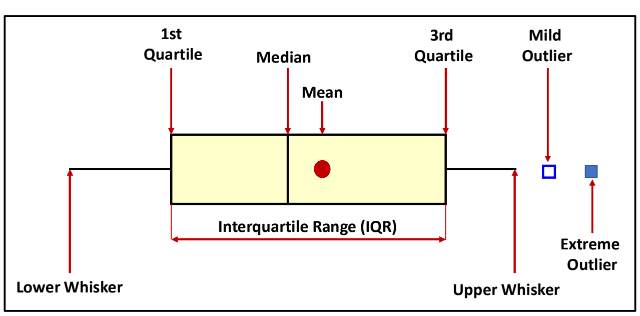
$$\boldsymbol{OFFICETURN_t = 6.653 - 0.012 * STOCKTURN_{t-1}} \quad \textbf{(6)}$$

(9.195) (-3.124)

Adjusted R^2 = 0.315
DW = 0.899
Mean dependent variable = 4.560
S.D. dependent var = 1.474
S.E. of regression = 1.219

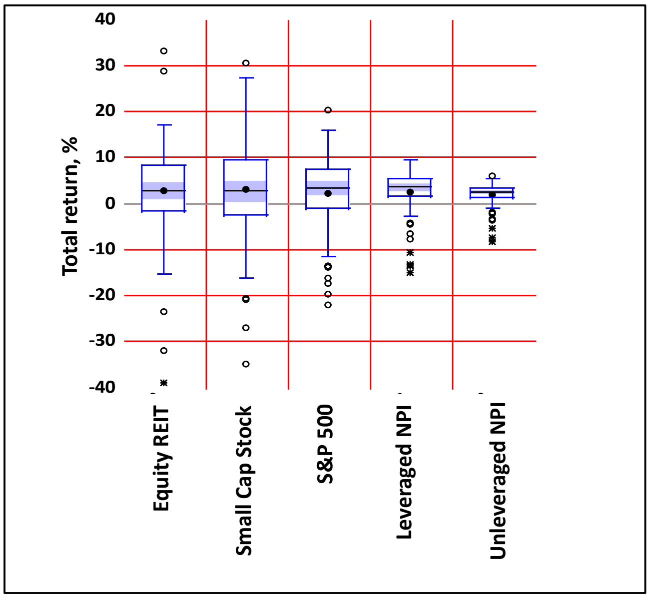
F. Descriptive statistics. Exhibit 12 shows box-whisker[3] plots of equity REITs, small cap stocks, S&P500 stocks, and the leveraged and the unleveraged NPI property returns. The plots indicate the extent to which the means and dispersions differ. Note that the two property indexes have a much lower measured spread due to return smoothing.

[3] **Definition of a box-whisker plot.** Specifically, the plot includes the interquartile range (IQR), which spans the second and third quartile. Within the IWR is the median and the mean. If the distribution is symmetrical, then the mean and the median are identical. Outliers that differ significantly from the rest of the dataset may be plotted as individual points beyond the whiskers on the box-plot. Box plots are non-parametric: they display variation in samples of a statistical population without making any assumptions of the underlying statistical distribution, which we did in the previous section. The spacings in each subsection of the box-plot indicate the degree of dispersion (spread) and skewness of the data. In addition, the box-plot allows visual inspection of various estimators, notably the interquartile range, mid hinge, range, mid-range, the mean and the median.



Source: Zisler Capital Associates, LLC

Exhibit 12. Box whisker plots



G. Applications preview: Why study the quadrants?

We show that the quadrants are interdependent. If the goal is forecasting total returns in one quadrant, then we must reach out to the other quadrants for help. For example, publicly traded REITs impound property market information faster than property prices can react.

Transactions volume is an important variable that helps explain leveraged property returns. Transactions data, which are serially correlated, impound important property market information and are useful in forecasting returns.

Cap rates reflect capital markets factors that include AAA- and Baa-rated corporate bond yields.

I apply these ideas in the following:

- **Application 1. Cap rates**. The cap rate is equal to the ratio of NOI to price, both of which are positively correlated with each other. This correlation helps explain why cap rates are less volatile than returns and more resistant to economic shocks, the long-awaited recent rise in cap rates notwithstanding. Exit cap rates are stochastic (uncertain) as are market rental growth rates.[4] (See page 39.)

- **Application 2. Transactions volume and liquidity**. I show that the rate at which the inventory turns over due to property sales is a good measure of liquidity and serial correlation. Serial correlation is also a good proxy for liquidity, and we use this proxy to measure MSA liquidity, which we model using quadrant-driven information. Liquidity, which varies by MSA, is an important variable in explaining property performance; it reflects capital markets factors. This application relates to a broader issue, which is the variation of market risk and liquidity across MSAs. I believe that the usual market research does not address this issue appropriately and,

[4] These findings are relevant to the pricing of highly structured transactions using Monte Carlo methods. These transactions include waterfalls, LP and GP positions, leverage and complex capital structures.

as a result, it may leave value on the table or cause investors to assume uncompensated or needless risk. (See page 44.)

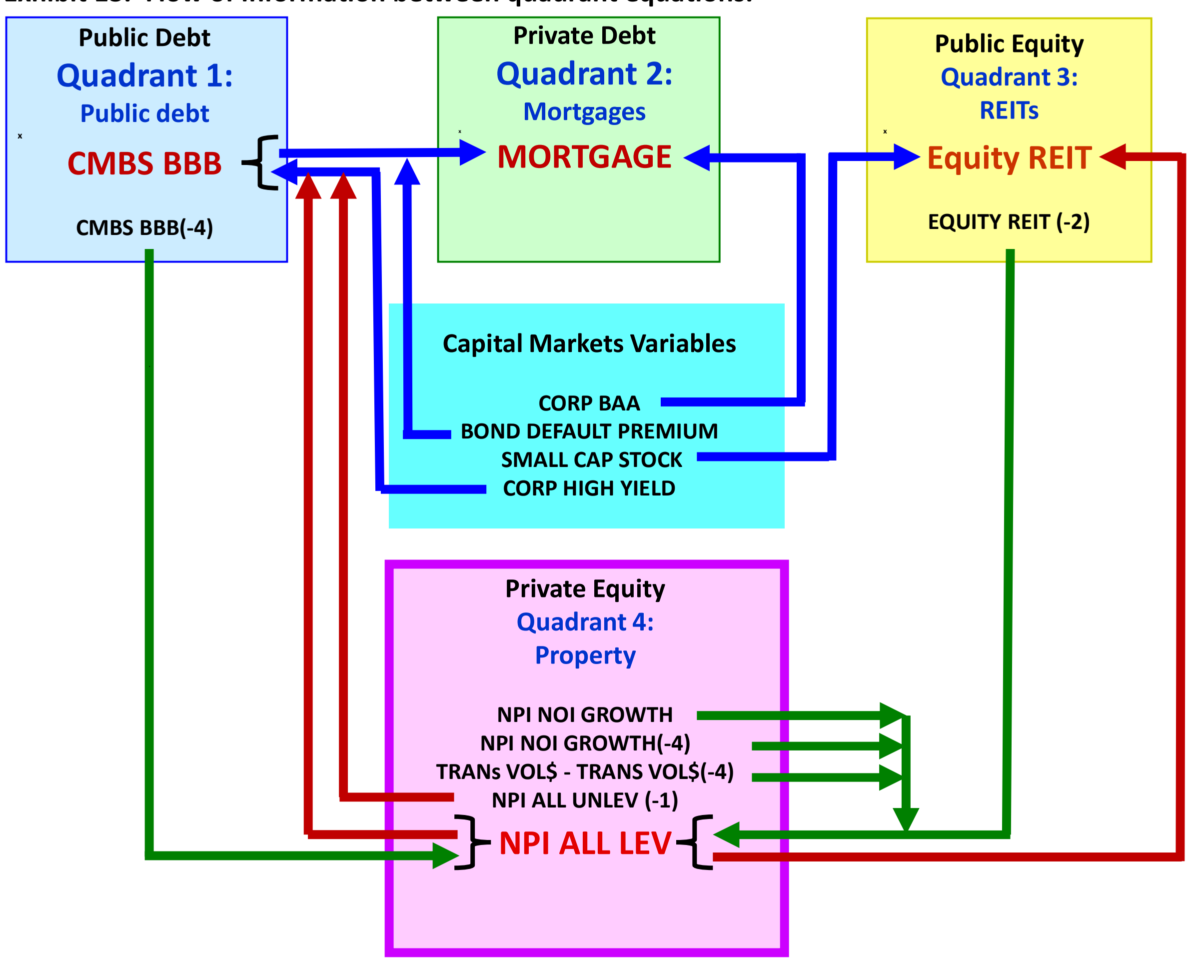
- **Application 3. Office employment**. Capital market conditions also affect the user demand for property, which is a function of the demand for office workers, or finance, insurance, and real estate (FIRE) workers. As an example, I draw on the quadrants to explain changes in FIRE employment, which is a function of NOI growth, lenders' expectations, bond yields, and transactions volume. I investigate the relationship between changes in profitability and FIRE employment. When employment increases, which represents an increase in current expenses, profitability declines. However, profits increase with growth in nominal GDP. (See page 48.)

IV. Quadrant Return Analysis

Overview. Our quadrant analysis consists of total return models of BBB-rated CMBS (Quadrant 1), mortgages (Quadrant 2), publicly traded equity REITs (Quadrant 3) and leveraged property (Quadrant 4.) The analysis of each quadrant includes performance graphs and a total return model. The capital markets and other data selected across the quadrants and the overall capital markets contribute the explanatory variables. I find that certain variables, such as the performance of BBB-rated CMBS lagged four quarters, are important variable in explaining property returns.

Exhibit 13 illustrates the data flow between quadrants. For example, Quadrant 4 contributes data to Quadrant 1 (CMBS) and Quadrant 3 (REITs), but receives data from Quadrants 1 and 3. Quadrant 2 just receives data from Quadrants 1 and 3 as well as from the general capital markets, e.g., bond default premium. We now introduce the models for each quadrant.

Exhibit 13. Flow of information between quadrant equations.



We now introduce the quadrant models.

Quadrant 1. Public Debt (CMBS)

Discussion. Public real estate debt includes commercial mortgage-backed securities or CMBS. Returns are marginally negative. However, spreads, while still high, are moderating a bit, as shown in Exhibit 17. The BBB - AAA-rated CMBS bond spread, cyclically wide, is negatively correlated with the leveraged property total return. CMBS subordinate bonds are typically more sensitive to real estate conditions than are the AAA-tranches.

Exhibit 14. AAA-rated CMBS returns

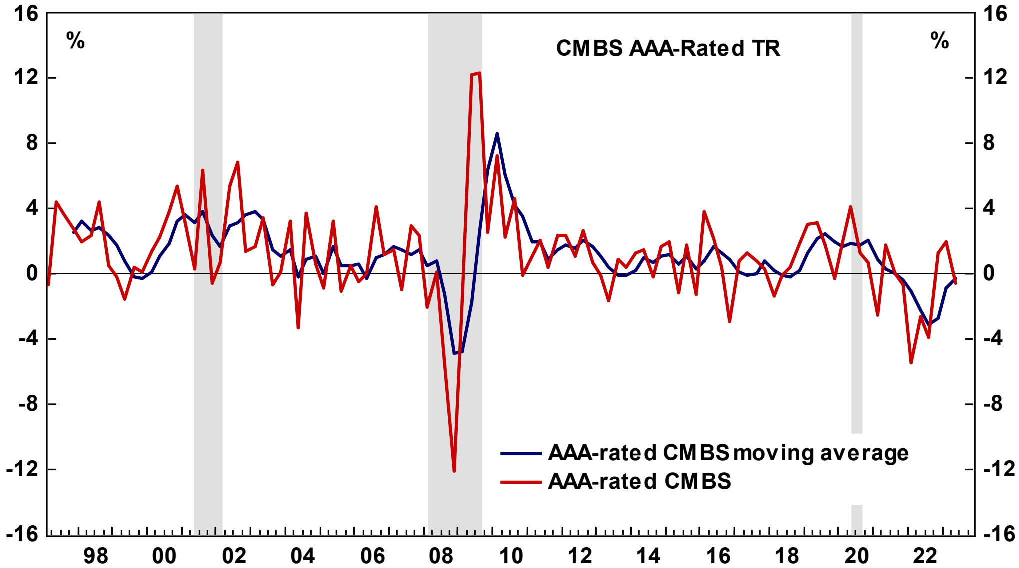
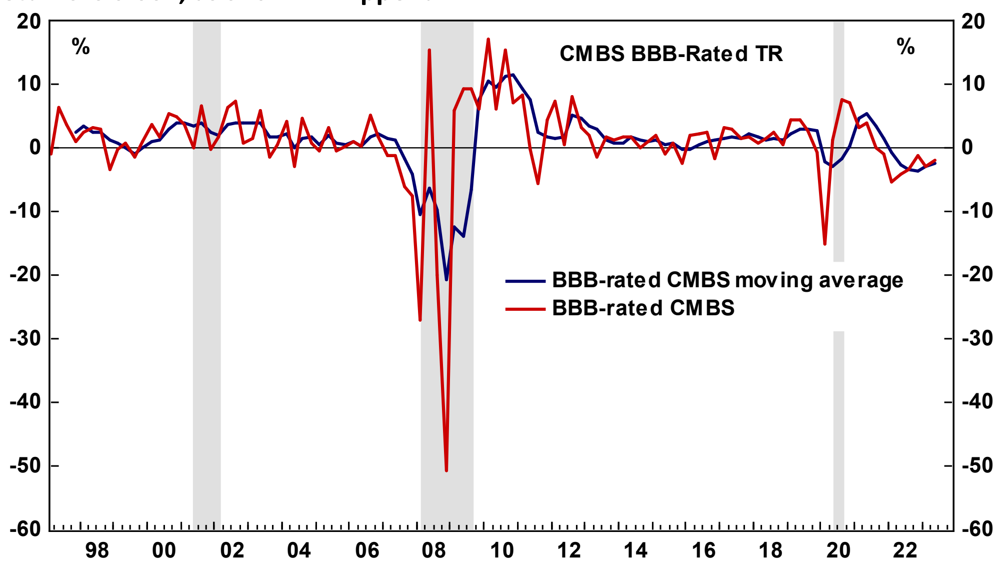
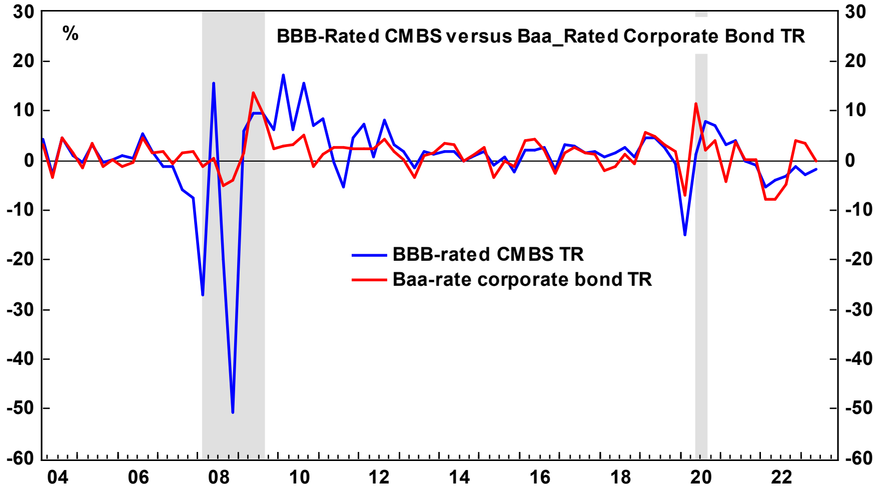


Exhibit 15. BBB-rated CMBS total returns. The correlation with AAA-rated CMBS returns is 0.661, as shown in Appendix B.



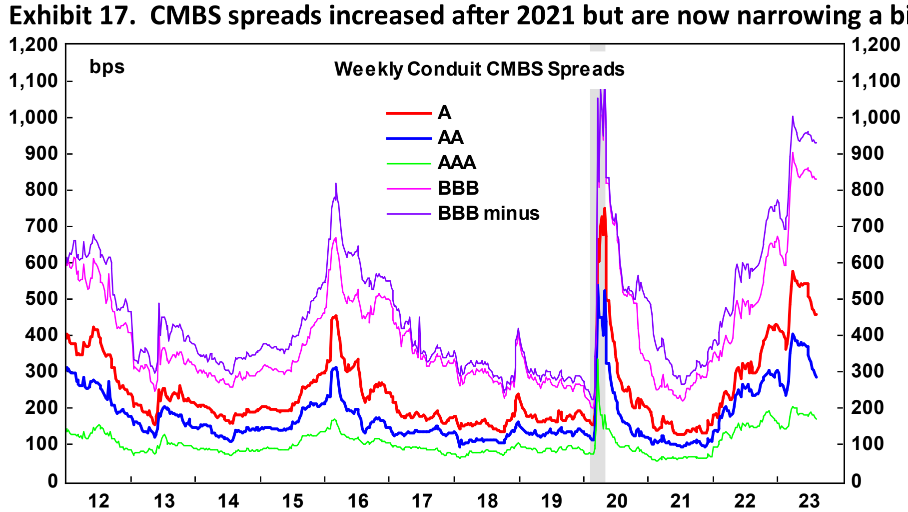
The coefficients of variation—standard deviation divided by the mean—of AAA- and BBB-rated CMBS is 3.800 and 13.739, respectively. Corporate bonds do not exhibit this disparity, which may indicate thin trading volume and greater inefficiency in the subordinate CMBS market.

Exhibit 16. BBB-rated CMBS is more volatile than Baa corporate bonds



The yields of the subordinate tranches are more sensitive than senior tranches to underlying real estate conditions and are therefore helpful in forecasting property performance.

Exhibit 17. CMBS spreads increased after 2021 but are now narrowing a bit



The CMBS BBB-AAA spread is inversely correlated with the NPI leveraged return, as shown in Exhibit 18. The CMBS subordinate and leveraged NPI property return are highly correlated, by contrast. (Exhibit 19) BBB-rated CMBS is very sensitive to economic conditions, as shown in Exhibit 20. BBB-rated CMBS returns are correlated with the bond default premium, as shown in Exhibit 21.

Exhibit 18. CMBS BBB-AAA spread and NPI TR

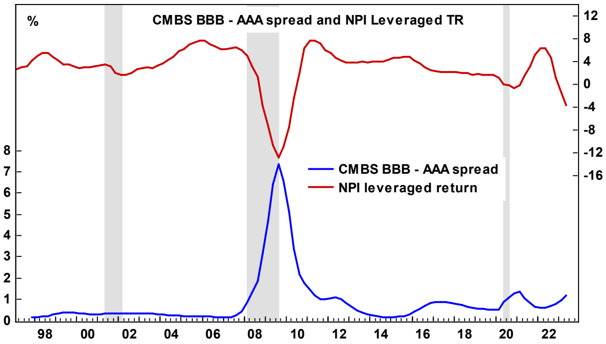


Exhibit 19. BBB-rated CMBS and NPI TR

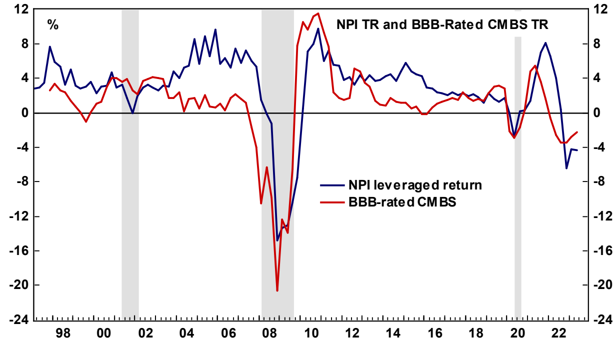


Exhibit 20. CMBS yields rise in weak markets

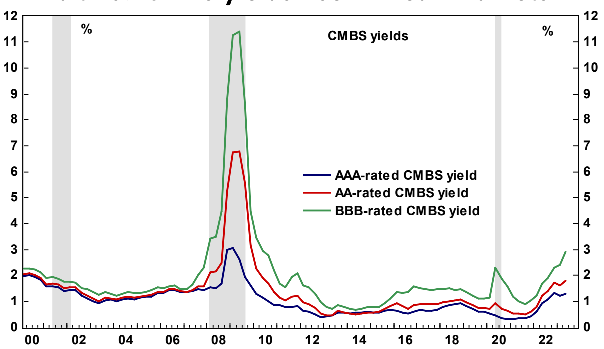
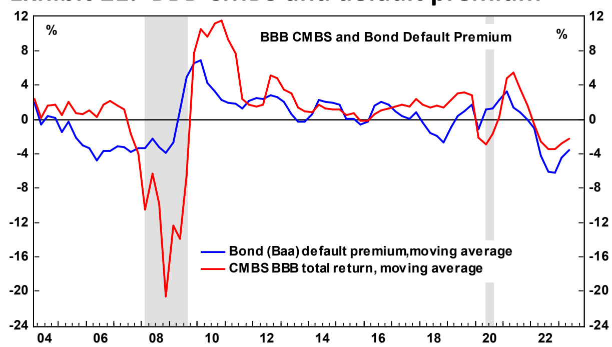


Exhibit 21. BBB CMBS and default premium



Total CBBS and corporate bond returns. AAA-rated CMBS total returns are most sensitive to the AAA-rated corporate bond total return; senior CMBS tranches and AAA-rated bonds are more sensitive to interest rates, whereas the BBB-rated CMBS and Baa-rated corporate bonds are not as strongly correlated, since the BBB-rated CMBS returns are driven more by the usual real estate-specific factors. (See Exhibits 22 and 23.)

Exhibit 22. AAA-rated CMBS and AAA-rated corporate TR;

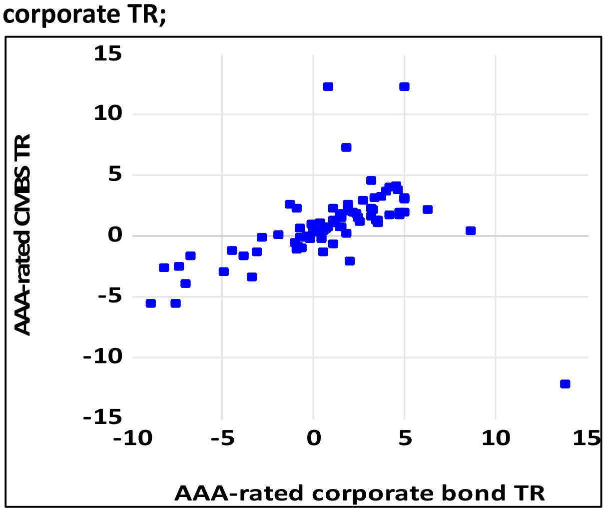
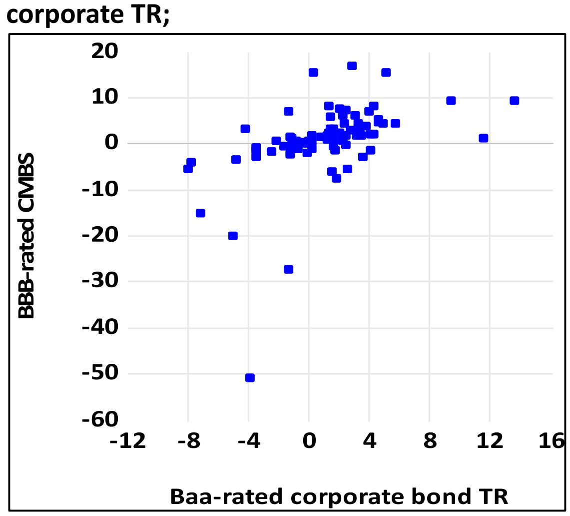


Exhibit 23. BBB-rated CMBS and BBB-rated corporate TR;



Equations 7 and 8 compare the sensitivities of CMBS bond to corporate bond total returns. AAA-rated CMBS is relatively insensitive to changes in AAA corporate bond returns, which differs from the significantly greater sensitivity of BBB-rated CMBS to Baa-rated corporate bonds.

$$CMBSAAA_t = 0.587 + 0.298 * CORPAAA_t \qquad (7)$$

(1.668) (3.277)

Adjusted R^2 = 0.112
DW = 1.395
Mean dependent variable = 0.846
S.D. dependent var = 3.217
S.E. of regression = 3.031

$$CMBSBBB_t = -0.702 + 1.138 * CORPBAA_t \qquad (8)$$

(-0.767) (4.723)

Adjusted R^2 = 0.217
DW = 1.756
Mean dependent variable = 0.632
S.D. dependent var = 8.683
S.E. of regression = 7.684

CMBS yields and NOI growth. Simple graphs can be misleading, especially when important variables are omitted. For example, the bivariate relationships between NOI growth and either CMBSAAA or CMBSBBB yield is insignificant, as shown below. Our multiple regression models, Equations 9 and 10, indicate that the 4-quarter moving average of NOI growth, lagged two quarters, is not significant in explaining yields, AAA- or BBB-rated. However, high yield corporate bond yields are significant.

Exhibit 24. NOI growth is not a good <u>bivariate</u> predictor of AAA-rated CMBS yield.

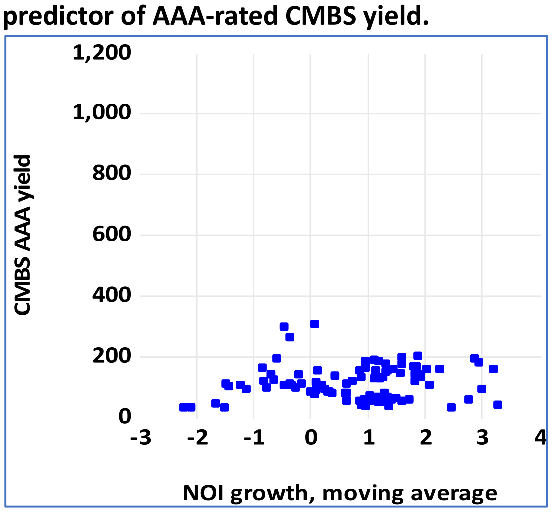
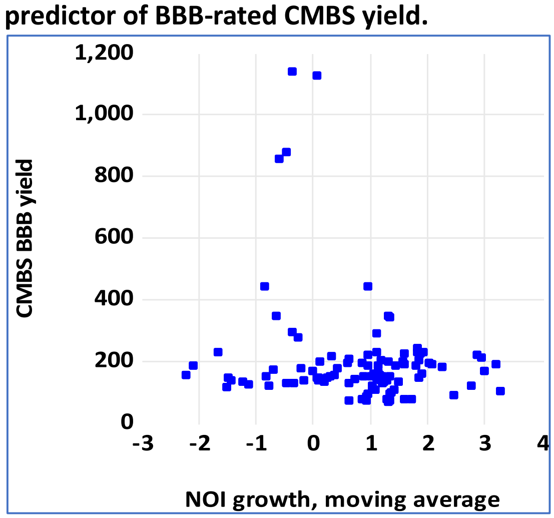


Exhibit 25. NOI growth is not a good <u>bivariate</u> predictor of BBB-rated CMBS yield.



Quadrant 1. Public Debt (CMBS) (Continued)

CMBS yield. Note that the coefficient on the moving average of NOI growth, even though it is not statistically significant, is over twice the size of the coefficient in the CMBSAAA equation below. The low t-statistic indicates low precision in the coefficient estimate. Since the BBB-rate CMBS tranche, the subordinate tranche, is the riskiest, we would expect that the yield for the BBB tranche would be more sensitive to underlying real estate conditions. The following equations[5], based on data from 1997Q1 through 2023.Q2, empirically validate this principle.

$$\boldsymbol{CMBSBBB_t = -2.973 - 0.080 * MOVAVG(NOIGROWTH_{t-2}) + 1.492 * HYCORPYLD_t - 0.014 * TREND_t}$$

(-0.728) (-0.590) (13.349) (0.447)

$$\boldsymbol{+0.880 * AR(1) + 0.315 * SIGMASQ} \qquad \textbf{(9)}$$

(27.763) (20.980))

Adjusted R^2 = 0.892
DW = 1.060
Mean dependent variable = 1.989
S.D. dependent var = 1.757
S.E. of regression = 0.578

$$\boldsymbol{CMBSAAA_t = 0.843 - 0.004 * MOVAVG(NOIGROWTH_{t-2}) + 0.447 * HYCORPYLD_t - 0.005 * TREND_t}$$

(1.609) (-0.558) (27.425) (-1.249)

$$\boldsymbol{-0.920 * AR(1) + 0.012 * SIGMASQ} \qquad \textbf{(10)}$$

(24.791) (9.811))

Adjusted R^2 = 0.959
DW = 1.303
Mean dependent variable = 1.108
S.D. dependent var = 0.563
S.E. of regression = 0.114

The yield of the senior or AAA-rated CMBS tranche is highly correlated with the AAA-corporate bond yield, as shown in Exhibit 26. By contrast, the relationship between the high yield corporate bond and the BBB-rated CMBS tranche is much more complicated, as shown in Exhibit 27.

Real estate-specific risks are more important in pricing subordinate CMBS. As a result, BBB-rated CMBS yields and returns are very useful in modeling and forecasting property returns, as our leveraged NPI property return forecasting model shows. This finding underscores the powerful relationship between the corporate bond market and the yields of senior and subordinate CMBS tranches.

[5] AR(1) is a correction for first order serial correlation.

Exhibit 26. AAA-rated corporate and AAA-rated CMBS yields

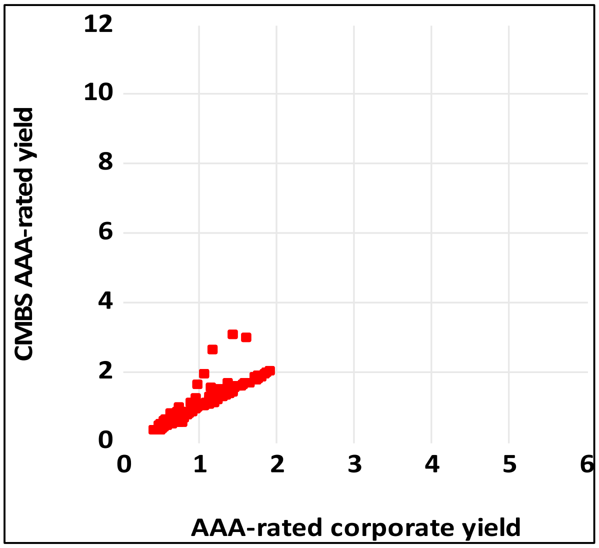
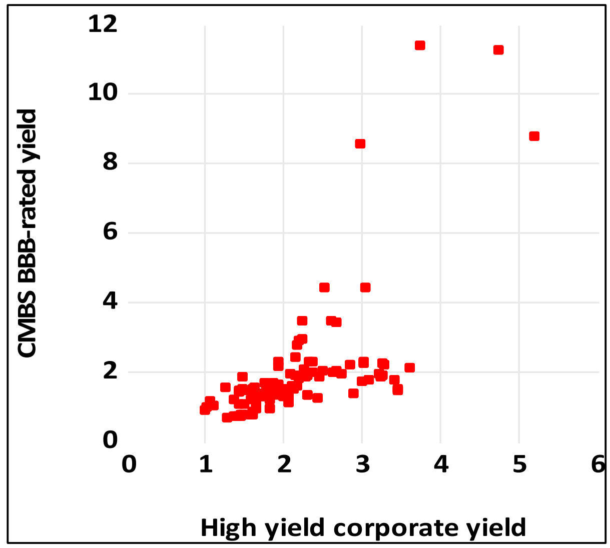


Exhibit 27. High yield corporate and BBB-rated CMBS yields



Our analysis of Quadrant 4, property, uses the BBB-rated CMBS total return, along with other variables, such as NOI growth, REIT returns, and transactions volume, to explain the total return of leveraged property. I observe that the capital markets are powerful in impounding real estate information in the returns of BBB tranches.

I incorporate bond variables in our models for senior mortgages (Quadrant 2) and property (Quadrant 4). The exception is REIT returns (Quadrant 3), which are a function of small cap stock returns and lagged leveraged property returns.

CMBS total returns. Subordinate CMBS (BBB) total returns increase if the total returns on high yield bonds and levered property are higher. (See Equation 11.) The greater is the lagged return for unlevered property, the lower is the total return of BBB-rated CMBS. We interpret the negative sign as indicating the presence of reversion to the mean or negative feedback. The model explains 52% of the variation in the dependent variable and the t-statistics (in parentheses) are highly significant. The Durbin Watson statistic, a measure of serial correlation, indicates no serial correlation in the residuals of the estimate equation.

$$\underset{}{CMBSBBB_t} = \underset{(0.311)}{0.274} + \underset{(6.369)}{0.766} * HYCORPRET_t + \underset{(5.746)}{1.374} * NPILEV_t - \underset{(-4.026)}{1.964} * NPIUNLEV_{t-1} \quad \textbf{(11)}$$

Adjusted R^2 = 0.523
DW = 2.076
Mean dependent variable = 1.084
S.D. dependent variable = 7.610
S.E. of regression = 5.258

Quadrant 2. Private Debt: Senior mortgages

Discussion. Senior mortgage total returns, measured by the Giliberto-Levy Index, defined by property type, are highly correlated; the average correlation across these mortgages' returns is 0.963, as shown in Exhibit 28. ("CLA" and "NCL" refer to credit- and non-credit-adjusted.) I use the credit adjusted returns. By contrast, the average correlation of property returns using the NPI property index is only 0.744. (Compare Exhibit 29 and 30.) The lower the leverage, the less mortgage returns are affected by the likelihood of default (or real estate shocks).

Exhibit 28. Credit and non-credit adjusted mortgage TR do not differ much.

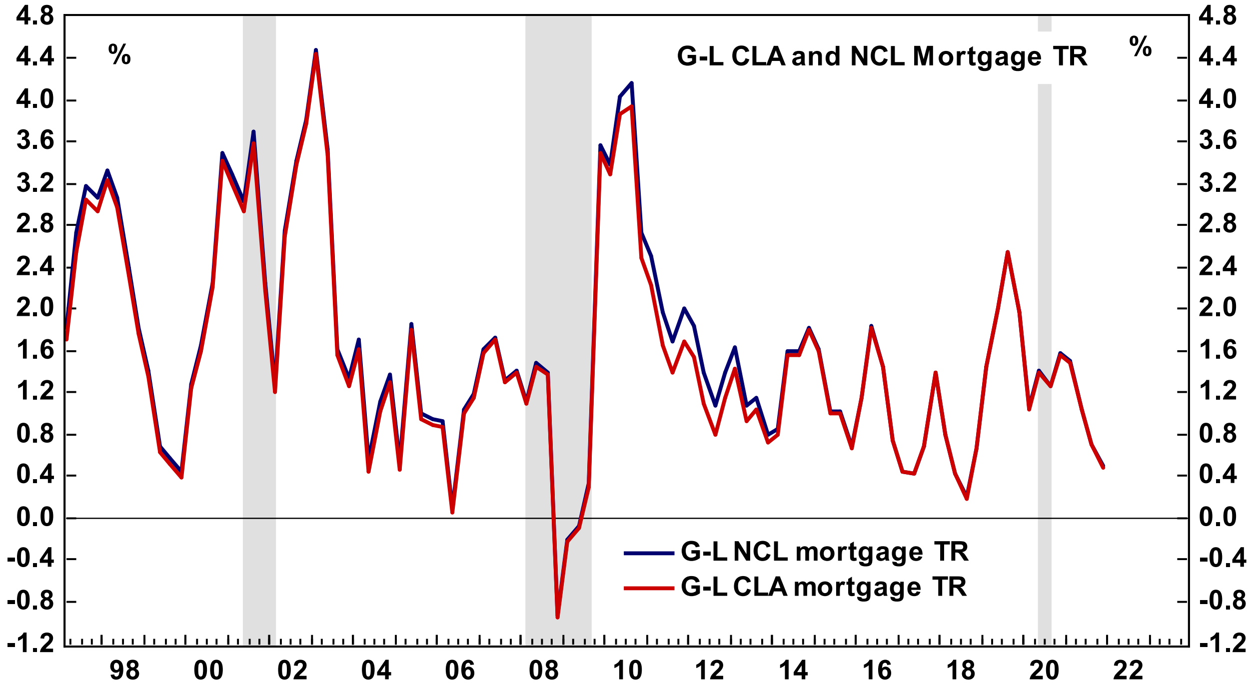


Exhibit 29. Total mortgage returns; average correlation across property types is 0.963.

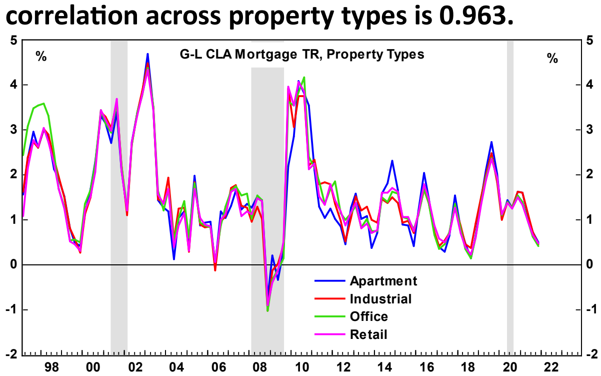
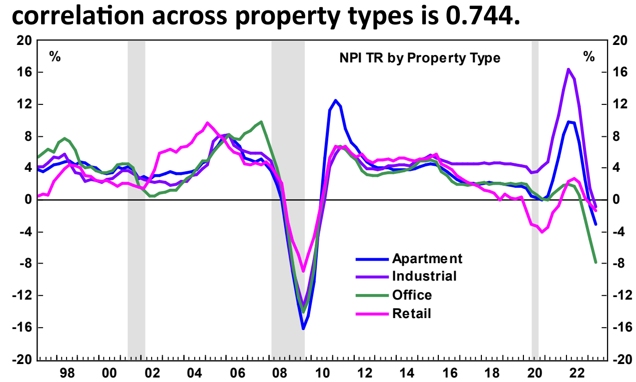


Exhibit 30. Total property returns; average correlation across property types is 0.744.



Quadrant 2. Private debt: Senior mortgages (Continued)

Exhibit 31. G-L commercial mortgage loss

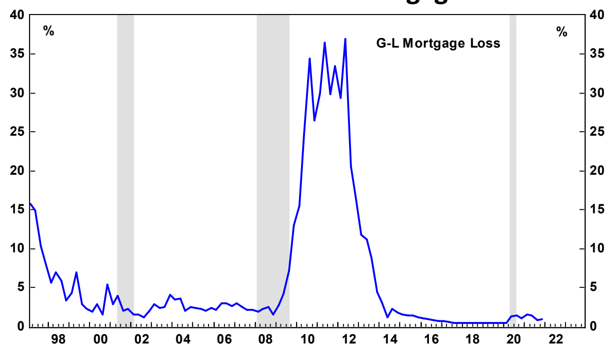
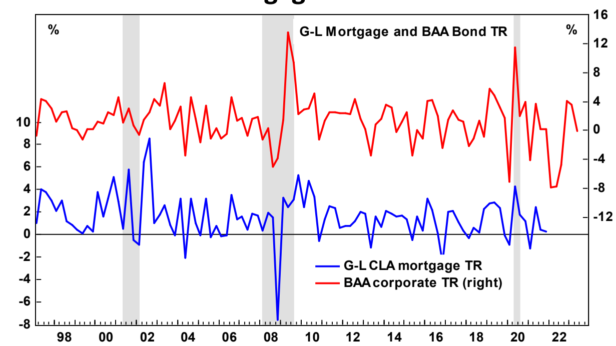


Exhibit 32. G-L mortgage and Baa bond TR



Mortgage losses rose dramatically, albeit with a lag after the GFC. Exhibit 32 shows the positive correlation between the total return for the Baa corporate bond and the CLA G-L mortgage. A regression of the mortgage return on the bond return explains 62% of the variation in the mortgage return. A 10% increase in the corporate bond return results in a 6.4% increase in the G-L mortgage return. The mortgage return is a function of the bond default premium lagged four quarters.

Exhibit 33. Mortgage TR and default premium

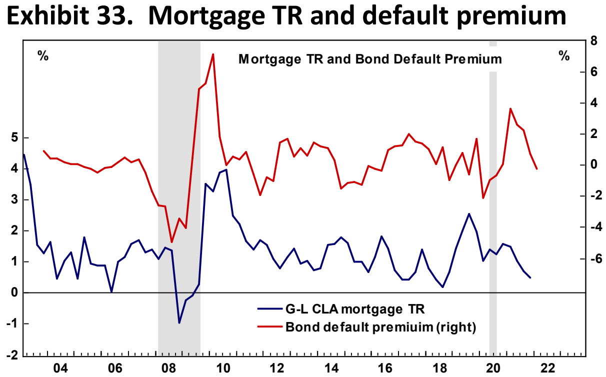


Exhibit 34. Mortgage and leveraged NPI TR

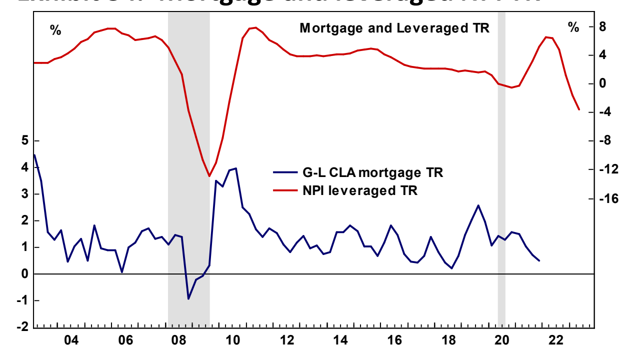
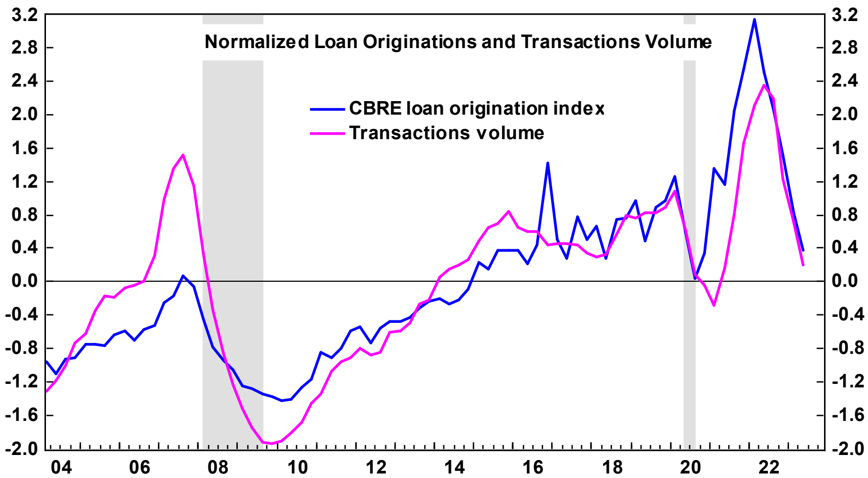


Exhibit 35 graphs the normalized loans and property sales volumes. (We normalize by subtracting the mean and dividing by the standard deviation.) The correlations are strong.

Quadrant 2. Private debt: Senior mortgages (Continued)

Exhibit 35. Normalized loan and sales volume are correlated: A 10% increase in volume is associated with a 11.6% increase in loans.



Mortgage model: The total return of the Giliberto-Levy commercial mortgage index increases the higher is the total return on BBB-rated CMBS and Baa corporate bonds.

The greater is the bond default premium—the geometric ratio of long-term Baa corporate bond total returns over long term government bond returns—the lower is the return for credit loss-adjusted (CLA) mortgage returns. Bond holders receive a premium for holding bonds with default risk. Callability risk is also subsumed with the bond default premium.

Neither NOI growth not leveraged property returns, current or lagged, help explain senior mortgage total returns directly. This finding seems reasonable since the mortgages comprising the index are low leverage and are less sensitive to property or local market risk than leveraged equity, for example. Hence, I exclude from our model NOI growth and the leveraged property return, but stress that BBB-rated CMBS total returns are a significant proxy for property risk due to market rental rate volatility, vacancy rates, and myriad other factors that affect total property risk.

The model explains 79% of the variation in the dependent variable, the t-statistics (in parentheses) are highly significant and all variables have the right sign. The Durbin Watson statistic, a measure of serial correlation, is also acceptable. This result is remarkably compelling given our aim to explain the total returns of a privately traded, illiquid security.

Note that subordinate CMBS and lower-rated (but still investment grade) CMBS returns have strong explanatory power. The Baa-rated corporate is more influential than the subordinate CMBS bond returns. If the default premium increases by 100 bps, then the total return on mortgages declines by 28 bps. A one percent increase in the BBB-rated CMBS bond return has a smaller effect on senior mortgage returns than an increases in the Baa-rated corporate bond return. A one percent increase in the corporate bond return is associated with a 0.4% increase in the senior mortgage return. This is a striking finding.

Quadrant 2. Private debt: Senior mortgages (Continued)

Equation 12 indicates that when investing in senior mortgages, it is a good idea to keep an eye on corporate bond returns and bond default premiums, but it is even more important to monitor the Baa-rated corporate bond yield and the bond default premium. Both variables explain most of senior mortgage returns! Mezzanine debt total returns, which we do not evaluate in this paper, would be much more sensitive to subordinate CMBS bond returns.

$$\boldsymbol{GLMORTCLA_t = 0.597 + 0.088 * CMBSBBB_t + 0.426 * CORPBAA_t - 0.279 * BONDDEFAULT_t} \quad (12)$$

(5.466) (6.850) (11.157) (-9.185)

Adjusted R^2 = 0.780
DW = 2.384
Mean dependent variable = 1.254
S.D. dependent variable = 1.797
S.E. of regression = 0.843

Quadrant 3. Public equity: REITs

Discussion. All property equity REITs (REIT) have been a leading indicator of property returns. Public market pricing incorporates information faster than backward-looking private markets. Exhibit 36 shows that REIT returns lead property returns by at least one quarter. REIT returns impound real estate news faster than do property returns. Lately, REITs and leveraged property returns have been highly correlated.

The total returns of REITS and small cap stocks are also highly correlated. (See Exhibit 37.) In fact, some investors regard equity REITs as a substitute for property. This should not be the case, since the return distributions of REITs and property are different. Question for investors: Should REITs be classified as small cap stocks and not as property within a multi-asset portfolio?

I show in our discussion of Quadrant 4 that property transactions volume and property performance are positively correlated. (See Exhibit 38.) When REIT investors are pessimistic, property transactions volume declines. REIT returns lagged four quarters are positively correlated with property returns in a bivariate regression. In that sense, REITs are the canary in the property coal mine.

Exhibit 36. Equity REIT and NPI property TR

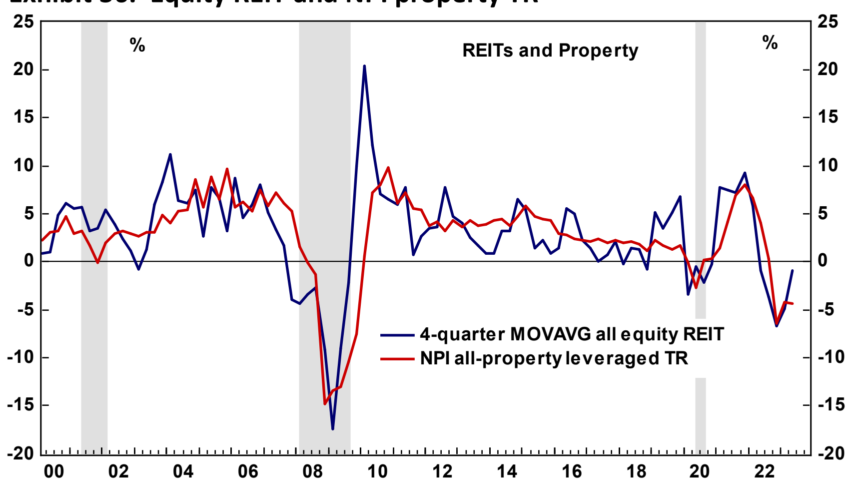


Exhibit 37. Small cap stock returns closely track equity REIT returns.

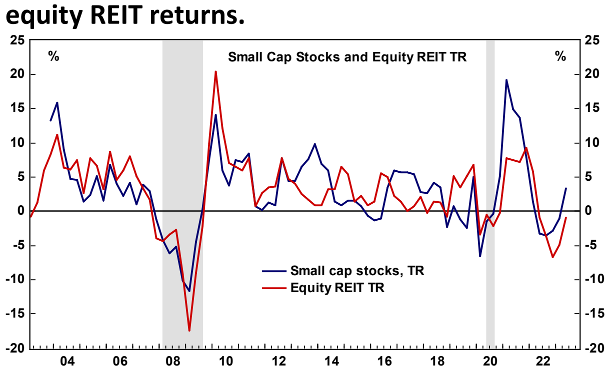
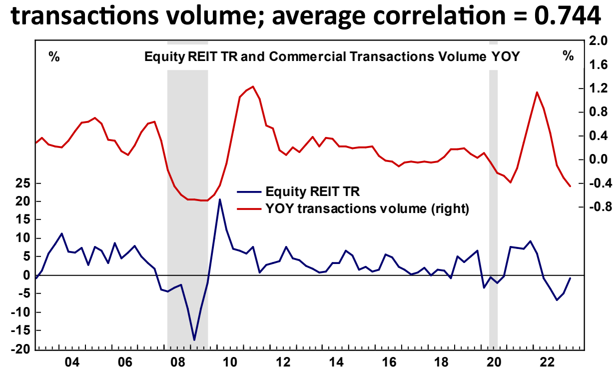


Exhibit 38. Total property returns and transactions volume; average correlation = 0.744



Quadrant 3. Public equity: Equity REIT (Continued)

REIT model: Our REIT model explains 61% of the variation of total equity REIT returns. Noteworthy is the statistically significant impact of small cap stock returns on REIT returns. A one percent increase in the small cap stock return is associated with a 0.65% increase in REIT returns.

Unleveraged property returns have a strong contemporaneous impact on REIT returns, but leveraged property returns lagged on period have a negative impact. I interpret the lagged result as an indicator of risks in the property market that affect REIT returns with a one quarter lag.

$$\boldsymbol{REIT_t = 0.078 + 0.649 * SMALL_t + 2.094 * NPIUNLEV_t - 1.684 * NPIUNLEV_{t-1}} \qquad \textbf{(13)}$$

(0.078) (9.131) (3.641) (-2.877)

Adjusted R^2 = 0.614
DW = 2.102
Mean dependent variable = 2.877
S.D. dependent = 10.836
S.E. of regression = 0.614

Quadrant 4. Private equity: Property

Discussion. The NOI growth rate has weakened and transactions volume has cratered, developments which are depressing leveraged and unleveraged NPI returns. Prices have also deteriorated as the growth rate of effective rents have cooled. Total property and BBB-rated CMBS returns are now negative but BBB-rated CMBS returns, still negative, have shown some early signs of improvement.

Exhibit 39. Property total and income returns

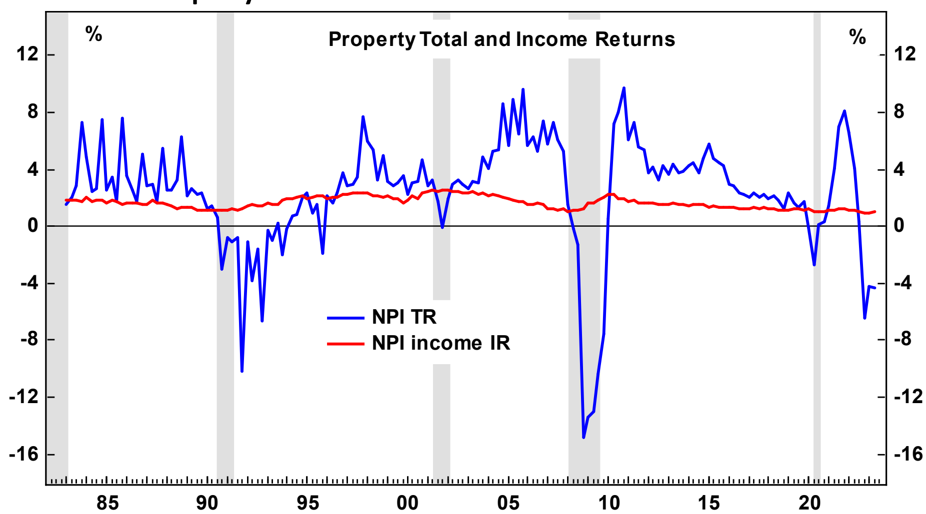
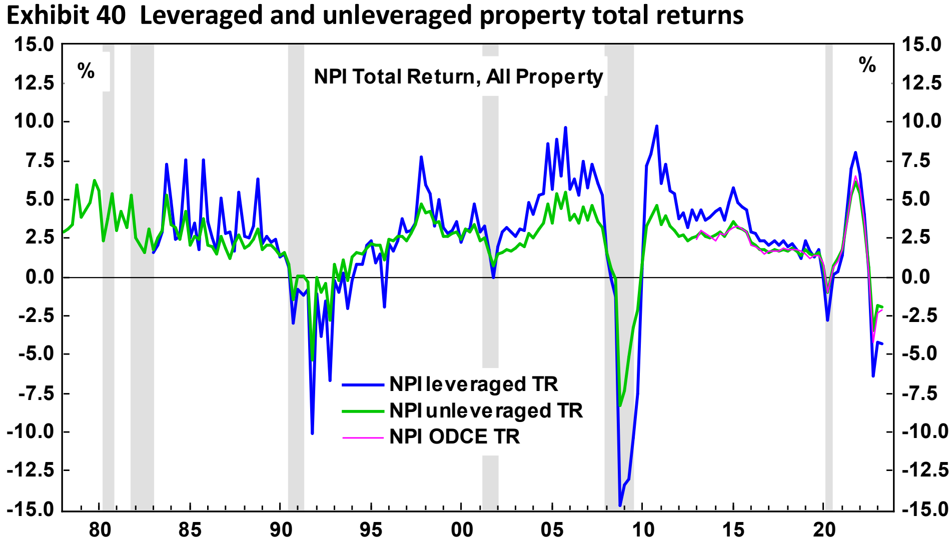


Exhibit 40 Leveraged and unleveraged property total returns



NCREIF's Open End Diversified Core Equity (NPI-ODCE), is a low-risk investment returns index of the largest private real estate funds that use low leverage and generally represent equity ownership positions in stable U.S. operating properties diversified across regions and property types. ODCE, leveraged and unleveraged returns are highly correlated, but the fit is less precise between 2002 and 2015.

The relationship between property returns and NOI growth is statistically significant but complex. For example, a bivariate regression indicates that NOI growth is a significant factor in explaining unleveraged returns but NOI growth by itself explains only about 6.4% of the variation in returns. Hence, I include in our forecasting model other variables, the omission of which would bias the estimated relationship between growth and returns. For instance, inclusion increases the adjusted R^2 from 6.4% to 85.4%, a substantial increase in the explanatory power of the model. The NOI growth coefficient decreases from 0.330 to 0.263, a reduction in the return's sensitivity to growth. (An important bonus insight is that bivariate correlations often fail to tell the whole story. Omitted variables are frequently a source of bias, so analysts should beware.)

Exhibit 41. NOI growth and unleveraged total return

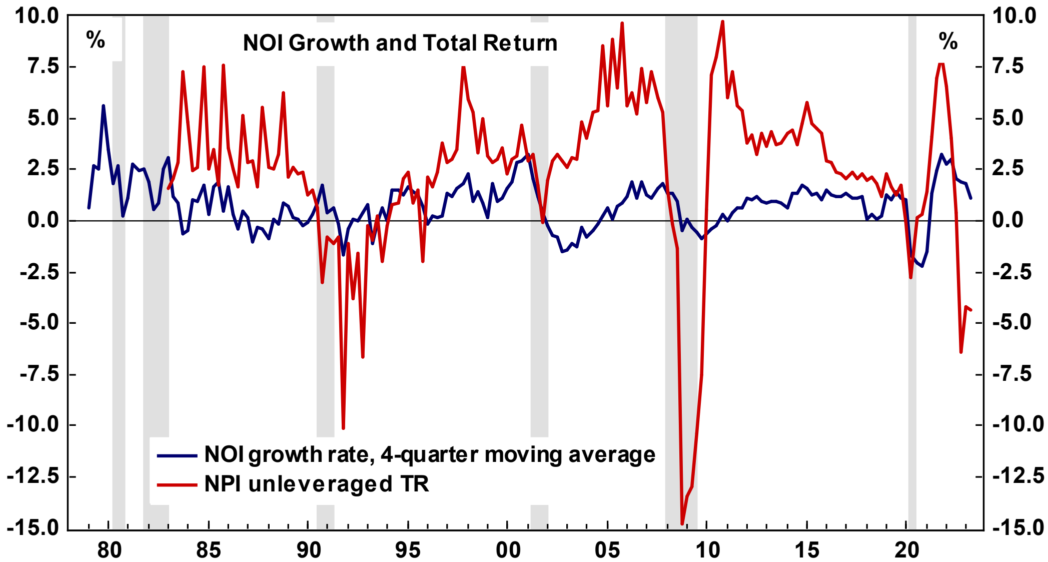
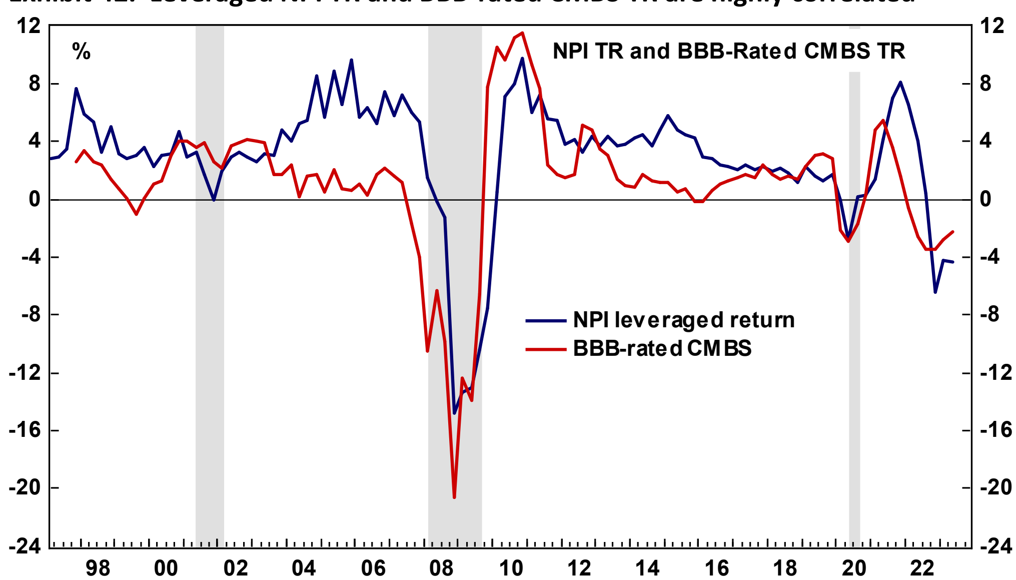


Exhibit 42. Leveraged NPI TR and BBB-rated CMBS TR are highly correlated



Quadrant 4. Property (Continued)

NOI growth leads appreciation by about one quarter, as shown in Exhibit 43.

Exhibit 43. NOI growth leads appreciation

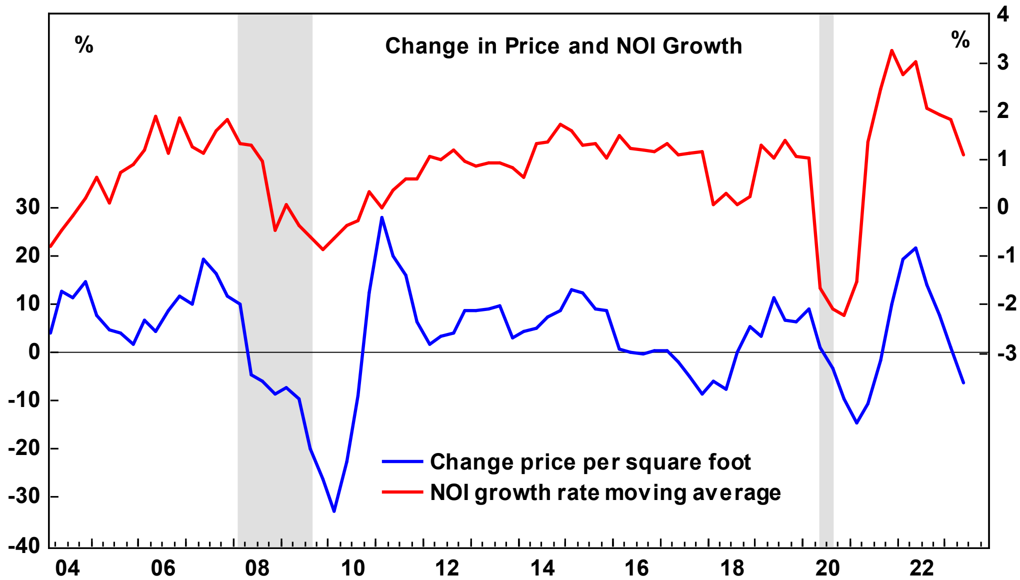
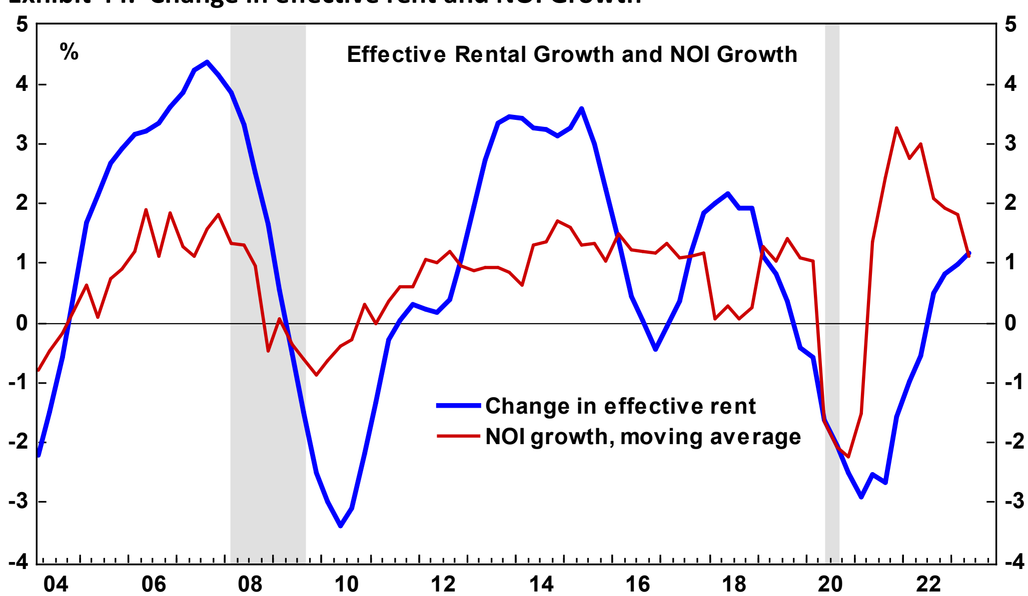


Exhibit 44 shows that the 4-quarter moving average of NOI growth leads effective rent by two quarters. A one percent increase in NOI growth is associated with a 1.1% increase in effective rents.

Exhibit 44. Change in effective rent and NOI Growth

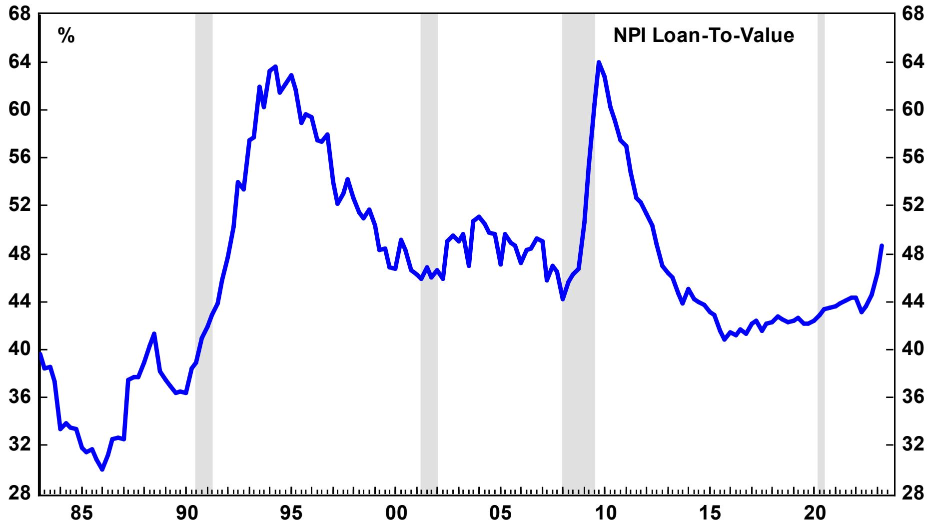


Quadrant 4. Property (Continued)

Property model: My property model is the centerpiece of this report.

I model (and forecast) leveraged and unleveraged property total returns. The properties included in the leverage index have loan-to-value (LTV) ratios of 50% to 60%, as shown below:

Exhibit 45. NCREIF loan-to-value ratio for leveraged property



The coefficient on equity REIT returns, REIT, is positive and significant for both leveraged and unleveraged property. REITs are a leading indicator of property performance. However, most of the coefficients in the leveraged model are two times as great as the coefficients in the unleveraged model. This finding is consistent with increased risk due to leverage. If sales transactions volume, TRANSACTIONS, increases, so does leveraged property returns. Transactions volume embodies important information. Current and lagged NOIGROWTH is a strong determinant of returns. The CMBSBBB variable is not lagged; lagged versions reduced statistical performance. The leveraged property model explains 86% of the variation in the dependent variable and the t-statistics (in parentheses) are highly significant.

$$\boldsymbol{NPILEV_t = 0.174 + 0.148 * CMBSBBB_t + 0.052 * REIT_{t-2} + 0.297 * NOIGROWTH_t}$$

(0.658) (5.654) (2.688) (2.930)

$$\boldsymbol{-0.237 * NOIGROWTH_{t-4} + 0.006 * (TRANSACTIONS_t - TRANSACTIONS_{-4}) + 0.763 * NPILEV_{t-1}} \quad \textbf{(14)}$$

(-2.346) (1.964) (11.977)

Adjusted R^2 = 0.861
DW = 2.449
Mean dependent variable = 2.700
S.D. dependent var = 4.818
S.E. of regression = 1.796

Quadrant 4. Property (Continued)

The model below explains 86% of the variation in unleveraged NCREIF property returns. In both models, the signs of all of the coefficients are statistically significant.

$$NPIUNLEV_t = \underset{(1.811)}{0.307} + \underset{(5.779)}{0.082} * CMBSBBB_t + \underset{(1.736)}{0.018} * REIT_{t-1} + \underset{(2.633)}{0.144} * NOIGROWTH_t$$

$$\underset{(-3.106)}{-0.166} * NOIGROWTH_{t-4} + \underset{(1.952)}{0.004} * (TRANSACTIONS_t - TRANSACTIONS_{t-4}) + \underset{(10.712)}{0.752} * NPIUNLEV_{t-1} \quad \textbf{(15)}$$

Adjusted R^2 = 0.859
DW = 2.381
Mean dependent variable = 2.023
S.D. dependent var = 2.538
S.E. of regression = 0.952

V. Analysis of Quadrant Econometrics

Good econometric analysis requires an understanding of the underlying data. What are their statistical characteristics and what are the econometric implications? Our choice of econometric method should reflect the nature of the data.

Our analysis spans three kinds of data: General capital markets, real estate securities and real estate macroeconomics. The economic drivers of our quadrant return equations include capital markets as well as macroeconomic data. What are the differences?

Exhibit 46. Estimates of serial correlation

	Capital Market Securities	Constant term	Constant term, t-statistic	Lagged dependent variable, coefficient	Lagged dependent variable, t-statistic	Adjusted R^2	Durbin-Watson	Mean dependent variable, %
1	S&P 500, TR, %	2.543	2.912	0.002	0.023	-0.010	1.995	2.549
2	**T-Bill, %**	0.049	0.787	0.977	**44.951***	0.951	0.661	2.008
3	**Corporate high yield, TR, %**	1.217	2.471	0.254	**2.685***	0.056	1.900	1.638
4	Corporate, AAA-rated, TR, %	1.153	3.218	-0.002	-0.022	-0.010	1.983	1.151
5	**Corporate, BBB-rated, TR, %**	1.089	3.198	0.192	**2.000**	0.028	1.983	1.236
	Real Estate Securities, Quadrants 1, 2, 3, and 4							
6	All equity REIT, TR, quarterly, %	0.611	0.385	0.140	1.142	0.005	1.943	0.731
7	**AAA-rated CMBS, TR, quarterly, %**	0.781	2.588	0.349	**3.777***	0.113	1.891	1.198
8	**BBB-rated CMBS, TR, %**	0.197	1.189	0.197	**2.036***	0.029	1.972	1.102
9	Giliberto-Levy Senior Mortgage (CLA), all, %	1.458	5.718	0.047	0.464	-0.008	1.983	1.531
10	Giliberto-Levy Senior Mortgage (CLA), office, %	1.433	5.539	0.080	0.793	-0.004	1.988	1.560
11	NPI unleveraged, all, %	0.424	2.994	0.794	**16.977***	0.615	2.151	2.158
12	NPI leveraged, all, %	0.488	2.097	0.783	**15.539***	0.600	2.199	2.388
	Property Macroeconomic Variables							
11	**Office sales volume $ billions**	6.259	1.648	0.944	**28.622***	0.907	0.483	104.876
12	**Office vacancy rate, %**	0.660	2.996	0.946	**46.681***	0.959	0.746	10.861
13	**Office net delivered space, million SQFT**	4.063	2.891	0.750	**10.951***	0.564	2.394	17.019
14	**Change in office inventory, %**	0.022	1.352	0.954	**64.097***	0.979	1.508	0.891
15	**Office inventory, billion SQFT**	0.160	10.888	0.982	**520.484***	1.000	0.943	7.811
16	**Office rental growth, %**	0.000	0.002	0.935	**28.618***	0.902	0.303	1.403
17	**Office net absorption, million SQFT**	3.781	2.151	0.553	**6.639***	0.319	1.745	9.432
18	**Office under construction, million SQFT**	4.420	1.387	0.959	**40.545***	0.946	1.393	127.478

t-statistic significance, 94 observations
*t-statistic = 2.366 1.0% significance

Compared with private securities, the performance of publicly traded securities, especially those that have high transactions volume and low trading costs, more closely resembles a random walk, in which today's performance is not a good predictor of tomorrow's performance.[6] This is especially true at high frequencies[7]. Private real estate return data exhibit significant serial correlation; past returns impound

[6] I estimate the following equation: $RETURN_t = a_0 + a_1 * RETURN_{t-1} + \varepsilon_t$. If a_1 is not significantly different than zero, then we conclude that the series resembles a random walk. The best predictor of $RETURN_t$ is a_0. Exhibit 47 shows the results of this return model for a variety of assets and economic indicators. The blue column shows the estimates of a_1 and the yellow column indicated the t-statistic, a measure that indicates the extent to which we can differentiate a_1 from zero.

[7] The likelihood that the return of a publicly traded security resembles a random walk increases with the frequency of the data, e.g., annual compared with daily data.

information that can predict future returns. Note unleveraged and leveraged NPI (property) returns and CMBS returns, as shown in Exhibit 46; the coefficients for one-quarter lagged variables are significant at the one percent level.

Real estate macroeconomic data, e.g., new office construction starts, rental growth rates, vacancy rates, absorption and sales volume, exhibit even greater serial correlation. As a result, econometric models with lagged dependent variables over many periods often have better explanatory power. Such is the case with our quadrant models of total returns.

Exhibits 47 through 50 visually drive this point home. S&P 500 returns most closely resemble a random walk whereas vacancy rates, shown in Exhibit 49, exhibits extreme serial correlation. Publicly traded equity REITs displays little serial correlation but NPI property returns, which are backward looking, have significant serial correlation.

Exhibit 47. No serial correlation: S&P 500

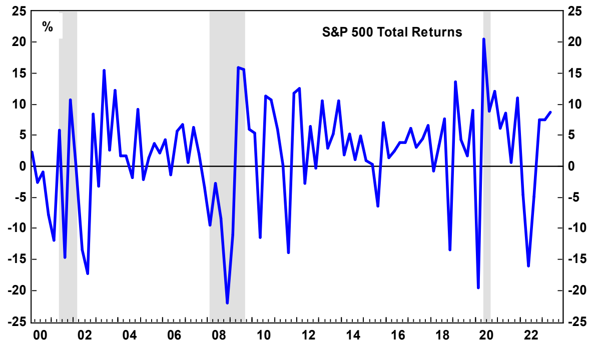


Exhibit 48. Very little serial correlation: All REITs

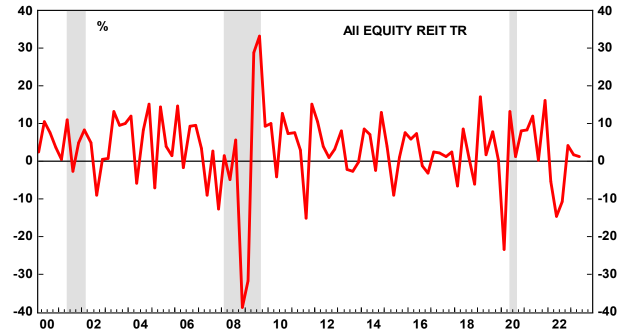


Exhibit 49. Leverage NPI: Serial correlation

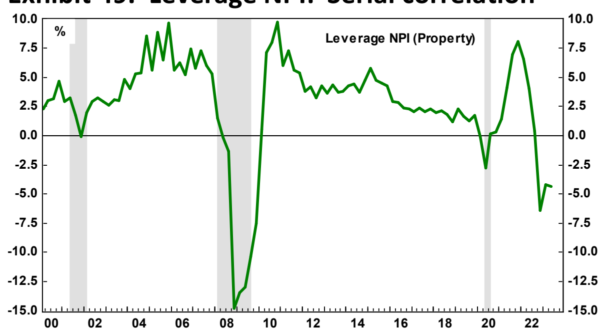
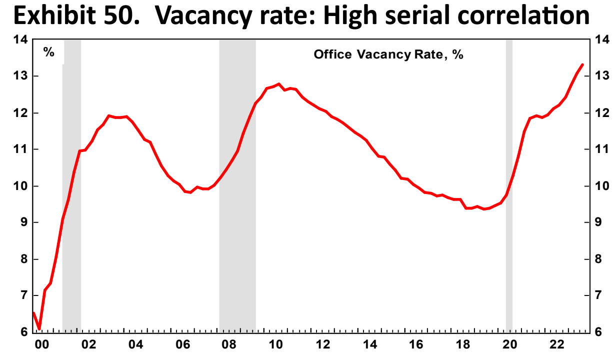


Exhibit 50. Vacancy rate: High serial correlation



Explanatory and explained variables. Forecasting explanatory variables may be just as difficult as forecasting the explained, or dependent, variables. For example, in my CMBS model, the high yield corporate bond return is an independent variable that has significant serial correlation. However, the REIT variable, a two-quarter lagged explanatory variable for leveraged and unleveraged property returns, Quadrant 4, may display some serial correlation, but not a great deal; it generally follows a random walk because past REIT returns are not a strong predictor of current values. Equation 13 uses small cap stock and NPI returns to predict equity REIT returns. The model explains 61% of the variation in REIT returns, the coefficients are highly significant and the Durban Watson statistic, a measure of the serial correlation of the equation residuals, indicates no serial correlation. The model includes small cap stock returns, the coefficient of which is highly significant[8].

[8] I have argued elsewhere that small cap stocks are highly correlated with REITs, which begs the question as to why investors should include REITs in their real estate allocation. In a bivariate regression, small cap stock returns

Econometric method. I estimate the quadrant models using ordinary least squares. The quadrant models include complex lags, which we believe reduces concerns regarding potential simultaneity bias[9]. Were simultaneity a problem—X causes Y and Y causes X—we would have used two-stage lease squares.

The models in summary: I summarize the quadrant models as follows:

Quadrant 1. Public debt (CMBS). Bloomberg subordinate class CMBS total returns. BBB-rated CMBS is a function of high yield debt returns, leveraged property returns, and unleveraged property returns lagged one period. There is no serial correlation in the residuals; the Durban Watson statistic is 2.076 and the variable's coefficients are highly significant.

$$CMBSBBB_t = 0.274 + 0.766 * HYCORPRET_t + 1.374 * NPILEV_t - 1.964 * NPIUNLEV_{t-1} \qquad \textbf{(16)}$$

(0.311) (6.369) (5.746) (-4.026)

Adjusted R^2 = 0.523
DW = 2.076
Mean dependent variable = 1.084
S.D. dependent variable = 7.610
S.E. of regression = 5.258

Exhibit 51. Residual analysis of CMBS model indicates a good fit; residuals after the GFC are generally within plus or minus one standard deviation of the actual CMBS value.

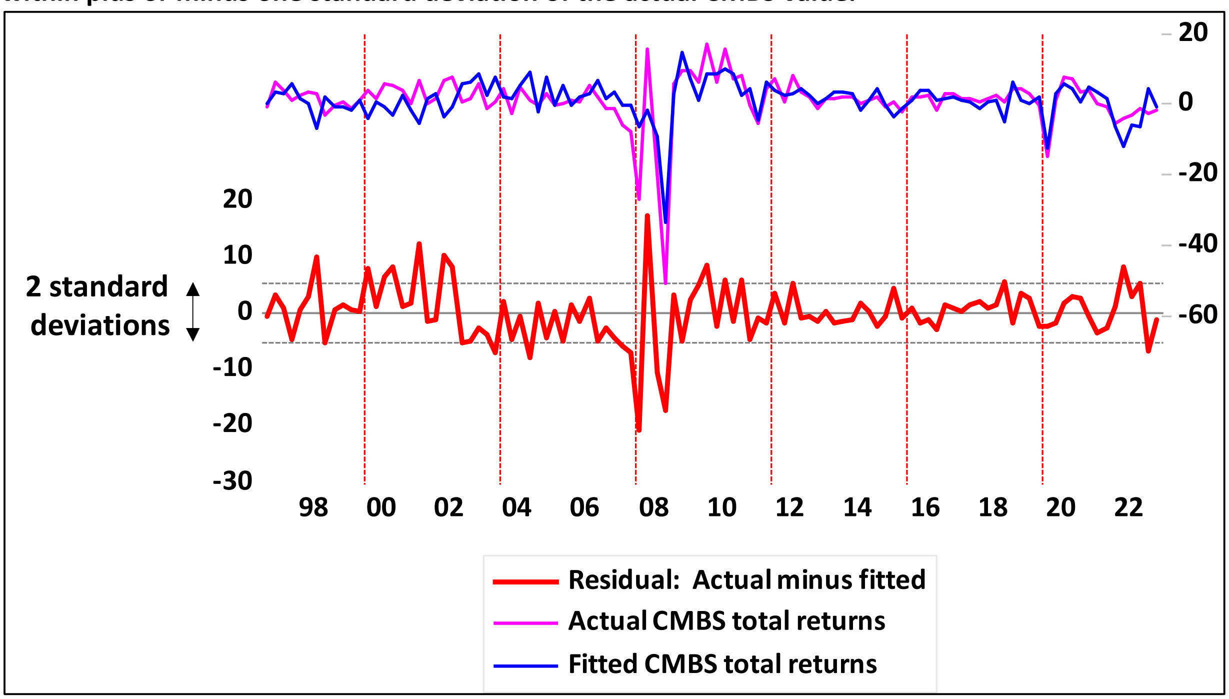


Exhibit 54 shows recent values of the CMBS return and the explanatory variables.

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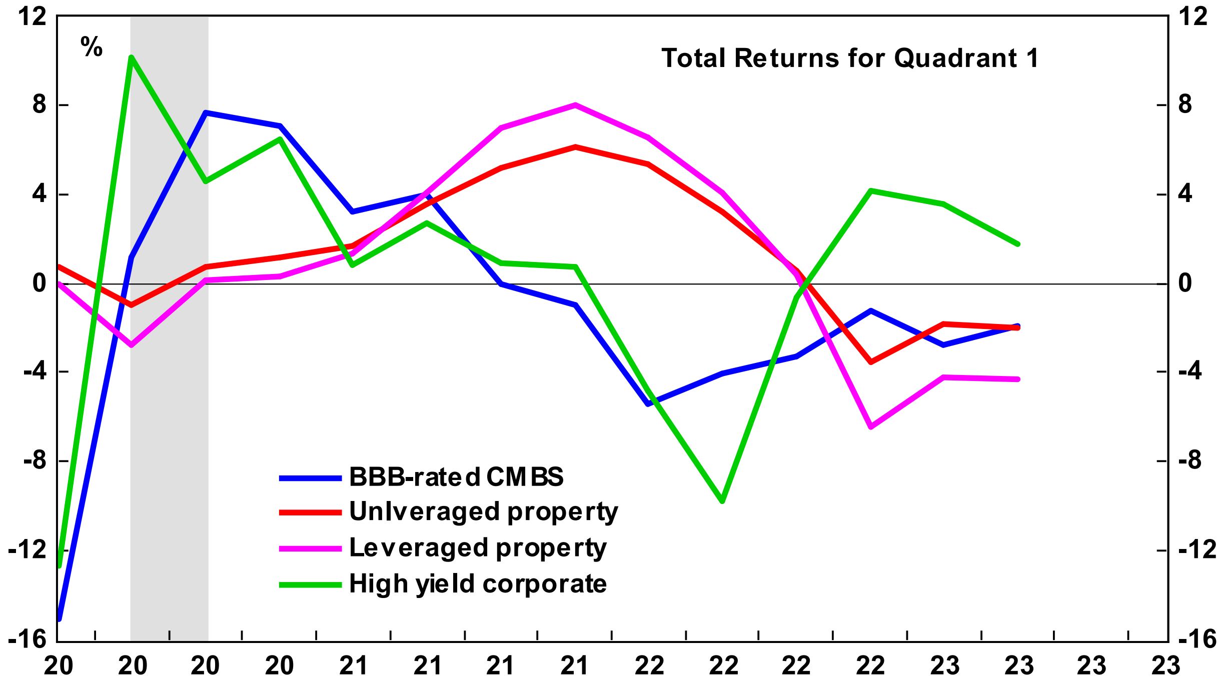
explain 56% of the variation in REIT returns; the small cap stock coefficient is highly significant statistically. A one percent increase in Baa-rated corporate bond returns increases REIT returns by 0.95% whereas an increase in the small cap stock return of one percent increases REIT returns by 0.59%.

[9] Simultaneity leads to coefficient estimates that are not only inefficient but inconsistent (or biased); increasing the sample size does not alleviate this problem.

Exhibit 52. Quadrant 1: Subordinate CMBS total return equation



Quadrant 2. Private debt. Giliberto-Levy senior mortgage total returns. The senior mortgage model explains 78% of the variation in mortgage returns. Explanatory variables include the bond default premium and the BBB-rated corporate bond return. The later exhibits serial correlation, which facilitates forecasting this variable.

$$GLMORTCLA_t = 0.597 + 0.088 * CMBSBBB_t + 0.426 * CORPBAA_t - 0.279 * BONDDEFAULT_t \quad (17)$$

(5.466) (6.850) (11.157) (-9.185)

Adjusted R^2 = 0.780
DW = 2.384
Mean dependent variable = 1.254
S.D. dependent variable = 1.797
S.E. of regression = 0.843

Quadrant 3. Public equity. NAREIT all-equity REITs. REIT returns reflect small cap stock and private real estate returns.

$$REIT_t = 0.078 + 0.649 * SMALL_t + 2.094 * NPIUNLEV_t - 1.684 * NPIUNLEV_{t-1} \quad (18)$$

(0.078) (9.131) (3.641) (-2.877)

Adjusted R^2 = 0.614
DW = 2.102
Mean dependent variable = 2.877
S.D. dependent = 10.836
S.E. of regression = 0.614

Quadrant 4. Private equity. Leveraged NCREIF total returns. The property models include REIT returns lagged two periods and do not suffer from simultaneity bias. Transactions volume, a real estate macroeconomic indicator, is an important explanatory variable.

$$SMALLNPILEV_t = 0.174 + 0.148 * CMBSBBB_t + 0.052 * REIT_{t-2} + 0.297 * NOIGROWTH_t$$

(0.658) (5.654) (2.688) (2.930)

$$-0.237 * NOIGROWTH_{-4} + 0.006 * (TRANSACTIONS - TRANSACTIONS_{-4}) + 0.763 * NPILEV_{-1} \quad \textbf{(19)}$$

(-2.346) (1.964) (11.977)

Adjusted R^2 = 0.861
DW = 2.449
Mean dependent variable = 2.700
S.D. dependent var = 4.818
S.E. of regression = 1.796

$$NPIUNLEV_t = 0.307 + 0.082 * CMBSBBB_t + 0.018 * REIT_{t-1} + 0.144 * NOIGROWTH_t$$

(1.811) (5.779) (1.736) (2.633)

$$-0.166 * NOIGROWTH_{t-4} + 0.004 * (TRANSACTIONS_t - TRANSACTIONS_{t-4}) + 0.752 * NPIUNLEV_{t-1} \quad \textbf{(20)}$$

(-3.106) (1.952) (10.712)

Adjusted R^2 = 0.859
DW = 2.381
Mean dependent variable = 2.023
S.D. dependent var = 2.538
S.E. of regression = 0.952

Forecasting example. Even though this paper does not include forecasts, some readers may benefit from seeing how we use the coefficients to predict CMBS returns. We must either forecast or assume values for the explanatory variables. For simplicity, we use the averages of past values from 1997 to 2023. The reader can create alternative scenarios, such as a high inflation, high interest rate environment with sluggish growth.

Exhibit 55 includes a simple forecast of BBB-rated CMBS returns. We adopt a scenario in which all explanatory variables assume their mean value during this period. The exhibit includes descriptive statistics: Mean, standard deviation, skewness and kurtosis[10].

I display the current values of the model's variables for the second quarter of 2023. The estimated coefficients are included as well. Highlighted in yellow are the actual and predicted values for this quarter.

[10] Skewness is a measure of asymmetry of the return distribution and kurtosis measures the thickness of the distribution tails, or the likelihood of extreme returns. Skewness equals zero if there is no skewness and kurtosis is three if there is no kurtosis.

Highlighted in blue are the predicted and actual values for our scenario in which the explanatory variables equal their mean value during the 1997 – 2023 period. The predicted value is 1.525 percent and the actual value is 1.084 percent.

Exhibit 53. Sample forecast assuming average value of independent variables during the period 2000Q1 – 2023Q2.

	BBB-Rated CMBS	High yield corporate	Leveraged Property	Unleveraged Property
Mean	1.084	1.638	2.852	2.177
Standard deviation	7.610	4.946	4.300	2.291
Skewness	-3.543	-0.106	-2.026	-2.143
Kurtosis	23.904	7.893	8.416	9.459

Current values: 2023Q2		**Model estimated coefficients**	
BBB-rated CMBS	-1.887	Constant	0.274
High yield corporate	-1.98	High yield corporate	0.766
Leveraged property	-4.33	Leveraged property	1.374
Unleveraged property	-2.98	Unleveraged proper	-1.964
		Predicted 2023Q2	**-1.244**
		Actual 2023Q2	**-1.887**

Scenario: Average values for period 1997 - 2023	
High yield corporate	1.638
Leveraged property	2.852
Unleveraged property	2.177
Predicted	**1.525**
Average value CMBS	**1.084**

VI. Quadrant Applications

Some readers may find the econometric analysis to be a bit theoretical; it is not. In fact, the implications are eminently practical and urgently needed by the industry. However, I do appreciate the value of pragmatic examples.

The underlying theme of this paper is that explicit inclusion of uncertainty in investment analysis is essential. The capital markets are a massive calculator that asses risk and expresses this assessment in value.

This chapter presents the following applications:

Application 1: Cap rates. Cap rates are the work horse of valuation and investments and a constant source of abuse. For example, two properties with similar cap rates can exhibit different risk attributes. Hence, too often investors misinterpret cap rates or rely on cap rates in ways they should not. This section provides important insights and presents a cap rate model driven by capital markets variables. I use the findings to illustrate the importance of explicit modeling of risk. (Page 37.)

Application 2: Transactions volume and liquidity. Sales transactions volume transmits important information. The ratio of trading volume to outstanding capitalization is a measure of liquidity and serial correlation. The lower is the ratio, the less is liquidity, which in turn affects price volatility. When markets collapse, transactions volume is an early casualty. I show that transactions volume, or liquidity, vary over the business cycle, by property type, property quality, and even by MSA. (Page 42)

Application 3: Office employment. Office employment (FIRE workers) trends affect vacancy rates, the demand for new space, and many other real estate considerations. I show that the change in FIRE employment responds to current transactions volume, lagged bankers' expectations regarding loan originations, the Baa-rated corporate bond lagged two quarters, the spread between Baa-rate bonds and the T-bill, and the change in the grow rate of NOI over two quarters. (Page 46)

Application 1. Cap rates

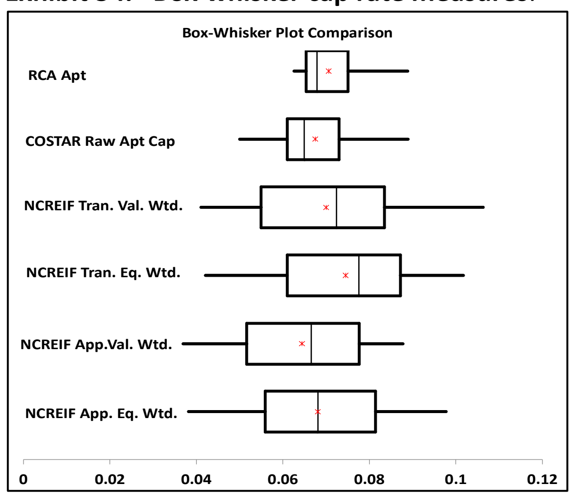
The cap rate is an important, but not necessarily the best, value measure. The cap rate is the ratio of NOI divided by the sales price or estimated value. Another way to think of the cap rate is as follows: The cap rate is equal to the risk-free rate plus the credit spread, minus the expected rate of growth of NOI. The expected rate of growth is a complex function of many factors, which we explore. There are several ways to measure the credit spread: The spread between Baa- and AAA-rated corporate bonds.

There are a number of cap rate indexes, as previously discussed. In Exhibit 54 we focus on apartment cap rates as an example. Cap rate measures include the RCA cap, the COSTAR raw and hedonic cap rate, and NCREIF appraisal- and transactions-based cap rates, either value- or equity-weighted.

I use box-whisker diagrams to highlight the differences in the statistical attributes of the cap rates. (See footnote 3.)

Which is the best cap rate measure? The choice depends on the intended use, the nature of the cap rate sample, and the statistical characteristics (and weaknesses) of the measure.

Exhibit 54. Box-whisker cap rate measures.



The cap rate for <u>all</u> commercial property has declined since the GFC, but it has recently risen, as shown in Exhibit 55. The spread between cap rates and bond yields remains substantial. (See Exhibit 56.)

Exhibit 55. The RCA cap rate, which declined after the GFC, has recently increased.

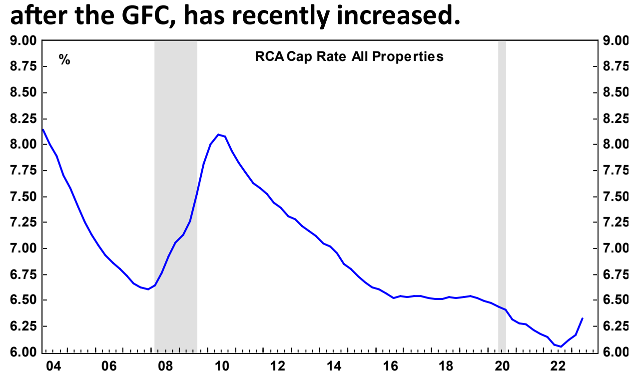
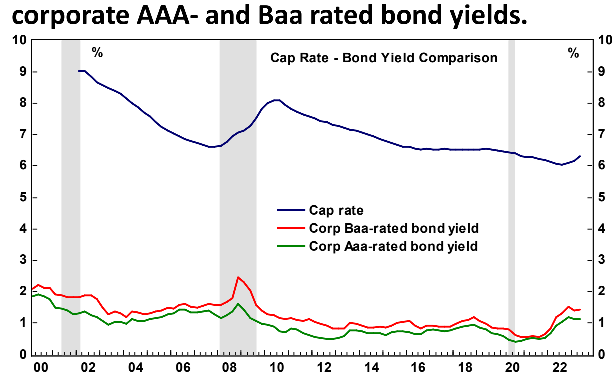


Exhibit 56. The RCA cap rate is higher than the corporate AAA- and Baa rated bond yields.



Many people opined over the last few years that an increase in the Fed funds rate would <u>necessarily</u> increase the cap rate. This view is incorrect. There is no <u>necessary</u> bivariate relationship between cap rates and interest rates. The bivariate correlation of these rates is low, as the following scatter plot shows. Even if the Fed funds rate increase, a narrowing credit spread and increased expected NOI growth could completely swamp the risk-free rate increase. A scatter of the Baa corporate bond yield and the RCA cap rate (Exhibit 57) shows that bivariate correlation, while positive (0.41), is relatively low, which implies that interest rates are not a strong bivariate predictor of cap rate levels or changes. The bivariate correlation between cap rates and REIT total returns, as shown in Exhibit 58, is close to zero, although we know using multiple regression that lagged REIT returns help explain property returns. Exhibit 59 shows an inverse relationship between NOI growth and cap rates, which is consistent with theory.

Exhibit 57. The bivariate correlation of cap rates with the BAA bond yield is 0.41

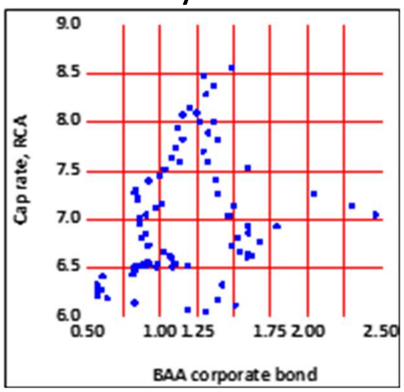


Exhibit 58. Contemporaneous REIT TR is not correlated with cap rates

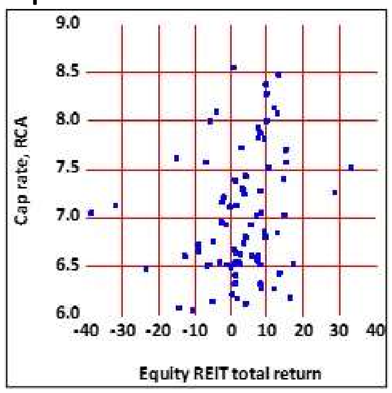
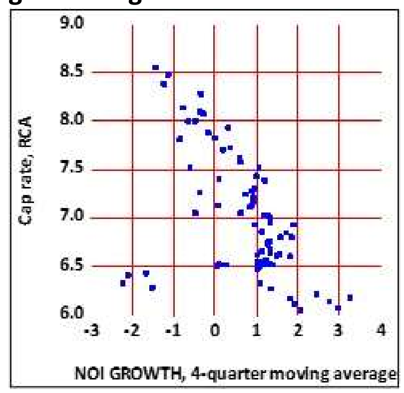


Exhibit 59. Cap rates on average are lower when NOI growth is greater.



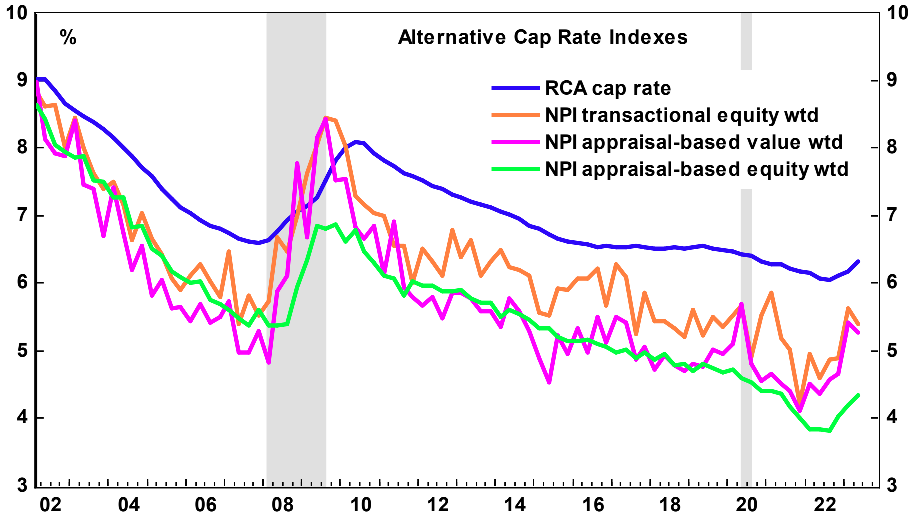
What drives cap rates? The various kinds of cap rates exhibit different sensitivities to the same economic drivers . For example, we estimate models for the RCA cap rate and the NPI appraisal-based cap rate (equity weighted), which have the greatest current spread, as shown in Exhibit 62.

The RCA, NPI transactions-based value- and equity-weighted, and NPI appraisal-based value and equity weighted[11] cap rates diverged before and especially after the GFC:

[11] The correlation of the NPI NOI growth rate (yellow) is consistently negative with respect to all cap rates and NPI cap rates have a high correlation with the RCA cap rate (blue).

	RCA CAP	NPI NOI GROWTH	NPI TRANS VALUE WTD	NPI TRANS EQUITY WTD	NPI APPR_EQUITY WTD	NPI APPR_VALUE WTD
RCA CAP	1.000	-0.275	0.871	0.888	0.961	0.963
NPI NOI GROWTH	-0.275	1.000	-0.308	-0.308	-0.249	-0.238
NPI TRANS VALUE WTD	0.871	-0.308	1.000	0.954	0.891	0.900
NPI TRANS EQUITY WTD	0.888	-0.308	0.954	1.000	0.914	0.911
NPI APPR_EQUITY WTD	0.961	-0.249	0.891	0.914	1.000	0.991
NPI APPR_VALUE WTD	0.963	-0.238	0.900	0.911	0.991	1.000

Exhibit 60. The RCA cap rate, based on a larger sample that includes lower grade properties, exceeds all NPI cap rates.



Equation 21 is a model of RCA cap rates. All of the variables are statistically significant; they include the Baa yield (positive coefficient), the spread between the Baa and AAA bond yields (positive coefficient and lagged four quarters), a moving average of NOI growth lagged four quarters and the four-quarter lagged moving average of REIT equity returns. The greater is expected NOI growth, the lower is the cap rate, which is consistent with theory.

The coefficient on REITs is positive, indicating that if REITs lagged four quarters perform well, then cap rates rise (or property returns fall). This apparent contradiction with our property models (equations 14 and 15) is no contradiction; it contains an important insight. If REITs are performing well in the previous year, current demand for property weakens and property cap rates rise. This represents a reversion to the mean. REITs lagged <u>two</u> periods in our leveraged and unleveraged property return models have a positive sign, indicating that near-term past REIT performance has a positive association with property returns. This important finding demonstrates the differential influence of REITs on cap rate and property total return performance as well as the importance of the lag structure. Our model explains 77% of the variation in RCA commercial cap rates and the high t-statistics indicate that our coefficient estimates are very significant.

$$CAP.RCA_t = 5.206 + 0.837 * CORPBAAYLD_{t-4} + 2.428 * (CORPBAAYLD_{t-4} - CORPAAAYLD_{t-4})$$

(35.684) (6.135) (6.565)

$$-0.072 * MOVAVG(NOIGROWTH_{t-4}) + 0.057 * MOVAVG(REIT_{t-4}) \qquad \textbf{(21)}$$

(-1.928) (6.292)

Adjusted $R^2 = 0.770$
DW = 0.613
Mean dependent variable = 7.089
S.D. dependent var = 0.743
S.E. of regression = 0.365

By contrast, the NPI equity weighted appraisal-based cap rate model (using the same variables) has much less explanatory power; the adjusted R^2 of the NPI model is 31%. (The RCA model's R^2 is 77%, by contrast.) The reason, we believe, is that Equation 22 relies more on appraisals, whereas the RCA cap rate data rely on a larger sample and are more representative of actual transactions cap rates. Additionally, the NPI index represents a much smaller sample of properties that are primarily owned by or on behalf of pension funds. The investment advisors often retain the appraisers, which may introduce biases. The NPI appraisal-based cap rate model performs differently. The sign on the spread coefficient is negative. While the REIT coefficient is negative, it is statistically insignificant as indicated by the low t-statistics in parentheses.

$$\boldsymbol{CAPAPPEQ.NPI_t = 5.322 + 0.988 * CORPBAAYLD_{-4} - 1.044 * (CORPBAAYLD_{t-4} - CORPAAAYLD_{-4})}$$

(18.186) (8.522) (-1.297)

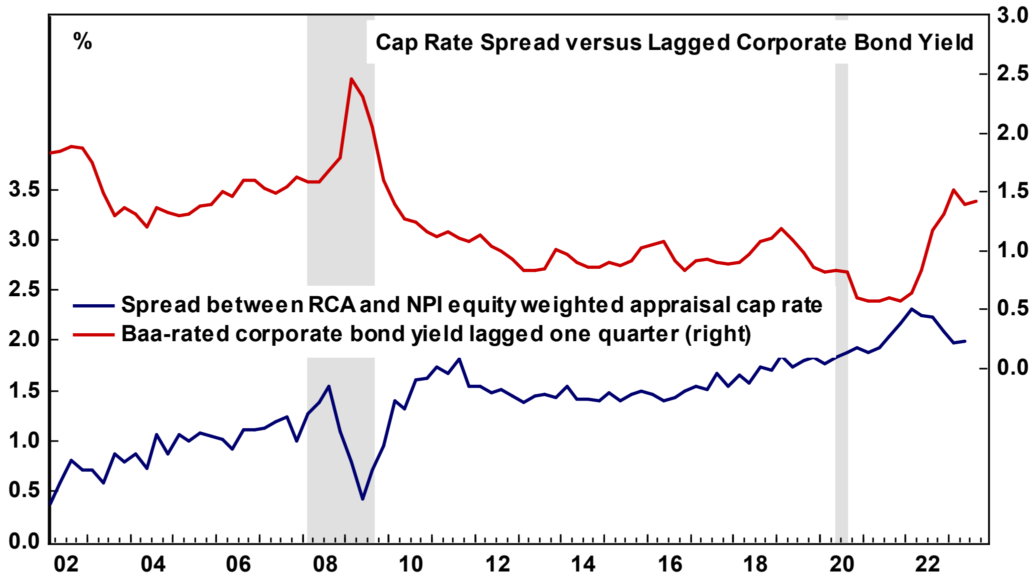
$$\boldsymbol{-0.085 * MOVAVG(NOIGROWTH_{t-4}) - 0.010 * MOVAVG(REIT_{t-4})} \quad \textbf{(22)}$$

(-1.015) (-0.424)

Adjusted R^2 = 0.305
DW = 0.053
Mean dependent variable = 6.817
S.D. dependent var = 1.490
S.E. of regression = 1.242
Mean dependent variable = 6.817

Capital market factors help explain the spread between the RCA and the NPI appraisal-based value weighted cap rate, as shown in Exhibit 61. During the GFC, the spread contracted as cap rates rose, but following the recession, the spread resumed its trend.

Exhibit 61. The spread between RCA and NPI appraisal-based value-weighted cap rate versus the Baa-rated corporate bond yield



The following model of the cap rate spread indicates that the spread decreases when monetary conditions tighten and the current and two-period lagged BBB-rated corporate bond yields rise. A one percentage point increase in the current bond yield decreases the spread by 0.529 percentage points.

(We include an AR(1) correlation for serial correlation.) The model explains 90% of the variation in the spread.

$$CAPSPREAD_t = 2.364 - 0.529 * CORPBAAYLD_{t-t} - 0.210 * DCORPBAAYL_t$$
(-8.896) (4.869) (-2.138)

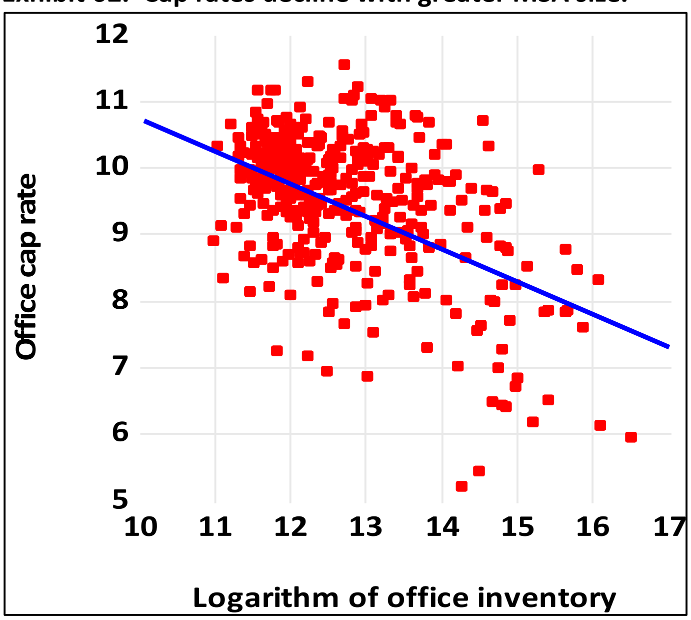
$$+0.931 * AR(1) + 0.016 * SIGMSQ \quad \textbf{(23)}$$
(17.734) (5.539)

Adjusted R^2 = 0.901
DW = 2.306
Mean dependent variable = 1.435
S.D. dependent var = 0.411
S.E. of regression = 0.129

Granularity. So far, I have looked at cap rates at the national level. However, cap rates vary by MSAs, submarkets and property quality.

MSA size and cap rates. Cap rates tend to be lower in larger MSAs even though NOI growth rates are lower as well. (See Exhibit 62.) Why is that the case? Perhaps investors (correctly?) judge that the risk premium is lower in larger MSAs. What about New York and San Francisco? Is the received wisdom wrong?

Exhibit 62. Cap rates decline with greater MSA size.



Quality of property. The quality-based cap rate spread—Class C minus Class A—has recently declined. It was very negative following the GFC. Class A cap rates since the COVID recession have fallen more than Class C cap rates even though both cap rates have identical volatilities. Since 2000, Class C cap rates have exceeded Class A cap rates by about 141 bps.

Application 2. Transactions volume and liquidity

Transactions volume analysis. Transactions are an important indicator of market liquidity and agent of price discovery. The quadrants help model transactions volume, which I have used elsewhere in this report as a liquidity proxy. My transactions model—Equation 24—incorporates general capital markets data as well as data from certain quadrants, such as NOI growth, the spread between Baa-rated bonds and T-bills, bankers' loan expectations, and the Baa corporate bond yield. The model explains 78% of the variation in transactions volume.

Exhibit 63. Transactions volume forecast and scenarios

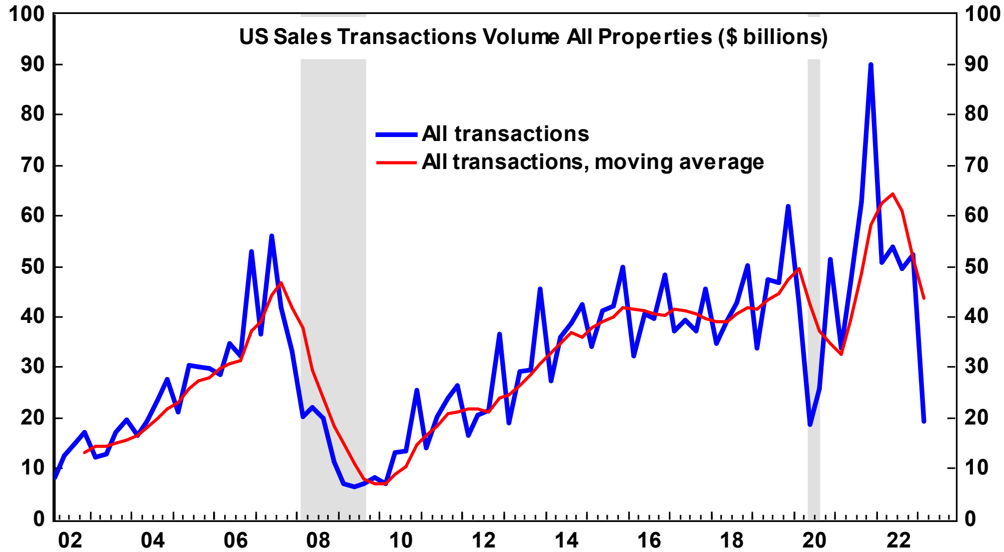
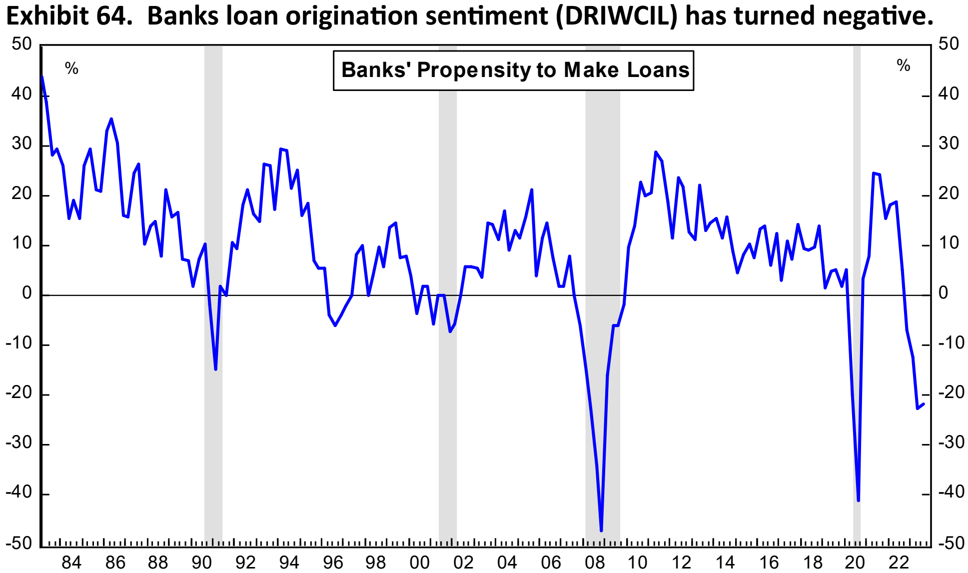


Exhibit 64. Banks loan origination sentiment (DRIWCIL) has turned negative.



In order to account for strength or weakness with regard to property operations, I include a 4-quarter moving average of NOI growth lagged one period; the coefficient is highly significant and positive. By the third quarter of 2020, transactions volume hit a low of $20 billion compared to the pre-COVID high of $55 billion—a 64% drop from the fourth quarter of 2019. Before the Fed tightened, the post-COVID high was $65 billion; this was an historic transactions record. Volume fell $25 billion in the first quarter of this year. DRIWCIL is an important variable in explaining transaction volume.

$$\boldsymbol{TRANSACTIONS_t = 2.421 - 0.793 * SPREAD_{t-1} - 0.302 * CORPAAA_{t-1}}$$

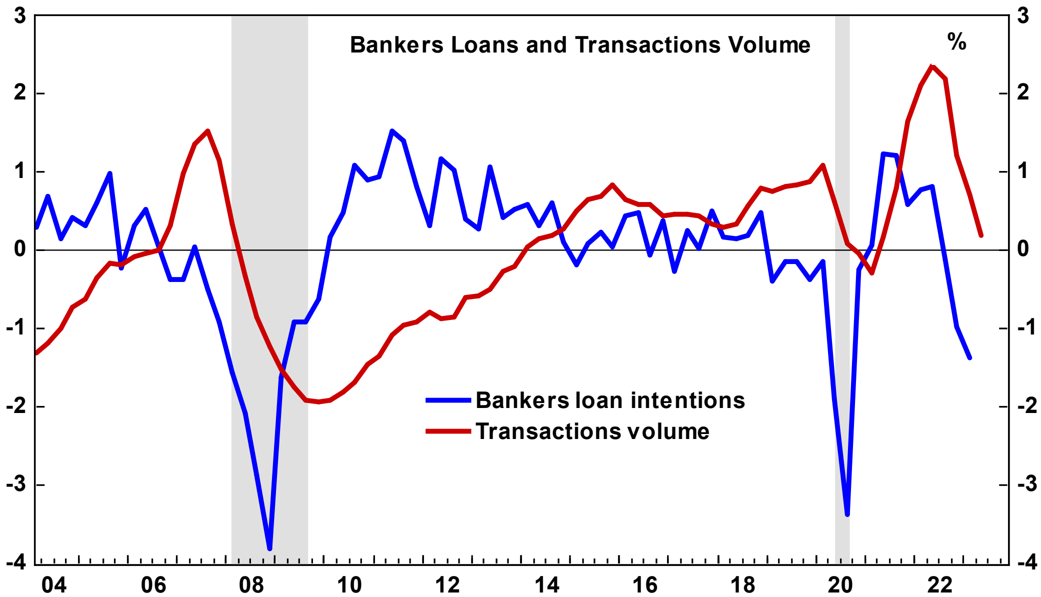
(16.990) (-8.791) (-2.672)

$$\boldsymbol{+0.007 * DRIWCIL_t - 0.010 * DRIWCIL_t * SPREAD_{t-1} + 0.217 * MOVAVG(NOIGROWTH_t)} \quad \textbf{(24)}$$

(1.930) (-2.816) (6.334)

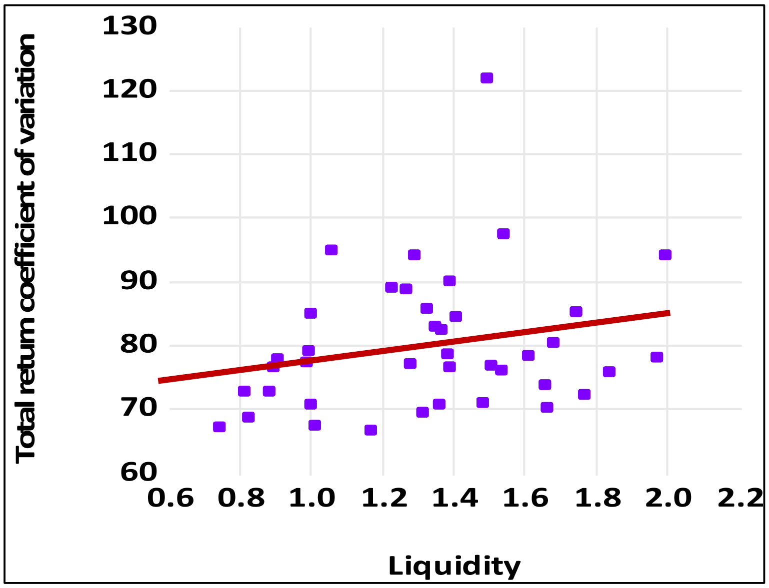
Adjusted R^2 = 0.728
Mean of dependent variable = 1.651
S.D. of dependent variable = 0.527
S.E. of regression = 0.275
DW = 0.709

Exhibit 65. Bankers' lending expectations lead transactions volume.



Capital markets and transactions liquidity. I have evaluated elsewhere the liquidity of the office markets; liquidity rises with MSA return volatility, which I measure with the coefficient of variation defined by the ratio of the standard deviation to the mean return.

Exhibit 66. Liquidity is associated with riskier returns.



MSA office turnover (liquidity)spread. I show that the cross-sectional mean spread responds to capital markets factors over time. In Exhibit 67, I plot the mean spread across about 67 MSAs and include plus and minus one standard deviation. During the GFC, liquidity plummeted. As a result, the market pricing mechanism, which is an important conveyer of information, ceased to function efficiently. In some cases, it was difficult to identify a buyer. Immediately following the last recession, liquidity fell but not as steeply as it did during the GFC.

The spread—plus and minus one standard deviation around the mean inventory turnover—tends to be strongest in non-recessionary years, as shown in Exhibit 68.

Exhibit 67. Liquidity and confidence interval

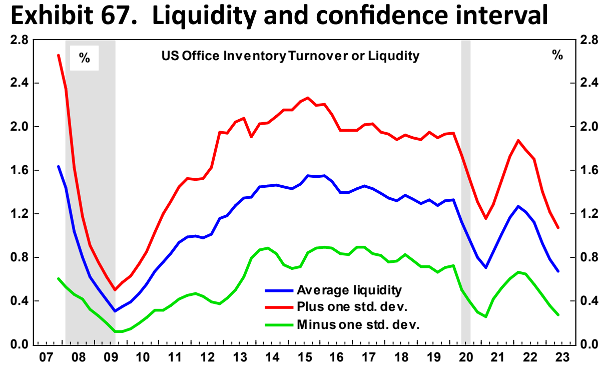
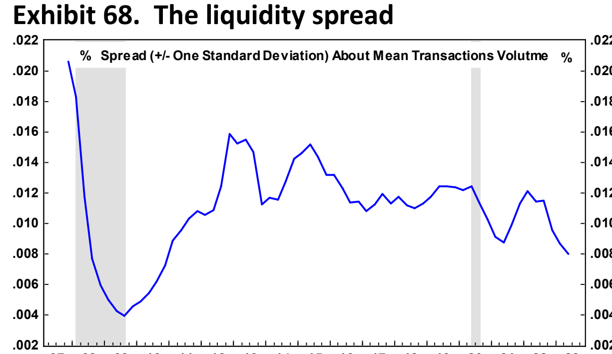


Exhibit 68. The liquidity spread



I model the cross-MSA spread using data from the quadrants. The spread is negatively related to the spread in the previous quarter. If bank willingness to make loans—DRIWCIL—increases, so does the spread. The spread is very sensitive to risk; an increase in the high yield bond yield decreases the MSA turnover spread.

$$MSASPREAD_t = 0.285 + 0.778 * MSASPREAD_{t-1} + 0.004 * DRIWCIL_{t-1} - 0.045 * HYCORPYLD_t \quad (25)$$

(3.506) (16.336) (3.657) (-2.000)

Adjusted R^2 = 0.882
Mean of dependent variable = 1.083
S.D. of dependent variable = 0.303
S.E. of regression = 0.104
DW = 1.522

Conclusion. Transactions volume is not only a predictor of other real estate capital market variables, but it is also a variable that itself responds to capital market forces. Sales volume represents buyers and sellers voting with their dollars, and these ballots may be more revealing than traditional surveys and market analyses.

Application 3. Office employment

Finance and real estate (FIRE) employment. Capital market conditions also affect the user demand for property. Office employment is a good example. I employ the quadrants to explain changes in FIRE workers.

The demand for FIRE workers, given market-determined space per worker, drives the demand for space, since space and workers are production complements. The ratio of space per worker is not constant. The demand for FIRE workers reflects activity in the real estate sector, much of which is a function of transactions volume, such as leasing as well as financing and refinancing. Transactions volume and FIRE employment are both indicators of activity.

Exhibit 69. Fire employment fell sharply during the COVID recession

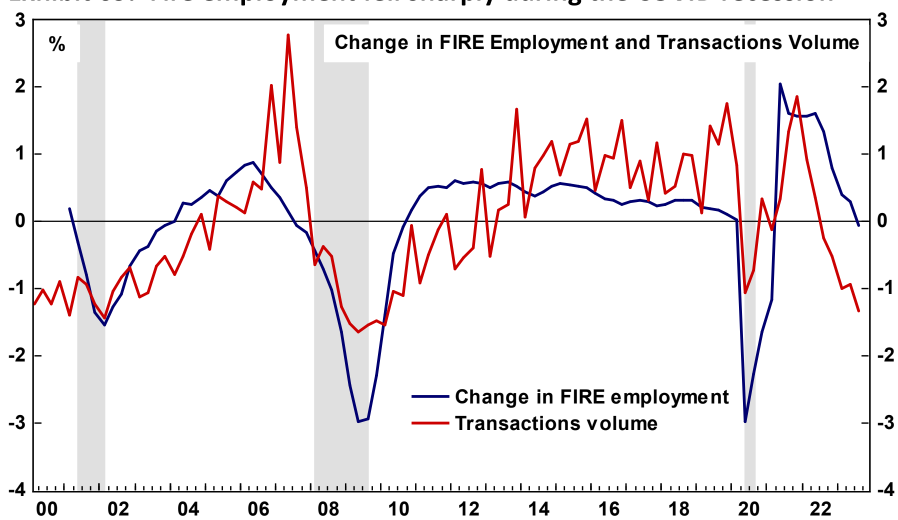
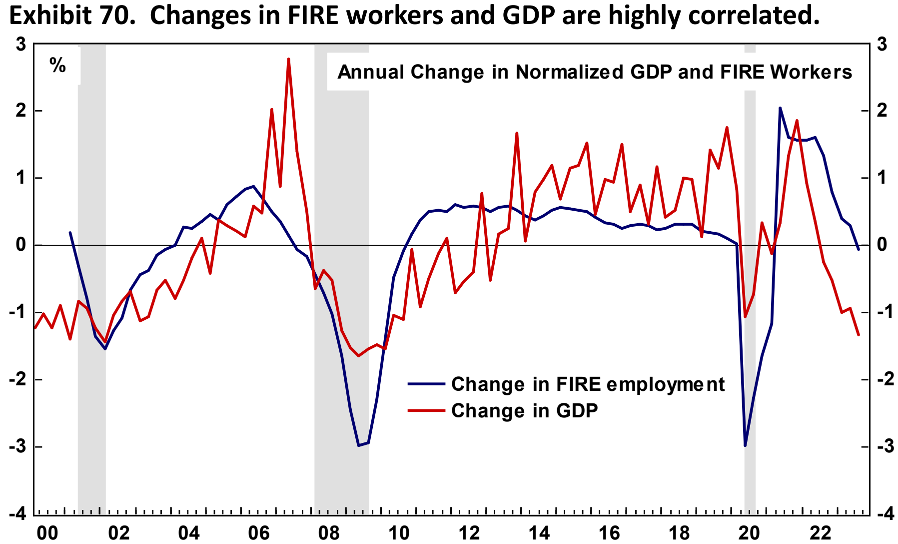


Exhibit 70. Changes in FIRE workers and GDP are highly correlated.



We model the change in FIRE employment, not the level. The change in employment is positively related to the level of transaction; when transactions rise, the sector needs more workers. Transactions volume is an indicator of demand. The willingness of banks to make loans, DRIWCIL, contributes to higher FIRE employment, but with a one quarter lag. Increases in the Baa-rated corporate bond yield reduces employment because higher yields increase the firm's weighted average cost of capital.

The FIRE model shows that the change in NOI growth over two quarters is positively associated with an increase in employment. The model explains 53% of the variation in changes in employment. The t-statistics, which are measures of the statistical significance of each coefficient, are all significant at the 2.5% level or better. The lags are consistent with labor market behavior: Firms take time to plan and execute hiring (and firing) decisions, hence the lagged relationship between the change in FIRE employment, Δ FIRE, and bankers' loan intentions, Baa-rated corporate bond returns, and the change in the growth rate of NOI.

$$\boldsymbol{\Delta\, FIRE_t = -26.140 + 1.024 * TRANSACTIONS_t + 1.459 * DRIWCIL_{t-1}}$$

(-2.941) (4.059) (5.137)

$$\boldsymbol{- 2.476 * CORPBAA_{t-2} + 651.9904 * (NOIGROWTH_t - NOIGROWTH_{-2})} \qquad \textbf{(26)}$$

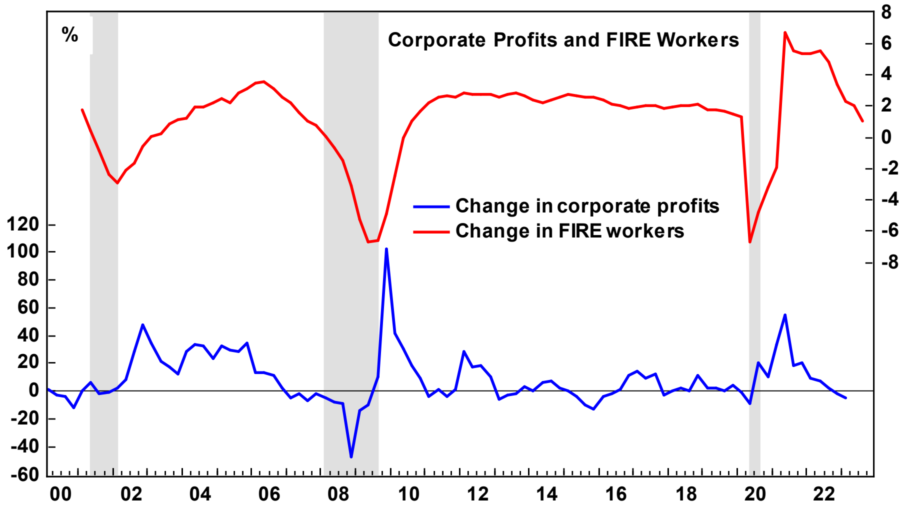
(-2.323)) (4.554)

Adjusted R^2 = 0.533
Mean of dependent variable = 13.710
S.D. of dependent variable = 48.003
S.E. of regression = 32.796
DW = 1.489

The change in FIRE employment is a function of NOI growth, lenders' expectations, bond yields, and transactions volume.

If the demand for office workers is a function of profitability, what determines profitability? I investigated the relationship between the changes in profitability and FIRE employment. When employment increases, profitability declines. Profits increase with growth in nominal GDP.

Exhibit 71. The changes in office workers and corporate profits are inversely correlated.



Equation 25 explains the annual change in corporate profitability, which is a function of the credit spread, the change in GDP, and the change in office worker employment.

$$PROFIT\%CH_t = 6.786 - 23.181 * SPREAD_t + 2.161 * GDP\%CH_t - 3.072 * FIRE\%CH_t$$

(1.067) (-2.450) (3.944) (-3.302)

$$+0.677 * AR(1) + 113.049 * SQIGMAQ \qquad \textbf{(27)}$$

(14.453) (14.020)

Adjusted R^2 = 0.551
DW = 1.991
Mean dependent variable = 7.225
S.D. dependent = 15.915
S.E. of regression = 10.820

Profits are very sensitive to GDP growth: A one percent increase in the rate of GDP growth increases profits by 2.2%. The variables' coefficients are statistically significant and the model explains 55% of the variation in corporate profits.

While the percentage change in corporate profits is, among other factors, a function of the change in FIRE employment, the change in the level of FIRE employment is a function of the annual difference in NOI growth, Baa corporate bond returns lagged two quarters, transactions volume, and lenders propensity to lend lagged one quarter.

There is clearly two-way causality involving corporate profits and FIRE employment. Models of the office sector should recognize these findings.

These models demonstrate that the capital markets convey important information that is useful in explaining FIRE employment and corporate profitability.

VII. Conclusion

Few real estate topics are as neglected or as fraught with inchoate controversy as the connection between capital markets and the performance of the underlying physical assets. This state of affairs contrasts with the sophistication of public fixed income, equities and derivatives markets.

This paper has shown that the quadrants are interrelated and that the relationships are complex and fascinating. I believe our results are practical and theoretically compelling. If taken seriously by investors and their advisors, one might envision two important and beneficial developments: A closer and much more efficient link between real estate pricing and the general capital markets as well as an industry-wide, greater commitment to risk analytics. Without appropriate risk analytics, such as Monte Carlo analysis, the usual deterministic analysis too often fails to value embedded real options properly, identify and price downside risk, and quantity what is still a metaphor in waiting—risk-adjusted returns. Without a new capital markets approach that spans the quadrants, investors will likely leave value on the table and incur uncompensated risk. An enlightened appreciation of the quadrants' interplay also requires the application of advance econometrics and stochastic methods, such as Monte Carlo Analysis. Otherwise, the standard analysis is likely flawed.

Thought-provoking questions for future research. This paper has covered new ground and sets an agenda for future research. Investors in particular will benefit from papers and analysis pertaining to questions such as the following:

1. **What kind of risk metrics best connect general economic performance—vacancy rates, new construction, and rental growth—with valuation, return and risk?** Not all MSAs are alike. Cities with very low space supply elasticities—relative insensitivity of new supply to current changes in prices—generally have greater rental growth volatility, and rental growth volatility affects the value of embedded real options, such as the option to release, the option to escalate, the options to sell, and, of course, the option to develop (or redevelop). These are all call options, the value of which increases as volatility rises. Most investment analysis is deterministic and is incapable of evaluating risk in a useful way.

2. **How should we measure liquidity and how can we incorporate liquidity measures in devising risk premia across MSAs, property types, and property quality?** Serial correlation of returns, or smoothing, is a good correlate of liquidity as measured by the percentage of the property inventory that turns over due to sales in a year. Cities with the greatest liquidity are the most volatile with regard to rental rates.

3. **What drives cap rates?** Will cap rates <u>necessarily</u> rise when interest rates increase? Cap rates are a function of the risk-free rate, the credit spread and the expected growth rate of NOI. Research has shown that an increase in interest rates will not necessarily increase cap rates, because other factors, such as demand-supply imbalances can swamp the effect of interest rate shocks. Investors show

embrace the received wisdom and recoil from the property markets due to rising interest rates should think twice.

4. **Do we overpay for growth, size, and gateway status?** Many investors do not realize that higher growth is associated with higher volatility, which begs the question: Do higher growth MSAs deliver great risk adjusted returns. If an investor and her advisor reduce leverage but invest in a riskier MSA, has the investor really reduced total risk? Do prevailing cap rates reflect true risk? How much of MSA risk is diversifiable?

5. **Is real estate including properties with short-term leases an inflation hedge?**

6. **How can we better apply risk analytics (including MSA risk metrics) to transactions with leverage waterfalls, and other embedded** options with the purpose of forecasting LP versus GP performance? (Risk analytics include Monte Carlo analysis of financial and macro data.)

7. **What are the characteristics of an ideal benchmark the recognizes the attributes found within the quadrants?** How should we measure real estate beta and alpha in practice.

8. **What is the price of liquidity and do prices reflect liquidity?** Should we apply a liquidity risk premium to MSAs according to the characteristics or each MSA? Is there a unique natural vacancy rate—the rate at which rents are neither rising nor falling and how does it relate to liquidity?

9. **Linking fundamentals to expectations for purposes of asset allocation**. How can we better integrate real estate macroeconomic forecasts within asset allocation, while accounting for assets, liabilities and shortfall constraints?

The market is like a cloud: The real estate market must come to terms with uncertainty, even when the landscape seems vaguely familiar. We can think of no better illustrative image than the following

Searching for Value and Avoiding Uncompensated Risk Is Like Shooting through a Dense Cloud

Appendix A. Descriptive Statistics of Data[12]

The following chart highlights the differences between publicly and privately traded assets. While the standard deviations of NPI returns are less than that of stocks, NPI has greater skewness and kurtosis than either stocks or bonds. The Jarque-Bera statistic, which is a measure of normality, indicates that property distributions are not normal. The serial correlation for NPI is much greater than the serial correlation for publicly traded assets. While the measured or apparent standard deviation of NPI is much less than the standard deviation of publicly traded assets, the true standard deviation of property is comparable to that of stocks, REITs, and AAA-rated corporate bonds. The serial correlations of BBB-rated CMBS and BBB-rated corporate bonds are comparable and in excess of their respective AAA-rated CMBS and corporate bonds. The reason is that BBB-rated securities are less liquid.

Exhibit 72. Descriptive statistics, 2000 - 2023

	NPI ALL LEV	NPI ALL UNLEV	CMBS AAA	CMBS BBB	G-L Mortgage	Equity REIT	NOI Growth	Sales Volume YOY	Bond default premium	S&P 500	Small stocks	CORP AAA	CORP BBB
Mean	2.966	2.159	1.052	0.983	1.254	3.343	0.007	0.161	0.285	3.069	3.466	1.188	1.526
Median	3.795	2.580	0.984	1.700	1.539	3.669	0.005	0.189	0.137	3.715	2.991	1.144	1.587
Maximum	9.750	6.150	12.297	17.065	5.238	33.275	0.059	1.228	17.721	20.543	30.589	13.864	13.617
Minimum	-14.800	-8.290	-12.181	-50.779	-7.599	-38.804	-0.083	-0.689	-12.758	-21.943	-34.748	-7.590	-7.101
Std. Dev.	4.721	2.434	3.110	8.742	1.797	11.123	0.022	0.407	3.874	7.833	11.348	3.371	3.322
Skewness	-2.049	-2.248	0.148	-3.248	-1.488	-1.030	-0.537	0.070	0.324	-0.814	-0.537	0.141	0.650
Coef. Var.	1.592	1.128	2.957	8.895	1.433	3.327	3.129	2.532	13.577	2.552	3.274	2.839	2.177
Coeff. lagged dep. Variable	0.815	0.816	0.197	0.349	-0.002	0.087	-0.344	0.892	-0.122	-0.004	0.016	0.030	0.206
Kurtosis	7.963	9.672	9.780	19.114	9.417	6.435	5.774	3.505	9.248	4.264	4.486	5.344	5.438
Jarque-Bera	131.177	204.945	145.836	955.897	158.440	50.800	28.012	0.868	124.963	13.447	10.639	17.648	24.184
Probability	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.648	0.000	0.001	0.005	0.000	0.000
Sum	225.390	164.070	79.917	74.692	95.290	254.064	0.532	12.222	21.687	233.278	263.449	90.256	115.979
Sum Sq. Dev.	1671.733	444.476	725.203	5732.087	242.271	9278.999	0.036	12.435	1125.734	4602.005	9658.319	852.428	827.513
Observations	76	76	76	76	76	76	76	76	76	76	76	76	76

[12] The Jarque-Bera (JB) statistic is zero for a normal distribution, wherein the skewness or lack of symmetry (S) is zero and the kurtosis, K, (or thickness of the tails of the distribution) is 3. The general equation is as follows:

$$JB = \left[\frac{n-k}{6}\right] * \left[S^2 + \frac{1}{4}(K-3)^2\right]$$

The coefficient on the lagged dependent variable, a_1, is an indicator of serial correlation: $Y_t = a_0 + a_1 * X_{t-1} + \epsilon_t$. If there is no serial correlation, then a_1 is not statistically different from zero. Stocks (including REITs) have a near-zero a_1.

Appendix B. Data Correlation Matrix

The bivariate correlation may obscure the true relationship between two variables due to omitted variables. For example, a scatter plot of interest rates and cap rates shows no apparent relationship, but in a multivariate context, where we can hold NOI growth statistically constant and control for credit risk, there is a strong positive relationship between interest rates and cap rates. In practice, supply-demand imbalances can swamp the interest rate- cap rate relationship. Hence, readers should use bivariate correlations with care.

The correlation matrix indicates the AAA-rated CMBS has a near zero bivariate correlation with property, whereas BBB-rated CMBS has a higher, but still low, correlation with leveraged or unleveraged property. In general, BBB-rated bonds should be more sensitive to real estate fundamentals than AAA-rated bonds. The G-L mortgage return has a near-zero correlation with property returns. Equity REITs have a low correlation with property, although we showed earlier that REIT returns help explain property returns in a multivariate context. REITs are highly correlated with the S&P 500 and small cap stocks. The BBB-rated corporate bond has a relatively high correlation with the AAA-rated CMBS tranche. Transactional sales volume growth is highly correlated with property. I believe that transactions volume, which is very volatile over the cycle, impounds important information regarding the underlying property markets. The G-L mortgage return is highly correlated with AAA- and BBB-rated CMBS. NOI growth exhibits modest correlation with leveraged and unleveraged property but low correlation with senior or subordinate CMBS.

Exhibit 73. Correlation matrix, 1997 - 2023

	NPI ALL LEV	NPI ALL UNLEV	CMBS AAA	CMBS BBB	G-L Mortgage	Equity REIT	NOI Growth	Sales Volume YOY	Bond default premium	S&P 500	Small stocks	CORP AAA	CORP BBB
NPI ALL LEV	1.000	0.983	-0.057	0.218	0.044	0.175	0.294	0.784	-0.235	0.117	0.088	-0.072	-0.211
NPI ALL UNLEV	0.983	1.000	0.009	0.254	0.075	0.257	0.307	0.748	-0.188	0.175	0.127	-0.090	-0.180
CMBS AAA	-0.057	0.009	1.000	0.661	0.706	0.617	-0.149	-0.015	0.364	0.451	0.332	0.253	0.783
CMBS BBB	0.218	0.254	0.661	1.000	0.604	0.526	0.017	0.101	0.351	0.582	0.505	-0.233	0.491
G-L Mortgage	0.044	0.075	0.706	0.604	1.000	0.439	-0.225	0.002	-0.013	0.235	0.133	0.161	0.663
Equity REIT	0.175	0.257	0.617	0.526	0.439	1.000	-0.104	0.070	0.485	0.748	0.752	-0.010	0.565
NOI Growth	0.294	0.307	-0.149	0.017	-0.225	-0.104	1.000	0.156	-0.125	-0.101	-0.096	-0.120	-0.302
Sales Volume YOY	0.784	0.748	-0.015	0.101	0.002	0.070	0.156	1.000	-0.162	0.079	0.000	0.078	-0.086
Bond default premium	-0.235	-0.188	0.364	0.351	-0.013	0.485	-0.125	-0.162	1.000	0.697	0.661	0.022	0.557
S&P 500	0.117	0.175	0.451	0.582	0.235	0.748	-0.101	0.079	0.697	1.000	0.894	-0.163	0.529
Small stocks	0.088	0.127	0.332	0.505	0.133	0.752	-0.096	0.000	0.661	0.894	1.000	-0.279	0.423
CORP AAA	-0.072	-0.090	0.253	-0.233	0.161	-0.010	-0.120	0.078	0.022	-0.163	-0.279	1.000	0.437
CORP BBB	-0.211	-0.180	0.783	0.491	0.663	0.565	-0.302	-0.086	0.557	0.529	0.423	0.437	1.000

Appendix C. Exhibit Sources and Notes

Exhibit	Source and notes
1	Zisler Capital Associates, LLC
2	PREA
3	NCREIF and RCA
4	NCREIF and RCA
5	U.S. Treasury
6	Morningstar
7	Morningstar
8	Morningstar
9	Morningstar
10	NCREIF
11	COSTAR and Morningstar
12	Morningstar and NCREIF
13	Zisler Capital Associates, LLC
14	Morningstar
15	Morningstar
16	Morningstar
17	Commercial Mortgage Alert
18	Morningstar and NCREIF
19	Morningstar and NCREIF
20	Morningstar
21	Morningstar
22	Morningstar
23	Morningstar
24	Morningstar and NCREIF
25	Morningstar and NCREIF
26	Morningstar
27	Zisler Capital Associates, LLC
28	Giliberto-Levy
29	Giliberto-Levy
30	NCREIF
31	Giliberto-Levy
32	Giliberto-Levy and Morningstar
33	Giliberto-Levy and Morningstar
34	Giliberto-Levy and NCREIF
35	CBRE and COSTAR
36	Morningstar and NCREIF
37	Morningstar
38	Morningstar and COSTAR
39	NCREIF
40	NCREIF
41	NCREIF and COSTAR
42	NCREIF and Morningstar
43	COSTAR and NCREIF
44	NCREIF and COSTAR

Exhibit	Source and notes
45	NCREIF
46	Zisler Capital Associates, LLC; COSTAR, Giliberto-Levy, Morningstar, NCREIF
47	Morningstar
48	Morningstar
49	NCREIF
50	COSTAR
51	Morningstar
52	Morningstar and NCREIF
53	Zisler Capital Associates, LLC
54	NCREIF, RCA, COSTAR
55	RCA
56	COSTAR and Morningstar
57	RCA and Morningstar
58	RCA and Morningstar
59	RCA and Morningstar
60	NCREIF and RCA
61	NCREIF and RCA
62	COSTAR
63	COSTAR
64	Board of Governors of the Federal Reserve System
65	COSTAR and Board of Governors of the Federal Reserve System
66	Zisler Capital Associates, LLC
67	Zisler Capital Associates, LLC
68	Zisler Capital Associates, LLC
69	COSTAR
70	COSTAR, Morningstar, Giliberto-Levy, NCREIF
71	COSTAR and Board of Governors of the Federal Reserve System
72	Zisler Capital Associates, LLC, COSTAR, Morningstar, Giliberto-Levy, NCREIF
73	Zisler Capital Associates, LLC, COSTAR, Morningstar, Giliberto-Levy, NCREIF