The Predictability of Real Estate Capitalization Rates

by

Vinod Chandrashekaran
Manager, Equity Risk Model Research
BARRA Inc.
2100 Milvia Street
Berkeley, California 94704
phone: 510-649-4689 / fax: 510-548-1709
e-mail: Vinod.Chandrashekaran@BARRA.com

and

Michael S. Young
Vice President and Director of Quantitative Research
RREEF
101 California Street
San Francisco, California 94111
phone: 415-781-3300 / fax: 415-781-2229
e-mail: MYoung@RREEF.com

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Abstract

Understanding the current and future levels of commercial capitalization rates is deeply embedded in the real estate investment decision-making process. Research on the determinants of capitalization rates has been limited largely to surveys of industry participants or modeling based on macroeconomic factors thought to drive changes in the rates. This empirical study of capitalization rates is the first to use a database of actual property operating performance, specifically properties included in the NCREIF Property Index. Two predictive regression models are examined: one with macroeconomic capital market variables and one with lagged capitalization rates. The latter was found uniformly but marginally superior to the former in its out-of-sample predictive power covering a four-quarter period.

I. Introduction

Estimating capitalization rates is an important step in the valuation of commercial real estate and an integral part of the real estate investment decision-making process.[1] Some might say that it is the single most important step because small errors in specification can lead to dramatic changes in value estimates.

Techniques for estimating capitalization rates range from surveys of industry participants to summing of various presumed risk components and adding a risk-free equity return. More mathematically-oriented approaches typically associate real estate capitalization rates with conditions in the broader capital markets, with suitable adjustments for lags and presumed risks. Our analysis is in this latter spirit.

We study the predictability of real estate capitalization rates evidenced by property-specific data in the National Council of Real Estate Investment Fiduciaries (NCREIF) Property Index, a database of institutional-grade, commercial property owned by or on behalf of public and

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[1] Clearly, the predominant approach to valuation of commercial income-producing property is the income approach. The two other sanctioned approaches, the market data approach and the cost approach, are less frequently used and, when used, are typically checks on the income approach. Until the advent of multiperiod discounted cash flow forecasting in the late 1970s, the income approach to value consisted of dividing stabilized net income by the overall capitalization rate. Multiperiod discounted cash flow forecasting uses the same idea when computing the reversionary value and the periodic discount rate, erroneously but popularly known as the IRR, is arguably the sum of the going-in capitalization rate and the net income growth rate. See Wang, Grissom, and Chan [1990].

corporate pension plans. As of year-end 1999 the NCREIF data contained operating information on 2,469 properties having an total market value of approximately $77.4 billion with disaggregations into four property types: Apartment, Industrial, Office, and Retail.

We investigate the predictability of capitalization rates in aggregate and in property-type disaggregates in two ways. First, we follow the approaches taken most often in investigations of this sort by employing macroeconomic variables as the independent variables. Second, based upon implications of the first predictive model, we seek an improvement in the predictive model with the use of four lags of the first differences in the capitalization rates. In both approaches, the dependent variable is the first difference of the capitalization rates over successive quarters.

This study differs from previous research in several ways. First, we use a database of actual property operating statistics. Second, we examine differences among property types across three temporal aggregations of implied capitalization rates: a four-quarter, a two-quarter, and a one-quarter aggregation. Third, because of the nature of our data set, the results are value-weighted.

II. Previous Research

Froland [1987] uses American Council of Life Insurance (ACLI) data and finds that variations in capitalization rates are a function of the mortgage contract rate, the corporate price/earnings ratio, and the yield premium of Treasury bonds over bills. Missing from the Froland study are capitalization rate differences by property type or across time, two variables that could have been incorporated.

Evans [1990] uses ACLI data on capitalization rates to examine the stochastic nature of the stock market's price/earnings ratio with its reciprocal equivalent in real estate, the capitalization rate. He finds a one quarter lag between the two indicating that real estate is slow to adjust to macroeconomic changes that are more immediately imparted to the stock market.

Capitalization rates have been used to study market segmentation by imputing prices from the rates. Liu, Hartzell, Greig, and Grissom [1990] also use capitalization rate data from ACLI to compute commercial property prices as a statistic for investigating whether real estate markets are integrated with the stock market. Their finding that segmentation occurs depending upon the market proxy and real estate returns chosen suggests that the linkage between capital markets and real estate markets may be tenuous.

Ambrose and Nourse [1993] also using capitalization rate data from ACLI show that property type differences are significant. They further show that location factors are insignificant, but their results may result from the crude four-region segmentation used in the study.

Jud and Winkler [1995] use transactions-based data from the National Real Estate Index (NREI) to examine capitalization rate integration with the debt and equity market spreads. Using a weighted average cost of capital approach, the authors find that while capitalization rates are

strongly related to returns in the capital markets, the relation has significant lags and varies across metropolitan areas confirming at the geographic level what other researchers have noticed at other levels of aggregation.

Both the ACLI and NREI data sets suffer from similar problems when it comes to reported capitalization rates and other statistics. First, these data sets report on one-time events at a property: commitments for mortgages in the case of ACLI and sale of a property in the case of NREI. Second, the reported capitalization rates are opinions of the people reporting or are computations made from estimates, oftentimes estimates of future events. In the ACLI case, the stabilized NOI is an opinion of the mortgage lender's appraiser or internal staff and the price is not necessarily verified. Also, in the case of refinancing, the price is unknown so an estimate of value is substituted. Similarly, in the NREI case, the NOI and the price are often opinions rather than verified facts since the data rely upon the party making the report, which may or may not be the property owner or his or her agent. Third, there is no obligation upon those reporting to either ACLI or NREI to be accurate or truthful.

III. Data

The data for this study consist of total and property-type disaggregated information contained in the so-called "detail diskette" from the NCREIF Property Index. In each quarter between the fourth quarter of 1984 and the fourth quarter 1999, we used reported ending market value, net operating income, and numbers of properties to compute implied capitalization rates for Apartment, Industrial, Office, and Retail groups as well as implied capitalization rates for the total of all reported properties. Since NCREIF market values and NOIs are summed across all reported properties, the resulting implied capitalization rates are, in effect, value-weighted.

The capitalization rate for real property is defined as the net operating income (NOI)[2] divided by purchase price or market value. More particularly in this paper, the capitalization rate is computed from NCREIF property data for three different time periods: four consecutive quarters, two consecutive quarters, and a single quarter. All the capitalization rates are annualized to permit comparisons across the temporal aggregations.

The four-quarter capitalization rate is the sum of the average NOIs for a particular quarter and for the three prior quarters divided by the average market value at the end of the quarter. The two-quarter capitalization rate is the sum of average NOIs for a particular quarter and for the immediately prior quarter divided by the average market value at the end of the quarter. The

[2] Net operating income is the gross revenue from a property less operating expenses like property management expense, utilities, real estate taxes, and insurance but exclusive of payments on mortgage indebtedness, capital expenditures, income taxes, or non-cash items such as depreciation or amortization.

NOIs and market values are normalized by the respective quarterly property counts because the number of properties in the NCREIF Property Index vary over time.

Exhibits 1 through 3 show the quarterly imputed capitalization rates for each property type and for all property types combined. The long-term pattern of capitalization rates shown in Exhibit 4 are almost a complete cycle over our sample period. More importantly for the computational approaches we describe later, the pattern of capitalization rates shows a high degree of autocorrelation. This can be seen best in Exhibit 5, which shows that differences between implied capitalization rates among the three temporal aggregations: four-quarter, two-quarter, and one-quarter.

IV. Results

We analyze the implied capitalization rates with two types of predictive regressions. These regressions differ by their explanatory variables, i.e., their 'right-hand-side' variables. The dependent variable in both sets of regressions is the first difference of the capitalization rates over successive quarters. As noted above, Exhibit 5 shows that the capitalization series is strongly autocorrelated. Also, the practice of taking first differences of real estate capitalization rates is consistent with the approach adopted in the literature in this area (see Evans [1990], for example).

Exhibit 6 reports the results from the first set of predictive regressions. In these regressions, the explanatory variables are a set of macroeconomic variables including the return on the S&P500 stock index, unexpected inflation, change in expected inflation, change in default spread, change in the term spread, and the lagged first difference in the real estate capitalization rate.

The return on the S&P500 index over the previous quarter is a proxy for the required rate of return on equity. Jud and Winkler [1995] present a model in which the rates of return on equity and debt are related to the capitalization rate in the real estate sector. Their paper motivates our use of the return on the S&P500 as an explanatory variable. Unexpected inflation and changes in expected inflation are computed on a monthly basis using the technique outlined in Fama and Schwert [1979] and Chen, Roll, and Ross [1986]. The monthly values of these variables over the prior quarter are then aggregated and used in the predictive regressions. The default spread is computed at the end of each month as the difference in the yield on a portfolio of BBB-rated corporate bonds over a portfolio of AAA-rated bonds. The term spread is computed at the end of each month as the difference in the yield on a portfolio of long-term Treasury bonds over the yield on short-term Treasury bills. The changes in the month-to-month values of the default spread and the term spread are aggregated over the prior quarter for use in the regression. In addition to the above macroeconomic variables, we also use the lagged first difference in the real estate capitalization rate in the regression.

The results displayed in Exhibit 6 show that our attempt to predict the changes in capitalization rates using macroeconomic variables is, by and large, unsuccessful, especially when we use the first differences of the four-quarter and two-quarter capitalization rates in the predictive regressions. Note that the actual magnitudes of the estimated coefficients are themselves somewhat meaningless since they depend on the units in which the macroeconomic variables and the dependent variables are stated. However, cross-sectional comparisons of these coefficients are valid since the units in which all variables are stated are consistent across all regressions. From Exhibit 6, it is clear that the R-squares are generally very close to zero and the t-statistics on the individual variables are mostly insignificant. The only scenarios when R-squares are relatively large are in Panel C, when the first differences of the one-quarter cap rates are used as the dependent variable in these regressions. In this case too, however, the significance of the regressions is not due to any of the macroeconomic variables in the regression. Rather, these regressions are significant due to the inclusion of the lagged first difference in the cap rate. In fact, this variable has a significant t-statistic in the regressions across all property types in Panel C of Exhibit 6.

We also ran diagnostic tests to examine if there was any evidence of misspecification in the regressions. One statistic that we computed was the 'variance inflation factor' (VIF) which is a measure of the level of multicollinearity across the explanatory variables in the regressions. A rule of thumb that is often used is to declare the variables in a regression to be multicollinear if any of the VIFs exceed a value of 10. The VIFs were all in the range of 1 to 3, well below the critical value of 10. Hence, we conclude that multicollinearity does not appear to be a problem in these regressions.

Another diagnostic check that we ran was to examine the residuals from the predictive regressions for evidence of serial correlation. If the regression residuals are serially correlated, then there are two implications: (a) the standard errors and t-statistics for the coefficients in the predictive regression computed using 'standard OLS' methodology will be biased, and (b) there is residual predictability in the cap rates that is not picked up by the model. We used the Breusch-Pagan Lagrange-multiplier (LM) test to detect serial correlation in the regression residuals. We found that there was evidence of serial correlation in the regression residuals in many of the fitted models implying that many of these models are misspecified.

Exhibit 7 reports the results of the second set of predictive regressions. In these regressions, the explanatory variables used were four lags of the first differences in cap rates. The choice of this set of variables was motivated by two findings in the previous set of regressions: (a) the first lag of the difference in cap rates was significant in a relatively large number of cases, and (b) there was evidence of serial correlation in the regression residuals.

The results in Exhibit 7 show that the lagged cap rates generally have greater explanatory power than macroeconomic variables. The regression R-squares are generally higher than in the macroeconomic case with very few exceptions. In particular, the regressions with the one-quarter cap rates as the dependent variables are quite significant with R-squares ranging from 17.7% to 54.7%. The other interesting observation from Exhibit 7, Panels B and C, is that the coefficients on the first lag of the difference in cap rates are negative for all property types (although not always statistically significant), the coefficients on lags 2 and 3 are somewhat mixed in sign across property types, while the coefficients on lag 4 are positive for all property types. This result strongly suggests the presence of a seasonal effect in cap rates, namely, that in the short term, cap rates tend to be mean-reverting while in the long term they tend to revert to a more seasonal pattern. We ran the same diagnostic checks for these regressions as discussed above (VIFs and serial correlation of residuals) and found that VIFs were far below danger levels and that serial correlation of residuals was substantially less than before, although not completely eliminated. In other words, the models described in Exhibit 7 appear to be an improvement over those in Exhibit 6 from a model-specification standpoint.

Exhibits 8 and 9 present the predicted cap rates for each of the quarters in 1999 using the two models discussed above. Since the regression coefficients were estimated using data strictly before 1999, the results in Exhibits 8 and 9 may be viewed as an out-of-sample validation of these predictive models. A comparison of the two exhibits reveals that the out-of-sample performance of both models is mixed and that neither model clearly dominates the other in terms of out-of-sample predictive accuracy. However, we caution that the out-of-sample validation has been performed over very few data points, so the RMSE numbers themselves are not measured with a high degree of precision. More work will need to be done to make any definitive statements about the relative accuracy of the two models presented here.

VI. Conclusions

This study of capitalization rates differs from most previous studies in three respects: (1) the underlying data are results from actual property operations reported by their fiduciary managers or owners, (2) the results are disaggregated by property type, and (3) the nature of the database produces value-weighted capitalization rate statistics.

Some may criticize the use of appraisal-based NCREIF data for the present study as they have criticized NCREIF data for value estimation in general. However, this study is not about the level of capitalization rates, but rather about the transfer of shocks or information from capital markets to real estate markets. Thus, this study should be valid across time provided that the definition of the data is consistent. Given the fiduciary obligations of those who contribute data to NCREIF and the long history of cooperation among the contributors in terms of accounting and

valuation conventions, we are reasonably confident that the data are consistently generated over time.

The theory of real estate cycles has as one of its major tenets the belief that real estate markets and capital markets are integrated. While most careful researchers acknowledge that lags are likely, some statistically supportable integration is necessary to support the theory. The present study provides little support for the theory of real estate cycles. Further, results of our predictive model incorporating a variety of equity and debt capital market variables are generally consistent with previous research that finds tenuous linkage between real estate capitalization rates and broader capital market indicators.

Real estate capitalization rates seem to operate in a world of their own. When we used a predictive regression model with four lags of the first differences in capitalization rates as the explanatory variables, we find improvement over the macroeconomic variables model. In particular, the R-squares are, with few exceptions, higher in the lagged first differences model. Additionally, the coefficients of the various lagged variables strongly suggest the presence of a seasonal effect on capitalization rates in the long term and a mean-reverting effect in the short term.

We examined the predictive power of both models by estimating capitalization rates for each of the quarters of 1999. Here the out-of-sample performance of the models is mixed and neither model clearly dominates the other. While these results are not as encouraging as the earlier analysis caused us to expect, we caution that this work covering just a few data points is preliminary. Further research is needed to make more definitive statements.

References

Ambrose, B.W. and H.O. Nourse, Factors Influencing Capitalization Rates, *Journal of Real Estate Research*, 1993, 8: 2, 221-237.

Chen, N., R. Roll, and S. Ross, Economic Forces and the Stock Market, *Journal of Business*, 1986, 59, 383-403.

Dokko, Y., R.H. Edelstein, M. Pomer, and E.S. Urdang, Determinants of the Rate of Return for Nonresidential Real Estate: Inflation Expectations and Market Adjustment Lags, *AREUEA Journal*, 1991, 19:1, 52-69.

Evans, R.D., A Transfer Function Analysis of Real Estate Capitalization Rates, *Journal of Real Estate Research*, 1990, 5:3, 371-379.

Fama, E.F. and G.W. Schwert, Inflation, Interest, and Relative Prices, *Journal of Business*, 1979, 52, 183-209.

Jud, G.D. and D.T. Winkler, The Capitalization Rate of Commercial Properties and Market Returns, *Journal of Real Estate Research*, 1995, 10:5, 509-518.

Liu, C.H., D.J. Hartzell, D.W. Greig, and T.V. Grissom, The Integration of the Real Estate Market and the Stock Market: Some Preliminary Evidence, *Journal of Real Estate Finance and Economics*, 1990, 3:3, 261-282.

National Council of Real Estate Investment Fiduciaries, *NCREIF Property Index*, Chicago, IL.

Wang, K., T.V. Grissom, and S.H. Chan, The Functional Relationship and Use of Going-in and Going-out Capitalization Rates, *Journal of Real Estate Research*, 1990, 5:2, 231-245.

Exhibit 1

Implied Annual Capitalization Rates Using Four Quarters of NCREIF Data
by Year and Quarter for All Properties and for Properties Disaggregated by Type

yyq	All Props	Apartment	Industrial	Office	Retail
853	6.85	7.35	7.42	6.81	6.82
854	6.63	7.31	7.18	6.69	6.62
861	6.92	7.57	7.24	6.65	7.03
862	6.91	7.80	7.13	6.74	7.09
863	6.95	7.91	7.20	6.77	6.94
864	6.81	7.16	7.30	6.70	6.52
871	6.84	7.20	6.97	6.85	6.66
872	6.72	6.23	7.20	6.60	6.55
873	6.77	6.42	7.22	6.59	6.57
874	6.72	7.17	7.18	6.69	6.26
881	6.71	7.45	7.04	6.71	6.31
882	6.41	7.55	7.10	6.06	6.37
883	6.39	7.30	7.06	6.04	6.33
884	6.37	7.34	6.98	6.11	6.06
891	6.39	7.11	7.05	6.10	6.10
892	6.49	7.01	7.11	6.07	6.09
893	6.40	6.70	7.10	5.95	6.10
894	6.30	6.63	7.12	5.94	5.77
901	6.18	6.88	6.80	5.93	6.24
902	6.15	6.86	6.99	5.76	6.08
903	6.16	6.76	6.91	5.90	6.02
904	6.48	6.72	7.16	6.42	6.04
911	6.69	6.85	7.15	6.70	6.70
912	6.83	6.98	7.28	6.79	6.65
913	6.77	7.13	7.52	6.70	6.37
914	7.09	7.27	7.89	7.10	6.41
921	7.06	7.45	8.02	7.13	6.16
922	7.40	7.84	8.12	7.57	6.54
923	7.41	8.51	8.23	7.46	6.49
924	7.64	8.47	8.53	7.80	6.63
931	7.43	8.56	7.88	8.05	6.82
932	7.48	8.43	8.06	8.00	6.75
933	7.49	8.32	8.23	7.82	6.71
934	7.86	8.36	8.83	8.28	6.73
941	7.86	8.41	8.82	8.38	6.39
942	8.06	8.53	8.74	8.80	6.60
943	8.16	8.74	9.05	9.04	6.92
944	8.33	8.45	9.36	9.02	7.32
951	8.47	8.49	9.18	9.29	7.52
952	8.99	8.56	9.18	9.30	9.33
953	8.80	8.83	9.20	8.89	8.89
954	8.65	8.72	9.26	8.66	8.43
961	8.36	8.57	9.23	8.56	7.64
962	8.40	8.62	9.33	8.45	7.59
963	8.32	8.57	9.14	8.27	7.68
964	8.18	8.39	8.96	7.92	7.79
971	8.13	8.01	8.26	8.26	7.70
972	8.24	8.06	8.39	8.20	8.14
973	8.47	8.04	8.58	8.57	8.13
974	8.09	8.04	8.49	8.07	8.05
981	8.02	8.06	8.38	8.17	8.09
982	8.13	8.10	8.57	8.14	8.22
983	8.21	8.09	8.53	8.03	8.37
984	8.17	8.00	8.41	7.91	8.44
991	7.85	7.83	8.21	7.85	7.58
992	7.68	7.77	8.21	7.64	7.36
993	7.60	7.69	8.16	7.44	7.44
994	7.71	7.55	8.51	7.44	7.62

Exhibit 2

Implied Annual Capitalization Rates Using Two Quarters of NCREIF Data
by Year and Quarter for All Properties and for Properties Disaggregated by Type

yyq	All Props	Apartment	Industrial	Office	Retail
853	7.27	7.52	7.81	7.22	7.25
854	6.86	7.96	7.44	6.88	6.77
861	7.03	7.50	7.47	6.73	7.04
862	7.13	7.01	7.43	6.90	7.31
863	7.13	8.24	7.49	6.89	7.09
864	6.82	7.56	7.46	6.69	6.58
871	6.93	6.61	7.20	6.84	6.93
872	6.98	6.69	7.59	6.81	6.73
873	7.00	7.71	7.51	6.95	6.56
874	6.80	7.68	7.36	6.73	6.43
881	6.78	7.28	7.26	6.54	6.67
882	6.64	7.51	7.41	6.19	6.59
883	6.66	7.43	7.31	6.38	6.37
884	6.51	7.39	7.07	6.29	6.18
891	6.54	7.11	7.22	6.21	6.37
892	6.63	6.89	7.29	6.32	6.18
893	6.32	6.59	7.02	6.11	5.90
894	6.19	6.78	7.00	5.93	5.66
901	6.25	7.01	6.90	5.98	6.27
902	6.31	6.78	7.28	5.90	5.95
903	6.28	6.72	7.05	6.09	5.87
904	6.62	6.99	7.30	6.60	6.09
911	6.76	7.18	7.46	6.64	6.61
912	6.73	6.87	7.44	6.58	6.22
913	6.69	6.99	7.62	6.60	6.00
914	7.06	7.42	7.90	7.07	6.30
921	7.10	7.60	7.93	7.10	6.36
922	7.58	8.10	8.14	7.77	6.78
923	7.52	8.69	8.20	7.70	6.51
924	7.63	8.11	8.36	7.82	6.81
931	7.67	8.29	8.05	8.26	7.09
932	7.90	8.58	8.66	8.19	6.84
933	7.69	8.38	8.55	7.83	6.83
934	8.10	8.45	8.97	8.68	6.98
941	8.18	8.69	9.08	8.77	6.80
942	8.27	8.68	8.84	8.84	7.08
943	8.34	8.74	9.23	9.07	7.28
944	8.54	8.46	9.63	9.19	7.62
951	8.66	8.65	9.34	9.47	7.76
952	9.02	8.84	9.48	9.39	8.92
953	8.68	8.94	9.52	9.03	7.84
954	8.68	8.72	9.34	8.87	8.00
961	8.52	8.57	9.27	8.63	7.89
962	8.52	8.61	9.44	8.57	7.76
963	8.41	8.62	9.15	8.62	7.71
964	8.27	8.45	9.01	8.10	7.97
971	8.33	8.06	8.62	8.45	8.04
972	8.58	8.20	9.05	8.71	8.29
973	8.71	8.29	9.00	9.00	8.11
974	8.24	8.26	8.61	8.28	8.17
981	8.36	8.23	8.74	8.43	8.39
982	8.39	8.25	8.91	8.23	8.31
983	8.16	8.19	8.50	7.97	8.05
984	8.12	8.08	8.48	7.93	8.18
991	7.90	7.93	8.49	7.74	7.79
992	7.90	7.85	8.54	7.64	7.94
993	7.91	7.75	8.48	7.69	7.94
994	7.81	7.67	8.63	7.49	7.79

Exhibit 3

Implied Annual Capitalization Rates Using One Quarter of NCREIF Data
by Year and Quarter for All Properties and for Properties Disaggregated by Type

yyq	All Props	Apartment	Industrial	Office	Retail
853	7.33	8.17	7.85	7.27	7.35
854	6.90	8.05	7.60	6.90	6.61
861	7.11	6.51	7.59	6.80	7.29
862	7.34	7.38	7.68	7.05	7.41
863	6.98	9.20	7.49	6.76	6.95
864	6.92	6.16	7.55	6.78	6.87
871	7.03	7.25	7.48	6.78	7.01
872	7.19	7.67	7.71	7.27	6.66
873	6.94	7.86	7.58	6.81	6.60
874	6.88	7.43	7.46	6.62	6.78
881	6.82	7.27	7.42	6.57	6.68
882	6.95	7.70	7.60	6.52	6.67
883	6.58	7.34	7.29	6.39	6.29
884	6.68	7.49	7.13	6.28	6.51
891	6.62	7.01	7.49	6.43	6.34
892	6.59	6.77	7.08	6.42	6.11
893	6.18	6.70	7.04	6.03	5.69
894	6.30	6.97	6.94	5.97	5.91
901	6.30	6.76	7.19	6.06	5.99
902	6.40	6.91	7.32	5.98	5.94
903	6.28	6.65	6.96	6.23	5.85
904	6.81	7.54	7.71	6.58	6.24
911	6.52	6.80	7.35	6.42	6.11
912	6.82	6.88	7.58	6.63	6.18
913	6.58	7.08	7.63	6.55	5.83
914	7.13	7.52	7.74	7.07	6.48
921	7.16	7.60	8.07	7.09	6.58
922	7.74	8.51	8.06	8.19	6.61
923	7.36	8.16	8.15	7.38	6.65
924	7.79	8.01	8.20	8.09	7.05
931	8.03	8.50	8.73	8.48	6.99
932	7.87	8.56	8.63	7.86	6.99
933	7.81	8.33	8.55	8.27	6.87
934	8.37	8.76	9.28	8.90	7.29
941	8.18	8.72	8.97	8.66	7.06
942	8.43	8.66	8.95	8.90	7.28
943	8.39	8.75	9.49	9.10	7.38
944	8.72	8.47	9.53	9.40	7.82
951	8.66	8.94	9.62	9.37	7.74
952	8.90	8.80	9.64	9.55	7.90
953	8.67	8.94	9.57	9.11	7.80
954	8.87	8.76	9.25	9.00	8.24
961	8.47	8.48	9.50	8.43	7.96
962	8.66	8.73	9.31	9.07	7.73
963	8.35	8.59	9.23	8.54	7.75
964	8.43	8.53	9.09	8.16	8.30
971	8.49	8.05	9.14	8.78	8.05
972	8.80	8.42	9.29	9.02	8.26
973	8.61	8.37	8.87	8.92	8.11
974	8.54	8.36	8.86	8.54	8.43
981	8.55	8.29	9.11	8.48	8.48
982	8.23	8.31	8.62	8.06	8.06
983	8.19	8.21	8.65	8.14	7.84
984	8.12	8.15	8.62	7.79	8.35
991	7.96	7.97	8.66	7.61	8.09
992	8.22	7.85	8.75	8.02	8.41
993	7.85	7.80	8.56	7.57	7.78
994	7.83	7.79	8.47	7.47	8.00

Exhibit 4

Implied Capitalization Rates for All NCREIF Properties
Computed from One, Two, and Four Quarters of Data

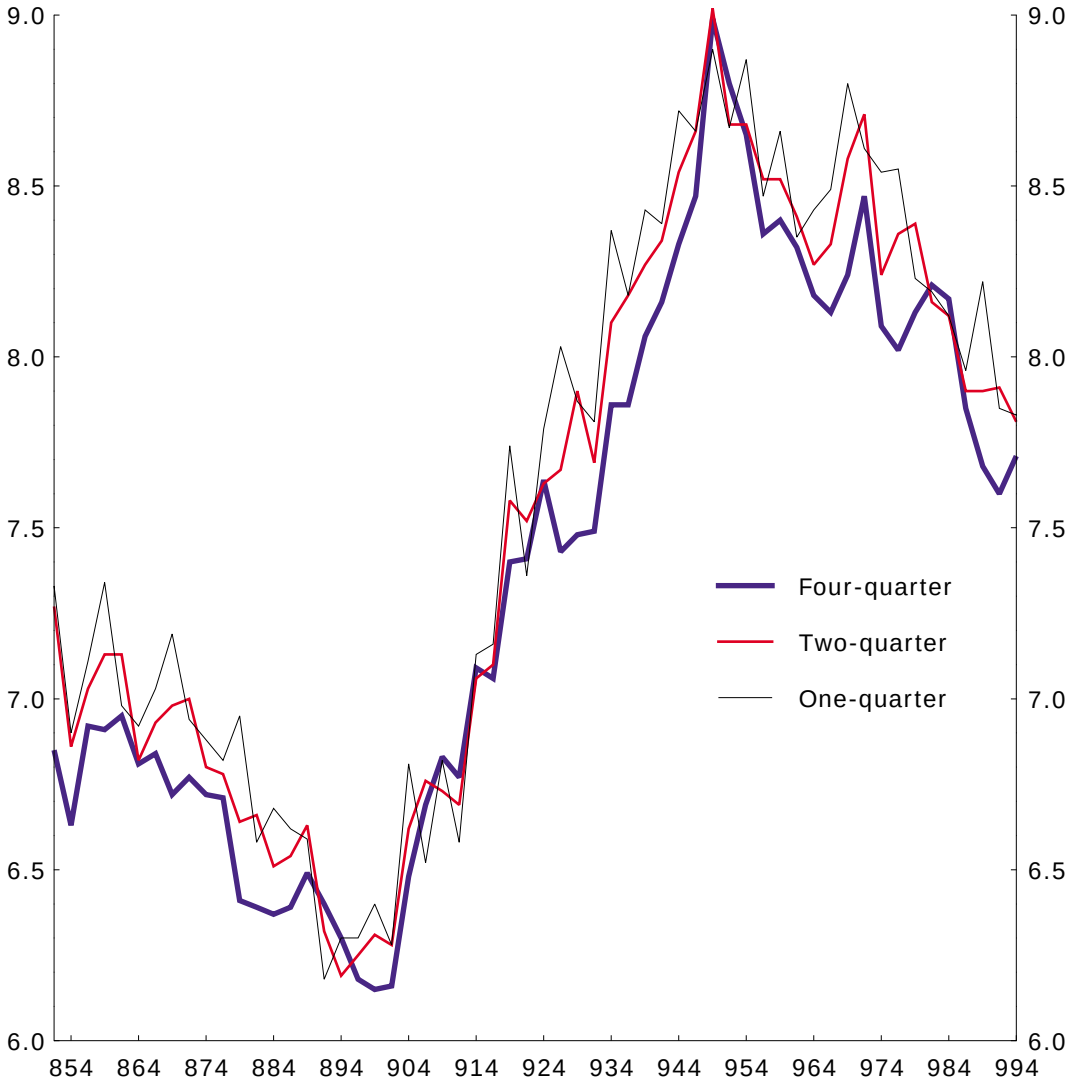

Exhibit 5

Implied Capitalization Rate Differences for All NCREIF Properties

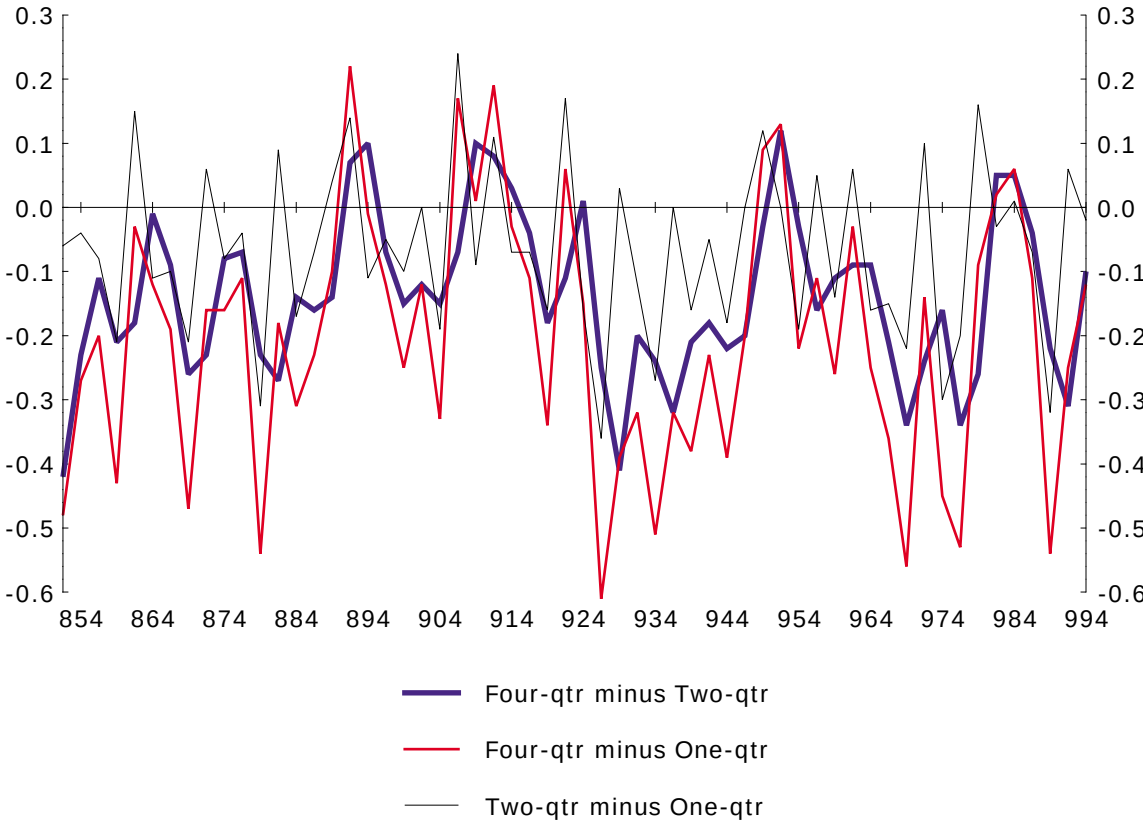

Exhibit 6

Panel A
Results of predictive regression for four-quarter real estate capitalization rate on macroeconomic variables

Property Type	Intercept	Return on S&P500	Unexpected inflation	Change in expected inflation	Change in default spread	Change in term spread	Lag of cap rate	R-square
All Properties	0.034	-0.145	-7.685	46.747	28.627	44.103	-0.021	0.024
Apartment	0.027	0.016	-38.359**	207.766*	319.542	175.466	0.180	0.177
Industrial	0.021	-0.053	-2.238	-64.401	-335.697	47.334	-0.058	0.073
Office	0.034	-0.186	-5.835	53.331	165.492	119.578	-0.022	0.051
Retail	0.041	-0.142	-11.108	142.059	352.353	-43.891	-0.035	0.052

Panel B
Results of predictive regression for two-quarter real estate capitalization rate on macroeconomic variables

Property Type	Intercept	Return on S&P500	Unexpected inflation	Change in expected inflation	Change in default spread	Change in term spread	Lag of cap rate	R-square
All Properties	0.033	-0.368	2.193	-6.606	-212.210	-29.152	-0.089	0.054
Apartment	0.007	0.935	-53.195**	243.019*	197.541	436.428**	-0.157	0.210
Industrial	0.022	-0.122	6.654	-53.424	-329.846	-6.207	-0.258	0.125
Office	0.027	-0.078	-3.012	42.791	-277.486	130.330	-0.078	0.071
Retail	0.049	-0.897	4.759	28.717	290.691	-216.727	-0.325*	0.211

Panel C
Results of predictive regression for one-quarter real estate capitalization rate on macroeconomic variables

Property Type	Intercept	Return on S&P500	Unexpected inflation	Change in expected inflation	Change in default spread	Change in term spread	Lag of cap rate	R-square
All Properties	0.028	-0.272	21.383	-109.033	-254.988	-97.627	-0.432**	0.274
Apartment	0.003	0.005	-33.645	-34.828	-831.288	29.895	-0.434**	0.262
Industrial	0.034	-0.748	23.170	-102.770	-491.745	-106.521	-0.346**	0.282
Office	0.007	0.325	25.577	-110.788	-393.577	29.593	-0.326*	0.173
Retail	0.056	-1.082	12.503	-62.119	137.857	-214.320	-0.379**	0.234

* Significant at the 5% level.
** Significant at the 1% level.

Exhibit 7

Panel A
Results of predictive regression for four-quarter real estate capitalization rate on lags of the capitalization rate

Property Type	Intercept	Lag 1	Lag 2	Lag 3	Lag 4	R-square
All Properties	0.013	0.143	0.145	-0.244	0.313*	0.202
Apartment	0.005	0.095	0.053	-0.204	-0.129	0.081
Industrial	0.018	-0.045	-0.006	-0.051	0.263	0.078
Office	0.012	0.007	0.122	0.008	0.254	0.010
Retail	0.033	-0.008	-0.009	-0.233	0.016	0.056

Panel B
Results of predictive regression for two-quarter real estate capitalization rate on lags of the capitalization rate

Property Type	Intercept	Lag 1	Lag 2	Lag 3	Lag 4	R-square
All Properties	0.011	-0.110	0.071	0.070	0.355*	0.154
Apartment	0.001	-0.053	-0.342*	0.099	0.128	0.261
Industrial	0.014	-0.397**	-0.064	0.356*	0.393**	0.283
Office	0.013	-0.100	0.039	0.174	0.146	0.052
Retail	0.025	-0.368*	-0.132	0.036	0.249	0.186

Panel C
Results of predictive regression for one-quarter real estate capitalization rate on lags of the capitalization rate

Property Type	Intercept	Lag 1	Lag 2	Lag 3	Lag 4	R-square
All Properties	0.008	-0.307*	0.155	0.135	0.487**	0.463
Apartment	0.004	-0.759**	-0.367*	0.003	0.168	0.547
Industrial	0.010	-0.519**	-0.005	0.495**	0.353*	0.363
Office	0.014	-0.361*	0.015	0.248	0.246	0.177
Retail	0.021	-0.259*	-0.049	-0.003	0.478**	0.364

* Significant at the 5% level.
** Significant at the 1% level.

Exhibit 8

Panel A

Out-of-sample accuracy of macroeconomic model with four-quarter cap rate

Property Type	Predicted cap rate for 1991.1	Predicted cap rate for 1999.2	Predicted cap rate for 1999.3	Predicted cap rate for 1999.4	Root Mean Squared Error (RMSE) of predicted cap rates
All Properties	8.16%	7.89%	7.70%	7.65%	0.199%
Apartment	8.01	7.85	7.72	7.80	0.167
Industrial	8.34	8.25	8.23	8.13	0.201
Office	7.96	7.87	7.69	7.52	0.189
Retail	8.49	7.64	7.36	7.54	0.481

Panel B

Out-of-sample accuracy of macroeconomic model with two-quarter cap rate

Property Type	Predicted cap rate for 1991.1	Predicted cap rate for 1999.2	Predicted cap rate for 1999.3	Predicted cap rate for 1999.4	Root Mean Squared Error (RMSE) of predicted cap rates
All Properties	8.01%	7.94%	7.93%	7.91%	0.082%
Apartment	8.26	8.07	7.89	7.92	0.250
Industrial	8.40	8.52	8.58	8.47	0.103
Office	7.85	7.82	7.74	7.72	0.165
Retail	8.06	7.88	7.83	7.98	0.178

Panel C

Out-of-sample accuracy of macroeconomic model with one-quarter cap rate

Property Type	Predicted cap rate for 1991.1	Predicted cap rate for 1999.2	Predicted cap rate for 1999.3	Predicted cap rate for 1999.4	Root Mean Squared Error (RMSE) of predicted cap rates
All Properties	8.09%	8.03%	8.16%	7.97%	0.208%
Apartment	7.85	8.11	7.80	7.72	0.151
Industrial	8.40	8.65	8.79	8.57	0.186
Office	7.93	7.71	8.02	7.67	0.336
Retail	8.04	8.14	8.24	8.02	0.268

Exhibit 9

Panel A

Out-of-sample accuracy of lagged cap rate model with four-quarter cap rate

Property Type	Predicted cap rate for 1991.1	Predicted cap rate for 1999.2	Predicted cap rate for 1999.3	Predicted cap rate for 1999.4	Root Mean Squared Error (RMSE) of predicted cap rates
All Properties	8.14%	7.82%	7.65%	7.64%	0.168%
Apartment	7.98	7.81	7.78	7.73	0.129
Industrial	8.39	8.29	8.22	8.15	0.205
Office	7.93	7.83	7.61	7.39	0.141
Retail	8.44	7.58	7.39	7.67	0.447

Panel B

Out-of-sample accuracy of lagged cap rate model with two-quarter cap rate

Property Type	Predicted cap rate for 1991.1	Predicted cap rate for 1999.2	Predicted cap rate for 1999.3	Predicted cap rate for 1999.4	Root Mean Squared Error (RMSE) of predicted cap rates
All Properties	8.16%	7.92%	7.81%	7.89%	0.147%
Apartment	8.10	7.97	7.88	7.75	0.134
Industrial	8.64	8.42	8.36	8.51	0.126
Office	7.92	7.69	7.61	7.65	0.133
Retail	8.24	7.91	7.90	7.96	0.244

Panel C

Out-of-sample accuracy of lagged cap rate model with one-quarter cap rate

Property Type	Predicted cap rate for 1991.1	Predicted cap rate for 1999.2	Predicted cap rate for 1999.3	Predicted cap rate for 1999.4	Root Mean Squared Error (RMSE) of predicted cap rates
All Properties	8.10%	7.84%	8.09%	7.96%	0.243%
Apartment	8.22	8.13	7.99	7.87	0.219
Industrial	8.49	8.49	8.70	8.67	0.200
Office	7.81	7.60	7.81	7.62	0.274
Retail	8.27	7.95	8.25	8.19	0.355