Predictability of Returns in Commercial Real Estate - Implications for Investment Decisions

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Submitted to the Department of Urban Studies and Planning in Partial Fulfillment of the Requirements for the Degree of Master of Science in Real Estate Development

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## Abstract

Prior studies suggest that variations of returns in all assets can be predicted to some extent. This study extends the subject of predictability of returns to commercial real estate. The main purpose of the present study is to investigate whether private real estate is predictable and the level of predictability associated with real estate return sufficient to realize superior investment performance by market timing. The study examines commercial real estate both at the aggregate level and in markets for four major property types in the United States. A rolling regression using a vector autoregressive model is employed to forecast returns and estimate the predictability of commercial real estate. Then the forecast model is used to construct simple rules regarding market timing.

The classical efficient market theory suggests that there is little to be gained by timing investment, and little hope to consistently beat the market since asset prices already reflect all information available in the market. However, the fact that returns in commercial real estate are predictable raises the possibility of market timing. The potential to use a market timing strategy based on the predicted returns to achieve superior investment performance is of interest to practitioners since it suggests a more efficient method for investment portfolio allocation.

The findings of the study suggest that commercial real estate returns are predictable to a certain extent and, although not statistically convincing, that the level of predictability associated with commercial real estate can be used to direct market timing decisions and achieve superior performance relative to a passive buy and hold portfolio. However, predictability of returns tends to decrease at the disaggregate property market level as the markets have smaller sample sizes and more exposure to idiosyncratic risk.

Thesis Supervisor: David Geltner
Title: Professor of Real Estate Finance

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## Chapter One: Introduction

Prior studies suggest that variation of returns in the securities market is predictable to some extent.[1] Traditionally, private (unsecuritized) commercial real estate is considered to be more predictable than the securities market.[2] Geltner and Mei (1995) developed a prediction model for commercial real estate in this regard. The model was relatively robust. However the study of Geltner and Mei had some practical limitations due to shortage of empirical data available at the time. This study is built upon foundation of their findings. The study analyzes predictability of aggregate real estate market with another 11 year of data accumulated since their study. A vector autoregressive model (VAR) is employed for this purpose. The study extends to predictability of disaggregate market level for four major property types: apartment, office, retail, and industrial.

The idea that returns are predictable raises important issue for investment decisions. Under the classical efficient market paradigm, there was little to be gained by timing investment, and little hope to consistently beat the market since asset prices already reflected all information available in the market. Consequently, little attention was paid to the importance of timing of investment decisions.[3] However, if the returns are predictable, investors can utilize this information and time the market, i.e. buy properties when returns expectations are favorable and sell them when pessimistic market is predicted.[4] Mei and Liu (1994) found that moderate success in market timing is possible by exploiting the level of predictability in case of securitized real

[1] See, for example, Keim and Stambaugh (1986), Fama and French (1988), and Liu and Mei (1992, 1994)
[2] Geltner and Miller (2001)
[3] Geltner and Mei (1995)
[4] Predictability of return does not necessary indicates inefficient market. See Campbell and Shiller (1987, 1988)

estate stocks. This study investigates whether the level of predictability associate with commercial real estate return is sufficient to allow an investor to construct a market timing strategy that would lead to superior investment performance in private real estate sector.[5] Simple investment rules using the forecast from VAR model are developed and then the performance of portfolios applying theses rules is compared with a passive buy and hold portfolio for the study of each market.

The remainder of the paper is organized as follows. Chapter two describes the data utilized. Chapter three briefly outlines the framework used for the forecast model followed by description of the investment strategies based on the forecast. Descriptions of regression estimations and analysis of empirical results for aggregate property market and individual property types are presented in chapter four. Chapter five concludes the study.

[5] The study investigates macro level commercial real estate in a certain market. Investors should be concerned about heterogeneous characteristics and perform due-diligence when selecting individual property.

## Chapter Two: Data

In this paper we first look into aggregate market for commercial real estate in the United States during 1975 to 2003. Then the study is extended to four different property types in US: apartment, office, retail, and industrial. Last we look into whether the model can be applied to certain property type at Metropolitan Statistical Area (MSA) level. Office market in MSA of Boston, New York, Washington, Chicago, Los Angeles, and Atlanta is chosen for this purpose. The results of MSA level analysis are reported in appendix.

For the study of aggregate market, annual frequency return and cash flow data from 1978 through 2003 is obtained from NCREIF Property Index (NPI) for private commercial real estate.[6] In addition to NPI, PRISA returns are used from 1975 to 1977.[7] These return series is composed of both appreciation and income component. As this study extends to disaggregate level of four property types, return data for each property type for 1978 through 2003 is also obtained from NCREIF Data Query. Data for office in certain MSA is also available from NCREIF Data Query, although starting year of data available varies depending on which MSA is chosen.[8]

In order to recover the market return series from appraisal –based index we unsmooth the appreciation returns to correct for disaggregate level appraisal smoothing, as well as aggregate level index construction effects such as temporal aggregation. The procedure for unsmoothing is

[6] NPI is quarterly based index published by National Council of Real Estate Investment Fiduciaries. Although the index is published quarterly, NPI is more like annual index due to the characteristics of NCREIF database (see Geltner and Goetzmann, 2000). Quarterly returns are annualized by chain linking quarterly rates of return. NPI is reported on unleveraged basis, although index consists of both equity and leveraged properties.
[7] PRISA Index was published by the Prudential Realty Group, Newark, New Jersey.
[8] See appendix for the sample period used for each MSA

that of Geltner's (1993), which does not assume efficient market for real estate. In particular, appreciation returns are unsmoothed using the following reverse filter:

$$g_t = \frac{g_t^* - 0.6 g_{t-1}^*}{0.4}$$

where $g_t^*$ is the observed appraisal-based index appreciation return in year *t*, and $g_t$ is the unsmoothed return. Figure 2.1 through 2.5 show history of aggregate and disaggregate value levels of US commercial property. The value levels in graphs are measured by both the appraisal-based PRISA-NCREIF index and the unsmoothed market value index.

An Index of the level of the net operating income (NOI) generated by PRISA and NCREIF properties is obtained by applying the current income yield series to the property value level series.[9]

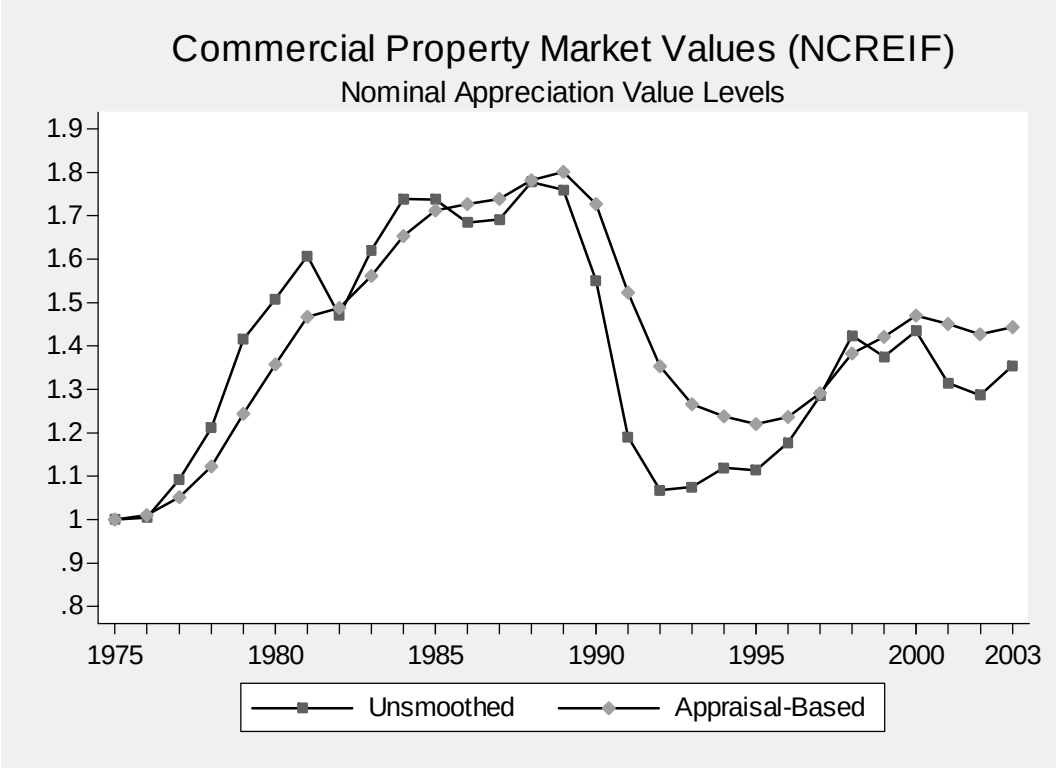


Figure 2.1 Historical aggregate market smoothed and unsmoothed value levels (1975-2003)

[9] $NOI_t = y_t * V_{t-1}$, where $y_t$ is the current income return component in the appraisal-based index, Vt-1 is value level in previous year from same index.

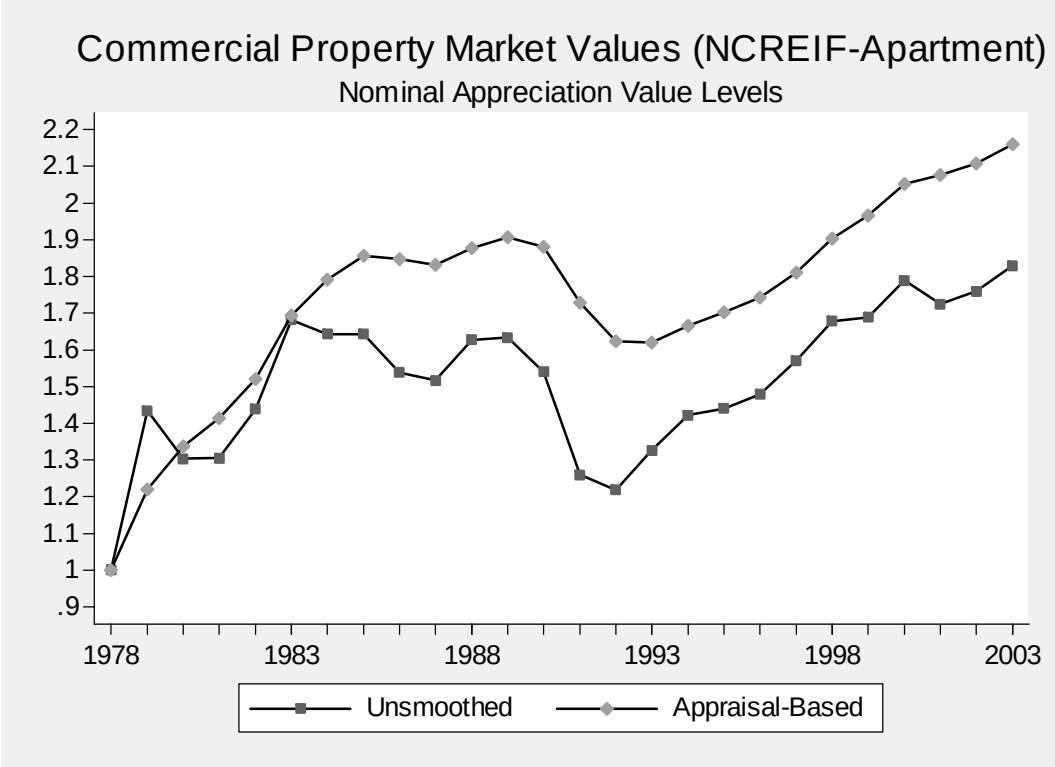


Figure 2.2 Historical apartment market smoothed and unsmoothed value levels (1978-2003)

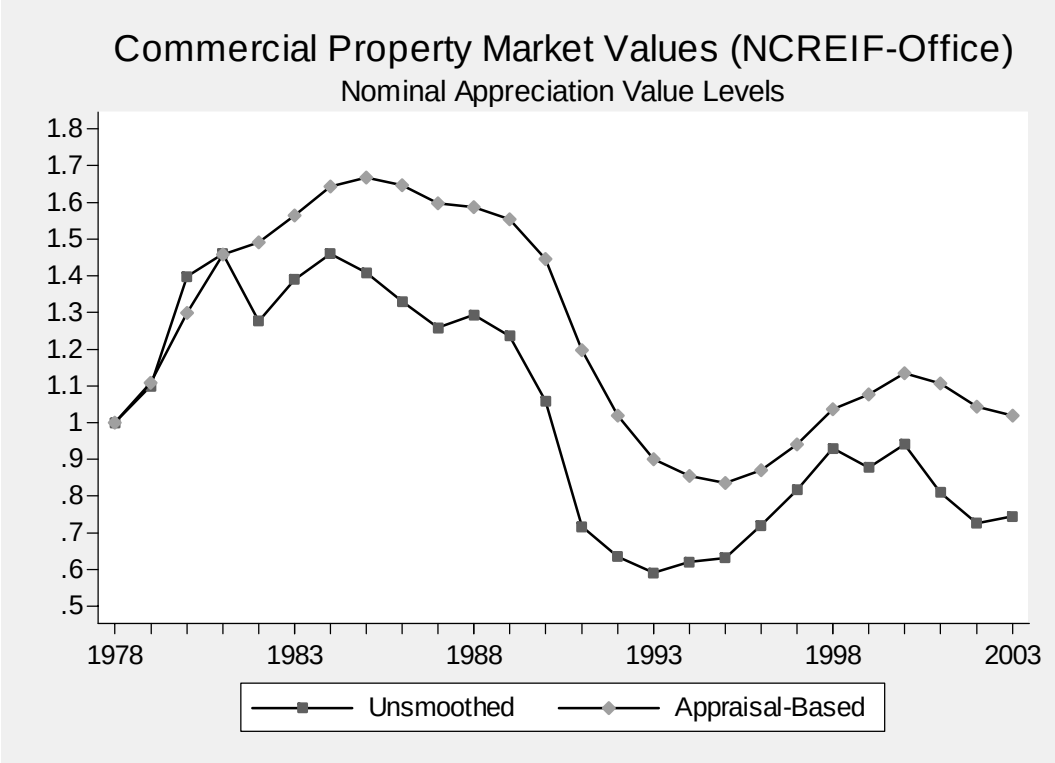


Figure 2.3 Historical office market smoothed and unsmoothed value levels (1978-2003)

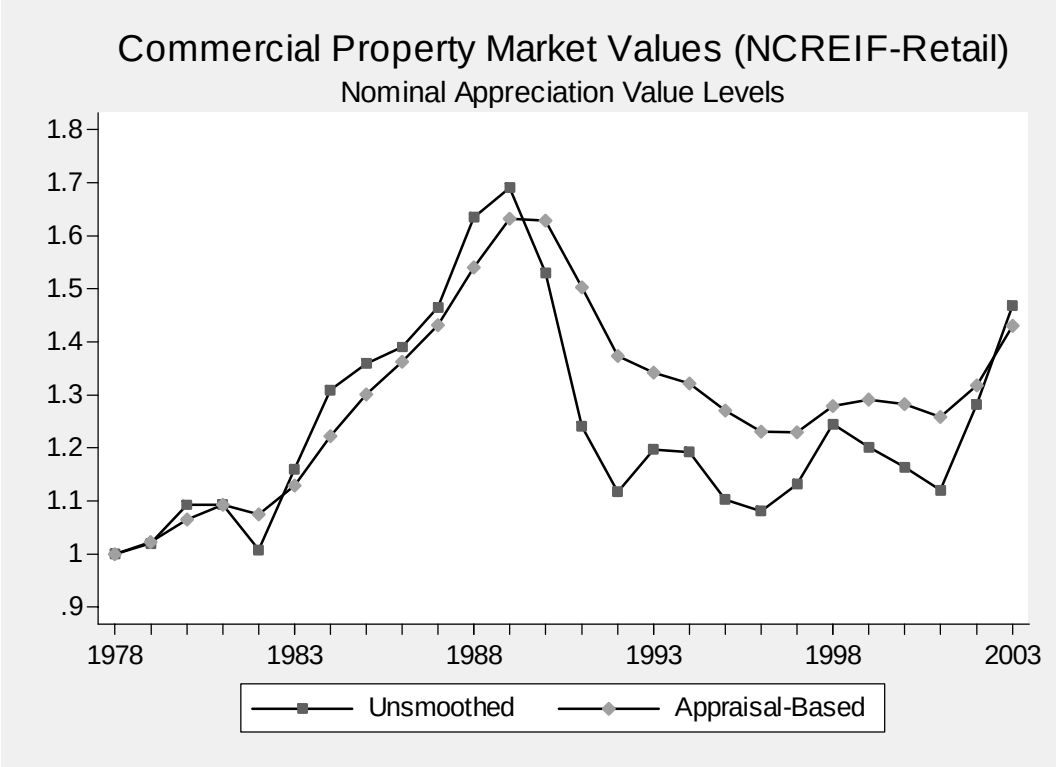


Figure 2.4 Historical retail market smoothed and unsmoothed value levels (1978-2003)

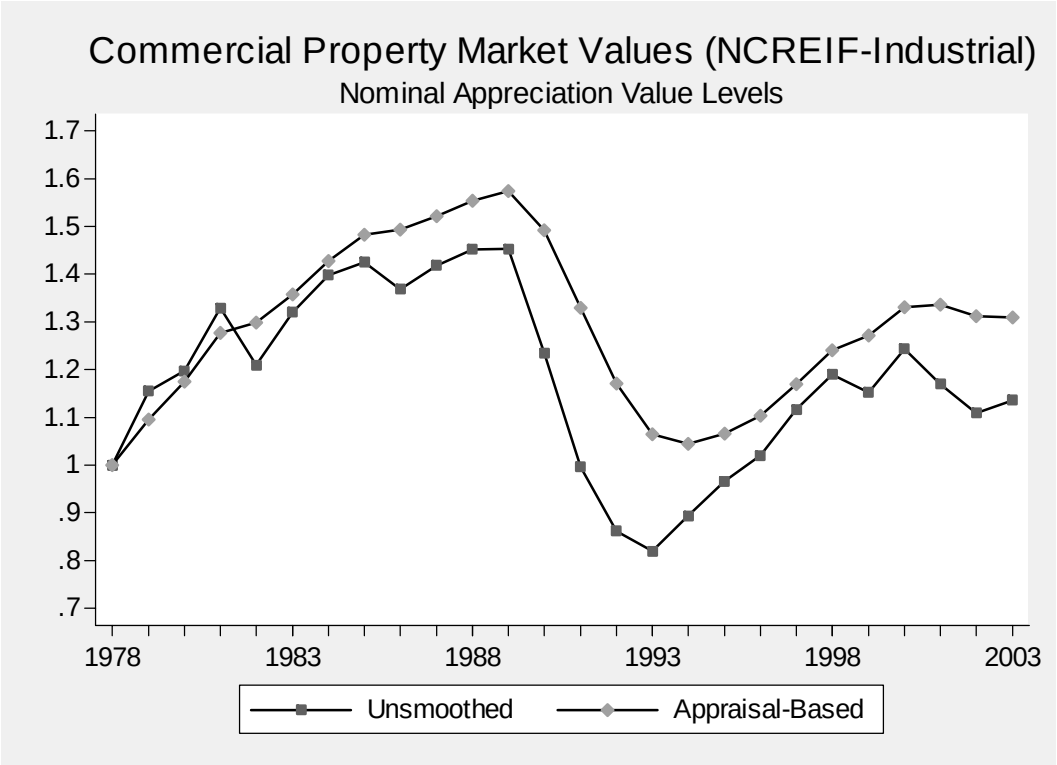


Figure 1.5 Historical industrial market smoothed and unsmoothed value levels (1978-2003)

In addition to private real estate market data, REIT returns in the public stock exchange are obtained from NAREIT index.[10] Several researches have shown that REIT returns as a leading indicator of private property returns (see Gyourko and Keim, 1992; Barkham and Geltner, 1995; Geltner and Goetzmann, 2000). While the property index returns of REIT, a disaggregate index value and returns for each property types, are obtainable from NAREIT index, it is only observable from 1994, which gives small sample data of the last 10 years. Therefore, we used index returns of all REIT throughout the study, even though property index returns might project a better forecast for the disaggregate level of the study.

[10] All REIT returns are employed for this study.

## Chapter Three: Methodology

The forecast model used in the current study follows VAR model from Geltner and Mei (1995), which employs 1 year lag in the model.[11] We also experiment 1 and 2 year lags structure within the variables of the model. The VAR model assumes that the expected returns conditional to information at time *t* is linear in the variables known to investors at time *t*. The VAR model consists of five forecasting variables derived from the data described above. The variable we are interested to forecast in this study is the unsmoothed commercial property market total return. The predictions of REIT return are also used to compare predictability of securitized and unsecuritized real estate returns. In addition to the market total return and REIT return, three other variables are included in the model: the cash flow level expressed as a fraction of the aggregate property value level at the beginning, the income return of the appraisal-based index, and appraisal total return based on appraisal index. There are prior studies indicating that income yields, as well as REIT returns, tend to be good predictors of returns (see Liu and Mei, 1992, 1994). Although the preceding variable observations do not necessarily include all relevant variables that carry information about factor premiums, the methodology that we use is relatively robust to omitted information. In addition, the variables used in this model are easily observed by market participants. Therefore the model does not require rigorous market research to be developed, which is merit of this model.

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[11] Mathematically,

$$y_t = c + \Phi_1 y_{t-1} + \Phi_2 y_{t-2} + \cdots + \Phi_p y_{t-p} + \varepsilon_t$$

$$E(\varepsilon_t) = 0$$

where *c* denotes an $(n \times 1)$ vector of constants and $\Phi_j$ an $(n \times n)$ matrix of autoregressive coefficients for *j*=1,2,…,*p*. See Hamilton (1994).

Ex ante expected returns for the study of each market are forecasted using rolling regressions. The rolling regressions are based on the information on forecasting variables available at each year. The study period of the rolling regressions are selected by looking into stability of each model since return forecasts tend to unrealistically amplify oscillations when the sample sizes are too small. For instance, in order to build a conditional forecast model for aggregate return in year *t*, we estimate parameters using data from 1975 to *t*. Then the values of the five endogenous variables are used to point forecast the following year's values of variables and those forecasted variables are used for point forecast for the year after and so on. Out-of-sample criteria, as well as in-sample criteria, are applied to see the predictability of the model.

Once we have the forecast results, Long (+) portfolios are constructed for each level of study based on the return forecast. The returns of the portfolios are then compared with returns of passive buy-and-hold portfolio of the corresponding properties. Investment decisions are made annually due to relatively small sample size to obtain both in-sample and out-of-sample observations, although annual trading frequency may not correspond the investment horizon of real estate. As a benchmark, the passive buy-and-hold portfolios are assumed to be held during the study period. The passive buy-and-hold portfolios follow the performance of the unsmoothed market total return for commercial properties at each level over the study period.

For the aggregate market study, three market timing rules are employed for investment decisions based on the predictions from the VAR model. The decisions are made based on only the information available at each point of time. If the forecast model predicts above-average returns for the next two consecutive years, we take a long position. If the model forecasts below-average returns for the two consecutive years, we close the position. Otherwise, we take it as a

hold signal and put half of the fund in long position and close the rest half. The study does not reckon transaction cost nor liquidity issues associated to implementing investment strategy.

For the disaggregate market study of property types of apartment, office, retail, and industrial, we use same rules applied to aggregate market to each property. The model projects a buy/sell/hold decision for each point of time. Performances of portfolios are analyzed based on the decisions. We also developed another investment rules using all four property types to make two Long (+) portfolios. One portfolio take a long position of a property type that the model forecasts the highest return in the following year. Another portfolio takes long position of two property types with highest return forecast. The performances of these portfolios are then compared with a passive buy-and-hold portfolio of aggregate market.

# Chapter Four: Results and Analysis

## Aggregate Property Market

Table 4.1 presents summary statistics for the five variables used in the VAR model. The sample period for the analysis is 1975 through 2003. The mean of the market total return during this period is 9.58%. As discussed earlier, real estate total return, whether it's unsmoothed market total return or smoothed appraisal total return, is comprised of income return and capital return. An inspection of the mean of appraisal yield reveals that most returns were generated from the income component in average. This is consistent with the mean of the cash flow level, which also shows small appreciation of property value over the sample period.

The market total returns were volatile during this period relative to stable appraisal yield. This implies that fluctuation of market total return is caused by variation in capital return. The appraisal total return is less volatile than market total return due to smoothing effect. Not surprisingly, REIT total return has highest return and standard deviation of the variables. High first autocorrelations in appraisal yield is partly because often times rents are based on multiple year contracts. High autocorrelation in appraisal total return, compared to market total return, corresponds with nature of appraisal, which is based on smoothing.

The market total return is highly correlated with appraisal return, as it is unsmoothed from appraisal return. Also, it has high positive correlation with appraisal yield, even though appraisal yield did not show much variation in the sample period. The cash flow is negatively correlated with all the other variables.

Table 4.1 Historical statistics of VAR model variables (annual nominal values: 1975-2003) - aggregate market

| Variable | Mean | Std. Dev. | $\rho_1$ * |
|---|---|---|---|
| Real Estate Market Total Return** | 0.0958 | 0.0920 | 0.4893 |
| Real Estate Cash Flow*** | 0.1138 | 0.0119 | 0.8100 |
| Appraisal Yield | 0.0809 | 0.0075 | 0.8934 |
| REIT Total Return | 0.1546 | 0.1723 | 0.0887 |
| Appraisal Total Return | 0.0958 | 0.0589 | 0.8082 |

* $\rho_1$ is the first autocorrelation of the series
** Unsmoothed from the appraisal-based returns
*** Aggregate cash flow level of apartment expressed as a fraction of the aggregate value level as of the end of 1974

| | Correlation Among Variables | | | | |
|---|---|---|---|---|---|
| | Mkt. Ret | CF | Appr. Yld | REIT Ret | Appr. Ret |
| Mkt. Ret | 1.000 | | | | |
| Cash Flow | -0.380 | 1.000 | | | |
| Appr. Yld | 0.621 | -0.409 | 1.000 | | |
| REIT Ret | 0.023 | -0.393 | 0.192 | 1.000 | |
| Appr. Ret | 0.825 | -0.269 | 0.497 | -0.004 | 1.000 |

Mkt. Ret : Real Estate Market total return obtained by unsmoothing the appraisal-based return
Cash Flow : Net operating income level obtained from income and appreciation return components of appraisal based index
Appr. Yld : Current income component of appraisal-based index
REIT Ret. : NAREIT All-REIT index total return
Appr. Ret : Appraisal-based index total return

A summary of estimation results of the VAR model using only 1 year lag and 1-2 year lags are presented in Table 4.2 and Table 4.3, respectively. Both results are based on rolling regression using the variables available at each point of time. In order to investigate both in-sample out-of-sample results, VAR models from 1989 through 2003 are examined for the study of 1-year-lag and 1996 to 2003 for the 1&2-year-lag study.

The summary tables report average and standard deviation of the coefficients for five variables from 1989 to 2003. These tables also reports summary statistics of adjusted R-square and root mean squared error (RMSE) of the VAR model during the study period as a measure of predictability. The returns in private real estate are by far more predictable than the returns on REIT for both in-sample and out-of sample, which is consistent with the prior study of Geltner and Mei (1995). The model predicted cash flow and appraisal yield precisely during both in-sample and out-of-sample period. The coefficients of regression equations are relatively stable.

Table 4.2 VAR Model(1 year lag) estimation results. Estimated coefficients - Aggregate market

| | Independent Variables | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Dep. Var. | Const. | Mkt. $Ret_t$ | $CF_t$ | Appr. $Yld_t$ | REIT $Ret_t$ | Appr. $Ret_t$ | Adj $R^2$ | RMSE |
| Mkt. $Ret_{t+1}$ | | | | | | | | |
| Ave. | -0.967 | 0.330 | 1.438 | 11.843 | 0.099 | -0.728 | 0.506 | 0.081 |
| | (-2.691) | (1.089) | (0.989) | (3.536) | (1.117) | (-1.405) | | |
| Std. | 0.551 | 0.117 | 1.590 | 5.882 | 0.068 | 0.704 | 0.085 | 0.024 |
| | (1.086) | (0.311) | (1.093) | (0.988) | (0.796) | (1.01) | | |
| Cash $Flow_{t+1}$ | | | | | | | | |
| Ave. | 0.0188 | -0.0131 | 0.8482 | -0.0549 | 0.0000 | 0.0544 | 0.9498 | 0.0064 |
| | (1.404) | (-1.175) | (16.977) | (-0.426) | (0.019) | (3.3) | | |
| Std. | 0.0074 | 0.0073 | 0.0248 | 0.0755 | 0.0010 | 0.0182 | 0.0169 | 0.0019 |
| | (0.656) | (0.604) | (2.104) | (0.585) | (0.299) | (0.339) | | |
| Appr. $Yld_{t+1}$ | | | | | | | | |
| Ave. | 0.0188 | -0.0058 | -0.1413 | 1.0244 | -0.0004 | -0.0426 | 0.9551 | 0.0085 |
| | (2.413) | (-0.808) | (-4.323) | (14.321) | (-0.177) | (-4.509) | | |
| Std. | 0.0050 | 0.0050 | 0.0159 | 0.0480 | 0.0010 | 0.0097 | 0.0118 | 0.0032 |
| | (0.703) | (0.665) | (0.277) | (3.156) | (0.419) | (1.813) | | |
| REIT $Ret_{t+1}$ | | | | | | | | |
| Ave. | 0.6994 | -1.0719 | -7.0967 | 3.2512 | -0.2004 | 1.1663 | -0.0344 | 0.2006 |
| | (0.792) | (-1.444) | (-2.051) | (0.565) | (-0.891) | (0.993) | | |
| Std. | 0.5770 | 0.1589 | 1.4316 | 6.2890 | 0.0914 | 0.6721 | 0.0558 | 0.0346 |
| | (0.491) | (0.309) | (0.324) | (0.726) | (0.381) | (0.29) | | |
| Appr. $Ret_{t+1}$ | | | | | | | | |
| Ave. | -0.3806 | 0.1327 | 0.5477 | 4.6983 | 0.0401 | 0.3089 | 0.8004 | 0.0418 |
| | (-2.644) | (1.091) | (0.937) | (3.507) | (1.133) | (2.177) | | |
| Std. | 0.2182 | 0.0471 | 0.6312 | 2.3328 | 0.0269 | 0.2812 | 0.0443 | 0.0150 |
| | (1.076) | (0.31) | (1.084) | (0.976) | (0.793) | (1.755) | | |

Notes: All data are annual (4th quarter to 4th quarter) in nominal terms. Observations 1975-2003

Summary statistics of regression coefficients are given by the first line of each row, while statistics of the z-ratio are given in parenthesis in the second row. Rolling regression technique using data from 1975 to time t is employed in order to analyze out-of-sample predictions between 1989 and 2003.

Table 4.3 VAR Model(1-2 year lags) estimation results. Estimated coefficients - Aggregate market

| | Independent Variables | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dep. Var. | Const. | Mkt. $Ret_t$ | Mkt. $Ret_{t+1}$ | $CF_t$ | $CF_{t+1}$ | Appr. $Yld_t$ | Appr. $Yld_{t+1}$ | REIT $Ret_t$ | REIT $Ret_{t+1}$ | Appr. $Ret_t$ | Appr. $Ret_{t+1}$ | Adj $R^2$ | RMSE |
| Mkt. $Ret_{t+2}$ | | | | | | | | | | | | | |
| Ave. | -1.657 | 16.776 | -0.509 | -91.100 | 96.315 | 137.783 | -133.902 | 0.204 | 0.198 | -42.527 | 35.743 | 0.483 | 0.101 |
| | (-3.039) | (0.8) | (-1.786) | (-2.828) | (2.811) | (2.861) | (-2.681) | (2.373) | (2.071) | (-0.811) | (1.116) | | |
| Std. | 0.560 | 7.349 | 0.187 | 23.412 | 26.312 | 40.487 | 41.231 | 0.053 | 0.059 | 18.287 | 11.793 | 0.102 | 0.024 |
| | (0.884) | (0.301) | (0.677) | (0.625) | (0.662) | (0.726) | (0.707) | (0.455) | (0.408) | (0.297) | (0.265) | | |
| Cash $Flow_{t+1}$ | | | | | | | | | | | | | |
| Ave. | 0.046 | 0.803 | 0.008 | 2.191 | -1.475 | -2.206 | 2.169 | 0.002 | 0.001 | -1.974 | 1.046 | 0.903 | 0.007 |
| | (2.179) | (0.916) | (0.654) | (1.749) | (-1.14) | (-1.223) | (1.175) | (0.429) | (0.094) | (-0.9) | (0.755) | | |
| Std. | 0.011 | 0.603 | 0.009 | 0.960 | 1.007 | 1.409 | 1.547 | 0.002 | 0.005 | 1.513 | 0.980 | 0.010 | 0.002 |
| | (0.919) | (0.613) | (0.752) | (0.963) | (0.895) | (0.868) | (0.88) | (0.544) | (1.328) | (0.616) | (0.636) | | |
| Appr. $Yld_{t+1}$ | | | | | | | | | | | | | |
| Ave. | 0.034 | 0.467 | 0.003 | 0.552 | -0.768 | -0.144 | 1.167 | 0.001 | 0.001 | -1.217 | 0.615 | 0.939 | 0.006 |
| | (2.383) | (0.788) | (0.373) | (0.689) | (-0.884) | (-0.188) | (0.943) | (0.303) | (0.325) | (-0.821) | (0.656) | | |
| Std. | 0.008 | 0.413 | 0.006 | 0.643 | 0.674 | 0.939 | 1.029 | 0.001 | 0.004 | 1.035 | 0.666 | 0.010 | 0.002 |
| | (0.927) | (0.644) | (0.78) | (0.823) | (0.846) | (0.716) | (0.823) | (0.569) | (1.309) | (0.643) | (0.661) | | |
| REIT $Ret_{t+1}$ | | | | | | | | | | | | | |
| Ave. | 1.268 | 10.328 | -0.871 | 96.600 | -108.560 | -121.284 | 136.170 | -0.410 | -0.559 | -26.079 | 6.790 | 0.015 | 0.277 |
| | (1.045) | (0.199) | (-1.464) | (1.416) | (-1.494) | (-1.184) | (1.279) | (-2.189) | (-2.756) | (-0.201) | (0.075) | | |
| Std. | 0.638 | 44.229 | 0.286 | 77.626 | 79.852 | 107.003 | 118.039 | 0.288 | 0.201 | 110.951 | 73.572 | 0.226 | 0.086 |
| | (0.481) | (1.031) | (0.611) | (1.231) | (1.196) | (1.118) | (1.175) | (1.467) | (0.932) | (1.033) | (1.116) | | |
| Appr. $Ret_{t+1}$ | | | | | | | | | | | | | |
| Ave. | -0.663 | 6.557 | -0.204 | -36.443 | 38.532 | 55.120 | -53.568 | 0.082 | 0.079 | -16.028 | 14.068 | 0.804 | 0.049 |
| | (-3.044) | (0.783) | (-1.786) | (-2.83) | (2.813) | (2.863) | (-2.685) | (2.375) | (2.069) | (-0.763) | (1.096) | | |
| Std. | 0.224 | 2.940 | 0.075 | 9.366 | 10.527 | 16.198 | 16.496 | 0.021 | 0.024 | 7.316 | 4.718 | 0.043 | 0.013 |
| | (0.884) | (0.303) | (0.677) | (0.627) | (0.663) | (0.726) | (0.71) | (0.458) | (0.406) | (0.302) | (0.266) | | |

Notes: All data are annual (4th quarter to 4th quarter) in nominal terms. Observations 1975-2003

Summary statistics of regression coefficients are given by the first line of each row, while statistics of the z-ratio are given in parenthesis in the second row. Rolling regression technique using data from 1975 to time t is employed in order to analyze out-of-sample predictions between 1996 and 2003.

The appraisal yield is the most significant variable for both market total return and appraisal return.

However, there is no evidence that returns are more predictable with increase of observations, or that higher in-sample predictability of a VAR model, represented by adjusted R-square, guarantees higher predictability of out-of-sample predictability, at least in the sample period.[12] The RMSEs of market total return forecast are random between 1989 and 2002. The adjusted R-square even shows a slightly downward trend with more observation, although the slope of trend is not significantly different from zero. The relation between RMSE and adjusted R-square is random with low correlation, excluding the last two year, which have less than two years' observation of forecast return and historical return.

Comparing the VAR model of 1-year-lag and 1&2-year-lag, the latter has slightly higher adjusted R-square, which measures in-sample predictability, for market total return. However, the VAR model of 1-year-lag shows much lower RMSE, which indicates better out-of-sample predictability. Other than adjusted R-square of market total return, the 1-year-lag VAR model presents better predictability for the variables used in the model. Also, standard deviations of adjusted R-square and RMSE of 1-year-lag model reveals predictability of the model remains relatively stationary over time. Figure 4.1 shows historic market total returns and predictions of the forecast model for each rolling regression model from 1989 through 2002. Both 1-year-lag and 1&2-year-lag model forecasted returns moving in similar direction but the returns of the latter model more fluctuating. Therefore, we use 1-year-lag forecasting model for the study of market timing for aggregate market.

[12] Analysis based on regression with year and R-square as independent variable and RMSE dependent variable.

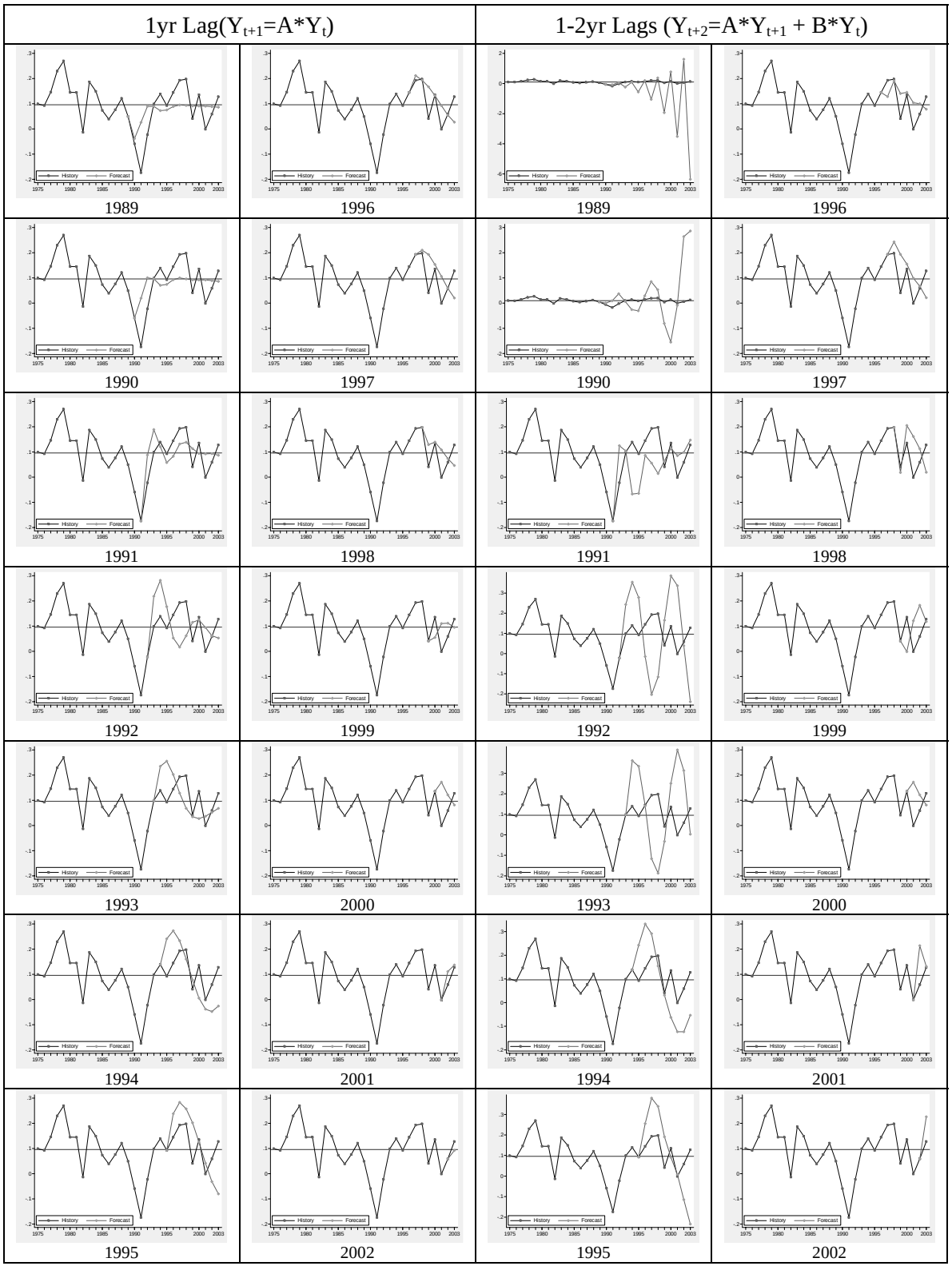
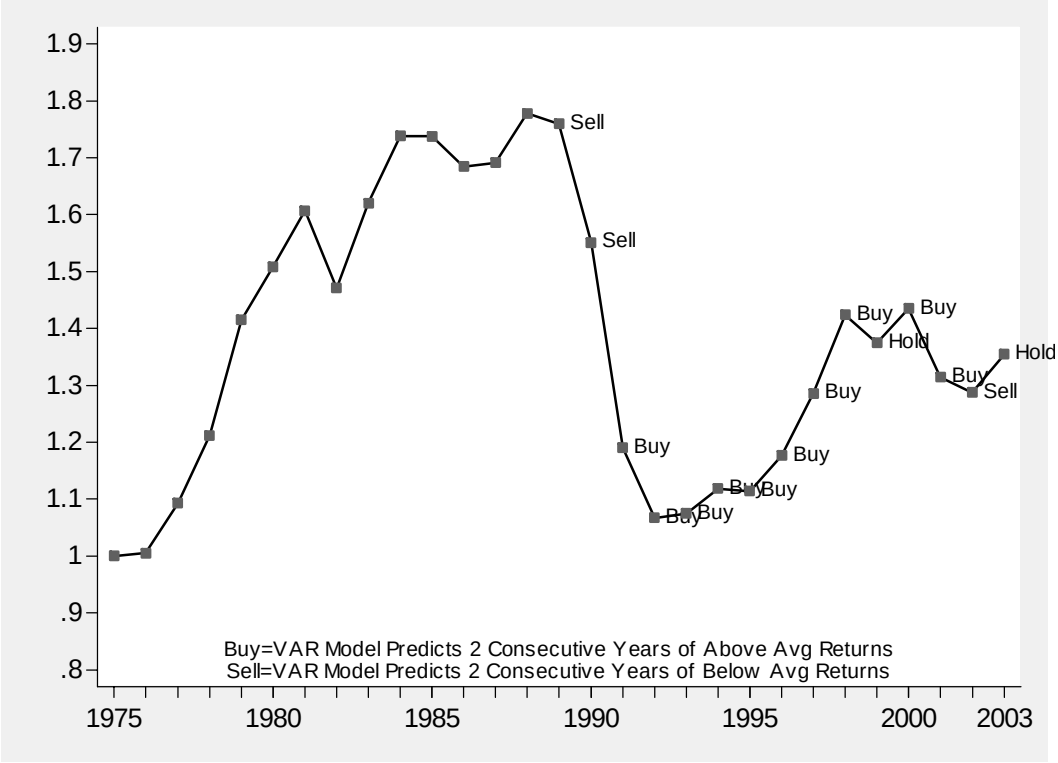



Figure 4.1 Historical market total returns and predicted returns from the forecast model based on rolling regression between 1989-2002 for aggregate market

Given the predictability of returns in commercial real estate, we examine another important issue related to predictability, the market timing. If the real estate market total return is predictable to certain extent, investors can use this information and achieve superior performance by employing market timing strategy, i.e. buy when expected returns are high and sell when expected returns are low. Two simple investment strategies are employed for the study of aggregate level. A buy-and-hold strategy is holding a passive portfolio comparable to NPI, which generates returns same as unsmoothed market total return through 1989 to 2003. The other strategy involves market timing using the VAR model forecast, similar to the one developed in previous study of Geltner and Mei (1995). If the model predicts two consecutive years of above average return, we take it as a 'buy' signal. If the model forecasts below-average returns for the two consecutive years the market timing model gives a 'sell' signal so we close the position.




Note: *Y*-axis shows unsmoothed market value level.
Figure 4.2 Market timing decisions for aggregate market based on the rolling regression between (1989-2003)

Otherwise, we take it as a 'hold' signal and put half of the fund in long position and close the rest half. Therefore only the returns of years when the portfolio has long position, whether the funds are invested in full or half, are taken into account for performance of the Long (+) strategy. The returns of years that have hold signal are weighted in half in order to compare the performance of the funds that are invested with the buy-and-hold portfolio. Investment signals using market timing model is presented in figure 4.2. Figure 4.2 shows the level of historical property market values and the buy/sell/hold signals at the corresponding points in time between 1989 and 2003. The model produced 10 buy signals, 3 sell signals, and 2 hold signals. The investment model works relatively well during the study period, although the model is less accurate in the recent years. The model produces correct signals 8 times in 14 years of sample period. It predicted return for one of the two consecutive years correct 4 times. Only time it gives opposite signal was 2001 and a buy signal in 2002 turned out to be wrong in 2003.

Performance of the Long (+) portfolio and buy-and-hold portfolio from 1989 to 2003 is compared in table 4.4. Investment decisions based on the market timing rule gives better performance during the study period. The average of market total return is 6.9% with the standard deviation of 10.4%. The Long (+) portfolio has average return of 9.6% and standard

Table 4.4 Portfolio return based on investment model using out-of-sample prediction
- Aggregate market (1989-2003)

| | Trading Strategies | |
|---|---|---|
| | Buy-and-Hold | Long (+) |
| Average | 0.069 | 0.096 |
| Standard deviation | 0.104 | 0.071 |
| P-value (t-test)* | | 0.232 |

* P-values based on one-tailed test assuming equal variances

deviation of 7.1%. The returns of the Long (+) portfolio are not only higher but also less volatile, which implies higher return with less risk can be achieved by market timing. However, sample of 14 year may not be sufficient to make general conclusion, also the P-value from t-test shows this results is statistically insignificant.

**Disaggregate Market of Property Types**

In this chapter we extend the study of predictability to next level of real estate market. Predictability of market return for apartment, office, retail, and industrial markets are examined. Predictability is analyzed for each property types as well as across the major property type and aggregate real estate market. The sample period for the disaggregate markets is 1978 through 2003. Except for the REIT return, for which all REIT return data is used, all variables employed in the VAR models for disaggregate market are data of its own property types.

***Apartment Market***

Table 4.5 reports summary statistics of five variables used in VAR model for apartment market. The mean of market total return during this period is 11.16%, the highest of four property types. Nevertheless, appraisal yield is relatively low at 7.97%, implying highest capital return of all property types. Not surprisingly, cash flow level was high at 0.1447 due to appreciation in property value. Appraisal total return is slightly higher than the unsmoothed market total return. The average REIT total return has decreased compare to the average of aggregate study period of 1975 through 2003.

The standard deviation of market total return is greater than the aggregate market while that of appraisal yield is almost the same. Appraisal total return shows less volatility. Appraisal yield has first autocorrelations much lower than other property types partly because rent contracts for apartment are primarily annual.[13] The market total return is less correlated to appraisal yield, which is important variable at aggregate level.

Table 4.6 shows summary of estimation results of the VAR model using 1 year lag. The results of 1&2-year-lag model are presented in Table 4.7. The 1-year-lag model results are

[13] Also, he private real estate markets tends to be. See Barkham and Geltner (1995)

Table 4.5 Historical statistics of VAR model variables (annual nominal values: 1978-2003) - Apartment market

| Variable | Mean | Std. Dev. | $\rho_1$ * |
|---|---|---|---|
| Real Estate Market Total Return** | 0.1116 | 0.1159 | 0.0589 |
| Real Estate Cash Flow*** | 0.1447 | 0.0253 | 0.8252 |
| Appraisal Yield | 0.0797 | 0.0078 | 0.6852 |
| REIT Total Return | 0.1323 | 0.1626 | -0.0256 |
| Appraisal Total Return | 0.1162 | 0.0616 | 0.6383 |

* $\rho_1$ is the first autocorrelation of the series

** Unsmoothed from the appraisal-based returns

*** Aggregate cash flow level of apartment expressed as a fraction of the aggregate apartment value level as of the end of 1977

| | Correlation Among Variables | | | | |
|---|---|---|---|---|---|
| | Mkt. Ret | CF | Appr. Yld | REIT Ret | Appr. Ret |
| Mkt. Ret | 1.000 | | | | |
| Cash Flow | -0.360 | 1.000 | | | |
| Appr. Yld | 0.301 | 0.193 | 1.000 | | |
| REIT Ret | 0.125 | -0.201 | -0.084 | 1.000 | |
| Appr. Ret | 0.797 | -0.584 | 0.258 | 0.170 | 1.000 |

based on rolling regression from 1992 to 2003 using the variables available at each point of time. Rolling regression from 1995 to 2003 is used for 1&2-year-lag model. The summary statistics of VAR model is presented in the tables including coefficients of forecast variables, adjusted R-square, and RMSE. The VAR model using 1-year-lag shows better predictability on both in-sample and out-of-sample period for all regression equations. Only exception was adjusted R-square of equation for REIT return. For the market total return, the 1-year-lag model shows adjusted R-square of 0.354 compare to 0.082 in 2-year-lag model and RMSE of 0.064 compare to 0.089 based on the rolling regression model between 1992 and 2003. Compare to aggregate

market, apartment market show better predictability in out-of-sample analysis. Also predictability, indicated by adjusted R-square and RMSE, of the 1-year-lag VAR model is more stable during the study period. However, if we look into volatility of the returns between 1992 and 2003, apartment returns are more stable compare to the aggregate market. The predictions of market total returns are compared to historical returns of apartment market in figure 4.3. The

Table 4.6 VAR Model(1 year lag) estimation results. Estimated coefficients - Apartment market

| | Independent Variables | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Dep. Var. | Const. | Mkt. $Ret_t$ | $CF_t$ | Appr. $Yld_t$ | REIT $Ret_t$ | Appr. $Ret_t$ | Adj $R^2$ | RMSE |
| Mkt. $Ret_{t+1}$ | | | | | | | | |
| Ave. | 0.124 | 0.170 | -5.621 | 12.000 | -0.074 | -1.765 | 0.354 | 0.064 |
| | (0.238) | (0.621) | (-4.218) | (3.709) | (-0.553) | (-2.653) | | |
| Std. | 0.242 | 0.104 | 1.349 | 0.863 | 0.028 | 0.479 | 0.056 | 0.022 |
| | (0.702) | (0.353) | (0.339) | (0.78) | (0.2) | (0.47) | | |
| Cash $Flow_{t+1}$ | | | | | | | | |
| Ave. | 0.048 | 0.018 | 0.912 | -0.457 | 0.010 | 0.007 | 0.854 | 0.018 |
| | (1.787) | (0.871) | (9.041) | (-1.651) | (0.92) | (0.143) | | |
| Std. | 0.025 | 0.005 | 0.062 | 0.248 | 0.003 | 0.016 | 0.026 | 0.006 |
| | (0.683) | (0.256) | (2.202) | (0.591) | (0.224) | (0.312) | | |
| Appr. $Yld_{t+1}$ | | | | | | | | |
| Ave. | 0.031 | 0.021 | -0.067 | 0.797 | 0.006 | -0.075 | 0.485 | 0.010 |
| | (2.234) | (1.713) | (-1.088) | (5.46) | (1.045) | (-2.529) | | |
| Std. | 0.012 | 0.003 | 0.029 | 0.116 | 0.002 | 0.008 | 0.234 | 0.001 |
| | (0.29) | (0.267) | (0.392) | (1.479) | (0.182) | (0.388) | | |
| REIT $Ret_{t+1}$ | | | | | | | | |
| Ave. | 0.387 | 0.203 | -4.174 | 5.172 | -0.163 | -0.814 | -0.104 | 0.215 |
| | (0.752) | (0.503) | (-2.02) | (1.039) | (-0.788) | (-0.799) | | |
| Std. | 0.371 | 0.146 | 1.359 | 2.617 | 0.076 | 0.442 | 0.066 | 0.048 |
| | (0.614) | (0.38) | (0.479) | (0.566) | (0.361) | (0.428) | | |
| Appr. $Ret_{t+1}$ | | | | | | | | |
| Ave. | 0.050 | 0.068 | -2.248 | 4.800 | -0.029 | -0.106 | 0.629 | 0.036 |
| | (0.238) | (0.621) | (-4.218) | (3.709) | (-0.553) | (-0.325) | | |
| Std. | 0.097 | 0.042 | 0.540 | 0.345 | 0.011 | 0.192 | 0.033 | 0.009 |
| | (0.702) | (0.353) | (0.339) | (0.78) | (0.2) | (0.702) | | |

Notes: All data are annual (4th quarter to 4th quarter) in nominal terms. Observations 1978-2003

Summary statistics of regression coefficients are given by the first line of each row, while statistics of the z-ratio are given in parenthesis in the second row. Rolling regression technique using data from 1978 to time t is employed in order to analyze out-of-sample predictions between 1992 and 2003.

Table 4.7 VAR Model(1-2 year lags) estimation results. Estimated coefficients - Apartment market

| | Independent Variables | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dep. Var. | Const. | Mkt. $Ret_t$ | Mkt. $Ret_{t+1}$ | $CF_t$ | $CF_{t+1}$ | Appr. $Yld_t$ | Appr. $Yld_{t+1}$ | REIT $Ret_t$ | REIT $Ret_{t+1}$ | Appr. $Ret_{t+1}$ | Adj $R^2$ | RMSE |
| Mkt. $Ret_{t+2}$ | | | | | | | | | | | | |
| Ave. | -0.481 | -0.047 | -0.621 | -16.037 | 16.979 | 29.839 | -26.609 | 0.182 | 0.224 | 2.318 | 0.082 | 0.089 |
| | (-2.046) | (-0.29) | (-1.897) | (-1.138) | (1.101) | (1.2) | (-0.947) | (1.834) | (2.526) | (1.022) | | |
| Std. | 0.168 | 0.094 | 0.143 | 4.708 | 5.816 | 8.263 | 9.642 | 0.098 | 0.081 | 0.943 | 0.066 | 0.032 |
| | (0.416) | (0.531) | (0.303) | (0.23) | (0.277) | (0.234) | (0.272) | (0.769) | (0.738) | (0.331) | | |
| Cash $Flow_{t+1}$ | | | | | | | | | | | | |
| Ave. | 0.088 | -0.024 | 0.111 | 5.432 | -4.968 | -8.438 | 9.038 | 0.010 | 0.010 | -0.757 | 0.832 | 0.018 |
| | (3.792) | (-1.209) | (3.403) | (3.942) | (-3.306) | (-3.454) | (3.321) | (1.102) | (1.217) | (-3.429) | | |
| Std. | 0.022 | 0.016 | 0.028 | 1.060 | 1.223 | 1.911 | 2.128 | 0.004 | 0.008 | 0.199 | 0.028 | 0.006 |
| | (0.756) | (0.752) | (0.817) | (0.761) | (0.74) | (0.773) | (0.739) | (0.472) | (0.944) | (0.777) | | |
| Appr. $Yld_{t+1}$ | | | | | | | | | | | | |
| Ave. | 0.054 | -0.036 | 0.059 | 2.403 | -2.736 | -3.554 | 4.962 | 0.005 | 0.004 | -0.462 | 0.607 | 0.009 |
| | (3.912) | (-3.06) | (3.057) | (2.918) | (-3.057) | (-2.427) | (3.062) | (0.989) | (0.763) | (-3.527) | | |
| Std. | 0.014 | 0.010 | 0.017 | 0.616 | 0.720 | 1.105 | 1.244 | 0.002 | 0.004 | 0.117 | 0.053 | 0.004 |
| | (0.577) | (0.551) | (0.648) | (0.567) | (0.581) | (0.623) | (0.573) | (0.366) | (0.73) | (0.606) | | |
| REIT $Ret_{t+1}$ | | | | | | | | | | | | |
| Ave. | 0.650 | -0.871 | 0.516 | 64.680 | -76.114 | -102.077 | 127.488 | -0.218 | -0.305 | -9.677 | 0.238 | 0.332 |
| | (1.659) | (-2.708) | (0.984) | (2.729) | (-2.949) | (-2.463) | (2.744) | (-1.408) | (-2.087) | (-2.564) | | |
| Std. | 0.607 | 0.407 | 0.768 | 35.585 | 39.890 | 60.800 | 69.887 | 0.165 | 0.096 | 5.887 | 0.206 | 0.244 |
| | (1.453) | (1.345) | (1.471) | (1.651) | (1.722) | (1.592) | (1.64) | (1.196) | (0.652) | (1.755) | | |
| Appr. $Ret_{t+1}$ | | | | | | | | | | | | |
| Ave. | -0.192 | 0.221 | -0.248 | -6.415 | 6.792 | 11.936 | -10.644 | 0.073 | 0.090 | 1.287 | 0.588 | 0.047 |
| | (-2.046) | (2.836) | (-1.897) | (-1.138) | (1.101) | (1.2) | (-0.947) | (1.834) | (2.526) | (1.444) | | |
| Std. | 0.067 | 0.037 | 0.057 | 1.883 | 2.326 | 3.305 | 3.857 | 0.039 | 0.033 | 0.377 | 0.034 | 0.022 |
| | (0.416) | (0.267) | (0.303) | (0.23) | (0.277) | (0.234) | (0.272) | (0.769) | (0.738) | (0.301) | | |

Notes: All data are annual (4th quarter to 4th quarter) in nominal terms. Observations 1978-2003

Summary statistics of regression coefficients are given by the first line of each row, while statistics of the z-ratio are given in parenthesis in the second row. Rolling regression technique using data from 1978 to time t is employed in order to analyze out-of-sample predictions between 1995 and 2003.

1&2-year-lag model forecasted returns more fluctuating than the 1-year-lag model and historical returns. Given the results of the predictability for apartment market, 1-year-lag forecasting model is used for the study of market timing. The model shows less accuracy in predicting appraisal

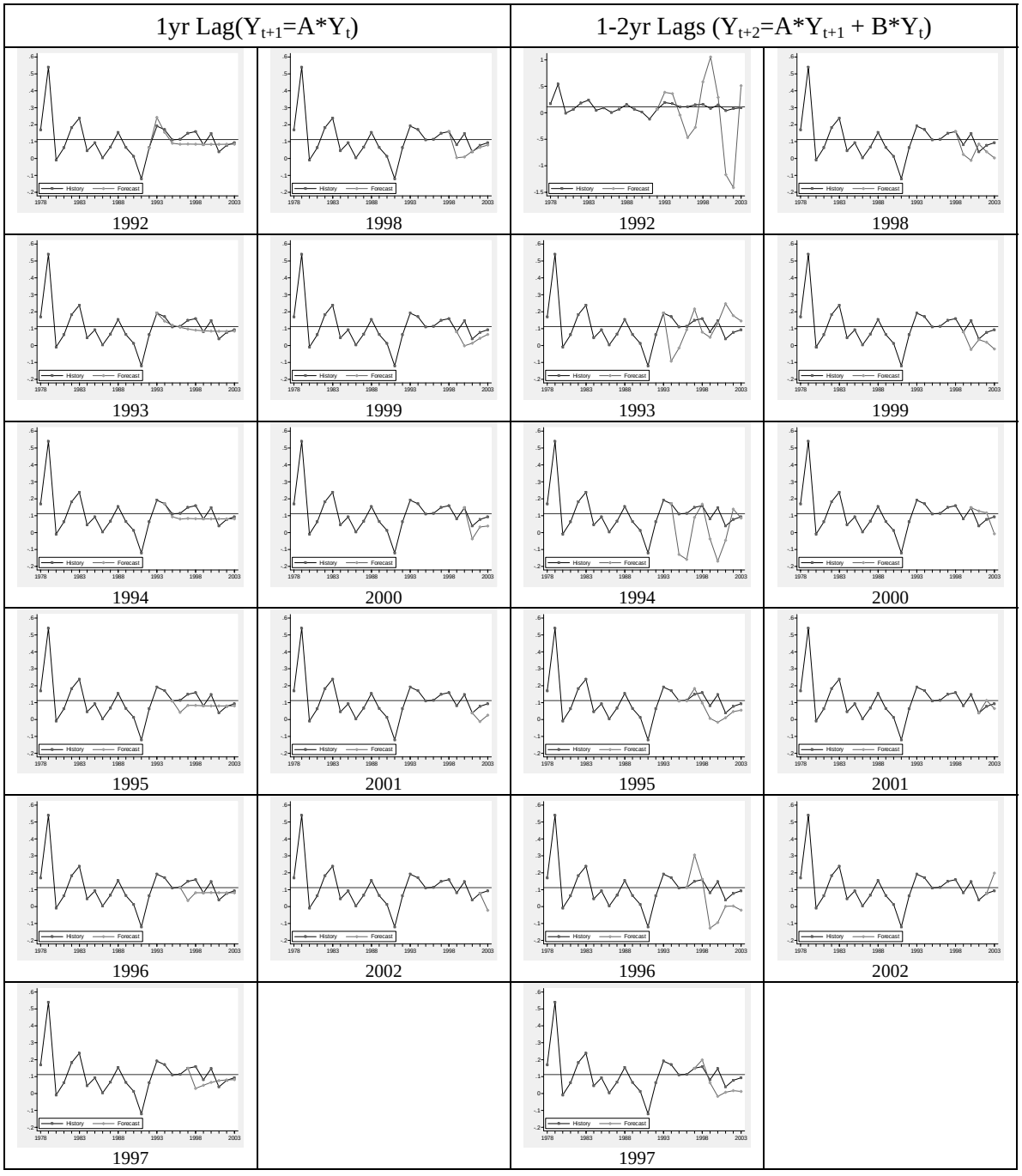
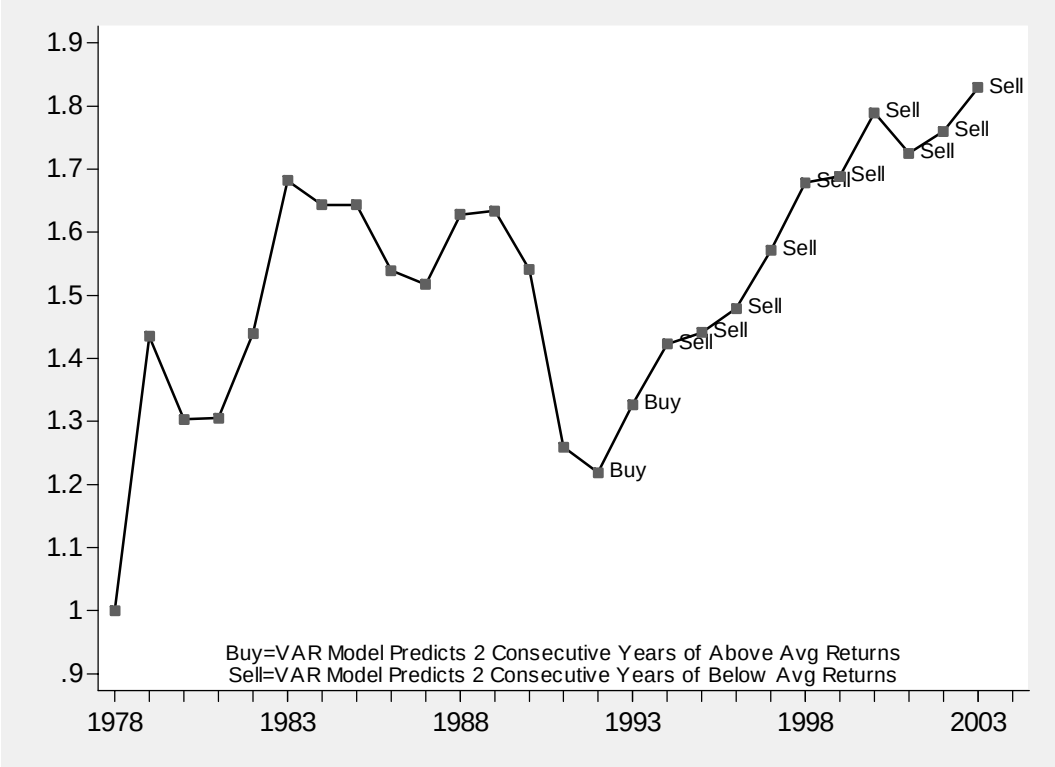



Figure 4.3 Historical market total returns and predicted returns from the forecast model based on rolling regression between 1992-2002 for apartment market

yield relative to aggregate model. Coefficients of regression equations are relatively stable. The coefficients of appraisal yield are major factor for both market total return and appraisal return. The results for apartment market also reports that the REIT return is less predictable than apartment market return.

We now apply the forecast model to market timing decision. The same investment rule used in aggregate market is applied to Long (+) strategy. Return forecasts of the two following years are observed at each point of time. Based on the forecast of the subsequent years, we make buy/sell/hold decisions. Figure 4.4 shows result of the market timing model between 1992 and 2003. Model suggested two years of buy and 10 years of sell. Considering that apartment was the best performing property type during the sample period, outcomes of the market timing model is disappointing. The model kept producing sell signal since 1994, while the property value was




Note: *Y*-axis shows unsmoothed market value level.

Figure 4.4 Market timing decisions for apartment market based on the rolling regression between (1992-2003)

Table 4.8 Portfolio return based on investment model using out-of-sample prediction - Apartment market (1992-2003)

| | Trading Strategies | |
|---|---|---|
| | Buy-and-Hold | Long (+) |
| Average | 0.121 | 0.182 |
| Standard deviation | 0.046 | 0.011 |
| P-value (t-test)* | | 0.003 |

* P-values based on two-tailed test assuming unequal variances

constantly appreciating in the apartment market. The model produces correct signals 4 times out of 12 years of sample period. It predicted return for one of the two consecutive years correct 4 times. Opposite signal was give twice. The model predicted 2003 return correct in 2002 and waiting to see the result of 2003 decision. One of the explanations of poor performance could be that market return was moving near average return with low volatility. Standard deviation for market return in this period was low at 4.7%. Table 4.8 reports the performance of two portfolios from 1992 to 2003. It reports that Long (+) portfolio has higher average return with low standard deviation. However, since the Long (+) portfolio has only two years of long positions it is not proper to make statistical conclusion.

***Office Market***

Summary statistics of the variables used in VAR model for office market is presented in table 4.9. The mean of office market total return between 1978 and 2003 is 7.95%, the lowest of the four property types. The average appraisal yield of 7.95% is also the lowest of all but retail. While the mean of market total return is almost the same of that of appraisal yield, it was much

Table 4.9 Historical statistics of VAR model variables (annual nominal values: 1978-2003) - Office market

| Variable | Mean | Std. Dev. | $\rho_1$ * |
|---|---|---|---|
| Real Estate Market Total Return** | 0.0795 | 0.1317 | 0.4378 |
| Real Estate Cash Flow*** | 0.1061 | 0.0147 | 0.8657 |
| Appraisal Yield | 0.0795 | 0.0099 | 0.8377 |
| REIT Total Return | 0.1323 | 0.1626 | -0.0256 |
| Appraisal Total Return | 0.0884 | 0.0913 | 0.8014 |

* $\rho_1$ is the first autocorrelation of the series

** Unsmoothed from the appraisal-based returns

*** Aggregate cash flow level of apartment expressed as a fraction of the aggregate office value level as of the end of 1977

| | Correlation Among Variables | | | | |
|---|---|---|---|---|---|
| | Mkt. Ret | CF | Appr. Yld | REIT Ret | Appr. Ret |
| Mkt. Ret | 1.000 | | | | |
| Cash Flow | -0.418 | 1.000 | | | |
| Appr. Yld | 0.497 | -0.666 | 1.000 | | |
| REIT Ret | 0.079 | -0.104 | 0.118 | 1.000 | |
| Appr. Ret | 0.823 | -0.246 | 0.329 | 0.019 | 1.000 |

more volatile. The standard deviation of market total return for office is highest of the four at 13.17% for the sample period. Office also has the highest standard deviation for appraisal yield, although the difference is relatively small. The appraisal total return was higher than the unsmoothed market return, which indicates more smoothing effect during depreciation of office value. High first autocorrelation of appraisal yield reflects that rents are contractual for multiple years.

The estimation results of the VAR model are summarized in table 4.10 and table 4.11. The study period for the 1-year-lag model is 1992 through 2003. Rolling regression between 1998 and 2003 is employed for the 1&2-year-lag model. Table 4.10 reports results of 1-year-lag model and table 4.11 1&2-year-lag model. The predictions of market total returns are compared to historical market return in figure 4.5. The office market model shows highest in-sample

Table 4.10 VAR Model(1 year lag) estimation results. Estimated coefficients - Office market

| | Independent Variables | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Dep. Var. | Const. | Mkt. $Ret_t$ | $CF_t$ | Appr. $Yld_t$ | REIT $Ret_t$ | Appr. $Ret_t$ | Adj $R^2$ | RMSE |
| Mkt. $Ret_{t+1}$ | | | | | | | | |
| Ave. | -0.871 | 0.039 | 1.041 | 10.038 | 0.371 | 0.130 | 0.558 | 0.127 |
| | (-2.768) | (0.118) | (0.757) | (3.633) | (3.438) | (0.482) | | |
| Std. | 0.221 | 0.127 | 0.636 | 2.390 | 0.044 | 0.224 | 0.109 | 0.046 |
| | (0.731) | (0.432) | (0.467) | (0.69) | (0.625) | (0.533) | | |
| Cash $Flow_{t+1}$ | | | | | | | | |
| Ave. | 0.031 | -0.012 | 0.861 | -0.291 | 0.013 | 0.066 | 0.893 | 0.014 |
| | (1.672) | (-0.853) | (11.053) | (-1.935) | (2.189) | (3.467) | | |
| Std. | 0.006 | 0.011 | 0.030 | 0.119 | 0.001 | 0.023 | 0.014 | 0.012 |
| | (0.67) | (0.67) | (0.884) | (0.606) | (0.179) | (0.615) | | |
| Appr. $Yld_{t+1}$ | | | | | | | | |
| Ave. | 0.027 | -0.003 | -0.110 | 0.819 | 0.010 | -0.032 | 0.845 | 0.009 |
| | (2.255) | (-0.331) | (-1.968) | (7.855) | (2.409) | (-2.526) | | |
| Std. | 0.005 | 0.008 | 0.027 | 0.080 | 0.001 | 0.017 | 0.048 | 0.004 |
| | (0.537) | (0.84) | (0.341) | (1.041) | (0.36) | (1.236) | | |
| REIT $Ret_{t+1}$ | | | | | | | | |
| Ave. | -0.110 | -1.102 | -2.382 | 6.601 | -0.155 | 1.241 | 0.012 | 0.203 |
| | (-0.216) | (-2.417) | (-0.986) | (1.416) | (-0.843) | (2.125) | | |
| Std. | 0.147 | 0.186 | 0.575 | 2.577 | 0.129 | 0.339 | 0.166 | 0.041 |
| | (0.285) | (0.522) | (0.327) | (0.639) | (0.711) | (0.707) | | |
| Appr. $Ret_{t+1}$ | | | | | | | | |
| Ave. | -0.349 | 0.016 | 0.416 | 4.015 | 0.149 | 0.652 | 0.856 | 0.076 |
| | (-2.768) | (0.118) | (0.757) | (3.633) | (3.438) | (4.943) | | |
| Std. | 0.089 | 0.051 | 0.254 | 0.956 | 0.017 | 0.089 | 0.041 | 0.032 |
| | (0.731) | (0.432) | (0.467) | (0.69) | (0.625) | (1.301) | | |

Notes: All data are annual (4th quarter to 4th quarter) in nominal terms. Observations 1978-2003

Summary statistics of regression coefficients are given by the first line of each row, while statistics of the z-ratio are given in parenthesis in the second row. Rolling regression technique using data from 1978 to time t is employed in order to analyze out-of-sample predictions between 1992 and 2003.

Table 4.11 VAR Model(1-2 year lags) estimation results. Estimated coefficients - Office market

| | Independent Variables | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dep. Var. | Const. | Mkt. $Ret_t$ | Mkt. $Ret_{t+1}$ | $CF_t$ | $CF_{t+1}$ | Appr. $Yld_t$ | Appr. $Yld_{t+1}$ | REIT $Ret_t$ | REIT $Ret_{t+1}$ | Appr. $Ret_{t+1}$ | Adj $R^2$ | RMSE |
| Mkt. $Ret_{t+2}$ | | | | | | | | | | | | |
| Ave. | -1.257 | -0.115 | -0.339 | -7.742 | 9.620 | 13.484 | -0.224 | 0.315 | 0.016 | 1.087 | 0.501 | 0.150 |
| | (-3.398) | (-0.433) | (-1.232) | (-0.58) | (0.707) | (0.825) | (-0.077) | (3.015) | (0.12) | (0.772) | | |
| Std. | 0.300 | 0.208 | 0.255 | 6.648 | 7.123 | 12.115 | 9.910 | 0.046 | 0.123 | 1.029 | 0.169 | 0.076 |
| | (0.926) | (0.797) | (0.976) | (0.476) | (0.514) | (0.737) | (0.537) | (0.73) | (0.82) | (0.717) | | |
| Cash $Flow_{t+1}$ | | | | | | | | | | | | |
| Ave. | 0.046 | 0.011 | 0.017 | 1.177 | -0.377 | -0.636 | 0.266 | 0.013 | 0.008 | -0.009 | 0.889 | 0.009 |
| | (2.347) | (0.965) | (1.138) | (1.567) | (-0.5) | (-0.683) | (0.293) | (2.28) | (0.807) | (-0.137) | | |
| Std. | 0.005 | 0.009 | 0.013 | 0.123 | 0.129 | 0.240 | 0.208 | 0.006 | 0.011 | 0.027 | 0.020 | 0.004 |
| | (0.529) | (0.89) | (0.846) | (0.273) | (0.192) | (0.314) | (0.25) | (0.805) | (1.231) | (0.345) | | |
| Appr. $Yld_{t+1}$ | | | | | | | | | | | | |
| Ave. | 0.040 | -0.018 | 0.009 | 0.315 | -0.481 | 0.278 | 0.497 | 0.009 | 0.005 | -0.071 | 0.855 | 0.006 |
| | (2.672) | (-1.733) | (0.79) | (0.56) | (-0.833) | (0.36) | (0.708) | (2.077) | (0.763) | (-1.172) | | |
| Std. | 0.004 | 0.006 | 0.010 | 0.101 | 0.099 | 0.210 | 0.176 | 0.004 | 0.008 | 0.023 | 0.027 | 0.004 |
| | (0.552) | (0.357) | (0.88) | (0.216) | (0.225) | (0.264) | (0.322) | (0.883) | (1.209) | (0.496) | | |
| REIT $Ret_{t+1}$ | | | | | | | | | | | | |
| Ave. | 0.699 | 0.072 | -0.311 | 48.661 | -52.415 | -51.903 | 55.011 | -0.204 | -0.418 | -3.828 | -0.269 | 0.232 |
| | (0.955) | (0.095) | (-0.583) | (1.793) | (-1.908) | (-1.518) | (1.627) | (-0.917) | (-1.37) | (-1.298) | | |
| Std. | 0.270 | 0.220 | 0.363 | 7.336 | 8.030 | 8.286 | 9.896 | 0.241 | 0.147 | 0.763 | 0.134 | 0.097 |
| | (0.334) | (0.476) | (0.693) | (0.323) | (0.356) | (0.319) | (0.407) | (0.938) | (0.282) | (0.247) | | |
| Appr. $Ret_{t+1}$ | | | | | | | | | | | | |
| Ave. | -0.503 | 0.194 | -0.136 | -3.097 | 3.848 | 5.394 | -0.090 | 0.126 | 0.006 | 0.795 | 0.823 | 0.076 |
| | (-3.398) | (2.052) | (-1.232) | (-0.58) | (0.707) | (0.825) | (-0.077) | (3.015) | (0.12) | (1.365) | | |
| Std. | 0.120 | 0.083 | 0.102 | 2.659 | 2.849 | 4.846 | 3.964 | 0.018 | 0.049 | 0.411 | 0.064 | 0.043 |
| | (0.926) | (0.957) | (0.976) | (0.476) | (0.514) | (0.737) | (0.537) | (0.73) | (0.82) | (0.782) | | |

Notes: All data are annual (4th quarter to 4th quarter) in nominal terms. Observations 1978-2003

Summary statistics of regression coefficients are given by the first line of each row, while statistics of the z-ratio are given in parenthesis in the second row. Rolling regression technique using data from 1978 to time t is employed in order to analyze out-of-sample predictions between 1998 and 2003.

predictability of all property types including the aggregate market at adjusted R-square of 0.558, although the R-square was most volatile. Adjusted R-square shows a sharp change after 2001. The volatile is comparable to other property types until 2000. Adjusted R-square of the last three

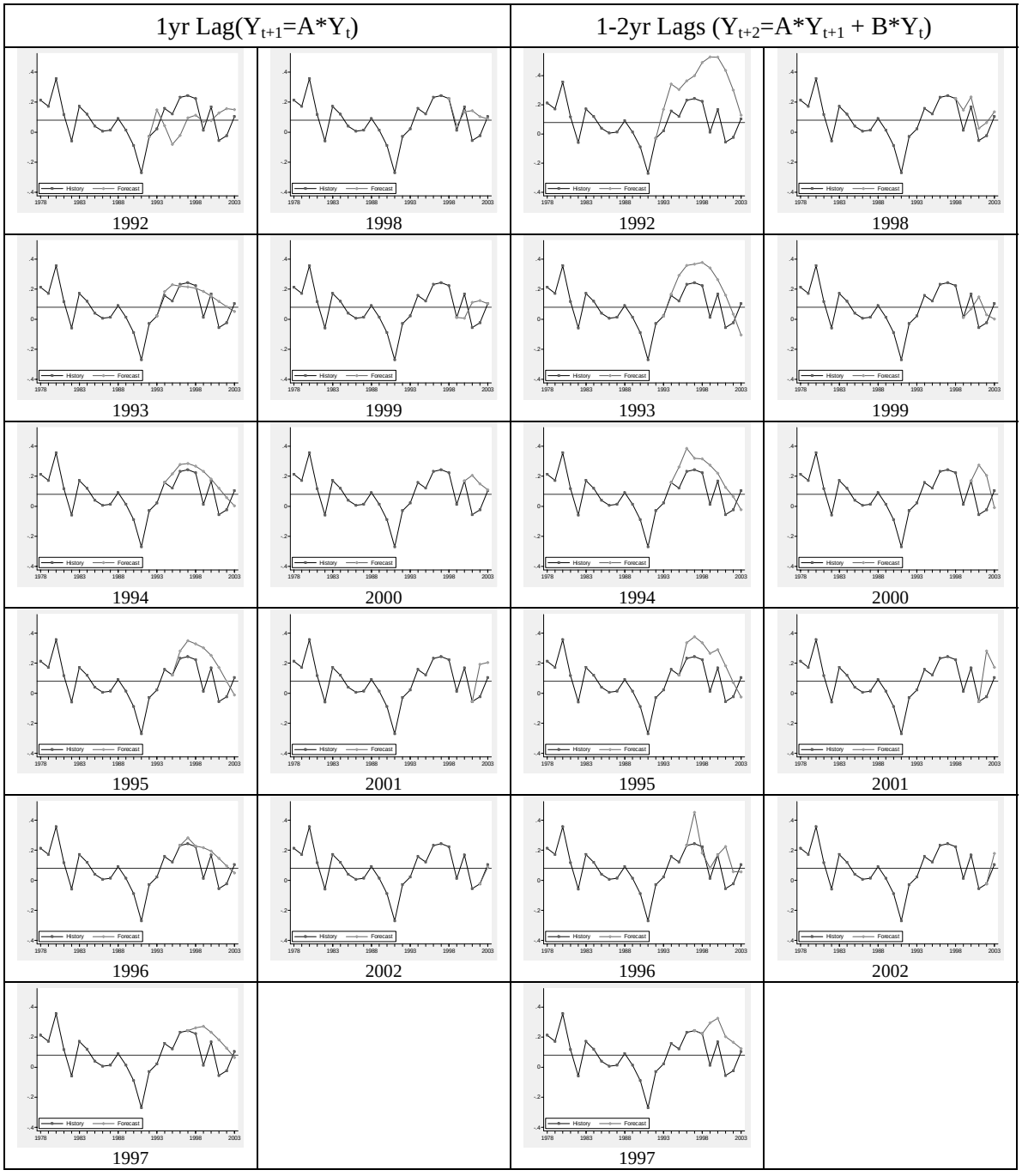
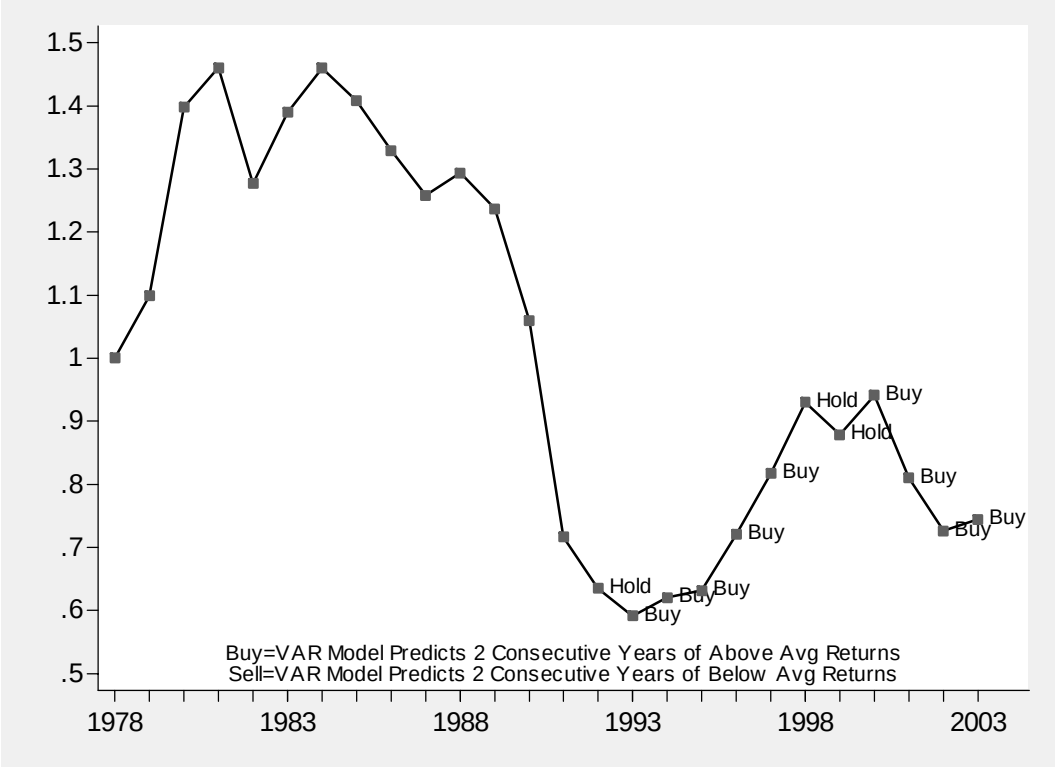



Figure 4.5 Historical market total returns and predicted returns from the forecast model based on rolling regression between 1992-2002 for office market

years shows difference from the earlier samples. On the other hand, RMSE of the office market return was highest of the four markets in both 1-year-lag model and 1&2-year-lag model. Also, the out-of-sample predictability the office market return was most volatile of the four markets using the prediction of 1-year lag model. The RMSE of market total return in 2000 and 2001 was particularly high, indicating poor prediction for the two year. The RMSE of these years are even high than RMSE of REIT return for the same years. The higher adjusted R-squares and lower RMSE of private real estate indicate high in-sample and out-of-sample predictability compared to REIT return. For the market total return, the appraisal yield, which has coefficients about 10 on average with average z-ration of 3.6, was the most important factor and also statistically significant. Comparing the two models, the VAR model using 1-year-lag proves better predictability for all variables showing higher adjusted R-square and lower RMSE. Especially, 1-




Note: *Y*-axis shows unsmoothed market value level.

Figure 4.6 Market timing decisions for office market based on the rolling regression between (1992-2003)

year-lag model's RMSE is about 2.5% lower on average. Therefore, 1-year-lag model is employed for the investment decision model.

The results of the investment model are presented in figure 4.6. The investment decisions are based on the rules equivalent to the one applied to apartment market, using only the information available as of that year. Base on the decision rules, 9 'buy's and 3 'hold's are reported. The fact that the model did not produces 'sell' signal is not surprising since there is only one year, 2000, where it should report 'sell' signal. The model projected correct signals 7 times out of 12 years of sample period. It predicted return for one of the two consecutive years correct 2 times. Opposite signal was give once. The model's prediction in 2002 return is correct in 2003. Just looking into these results, the model seems to work relatively well. However, the performance of portfolio is not as great. The performance of the model is compared with the buy-and-hold portfolio at table 4.12. Average return of the active portfolio is 11.6%, slightly higher than 10.9% of the passive one. Standard deviation did not show much difference, although slightly lower. As expected, P-value shows that the probability of Long (+) portfolio having higher return is very low. One of the reasons for the active strategy not outperforming the bench mark is that average return of 10.9% in sample period for rolling regression, from 1992 to 2003, was higher than average of entire sample period, which is 7.95%. Since the investment

Table 4.12 Portfolio return based on investment model using out-of-sample prediction
- Office market (1992-2003)

| | Trading Strategies | |
|---|---|---|
| | Buy-and-Hold | Long (+) |
| Average | 0.109 | 0.116 |
| Standard deviation | 0.106 | 0.101 |
| P-value (t-test)* | | 0.305 |

*P-values based on two-tailed test assuming unequal variances

criteria are to invest when the model forecast above average return, it is possible that the active portfolio has return lower than the bench mark with perfect investment signals. Another reason why the model did not out perform the bench mark is that the wrong signals model produced had significant effect on the performance. Particularly the model did not predict 2001 and 2002 correct when negative return was reported. However, expected return and ex post return tend to be different and it is hard to reckon unexpected events, such as 9/11 in 2001, in the model. One important thing to point out is that model predicted high return in 2002. Since the model is based on historical statistics of returns, it does not recognize changes in other economic components. The high appraisal yield in 2001, which is largest factor for market return, result in high return forecast for 2002. We could not verify whether the changes in beginning of the century are permanent or temporary with data available. Interestingly, model forecasts hold at the end of 2003.

***Retail Market***

Table 4.13 shows summary statistics of the five variables used in VAR model for retail. The average market total return for the sample period is 9.965, second highest return next to apartment return, while the volatility is the lowest. The mean of appraisal yield is lowest of the four properties at 7.89%. The volatility of the appraisal yield is second highest next to office at 0.86%, although trivial compare to the market total return. The appraisal total return of retail is the only one that is higher than unsmoothed market total return, which indicates more smoothing effect during appreciation of retail market. The first autocorrelation of .appraisal yield is high at 0.8978, while market return is at 0.3875. Even though appraisal yield was stationary during this

Table 4.13 Historical statistics of VAR model variables (annual nominal values: 1978-2003) - Retail market

| Variable | Mean | Std. Dev. | $\rho_1$ * |
|---|---|---|---|
| Real Estate Market Total Return** | 0.0996 | 0.0924 | 0.3875 |
| Real Estate Cash Flow*** | 0.1019 | 0.0086 | 0.7928 |
| Appraisal Yield | 0.0789 | 0.0086 | 0.8978 |
| REIT Total Return | 0.1323 | 0.1626 | -0.0256 |
| Appraisal Total Return | 0.0957 | 0.0510 | 0.6625 |

* $\rho_1$ is the first autocorrelation of the series

** Unsmoothed from the appraisal-based returns

*** Aggregate cash flow level of apartment expressed as a fraction of the aggregate retail value level as of the end of 1977

| | Correlation Among Variables | | | | |
|---|---|---|---|---|---|
| | Mkt. Ret | CF | Appr. Yld | REIT Ret | Appr. Ret |
| Mkt. Ret | 1.000 | | | | |
| Cash Flow | -0.113 | 1.000 | | | |
| Appr. Yld | 0.451 | 0.067 | 1.000 | | |
| REIT Ret | -0.032 | -0.015 | 0.254 | 1.000 | |
| Appr. Ret | 0.828 | -0.253 | 0.347 | -0.142 | 1.000 |

period, it showed relatively high correlation with the market return.

The coefficients estimated from the VAR model using 1-year-lag are reported in table 4.14. Table 4.15 reports coefficients estimation from the 1&2-year-lag VAR model. The results are derived from rolling regression from 1992 to 2003 for 1-year-lag and 1997 to 2003 for 1&2-year-lag. One thing that draws attention is that the average of adjusted R-square for REIT is very high, even higher than that of unsmoothed total return for both 1-year-lag model and 1&2-year-lag model. However, high in-sample fit of the model did not result in high out-of-sample

predictability as RMSE is also high. For the regression equation of market return using 1-year-lag, retail has lowest adjusted R-square at 0.282 and a high RMSE of 0.113, which was relatively stable during sample period. This indicates predictability of retail market total return was low compare to other property types. The appraisal yield has highest coefficient and also statistically

Table 4.14 VAR Model(1 year lag) estimation results. Estimated coefficients -Retail market

| | Independent Variables | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Dep. Var. | Const. | Mkt. $Ret_t$ | $CF_t$ | Appr. $Yld_t$ | REIT $Ret_t$ | Appr. $Ret_t$ | Adj $R^2$ | RMSE |
| Mkt. $Ret_{t+1}$ | | | | | | | | |
| Ave. | -0.648 | 0.512 | 2.845 | 5.945 | 0.109 | -0.531 | 0.282 | 0.113 |
| | (-1.308) | (1.593) | (0.644) | (2.258) | (1.007) | (-0.854) | | |
| Std. | 0.600 | 0.165 | 4.258 | 2.867 | 0.083 | 0.302 | 0.082 | 0.020 |
| | (0.804) | (0.35) | (0.97) | (0.577) | (0.798) | (0.394) | | |
| Cash $Flow_{t+1}$ | | | | | | | | |
| Ave. | 0.052 | 0.011 | 0.611 | -0.138 | -0.008 | -0.019 | 0.760 | 0.007 |
| | (2.744) | (0.9) | (5.778) | (-1.27) | (-1.695) | (-0.833) | | |
| Std. | 0.033 | 0.008 | 0.240 | 0.147 | 0.003 | 0.015 | 0.046 | 0.003 |
| | (1.439) | (0.61) | (3.328) | (1.291) | (0.596) | (0.602) | | |
| Appr. $Yld_{t+1}$ | | | | | | | | |
| Ave. | 0.044 | 0.010 | -0.330 | 0.952 | -0.007 | -0.086 | 0.912 | 0.011 |
| | (3.003) | (1.021) | (-3.075) | (12.295) | (-1.888) | (-4.545) | | |
| Std. | 0.029 | 0.006 | 0.206 | 0.126 | 0.002 | 0.011 | 0.019 | 0.006 |
| | (1.203) | (0.562) | (1.281) | (3.397) | (0.536) | (0.988) | | |
| REIT $Ret_{t+1}$ | | | | | | | | |
| Ave. | -0.176 | -0.839 | -4.924 | 13.803 | -0.483 | -1.190 | 0.417 | 0.228 |
| | (-0.102) | (-1.897) | (-1.268) | (3.76) | (-2.819) | (-1.252) | | |
| Std. | 0.676 | 0.461 | 4.758 | 3.564 | 0.162 | 0.875 | 0.148 | 0.089 |
| | (1.164) | (0.934) | (1.239) | (0.978) | (0.997) | (0.533) | | |
| Appr. $Ret_{t+1}$ | | | | | | | | |
| Ave. | -0.259 | 0.205 | 1.138 | 2.378 | 0.044 | 0.388 | 0.649 | 0.055 |
| | (-1.308) | (1.593) | (0.644) | (2.258) | (1.007) | (1.688) | | |
| Std. | 0.240 | 0.066 | 1.703 | 1.147 | 0.033 | 0.121 | 0.036 | 0.012 |
| | (0.804) | (0.35) | (0.97) | (0.577) | (0.798) | (0.614) | | |

Notes: All data are annual (4th quarter to 4th quarter) in nominal terms. Observations 1978-2003

Summary statistics of regression coefficients are given by the first line of each row, while statistics of the z-ratio are given in parenthesis in the second row. Rolling regression technique using data from 1978 to time t is employed in order to analyze out-of-sample predictions between 1992 and 2003.

Table 4.15 VAR Model(1-2 year lags) estimation results. Estimated coefficients - Retail market

| | Independent Variables | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dep. Var. | Const. | Mkt. $Ret_t$ | Mkt. $Ret_{t+1}$ | $CF_t$ | $CF_{t+1}$ | Appr. $Yld_t$ | Appr. $Yld_{t+1}$ | REIT $Ret_t$ | REIT $Ret_{t+1}$ | Appr. $Ret_{t+1}$ | Adj $R^2$ | RMSE |
| Mkt. $Ret_{t+2}$ | | | | | | | | | | | | |
| Ave. | -0.747 | 0.551 | -0.886 | 0.745 | 3.708 | 15.151 | -12.794 | 0.195 | 0.223 | 2.044 | 0.397 | 0.081 |
| | (-2.476) | (2.791) | (-3.249) | (0.033) | (0.174) | (0.591) | (-0.466) | (1.667) | (2.013) | (1.109) | | |
| Std. | 0.191 | 0.068 | 0.120 | 2.369 | 3.183 | 4.713 | 5.133 | 0.040 | 0.039 | 0.485 | 0.053 | 0.041 |
| | (0.418) | (0.366) | (0.462) | (0.11) | (0.154) | (0.191) | (0.189) | (0.496) | (0.365) | (0.269) | | |
| Cash $Flow_{t+1}$ | | | | | | | | | | | | |
| Ave. | 0.020 | -0.015 | 0.030 | -0.091 | 0.926 | 0.317 | -0.328 | -0.006 | 0.002 | -0.010 | 0.851 | 0.004 |
| | (1.729) | (-2.171) | (3.01) | (-0.12) | (1.194) | (0.344) | (-0.336) | (-1.496) | (0.514) | (-0.15) | | |
| Std. | 0.010 | 0.002 | 0.005 | 0.090 | 0.082 | 0.119 | 0.130 | 0.001 | 0.001 | 0.014 | 0.030 | 0.002 |
| | (0.646) | (0.304) | (0.582) | (0.122) | (0.147) | (0.139) | (0.148) | (0.329) | (0.296) | (0.208) | | |
| Appr. $Yld_{t+1}$ | | | | | | | | | | | | |
| Ave. | 0.013 | -0.038 | 0.023 | -0.572 | 0.477 | 1.003 | 0.059 | -0.004 | 0.002 | -0.066 | 0.934 | 0.006 |
| | (1.351) | (-6.396) | (2.734) | (-0.873) | (0.737) | (1.294) | (0.069) | (-1.186) | (0.774) | (-1.18) | | |
| Std. | 0.007 | 0.001 | 0.003 | 0.072 | 0.054 | 0.082 | 0.096 | 0.001 | 0.001 | 0.010 | 0.007 | 0.007 |
| | (0.535) | (0.381) | (0.442) | (0.148) | (0.11) | (0.156) | (0.117) | (0.267) | (0.348) | (0.163) | | |
| REIT $Ret_{t+1}$ | | | | | | | | | | | | |
| Ave. | 0.597 | -1.396 | -0.182 | 30.412 | -44.403 | -44.333 | 66.196 | -0.706 | -0.530 | -5.380 | 0.290 | 0.336 |
| | (1.079) | (-4.046) | (-0.42) | (0.821) | (-1.184) | (-0.993) | (1.409) | (-3.304) | (-2.647) | (-1.676) | | |
| Std. | 0.843 | 0.225 | 0.287 | 10.332 | 12.254 | 15.786 | 19.658 | 0.325 | 0.195 | 1.531 | 0.229 | 0.097 |
| | (1.614) | (1.269) | (0.634) | (0.372) | (0.41) | (0.41) | (0.607) | (1.647) | (0.982) | (0.653) | | |
| Appr. $Ret_{t+1}$ | | | | | | | | | | | | |
| Ave. | -0.299 | 0.460 | -0.354 | 0.298 | 1.483 | 6.060 | -5.117 | 0.078 | 0.089 | 1.178 | 0.699 | 0.038 |
| | (-2.476) | (5.829) | (-3.249) | (0.033) | (0.174) | (0.591) | (-0.466) | (1.667) | (2.013) | (1.591) | | |
| Std. | 0.077 | 0.027 | 0.048 | 0.948 | 1.273 | 1.885 | 2.053 | 0.016 | 0.016 | 0.194 | 0.025 | 0.021 |
| | (0.418) | (0.416) | (0.462) | (0.11) | (0.154) | (0.191) | (0.189) | (0.496) | (0.365) | (0.271) | | |

Notes: All data are annual (4th quarter to 4th quarter) in nominal terms. Observations 1978-2003

Summary statistics of regression coefficients are given by the first line of each row, while statistics of the z-ratio are given in parenthesis in the second row. Rolling regression technique using data from 1978 to time t is employed in order to analyze out-of-sample predictions between 1997 and 2003.

significant for the regression equation of market total return.

The results of the model, in terms of comparing 1-year-lag and 1&2-year-lag model, are more or less different from the results of other property types. Unlike results of other property

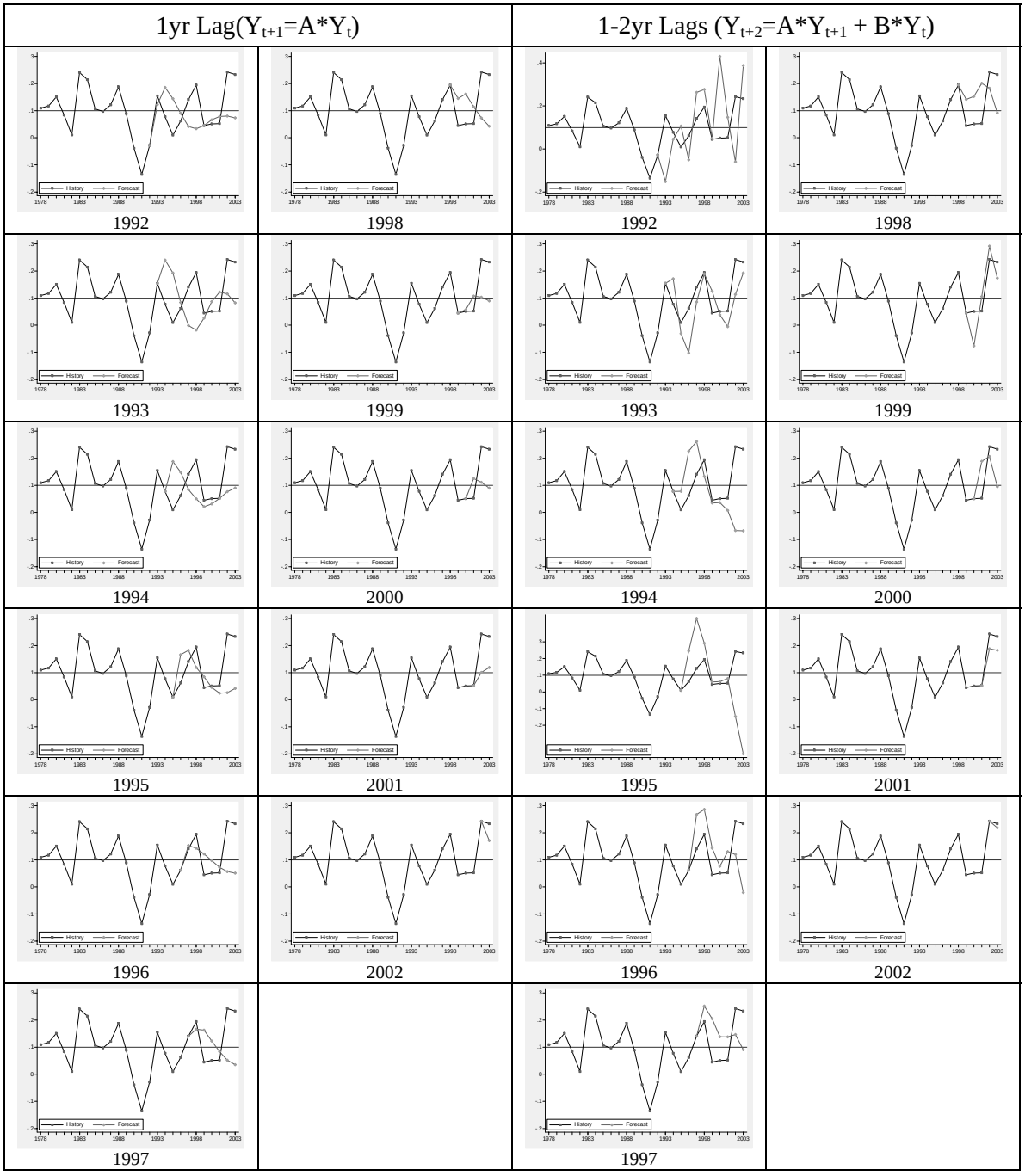
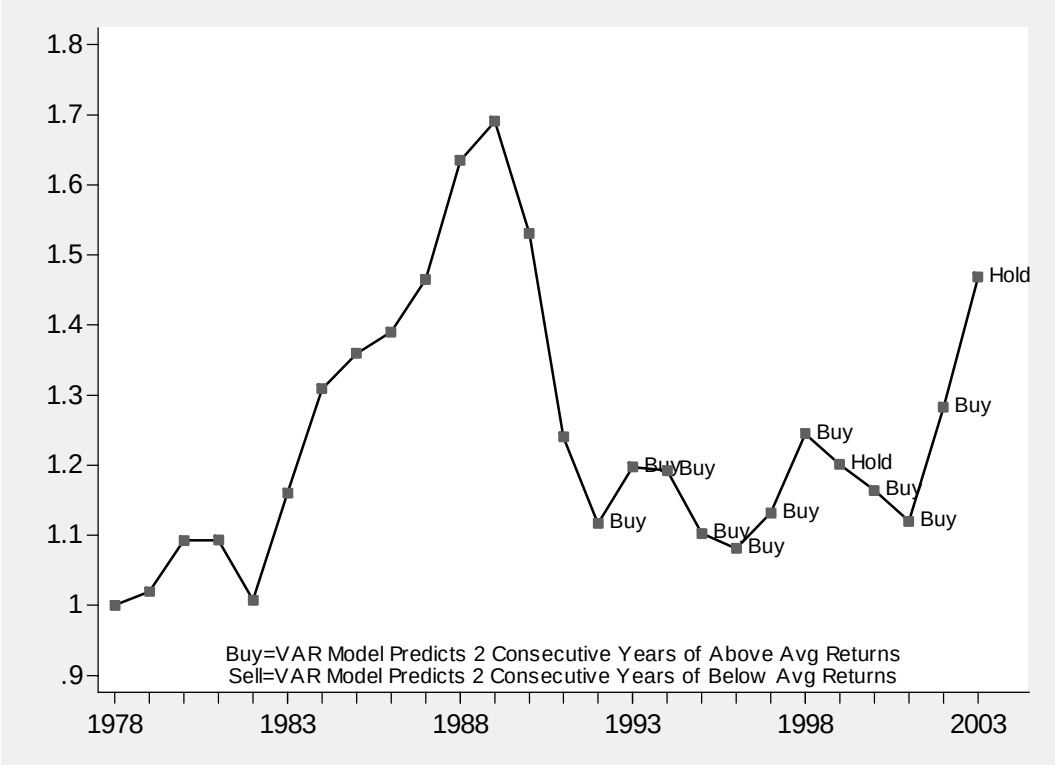



Figure 4.7 Historical market total returns and predicted returns from the forecast model based on rolling regression between 1992-2002 for retail market

types, average of adjusted R-square shows that 2-year-lag model explains the variation of returns better for in-sample period. The 1-year-lag model reports smaller RMSE, indicating better out-of-sample predictability. However, investors would be more concerned about out-of-sample predictability for investment implementation. Average of RMSE was lower in 1-year-lag model 1993 through 2003, although out-of-sample information would not be available in first sample. Therefore, it would be reasonable to apply the forecasts of 1-year-lag model to market timing decisions. The predictions of market total returns are compared with historical market return in figure 4.7.

The same market timing rules are applied for the Long (+) strategy based on forecast of the VAR model. Then, the performance of the Long (+) portfolio is compare with the returns of retail market total return from 1992 to 2003. The investment model reports 10 'buy's and 2




Note: *Y*-axis shows unsmoothed market value level.

Figure 4.8 Market timing decisions for retail market based on the rolling regression between (1992-2003)

'hold'. It did not give any 'sell' signal during the sample period, which it would have signaled 4 times when applying the same rules ex post. Figure 4.8 presents the result of investment model. During the sample period, 3 out of 12 signals are correct ones. The model predicted return for one of the two consecutive years correct 5 times. Opposite signal was give twice. The 'buy' in 2002 proved to be a good decision, although it might turn out to be a wrong signal depending on return of 2004. The inaccuracy of the model is not surprising since RMSE is higher than the standard deviation during the sample period and the RMSE stay constantly at high level. Considering the inaccuracy of the model, the performance is better than expected. The relatively high return considering the inaccurate investment model was possible partly because it predicted some of the high return correct and few incorrect 'buy' decisions, instead of 'hold', turn out well. The average return of the portfolio is slightly above the bench mark and average of entire sample period. The return of portfolio is less volatile. Not surprisingly, P-value shows that difference between the portfolio return and the bench mark is not significant. Table 4.16 reports the performance of the two portfolios.

Table 4.16 Portfolio return based on investment model using out-of-sample prediction - Retail market (1992-2003)

| | Trading Strategies | |
|---|---|---|
| | Buy-and-Hold | Long (+) |
| Average | 0.115 | 0.118 |
| Standard deviation | 0.082 | 0.078 |
| P-value (t-test)* | | 0.369 |

*P-values based on two-tailed test assuming unequal variances

***Industrial Market***

The summary statistics of the variables used in the forecast model for industrial properties are shown in table 4.17. The mean of market total return for industrial during the sample period, 1978 through 2003, is 9.67%. The standard deviation of the market return is 9.55%. The average of unsmoothed return and the volatility of the return are similar to the aggregate market total return. On the other hand, the appraisal yield, one of the two components comprising the total return, was the highest of the four properties with lowest volatility.

Table 4.17 Historical statistics of VAR model variables (annual nominal values: 1978-2003) - Industrial market

| Variable | Mean | Std. Dev. | $\rho_1$ * |
|---|---|---|---|
| Real Estate Market Total Return** | 0.0967 | 0.0955 | 0.4223 |
| Real Estate Cash Flow*** | 0.1125 | 0.0142 | 0.5060 |
| Appraisal Yield | 0.0851 | 0.0074 | 0.8945 |
| REIT Total Return | 0.1323 | 0.1626 | -0.0256 |
| Appraisal Total Return | 0.1001 | 0.0610 | 0.7921 |

* $\rho_1$ is the first autocorrelation of the series

** Unsmoothed from the appraisal-based returns

*** Aggregate cash flow level of apartment expressed as a fraction of the aggregate industrial value level as of the end of 1977

| | Correlation Among Variables | | | | |
|---|---|---|---|---|---|
| | Mkt. Ret | CF | Appr. Yld | REIT Ret | Appr. Ret |
| Mkt. Ret | 1.000 | | | | |
| Cash Flow | -0.393 | 1.000 | | | |
| Appr. Yld | 0.521 | -0.143 | 1.000 | | |
| REIT Ret | 0.061 | -0.075 | 0.134 | 1.000 | |
| Appr. Ret | 0.820 | -0.362 | 0.333 | 0.018 | 1.000 |

Consequently, capital return component of the total return during the study period was higher than average. The appraisal total return of industrial is lower than the market total return, which indicates more smoothing effect during depreciation of retail market. The first autocorrelation of the variables are similar to aggregate market. Only one that shows difference is the

Table 4.18 VAR Model(1 year lag) estimation results. Estimated coefficients - Industrial market

| | Independent Variables | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Dep. Var. | Const. | Mkt. $Ret_t$ | $CF_t$ | Appr. $Yld_t$ | REIT $Ret_t$ | Appr. $Ret_t$ | Adj $R^2$ | RMSE |
| Mkt. $Ret_{t+1}$ | | | | | | | | |
| Ave. | -0.016 | 0.055 | -2.862 | 4.690 | 0.137 | 0.087 | 0.338 | 0.086 |
| | (-0.085) | (0.189) | (-2.567) | (1.626) | (1.26) | (0.028) | | |
| Std. | 0.206 | 0.154 | 0.258 | 2.833 | 0.032 | 0.404 | 0.071 | 0.051 |
| | (0.36) | (0.38) | (0.438) | (0.853) | (0.236) | (0.465) | | |
| Cash $Flow_{t+1}$ | | | | | | | | |
| Ave. | 0.094 | 0.012 | 0.494 | -0.437 | -0.010 | 0.016 | 0.837 | 0.011 |
| | (5.85) | (0.719) | (10.173) | (-2.449) | (-2.233) | (0.774) | | |
| Std. | 0.028 | 0.008 | 0.037 | 0.301 | 0.002 | 0.012 | 0.019 | 0.012 |
| | (2.019) | (0.475) | (0.962) | (0.546) | (0.572) | (0.652) | | |
| Appr. $Yld_{t+1}$ | | | | | | | | |
| Ave. | 0.031 | 0.017 | -0.142 | 0.885 | -0.001 | -0.070 | 0.942 | 0.006 |
| | (5.304) | (2.711) | (-7.028) | (16.095) | (-0.473) | (-7.973) | | |
| Std. | 0.007 | 0.004 | 0.007 | 0.080 | 0.001 | 0.007 | 0.048 | 0.004 |
| | (1.28) | (0.535) | (0.436) | (6.975) | (0.755) | (1.784) | | |
| REIT $Ret_{t+1}$ | | | | | | | | |
| Ave. | -0.291 | -0.718 | -3.928 | 11.235 | -0.199 | 0.412 | -0.077 | 0.267 |
| | (-0.157) | (-1.056) | (-1.791) | (1.37) | (-0.928) | (0.505) | | |
| Std. | 0.852 | 0.337 | 0.788 | 10.294 | 0.142 | 0.773 | 0.090 | 0.148 |
| | (0.991) | (0.51) | (0.273) | (0.747) | (0.637) | (0.716) | | |
| Appr. $Ret_{t+1}$ | | | | | | | | |
| Ave. | -0.006 | 0.022 | -1.145 | 1.876 | 0.055 | 0.635 | 0.747 | 0.050 |
| | (-0.085) | (0.189) | (-2.567) | (1.626) | (1.26) | (3.103) | | |
| Std. | 0.082 | 0.062 | 0.103 | 1.133 | 0.013 | 0.162 | 0.023 | 0.043 |
| | (0.36) | (0.38) | (0.438) | (0.853) | (0.236) | (0.471) | | |

Notes: All data are annual (4th quarter to 4th quarter) in nominal terms. Observations 1978-2003

Summary statistics of regression coefficients are given by the first line of each row, while statistics of the z-ratio are given in parenthesis in the second row. Rolling regression technique using data from 1978 to time t is employed in order to analyze out-of-sample predictions between 1992 and 2003.

Table 4.19 VAR Model(1-2 year lags) estimation results. Estimated coefficients - Industrial market

| | Independent Variables | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dep. Var. | Const. | Mkt. $Ret_t$ | Mkt. $Ret_{t+1}$ | $CF_t$ | $CF_{t+1}$ | Appr. $Yld_t$ | Appr. $Yld_{t+1}$ | REIT $Ret_t$ | REIT $Ret_{t+1}$ | Appr. $Ret_{t+1}$ | Adj $R^2$ | RMSE |
| Mkt. $Ret_{t+2}$ | | | | | | | | | | | | |
| Ave. | -0.338 | 0.213 | 0.246 | -2.754 | 3.230 | 12.594 | -9.458 | 0.279 | 0.117 | 0.147 | 0.192 | 0.093 |
| | (-0.604) | (0.974) | (0.634) | (-0.496) | (0.664) | (0.851) | (-0.64) | (2.445) | (0.854) | (0.141) | | |
| Std. | 0.331 | 0.108 | 0.199 | 4.425 | 2.431 | 6.477 | 6.979 | 0.126 | 0.114 | 0.627 | 0.092 | 0.024 |
| | (0.528) | (0.5) | (0.483) | (0.64) | (0.451) | (0.429) | (0.43) | (0.862) | (0.786) | (0.487) | | |
| Cash $Flow_{t+1}$ | | | | | | | | | | | | |
| Ave. | 0.029 | 0.029 | 0.006 | 0.841 | 0.056 | -0.086 | -0.168 | 0.001 | 0.004 | 0.011 | 0.894 | 0.007 |
| | (2.115) | (4.714) | (0.543) | (4.691) | (0.375) | (-0.215) | (-0.353) | (0.28) | (1.07) | (0.354) | | |
| Std. | 0.010 | 0.003 | 0.013 | 0.114 | 0.091 | 0.274 | 0.240 | 0.004 | 0.004 | 0.032 | 0.017 | 0.004 |
| | (0.5) | (0.604) | (1.202) | (1.008) | (0.644) | (0.672) | (0.521) | (1.136) | (1.18) | (0.979) | | |
| Appr. $Yld_{t+1}$ | | | | | | | | | | | | |
| Ave. | 0.027 | -0.011 | 0.003 | -0.146 | 0.034 | 1.029 | -0.146 | 0.000 | 0.003 | -0.039 | 0.959 | 0.006 |
| | (2.954) | (-2.62) | (0.355) | (-1.181) | (0.329) | (3.628) | (-0.459) | (0.035) | (1.066) | (-1.716) | | |
| Std. | 0.007 | 0.002 | 0.009 | 0.076 | 0.061 | 0.191 | 0.170 | 0.003 | 0.003 | 0.022 | 0.009 | 0.003 |
| | (0.584) | (0.49) | (1.278) | (0.605) | (0.64) | (0.631) | (0.534) | (1.227) | (1.224) | (1.004) | | |
| REIT $Ret_{t+1}$ | | | | | | | | | | | | |
| Ave. | 0.333 | -0.480 | -1.562 | -25.426 | 15.982 | 72.605 | -65.292 | -0.366 | -0.420 | 5.863 | 0.014 | 0.239 |
| | (0.385) | (-1.269) | (-2.314) | (-2.158) | (1.689) | (2.665) | (-2.281) | (-1.819) | (-1.886) | (2.689) | | |
| Std. | 0.747 | 0.213 | 0.544 | 5.351 | 3.927 | 8.146 | 13.207 | 0.236 | 0.105 | 0.906 | 0.162 | 0.098 |
| | (0.9) | (0.692) | (0.954) | (0.342) | (0.319) | (0.297) | (0.385) | (1.156) | (0.278) | (0.514) | | |
| Appr. $Ret_{t+1}$ | | | | | | | | | | | | |
| Ave. | -0.135 | 0.325 | 0.098 | -1.101 | 1.292 | 5.037 | -3.783 | 0.112 | 0.047 | 0.419 | 0.698 | 0.044 |
| | (-0.604) | (3.725) | (0.634) | (-0.496) | (0.664) | (0.851) | (-0.64) | (2.445) | (0.854) | (0.885) | | |
| Std. | 0.132 | 0.043 | 0.079 | 1.770 | 0.972 | 2.591 | 2.792 | 0.050 | 0.046 | 0.251 | 0.039 | 0.016 |
| | (0.528) | (0.547) | (0.483) | (0.64) | (0.451) | (0.429) | (0.43) | (0.862) | (0.786) | (0.522) | | |

Notes: All data are annual (4th quarter to 4th quarter) in nominal terms. Observations 1978-2003

Summary statistics of regression coefficients are given by the first line of each row, while statistics of the z-ratio are given in parenthesis in the second row. Rolling regression technique using data from 1978 to time t is employed in order to analyze out-of-sample predictions between 1996 and 2003.

autocorrelation of cash flow largely due to steep rise in the early period.[14] As studies of other property type, industrial also shows high correlation between market return and appraisal yield.

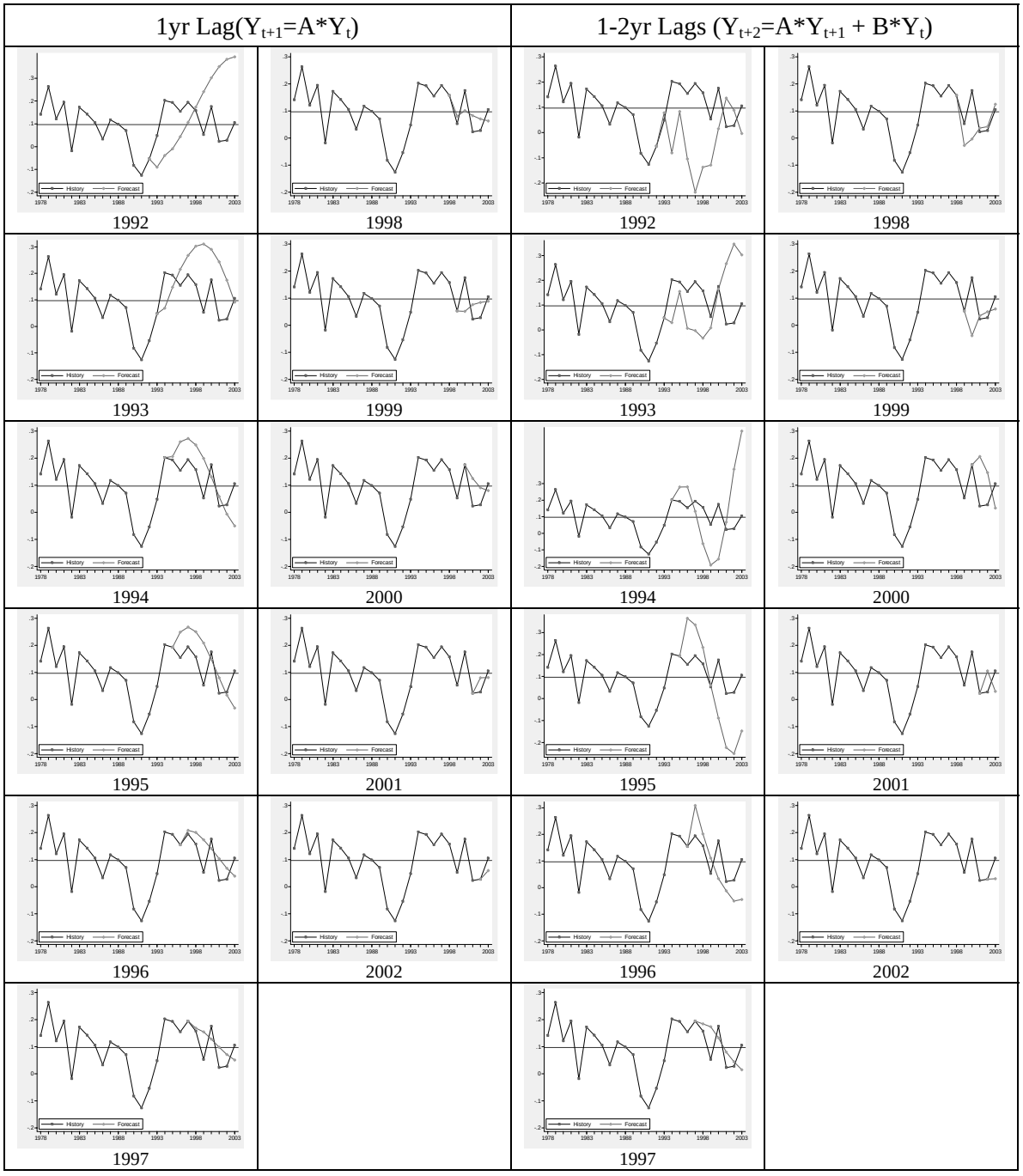
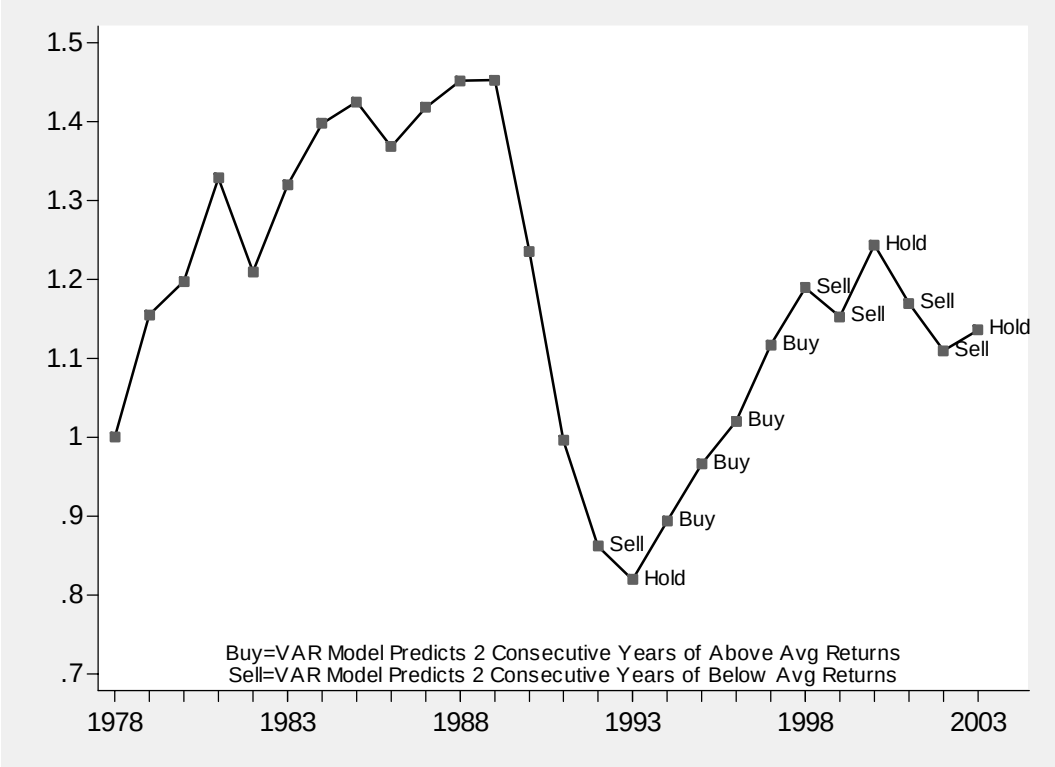



Figure 4.9 Historical market total returns and predicted returns from the forecast model based on rolling regression between 1992-2002 for industrial market

[14] First autocorrelation of cash flow without 1992 data is similar to other property types.

The estimated coefficients of the VAR model are summarized in table 4.18 and table 4.19. Table 4.18 shows results of 1-year-lag model and table 4.19 1&2-year-lag model. The summaries are the results of rolling regression from 1992 to 2003 for the 1-year-lag model and 1996 to 2003 for the 1&2-year-lag model. The return graphs that compare the predictions of market total returns to historical market return are presented in figure 4.9. As returns of other private real estate properties, the industrial market return shows better predictability than the REIT return. Average adjusted R-square for the study of industrial market is 0.338 and average RMSE is 0.087. Interestingly, industrial is the only property type that shows higher out-of-sample predictability with more observations. Also, better in-sample fit of the model, indicated by adjusted R-square, result in better out-of-sample predictability in general. For regression equation of market total return, the coefficients of appraisal yield was lowest of the four property




Note: *Y*-axis shows unsmoothed market value level.

Figure 4.10 Market timing decisions for industrial market based on the rolling regression between (1992-2003)

types and also z-ratio was insignificant. The 1-year-lag VAR model shows better in-sample and out-of-sample predictability than the 1-2 year model. Especially, the 1-year-model had lower average RMSEs for all variables and better in-sample fit for the model. Consequently, the predictions of 1-year-lag model are employed for the investment decision model.

Figure 4.10 shows the result of investment decision model on each point of time between 1992 and 2003 along with historical unsmoothed total return of industrial market between 1978 and 2003. The investment decisions are based on the same buy/sell/hold rules applied to other property types. The model gives 4 'buy', 3 'hold', and 5 'sell' signals. Out of these12 projections, 3 turn out to be correct, 7 have one of the two following years right, none of the projection give opposite signal, and 2 are waiting to see outcomes of 2004 and 2005. The sell signal in 2002 proved to be false since the market return on 2003 was slightly over average at 10.5%. It seems that improvement of predictability of the predictability did not enhance outcome of the market timing model. A closer look to the historical market return series reveals that the inaccuracy of the model is understandable. If the same decision rules are apply to the historical returns ex post, the model projects 5 hold signal, which indicate fluctuation of the returns. The portfolio returns are compared in table 4.20. Considering inaccuracy of the investment model, the Long (+) portfolio performed quite well. The average return are about 4% higher and volatility of return is

Table 4.20 Portfolio return based on investment model using out-of-sample prediction - Industrial market (1992-2003)

| | Trading Strategies | |
|---|---|---|
| | Buy-and-Hold | Long (+) |
| Average | 0.121 | 0.162 |
| Standard deviation | 0.071 | 0.038 |
| P-value (t-test)* | | 0.194 |

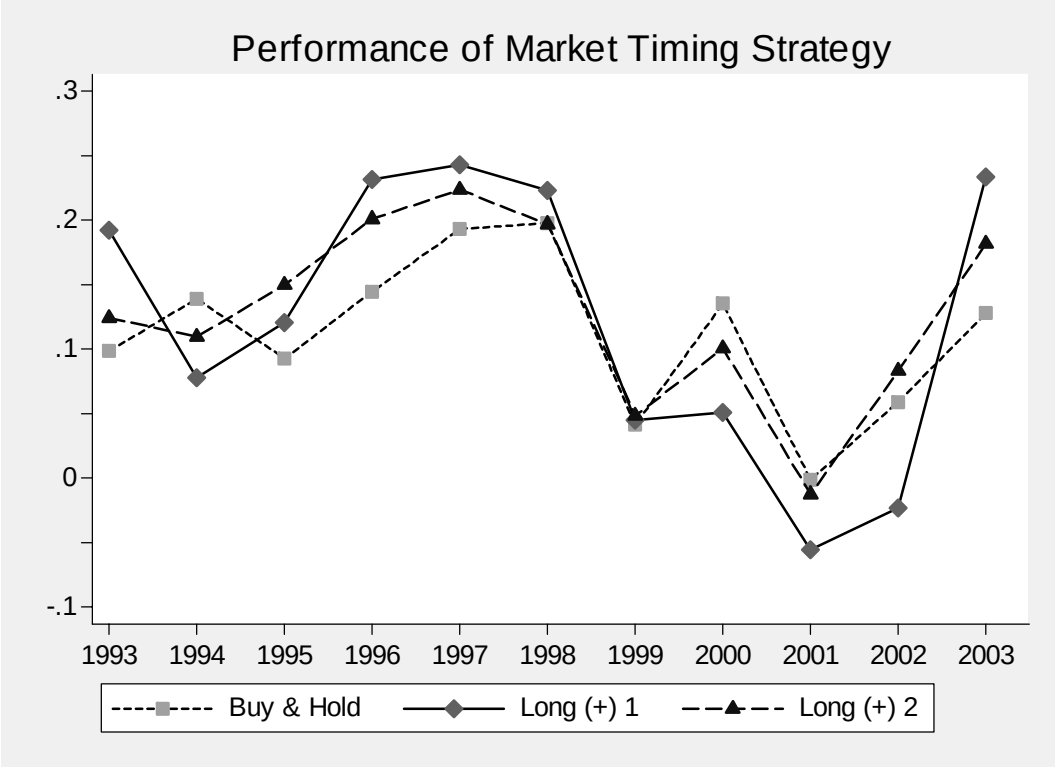
*P-values based on two-tailed test assuming unequal variances

about half of the passive portfolio. P-value shows that the result cannot be said statistically significant, but still the probability that the active portfolio actually performs better is high.

***Diversified Portfolio***

So far, the investment model used for market timing involves only one type of real estate market, whether it is aggregate market or a market for individual property type. The model basically suggests whether portfolio should take long position or close the position of the certain real estate class. For instance, the aggregate model can be used for portfolio manager of various asset class and see if it is good time to invest in real estate. The disaggregate property level model can be used in situations when real estate investors with expertise in particular property type trying to choose time to sell or buy a property. However, often time real estate investors face circumstance when they have to choose which property type within real estate to put their money in, e.g. diversified real estate companies. The next investment model is built to see whether level of predictability in return can be exploited for such purpose.

Two active investment strategies using the forecast of the unsmoothed market total returns for four property types are constructed. First portfolio holds long position of a property that the forecasting model predicts the highest return for the following year. For the second portfolio, two properties that the prediction model forecast to project highest returns are chosen. With the two property types, active Long (+) portfolio is composed by investing 60% in the highest one and 40% in the other. The returns of the active Long (+) portfolios are than compare




Returns of Buy & Hold strategy follow the unsmoothed market total return
Long (+) 1 portfolio invests in property with highest predicted return for the following year. Long (+) 2 portfolio invests in two properties with highest predicted return for the following year.

Figure 4.11 Performance of market timing using prediction of the forecast model (1993-2003)

with aggregate market total returns. Figure 4.11 presents the result of the investment models and returns of aggregate market as a bench mark. As outcome of 2003 forecast is not known, there are 11 return results from the model.

The first model ended with holding a property that has highest return 5 times out of 11 years. For the second model, it predicted both properties with highest returns correct 3 times. The properties with highest return are included in the portfolio 9 times out of 11 years. The performance of three portfolios is summarized in table 4.21. Two active portfolios show superior performance to the passive buy-and-hold portfolio, with portfolio with two property types having higher return. One of the reasons why second portfolio has higher return is that the model predicted office return to be highest for 2001 and 2002, the years when office return was the

Table 4.21 Portfolio return based on investment model using out-of-sample prediction - Multiple Property types (1992-2003)

| | Trading Strategies | | |
|---|---|---|---|
| | Buy-and-Hold | Long (+) 1 property | Long (+) 2 properties |
| Average | 0.112 | 0.122 | 0.128 |
| Standard deviation | 0.061 | 0.109 | 0.072 |
| P-value (t-test)* | | 0.396 | 0.288 |

* P-values based on one-tailed test assuming equal variances

lowest. As discussed earlier, the failure of the prediction might result from the fact that model cannot take the effect of unexpected event into account. However, the model's second choice, the retail, turned out to project highest return for those years. Standard deviations of the three portfolio shows different result from previous investment models. Two active models show higher volatility. The lower volatility of aggregate market return is understandable since it consists of diversified portfolio of various property types. We can observe similar effect in the second Long (+) portfolio, which has higher return but lower volatility than the portfolio of one property type. However, the P-value shows that neither of the Long (+) portfolio return is statistically significant.

## Chapter Five: Conclusion

The study has analyzed the predictability of commercial real estate and implications of the predictability for investment decisions. Income component of Real estate return, which we find highly predictable, is stable and comprises larger portion of total on average during the study period. Most of volatility of the total return comes from the volatility in capital component. These return characteristics are consistent across the property type and aggregate market. The coefficients of appraisal yield in regression equation of market total returns are both high and significant. Therefore, appraisal yield can be a good predictor of returns in private real estate. However this does not necessary indicates causality of appraisal yield and real estate return.

The study shows that returns in private real estate are more predictable compare to securitized REIT returns. The market total returns consistently reported better out-of-sample predictability over REIT returns. The only exception is RMSE of office returns in 1999 and 2000, largely due to unexpected return in 2001. The REIT return has higher in-sample fit than the unsmoothed return in retail market using observations from the retail market as variables. Other than retail market, commercial real estate show better in-sample predictability.

Predictability, measured by RMSE, varied among the property types during the sample period, with apartment the highest and office the lowest. The aggregate market was more predictable than the market for individual property types in general.[15] This can be explained by the fact that aggregate market has a larger sample size. Also aggregate market is less affected by unexpected event that is idiosyncratic to certain property type. Standard deviations of RMSE for

[15] RMSE of apartment is lower during the study period. However the volatility of returns in apartment market is also lower than the aggregate market.

market returns are relatively low showing stableness of predictability. In-sample and out-of-sample predictability varied among the property types. The office market shows relatively high volatility because of high RMSEs in recent years. Industrial market shows improvements in predictability with more observations. The predictability does not show correlation with sample size or adjusted R-square, except for industrial market. The study also shows that the predictability of 1-year-lag forecasting model better than the predictability of 1-2 year lags model, at least during the study period. However, while the rolling regression method provides good measure of the out-of-sample fit for the forecast model, it is important to note that the empirical data available to the present study was somewhat limited to draw statistically convincing outcomes.

With the finding from the study of predictability of commercial real estate, we have constructed a few investment models to see whether we can achieve superior returns by market timing. All of the investment models using one real estate class have higher returns and lower volatility compare to their benchmark. However, portfolios investing in one or two property types at a time have higher volatility than the passive portfolio of aggregate market, albeit the average return is higher. The portfolio holding two property types is less volatile than the portfolio holding one property type at a time. Even in the portfolio using the forecast, we can observer diversified portfolio less volatile, partly because of imperfection of the forecast model. However, these results are not statistically significant. We have observed some occasions when the model did not consider unexpected incidents or sudden change in underlying economy. Also we have examined some consequences of incorrect prediction to the performance of portfolio, whether the failures are caused by defect of the model or by unexpected return. When employing

a forecast model, investor should keep in mind that predictions the model forecasts are expected returns at best and tend to have error embedded in estimations.

In summary, returns of commercial real estate are predictable to certain extent and, although statistically not convincing, the level of predictability associated with commercial real estate can be successfully exploit to achieve superior performance over a passive buy and hold portfolio by market timing decisions. However, predictability tends to decrease at disaggregate property market level as the markets has smaller sample size and more exposure to idiosyncratic risk.

# *Appendix*

## Empirical Results for Office Market in Atlanta MSA

VAR Model(1 year lag) estimation results. Estimated coefficients - Atlanta MSA

| | Independent Variables | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Dep. Var. | Const. | Mkt. $Ret_t$ | $CF_t$ | Appr. $Yld_t$ | REIT $Ret_t$ | Appr. $Ret_t$ | Adj $R^2$ | RMSE |
| Mkt. $Ret_{t+1}$ | | | | | | | | |
| Ave. | -0.185 | -0.388 | -4.647 | 5.690 | 0.647 | 0.056 | 0.286 | 0.117 |
| | (-0.618) | (-1.315) | (-1.709) | (1.678) | (3.281) | (0.109) | | |
| Std. | 0.171 | 0.054 | 0.967 | 1.778 | 0.095 | 0.234 | 0.086 | 0.025 |
| | (0.579) | (0.248) | (0.41) | (0.443) | (0.496) | (0.325) | | |
| Cash $Flow_{t+1}$ | | | | | | | | |
| Ave. | 0.046 | -0.004 | 0.653 | -0.436 | 0.014 | 0.077 | 0.333 | 0.007 |
| | (2.403) | (-0.241) | (3.95) | (-2.144) | (1.203) | (1.79) | | |
| Std. | 0.005 | 0.002 | 0.027 | 0.057 | 0.002 | 0.012 | 0.085 | 0.004 |
| | (1.025) | (0.146) | (0.597) | (0.219) | (0.247) | (0.216) | | |
| Appr. $Yld_{t+1}$ | | | | | | | | |
| Ave. | 0.062 | 0.010 | -0.397 | 0.432 | 0.025 | 0.011 | 0.208 | 0.010 |
| | (2.774) | (0.396) | (-1.803) | (1.646) | (1.583) | (0.195) | | |
| Std. | 0.005 | 0.005 | 0.030 | 0.062 | 0.001 | 0.008 | 0.178 | 0.003 |
| | (0.492) | (0.182) | (0.297) | (0.512) | (0.279) | (0.158) | | |
| REIT $Ret_{t+1}$ | | | | | | | | |
| Ave. | 0.607 | -0.520 | -8.816 | -0.370 | -0.154 | 0.871 | -0.068 | 0.219 |
| | (1.935) | (-1.623) | (-2.908) | (-0.075) | (-0.701) | (1.115) | | |
| Std. | 0.149 | 0.211 | 1.772 | 1.431 | 0.106 | 0.820 | 0.200 | 0.055 |
| | (0.553) | (0.917) | (0.979) | (0.39) | (0.517) | (1.081) | | |
| Appr. $Ret_{t+1}$ | | | | | | | | |
| Ave. | -0.074 | -0.155 | -1.859 | 2.276 | 0.259 | 0.623 | 0.532 | 0.061 |
| | (-0.618) | (-1.315) | (-1.709) | (1.678) | (3.281) | (2.256) | | |
| Std. | 0.069 | 0.021 | 0.387 | 0.711 | 0.038 | 0.093 | 0.086 | 0.023 |
| | (0.579) | (0.248) | (0.41) | (0.443) | (0.496) | (0.554) | | |

Notes: All data are annual (4th quarter to 4th quarter) in nominal terms. Observations 1984-2003

Summary statistics of regression coefficients are given by the first line of each row, while statistics of the z-ratio are given in parenthesis in the second row. Rolling regression technique using data from 1984 to time t is employed in order to analyze out-of-sample predictions between 1996 and 2003.

VAR Model(1-2 year lags) estimation results. Estimated coefficients - Atlanta MSA

| | Independent Variables | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dep. Var. | Const. | Mkt. $Ret_t$ | Mkt. $Ret_{t+1}$ | $CF_t$ | $CF_{t+1}$ | Appr. $Yld_t$ | Appr. $Yld_{t+1}$ | REIT $Ret_t$ | REIT $Ret_{t+1}$ | Appr. $Ret_{t+1}$ | Adj $R^2$ | RMSE |
| Mkt. $Ret_{t+2}$ | | | | | | | | | | | | |
| Ave. | -0.740 | -0.744 | -0.161 | 4.178 | -9.579 | 2.348 | 12.229 | 0.545 | 0.149 | -1.085 | 0.058 | 0.187 |
| | (-2.216) | (-2.75) | (-0.58) | (0.266) | (-0.618) | (0.274) | (1.094) | (2.906) | (0.674) | (-1.016) | | |
| Std. | 0.455 | 0.386 | 0.270 | 5.471 | 5.831 | 7.534 | 4.064 | 0.111 | 0.226 | 0.412 | 0.158 | 0.061 |
| | (1.423) | (1.411) | (0.915) | (0.367) | (0.358) | (0.724) | (0.389) | (0.959) | (1.001) | (0.401) | | |
| Cash $Flow_{t+1}$ | | | | | | | | | | | | |
| Ave. | 0.025 | 0.001 | -0.032 | -0.446 | 0.956 | 0.621 | -0.744 | 0.015 | 0.008 | 0.116 | -0.256 | 0.006 |
| | (1.406) | (0.114) | (-1.874) | (-0.54) | (1.138) | (1.038) | (-1.186) | (1.388) | (0.604) | (1.954) | | |
| Std. | 0.007 | 0.006 | 0.006 | 0.147 | 0.086 | 0.070 | 0.109 | 0.004 | 0.009 | 0.023 | 0.336 | 0.005 |
| | (0.62) | (0.414) | (0.464) | (0.194) | (0.156) | (0.182) | (0.251) | (0.315) | (0.538) | (0.522) | | |
| Appr. $Yld_{t+1}$ | | | | | | | | | | | | |
| Ave. | 0.041 | -0.013 | -0.039 | -1.478 | 0.914 | 1.468 | -0.699 | 0.025 | 0.011 | 0.088 | -0.179 | 0.010 |
| | (1.43) | (-0.546) | (-1.51) | (-1.142) | (0.694) | (1.576) | (-0.716) | (1.462) | (0.49) | (0.962) | | |
| Std. | 0.010 | 0.009 | 0.011 | 0.239 | 0.142 | 0.131 | 0.170 | 0.006 | 0.014 | 0.038 | 0.351 | 0.006 |
| | (0.518) | (0.337) | (0.496) | (0.232) | (0.136) | (0.249) | (0.211) | (0.331) | (0.555) | (0.444) | | |
| REIT $Ret_{t+1}$ | | | | | | | | | | | | |
| Ave. | -0.219 | -0.408 | -0.094 | -2.656 | -3.856 | -1.270 | 11.195 | -0.096 | -0.145 | -1.060 | -0.765 | 0.179 |
| | (-0.514) | (-1.174) | (-0.266) | (-0.158) | (-0.178) | (-0.064) | (0.738) | (-0.382) | (-0.6) | (-0.722) | | |
| Std. | 0.095 | 0.089 | 0.121 | 6.702 | 6.298 | 5.160 | 5.517 | 0.033 | 0.134 | 0.580 | 0.611 | 0.020 |
| | (0.292) | (0.306) | (0.334) | (0.346) | (0.299) | (0.353) | (0.297) | (0.131) | (0.534) | (0.312) | | |
| Appr. $Ret_{t+1}$ | | | | | | | | | | | | |
| Ave. | -0.296 | -0.058 | -0.065 | 1.671 | -3.831 | 0.939 | 4.891 | 0.218 | 0.059 | -0.074 | 0.404 | 0.087 |
| | (-2.216) | (-0.498) | (-0.58) | (0.266) | (-0.618) | (0.274) | (1.094) | (2.906) | (0.674) | (-0.168) | | |
| Std. | 0.182 | 0.155 | 0.108 | 2.188 | 2.333 | 3.014 | 1.625 | 0.044 | 0.090 | 0.165 | 0.101 | 0.033 |
| | (1.423) | (1.484) | (0.915) | (0.367) | (0.358) | (0.724) | (0.389) | (0.959) | (1.001) | (0.394) | | |

Notes: All data are annual (4th quarter to 4th quarter) in nominal terms. Observations 1984-2003

Summary statistics of regression coefficients are given by the first line of each row, while statistics of the z-ratio are given in parenthesis in the second row. Rolling regression technique using data from 1984 to time t is employed in order to analyze out-of-sample predictions between 1999 and 2003.

## Empirical Results for Office Market in Boston MSA

VAR Model(1 year lag) estimation results. Estimated coefficients - Boston MSA

| | Independent Variables | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Dep. Var. | Const. | Mkt. $Ret_t$ | $CF_t$ | Appr. $Yld_t$ | REIT $Ret_t$ | Appr. $Ret_t$ | Adj $R^2$ | RMSE |
| Mkt. $Ret_{t+1}$ | | | | | | | | |
| Ave. | -0.586 | -0.779 | -4.082 | 13.001 | -0.036 | 0.860 | 0.145 | 0.187 |
| | (-0.991) | (-2.581) | (-1.146) | (2.921) | (-0.128) | (1.471) | | |
| Std. | 0.237 | 0.067 | 1.511 | 1.239 | 0.086 | 0.115 | 0.067 | 0.047 |
| | (0.358) | (0.28) | (0.563) | (0.215) | (0.289) | (0.213) | | |
| Cash $Flow_{t+1}$ | | | | | | | | |
| Ave. | 0.057 | 0.006 | 0.689 | -0.402 | 0.021 | 0.038 | 0.593 | 0.017 |
| | (2.283) | (0.495) | (4.545) | (-2.365) | (1.571) | (1.604) | | |
| Std. | 0.009 | 0.004 | 0.082 | 0.149 | 0.002 | 0.009 | 0.152 | 0.019 |
| | (0.905) | (0.361) | (1.498) | (0.872) | (0.256) | (0.381) | | |
| Appr. $Yld_{t+1}$ | | | | | | | | |
| Ave. | 0.053 | 0.007 | -0.255 | 0.686 | 0.017 | -0.051 | 0.642 | 0.018 |
| | (2.614) | (0.616) | (-1.847) | (4.351) | (1.484) | (-2.49) | | |
| Std. | 0.012 | 0.003 | 0.049 | 0.178 | 0.003 | 0.008 | 0.051 | 0.022 |
| | (0.661) | (0.303) | (0.433) | (0.862) | (0.237) | (0.618) | | |
| REIT $Ret_{t+1}$ | | | | | | | | |
| Ave. | 1.070 | 0.226 | -6.826 | -3.387 | -0.303 | -0.305 | 0.204 | 0.238 |
| | (3.625) | (1.218) | (-3.196) | (-1.478) | (-1.819) | (-0.774) | | |
| Std. | 0.358 | 0.145 | 3.223 | 1.190 | 0.202 | 0.315 | 0.337 | 0.080 |
| | (1.905) | (0.657) | (1.764) | (0.808) | (1.395) | (0.81) | | |
| Appr. $Ret_{t+1}$ | | | | | | | | |
| Ave. | -0.298 | -0.303 | -1.449 | 5.827 | 0.008 | 0.927 | 0.453 | 0.160 |
| | (-1.187) | (-2.369) | (-0.952) | (3.002) | (0.01) | (3.725) | | |
| Std. | 0.190 | 0.040 | 0.782 | 1.998 | 0.056 | 0.105 | 0.102 | 0.254 |
| | (0.714) | (0.495) | (0.623) | (0.585) | (0.361) | (0.712) | | |

Notes: All data are annual (4th quarter to 4th quarter) in nominal terms. Observations 1983-2003

Summary statistics of regression coefficients are given by the first line of each row, while statistics of the z-ratio are given in parenthesis in the second row. Rolling regression technique using data from 1983 to time t is employed in order to analyze out-of-sample predictions between 1996 and 2003.

VAR Model(1-2 year lags) estimation results. Estimated coefficients - Boston MSA

| | Independent Variables | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dep. Var. | Const. | Mkt. $Ret_t$ | Mkt. $Ret_{t+1}$ | $CF_t$ | $CF_{t+1}$ | Appr. $Yld_t$ | Appr. $Yld_{t+1}$ | REIT $Ret_t$ | REIT $Ret_{t+1}$ | Appr. $Ret_{t+1}$ | Adj $R^2$ | RMSE |
| Mkt. $Ret_{t+2}$ | | | | | | | | | | | | |
| Ave. | -0.491 | -0.576 | -0.113 | 41.170 | -45.360 | -35.656 | 51.902 | -0.344 | 0.354 | -3.327 | 0.266 | 0.281 |
| | (-0.6) | (-2.09) | (-0.323) | (2.116) | (-2.186) | (-1.466) | (2.446) | (-1.017) | (1.206) | (-1.551) | | |
| Std. | 0.619 | 0.192 | 0.214 | 6.953 | 9.229 | 12.929 | 9.072 | 0.193 | 0.236 | 1.153 | 0.139 | 0.090 |
| | (0.858) | (0.668) | (0.629) | (0.172) | (0.249) | (0.4) | (0.191) | (0.683) | (0.821) | (0.421) | | |
| Cash $Flow_{t+1}$ | | | | | | | | | | | | |
| Ave. | 0.108 | 0.035 | 0.013 | 2.353 | -1.738 | -2.477 | 1.683 | 0.008 | 0.008 | -0.148 | 0.497 | 0.011 |
| | (2.617) | (2.501) | (0.729) | (2.427) | (-1.677) | (-2.066) | (1.594) | (0.586) | (0.536) | (-1.391) | | |
| Std. | 0.020 | 0.009 | 0.009 | 0.285 | 0.329 | 0.477 | 0.312 | 0.007 | 0.007 | 0.047 | 0.130 | 0.009 |
| | (0.345) | (0.541) | (0.498) | (0.33) | (0.289) | (0.401) | (0.322) | (0.494) | (0.449) | (0.435) | | |
| Appr. $Yld_{t+1}$ | | | | | | | | | | | | |
| Ave. | 0.104 | -0.003 | 0.010 | 1.668 | -2.022 | -1.678 | 2.016 | 0.003 | 0.013 | -0.220 | 0.614 | 0.010 |
| | (3.391) | (-0.333) | (0.797) | (2.299) | (-2.613) | (-1.871) | (2.553) | (0.294) | (1.2) | (-2.766) | | |
| Std. | 0.014 | 0.007 | 0.007 | 0.206 | 0.240 | 0.336 | 0.218 | 0.006 | 0.007 | 0.034 | 0.061 | 0.005 |
| | (0.332) | (0.702) | (0.565) | (0.319) | (0.253) | (0.396) | (0.352) | (0.541) | (0.622) | (0.489) | | |
| REIT $Ret_{t+1}$ | | | | | | | | | | | | |
| Ave. | 0.956 | 0.299 | 0.069 | -0.681 | -4.045 | -11.908 | 8.198 | -0.143 | -0.257 | -0.981 | -0.209 | 0.274 |
| | (2.271) | (1.5) | (-0.29) | (-0.52) | (-0.131) | (-0.454) | (0.187) | (-0.723) | (-1.29) | (-0.211) | | |
| Std. | 0.813 | 0.222 | 0.321 | 9.878 | 9.636 | 14.037 | 10.523 | 0.294 | 0.129 | 1.500 | 0.511 | 0.105 |
| | (3.365) | (1.053) | (2.081) | (1.772) | (0.629) | (0.902) | (1.224) | (1.607) | (0.623) | (1.555) | | |
| Appr. $Ret_{t+1}$ | | | | | | | | | | | | |
| Ave. | -0.196 | 0.010 | -0.045 | 16.468 | -18.144 | -14.263 | 20.761 | -0.138 | 0.141 | -0.971 | 0.546 | 0.112 |
| | (-0.6) | (0.113) | (-0.323) | (2.116) | (-2.186) | (-1.466) | (2.446) | (-1.017) | (1.206) | (-1.121) | | |
| Std. | 0.248 | 0.077 | 0.086 | 2.781 | 3.692 | 5.172 | 3.629 | 0.077 | 0.094 | 0.461 | 0.094 | 0.025 |
| | (0.858) | (0.717) | (0.629) | (0.172) | (0.249) | (0.4) | (0.191) | (0.683) | (0.821) | (0.44) | | |

Notes: All data are annual (4th quarter to 4th quarter) in nominal terms. Observations 1983-2003

Summary statistics of regression coefficients are given by the first line of each row, while statistics of the z-ratio are given in parenthesis in the second row. Rolling regression technique using data from 1983 to time t is employed in order to analyze out-of-sample predictions between 1997 and 2003.

## Empirical Results for Office Market in Chicago MSA

VAR Model(1 year lag) estimation results. Estimated coefficients - Chicago MSA

| | Independent Variables | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Dep. Var. | Const. | Mkt. $Ret_t$ | $CF_t$ | Appr. $Yld_t$ | REIT $Ret_t$ | Appr. $Ret_t$ | Adj $R^2$ | RMSE |
| Mkt. $Ret_{t+1}$ | | | | | | | | |
| Ave. | 0.008 | -0.256 | -3.717 | 3.401 | 0.493 | 0.737 | 0.416 | 0.109 |
| | (0.023) | (-0.86) | (-2.043) | (1.537) | (3.557) | (1.602) | | |
| Std. | 0.067 | 0.230 | 0.476 | 1.343 | 0.038 | 0.316 | 0.087 | 0.053 |
| | (0.293) | (0.745) | (0.299) | (0.586) | (0.46) | (0.63) | | |
| Cash $Flow_{t+1}$ | | | | | | | | |
| Ave. | 0.063 | -0.032 | 0.568 | -0.486 | 0.017 | 0.093 | 0.373 | 0.017 |
| | (2.897) | (-1.097) | (2.933) | (-2.035) | (1.203) | (1.972) | | |
| Std. | 0.002 | 0.010 | 0.131 | 0.187 | 0.006 | 0.010 | 0.208 | 0.013 |
| | (1.001) | (0.447) | (1.076) | (0.763) | (0.203) | (0.627) | | |
| Appr. $Yld_{t+1}$ | | | | | | | | |
| Ave. | 0.054 | -0.029 | -0.364 | 0.655 | 0.015 | 0.013 | 0.333 | 0.012 |
| | (3.235) | (-1.168) | (-2.333) | (3.459) | (1.29) | (0.343) | | |
| Std. | 0.002 | 0.010 | 0.120 | 0.163 | 0.004 | 0.011 | 0.252 | 0.008 |
| | (0.342) | (0.478) | (0.969) | (1.318) | (0.28) | (0.234) | | |
| REIT $Ret_{t+1}$ | | | | | | | | |
| Ave. | 0.041 | -0.286 | -4.872 | 7.145 | -0.235 | 0.134 | -0.280 | 0.269 |
| | (0.106) | (-0.395) | (-1.027) | (1.296) | (-0.895) | (0.021) | | |
| Std. | 0.078 | 0.693 | 7.326 | 9.186 | 0.280 | 1.094 | 0.209 | 0.100 |
| | (0.251) | (1.152) | (1.399) | (1.184) | (1.09) | (1.247) | | |
| Appr. $Ret_{t+1}$ | | | | | | | | |
| Ave. | 0.002 | -0.101 | -1.469 | 1.289 | 0.212 | 0.947 | 0.755 | 0.135 |
| | (0.025) | (-0.772) | (-1.807) | (1.385) | (3.569) | (4.536) | | |
| Std. | 0.020 | 0.123 | 0.728 | 1.005 | 0.032 | 0.166 | 0.044 | 0.094 |
| | (0.22) | (0.863) | (0.859) | (0.959) | (0.53) | (0.75) | | |

Notes: All data are annual (4th quarter to 4th quarter) in nominal terms. Observations 1980-2003

Summary statistics of regression coefficients are given by the first line of each row, while statistics of the z-ratio are given in parenthesis in the second row. Rolling regression technique using data from 1980 to time t is employed in order to analyze out-of-sample predictions between 1998 and 2003.

VAR Model(1-2 year lags) estimation results. Estimated coefficients - Chicago MSA

| | Independent Variables | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dep. Var. | Const. | Mkt. $Ret_t$ | Mkt. $Ret_{t+1}$ | $CF_t$ | $CF_{t+1}$ | Appr. $Yld_t$ | Appr. $Yld_{t+1}$ | REIT $Ret_t$ | REIT $Ret_{t+1}$ | Appr. $Ret_{t+1}$ | Adj $R^2$ | RMSE |
| Mkt. $Ret_{t+2}$ | | | | | | | | | | | | |
| Ave. | -0.399 | 0.012 | 0.074 | 6.487 | -7.626 | -10.194 | 17.230 | 0.389 | 0.171 | -0.555 | 0.420 | 0.118 |
| | (-1.652) | (0.074) | (0.328) | (0.8) | (-0.914) | (-1.03) | (1.636) | (3.312) | (1.09) | (-0.74) | | |
| Std. | 0.018 | 0.136 | 0.299 | 0.978 | 2.345 | 1.359 | 2.944 | 0.039 | 0.053 | 0.459 | 0.083 | 0.085 |
| | (0.198) | (0.746) | (1.14) | (0.181) | (0.351) | (0.213) | (0.403) | (0.553) | (0.346) | (0.614) | | |
| Cash $Flow_{t+1}$ | | | | | | | | | | | | |
| Ave. | 0.056 | 0.004 | 0.023 | -0.385 | 1.051 | 0.664 | -1.233 | 0.021 | 0.005 | 0.101 | 0.454 | 0.006 |
| | (2.656) | (0.25) | (0.98) | (-0.54) | (1.422) | (0.764) | (-1.334) | (2.042) | (0.33) | (1.576) | | |
| Std. | 0.000 | 0.001 | 0.005 | 0.024 | 0.046 | 0.032 | 0.056 | 0.001 | 0.001 | 0.006 | 0.058 | 0.005 |
| | (0.117) | (0.072) | (0.088) | (0.025) | (0.049) | (0.036) | (0.058) | (0.183) | (0.032) | (0.231) | | |
| Appr. $Yld_{t+1}$ | | | | | | | | | | | | |
| Ave. | 0.052 | -0.027 | 0.022 | -0.891 | 0.582 | 1.264 | -0.695 | 0.018 | 0.008 | 0.024 | 0.455 | 0.006 |
| | (3.002) | (-2.05) | (1.158) | (-1.518) | (0.954) | (1.764) | (-0.91) | (2.134) | (0.716) | (0.458) | | |
| Std. | 0.001 | 0.002 | 0.005 | 0.035 | 0.057 | 0.047 | 0.074 | 0.001 | 0.002 | 0.007 | 0.060 | 0.003 |
| | (0.129) | (0.282) | (0.173) | (0.07) | (0.082) | (0.082) | (0.097) | (0.22) | (0.076) | (0.15) | | |
| REIT $Ret_{t+1}$ | | | | | | | | | | | | |
| Ave. | 0.139 | 0.042 | -0.422 | 17.530 | -19.267 | -19.088 | 22.922 | -0.084 | -0.255 | -1.389 | -0.674 | 0.196 |
| | (0.29) | (0.114) | (-0.818) | (1.09) | (-1.152) | (-0.972) | (1.098) | (-0.364) | (-0.838) | (-0.962) | | |
| Std. | 0.025 | 0.049 | 0.070 | 1.648 | 1.852 | 2.206 | 2.940 | 0.039 | 0.054 | 0.136 | 0.199 | 0.024 |
| | (0.051) | (0.148) | (0.193) | (0.126) | (0.136) | (0.135) | (0.17) | (0.181) | (0.237) | (0.154) | | |
| Appr. $Ret_{t+1}$ | | | | | | | | | | | | |
| Ave. | -0.160 | 0.245 | 0.030 | 2.595 | -3.050 | -4.078 | 6.892 | 0.156 | 0.068 | 0.138 | 0.741 | 0.074 |
| | (-1.652) | (3.286) | (0.328) | (0.8) | (-0.914) | (-1.03) | (1.636) | (3.312) | (1.09) | (0.48) | | |
| Std. | 0.007 | 0.054 | 0.120 | 0.391 | 0.938 | 0.544 | 1.178 | 0.016 | 0.021 | 0.183 | 0.039 | 0.059 |
| | (0.198) | (0.824) | (1.14) | (0.181) | (0.351) | (0.213) | (0.403) | (0.553) | (0.346) | (0.647) | | |

Notes: All data are annual (4th quarter to 4th quarter) in nominal terms. Observations 1980-2003

Summary statistics of regression coefficients are given by the first line of each row, while statistics of the z-ratio are given in parenthesis in the second row. Rolling regression technique using data from 1980 to time t is employed in order to analyze out-of-sample predictions between 1999 and 2003.

## Empirical Results for Office Market in Los Angeles MSA

VAR Model(1 year lag) estimation results. Estimated coefficients - Los Angeles MSA

| | Independent Variables | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Dep. Var. | Const. | Mkt. $Ret_t$ | $CF_t$ | Appr. $Yld_t$ | REIT $Ret_t$ | Appr. $Ret_t$ | Adj $R^2$ | RMSE |
| Mkt. $Ret_{t+1}$ | | | | | | | | |
| Ave. | -0.483 | -0.237 | -0.894 | 7.882 | 0.095 | 0.237 | 0.211 | 0.086 |
| | (-2.409) | (-0.574) | (-0.476) | (3.039) | (0.541) | (0.41) | | |
| Std. | 0.031 | 0.132 | 0.620 | 0.702 | 0.034 | 0.212 | 0.041 | 0.042 |
| | (0.165) | (0.322) | (0.297) | (0.318) | (0.215) | (0.345) | | |
| Cash $Flow_{t+1}$ | | | | | | | | |
| Ave. | 0.030 | -0.052 | 0.138 | 0.316 | 0.025 | 0.140 | 0.519 | 0.128 |
| | (1.983) | (-1.279) | (2.845) | (0.024) | (1.847) | (1.937) | | |
| Std. | 0.004 | 0.055 | 1.056 | 0.977 | 0.008 | 0.141 | 0.072 | 0.187 |
| | (0.792) | (1.224) | (3.526) | (1.794) | (0.627) | (1.43) | | |
| Appr. $Yld_{t+1}$ | | | | | | | | |
| Ave. | 0.028 | -0.055 | -0.851 | 1.412 | 0.021 | 0.066 | 0.432 | 0.120 |
| | (1.925) | (-1.378) | (-2.224) | (4.277) | (1.465) | (0.697) | | |
| Std. | 0.005 | 0.047 | 1.065 | 0.970 | 0.009 | 0.138 | 0.115 | 0.194 |
| | (0.715) | (1.135) | (1.489) | (1.165) | (0.825) | (1.794) | | |
| REIT $Ret_{t+1}$ | | | | | | | | |
| Ave. | -0.136 | -1.153 | -7.733 | 11.005 | -0.061 | 1.312 | -0.128 | 0.607 |
| | (-0.615) | (-2.179) | (-1.281) | (2.194) | (-0.34) | (1.258) | | |
| Std. | 0.092 | 0.878 | 13.841 | 13.665 | 0.067 | 1.766 | 0.284 | 0.814 |
| | (0.456) | (1.868) | (1.75) | (1.384) | (0.474) | (1.845) | | |
| Appr. $Ret_{t+1}$ | | | | | | | | |
| Ave. | -0.182 | -0.071 | 0.061 | 2.508 | 0.056 | 0.708 | 0.604 | 0.558 |
| | (-2.276) | (-0.406) | (-0.322) | (2.323) | (0.727) | (2.432) | | |
| Std. | 0.022 | 0.082 | 2.151 | 2.451 | 0.037 | 0.157 | 0.063 | 0.812 |
| | (0.245) | (0.413) | (0.654) | (1.347) | (0.442) | (0.98) | | |

Notes: All data are annual (4th quarter to 4th quarter) in nominal terms. Observations 1982-2003

Summary statistics of regression coefficients are given by the first line of each row, while statistics of the z-ratio are given in parenthesis in the second row. Rolling regression technique using data from 1982 to time t is employed in order to analyze out-of-sample predictions between 1997 and 2003.

VAR Model(1-2 year lags) estimation results. Estimated coefficients - Los Angeles MSA

| | Independent Variables | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dep. Var. | Const. | Mkt. $Ret_t$ | Mkt. $Ret_{t+1}$ | $CF_t$ | $CF_{t+1}$ | Appr. $Yld_t$ | Appr. $Yld_{t+1}$ | REIT $Ret_t$ | REIT $Ret_{t+1}$ | Appr. $Ret_{t+1}$ | Adj $R^2$ | RMSE |
| Mkt. $Ret_{t+2}$ | | | | | | | | | | | | |
| Ave. | -0.971 | -0.334 | -0.648 | 21.705 | -21.777 | -9.124 | 25.668 | -0.348 | -0.257 | -0.962 | 0.167 | 0.138 |
| | (-3.84) | (-1.434) | (-1.664) | (1.704) | (-1.762) | (-0.838) | (1.94) | (-1.592) | (-1.406) | (-1.102) | | |
| Std. | 0.075 | 0.078 | 0.168 | 4.049 | 3.527 | 3.725 | 3.849 | 0.062 | 0.035 | 0.491 | 0.075 | 0.050 |
| | (0.169) | (0.261) | (0.315) | (0.505) | (0.454) | (0.434) | (0.464) | (0.393) | (0.341) | (0.713) | | |
| Cash $Flow_{t+1}$ | | | | | | | | | | | | |
| Ave. | 0.001 | -0.026 | -0.007 | 0.047 | 0.708 | 0.713 | -0.629 | 0.003 | 0.014 | 0.083 | 0.825 | 0.010 |
| | (0.074) | (-3.036) | (-0.496) | (0.1) | (1.484) | (1.64) | (-1.234) | (0.39) | (2.012) | (2.276) | | |
| Std. | 0.004 | 0.006 | 0.006 | 0.245 | 0.232 | 0.236 | 0.244 | 0.003 | 0.005 | 0.021 | 0.028 | 0.005 |
| | (0.425) | (0.801) | (0.418) | (0.509) | (0.488) | (0.527) | (0.481) | (0.363) | (0.681) | (0.607) | | |
| Appr. $Yld_{t+1}$ | | | | | | | | | | | | |
| Ave. | -0.006 | -0.063 | -0.023 | -0.484 | 0.241 | 1.405 | -0.107 | -0.009 | 0.015 | 0.025 | 0.736 | 0.017 |
| | (-0.47) | (-5.27) | (-1.132) | (-0.708) | (0.362) | (2.366) | (-0.15) | (-0.796) | (1.508) | (0.516) | | |
| Std. | 0.008 | 0.008 | 0.012 | 0.282 | 0.265 | 0.258 | 0.307 | 0.005 | 0.006 | 0.026 | 0.052 | 0.005 |
| | (0.577) | (0.946) | (0.56) | (0.41) | (0.404) | (0.381) | (0.439) | (0.441) | (0.617) | (0.549) | | |
| REIT $Ret_{t+1}$ | | | | | | | | | | | | |
| Ave. | -0.290 | -0.698 | 0.668 | -3.318 | 4.243 | 13.058 | -7.667 | -0.201 | -0.313 | -0.529 | -0.175 | 0.231 |
| | (-0.984) | (-2.574) | (1.454) | (-0.202) | (0.272) | (0.966) | (-0.464) | (-0.78) | (-1.456) | (-0.46) | | |
| Std. | 0.128 | 0.064 | 0.316 | 5.976 | 5.909 | 5.038 | 7.316 | 0.106 | 0.069 | 0.392 | 0.115 | 0.050 |
| | (0.459) | (0.273) | (0.647) | (0.399) | (0.403) | (0.347) | (0.462) | (0.451) | (0.428) | (0.322) | | |
| Appr. $Ret_{t+1}$ | | | | | | | | | | | | |
| Ave. | -0.388 | 0.106 | -0.259 | 8.682 | -8.711 | -3.650 | 10.267 | -0.139 | -0.103 | -0.025 | 0.628 | 0.063 |
| | (-3.84) | (1.172) | (-1.664) | (1.704) | (-1.762) | (-0.838) | (1.94) | (-1.592) | (-1.406) | (-0.146) | | |
| Std. | 0.030 | 0.031 | 0.067 | 1.620 | 1.411 | 1.490 | 1.539 | 0.025 | 0.014 | 0.197 | 0.038 | 0.022 |
| | (0.169) | (0.438) | (0.315) | (0.505) | (0.454) | (0.434) | (0.464) | (0.393) | (0.341) | (0.528) | | |

Notes: All data are annual (4th quarter to 4th quarter) in nominal terms. Observations 1982-2003

Summary statistics of regression coefficients are given by the first line of each row, while statistics of the z-ratio are given in parenthesis in the second row. Rolling regression technique using data from 1982 to time t is employed in order to analyze out-of-sample predictions between 1999 and 2003.

## Empirical Results for Office Market in New York MSA

VAR Model(1 year lag) estimation results. Estimated coefficients - New York MSA

| | Independent Variables | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Dep. Var. | Const. | Mkt. $Ret_t$ | $CF_t$ | Appr. $Yld_t$ | REIT $Ret_t$ | Appr. $Ret_t$ | Adj $R^2$ | RMSE |
| Mkt. $Ret_{t+1}$ | | | | | | | | |
| Ave. | -0.313 | 0.202 | -2.010 | 6.302 | 0.594 | -0.306 | -0.046 | 0.101 |
| | (-0.427) | (0.429) | (-0.508) | (0.877) | (1.726) | (-0.348) | | |
| Std. | 0.064 | 0.098 | 1.109 | 1.200 | 0.104 | 0.117 | 0.140 | 0.051 |
| | (0.093) | (0.198) | (0.31) | (0.19) | (0.219) | (0.127) | | |
| Cash $Flow_{t+1}$ | | | | | | | | |
| Ave. | 0.068 | -0.001 | 0.721 | -0.606 | 0.005 | 0.029 | 0.763 | 0.010 |
| | (3.495) | (-0.007) | (7.444) | (-3.485) | (0.619) | (1.295) | | |
| Std. | 0.005 | 0.010 | 0.148 | 0.117 | 0.004 | 0.014 | 0.180 | 0.010 |
| | (1.175) | (0.662) | (3.214) | (1.016) | (0.602) | (0.436) | | |
| Appr. $Yld_{t+1}$ | | | | | | | | |
| Ave. | 0.061 | -0.003 | -0.207 | 0.493 | 0.012 | -0.048 | 0.722 | 0.006 |
| | (4.079) | (-0.211) | (-2.104) | (3.205) | (1.705) | (-2.657) | | |
| Std. | 0.002 | 0.009 | 0.128 | 0.136 | 0.004 | 0.012 | 0.029 | 0.005 |
| | (0.383) | (0.733) | (0.541) | (0.451) | (0.74) | (0.775) | | |
| REIT $Ret_{t+1}$ | | | | | | | | |
| Ave. | 0.560 | -0.168 | -5.281 | 0.559 | -0.199 | -0.306 | -0.285 | 0.204 |
| | (1.134) | (-0.507) | (-1.683) | (0.08) | (-0.815) | (-0.5) | | |
| Std. | 0.079 | 0.098 | 2.428 | 2.702 | 0.123 | 0.206 | 0.168 | 0.046 |
| | (0.208) | (0.282) | (0.501) | (0.468) | (0.45) | (0.331) | | |
| Appr. $Ret_{t+1}$ | | | | | | | | |
| Ave. | -0.121 | 0.083 | -1.140 | 2.887 | 0.228 | 0.466 | 0.290 | 0.076 |
| | (-0.41) | (0.426) | (-0.58) | (0.94) | (1.635) | (1.306) | | |
| Std. | 0.028 | 0.038 | 1.191 | 1.295 | 0.051 | 0.059 | 0.111 | 0.105 |
| | (0.104) | (0.188) | (0.379) | (0.276) | (0.365) | (0.287) | | |

Notes: All data are annual (4th quarter to 4th quarter) in nominal terms. Observations 1982-2003

Summary statistics of regression coefficients are given by the first line of each row, while statistics of the z-ratio are given in parenthesis in the second row. Rolling regression technique using data from 1982 to time t is employed in order to analyze out-of-sample predictions between 1994 and 2003.

VAR Model(1-2 year lags) estimation results. Estimated coefficients - New York MSA

| | Independent Variables | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dep. Var. | Const. | Mkt. $Ret_t$ | Mkt. $Ret_{t+1}$ | $CF_t$ | $CF_{t+1}$ | Appr. $Yld_t$ | Appr. $Yld_{t+1}$ | REIT $Ret_t$ | REIT $Ret_{t+1}$ | Appr. $Ret_{t+1}$ | Adj $R^2$ | RMSE |
| Mkt. $Ret_{t+2}$ | | | | | | | | | | | | |
| Ave. | -2.238 | 0.017 | -0.906 | -13.265 | 14.207 | 34.241 | -9.412 | 0.316 | 0.234 | 3.287 | 0.517 | 0.183 |
| | (-4.753) | (0.167) | (-4.205) | (-0.987) | (1.068) | (2.178) | (-0.603) | (1.94) | (1.053) | (2.758) | | |
| Std. | 0.139 | 0.030 | 0.074 | 10.522 | 9.333 | 12.597 | 12.221 | 0.070 | 0.219 | 0.880 | 0.091 | 0.050 |
| | (0.756) | (0.276) | (0.749) | (0.784) | (0.697) | (0.813) | (0.782) | (0.661) | (0.936) | (0.746) | | |
| Cash $Flow_{t+1}$ | | | | | | | | | | | | |
| Ave. | 0.065 | 0.013 | -0.003 | 1.061 | -0.271 | -0.771 | 0.140 | 0.003 | 0.005 | 0.004 | 0.793 | 0.007 |
| | (2.797) | (2.225) | (-0.268) | (1.633) | (-0.42) | (-1.015) | (0.178) | (0.412) | (0.487) | (0.077) | | |
| Std. | 0.002 | 0.001 | 0.002 | 0.147 | 0.122 | 0.188 | 0.186 | 0.004 | 0.002 | 0.015 | 0.035 | 0.005 |
| | (0.241) | (0.175) | (0.128) | (0.314) | (0.188) | (0.283) | (0.243) | (0.464) | (0.26) | (0.248) | | |
| Appr. $Yld_{t+1}$ | | | | | | | | | | | | |
| Ave. | 0.058 | -0.020 | -0.006 | -0.096 | -0.076 | 0.518 | -0.054 | 0.010 | 0.006 | -0.019 | 0.622 | 0.005 |
| | (3.133) | (-4.407) | (-0.737) | (-0.215) | (-0.128) | (0.88) | (-0.127) | (1.585) | (0.715) | (-0.368) | | |
| Std. | 0.004 | 0.001 | 0.001 | 0.147 | 0.123 | 0.153 | 0.182 | 0.001 | 0.002 | 0.013 | 0.059 | 0.003 |
| | (0.355) | (0.202) | (0.123) | (0.307) | (0.227) | (0.387) | (0.318) | (0.359) | (0.174) | (0.228) | | |
| REIT $Ret_{t+1}$ | | | | | | | | | | | | |
| Ave. | 0.838 | -0.170 | 0.259 | 36.901 | -39.996 | -40.157 | 38.333 | -0.282 | 0.007 | -4.020 | -0.393 | 0.251 |
| | (1.38) | (-1.122) | (0.933) | (2.097) | (-2.353) | (-1.942) | (1.87) | (-1.302) | (-0.08) | (-2.583) | | |
| Std. | 0.219 | 0.014 | 0.116 | 11.522 | 10.263 | 14.115 | 13.489 | 0.073 | 0.237 | 1.108 | 0.084 | 0.074 |
| | (0.373) | (0.105) | (0.418) | (0.459) | (0.461) | (0.487) | (0.47) | (0.223) | (0.803) | (0.495) | | |
| Appr. $Ret_{t+1}$ | | | | | | | | | | | | |
| Ave. | -0.895 | 0.247 | -0.362 | -5.306 | 5.683 | 13.697 | -3.765 | 0.126 | 0.093 | 1.675 | 0.741 | 0.087 |
| | (-4.753) | (5.288) | (-4.205) | (-0.987) | (1.068) | (2.178) | (-0.603) | (1.94) | (1.053) | (3.51) | | |
| Std. | 0.056 | 0.012 | 0.030 | 4.209 | 3.733 | 5.039 | 4.888 | 0.028 | 0.088 | 0.352 | 0.049 | 0.046 |
| | (0.756) | (0.894) | (0.749) | (0.784) | (0.697) | (0.813) | (0.782) | (0.661) | (0.936) | (0.753) | | |

Notes: All data are annual (4th quarter to 4th quarter) in nominal terms. Observations 1982-2003

Summary statistics of regression coefficients are given by the first line of each row, while statistics of the z-ratio are given in parenthesis in the second row. Rolling regression technique using data from 1982 to time t is employed in order to analyze out-of-sample predictions between 1998 and 2003.

## Empirical Results for Office Market in Washington DC MSA

VAR Model(1 year lag) estimation results. Estimated coefficients - Washington DC MSA

| | Independent Variables | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Dep. Var. | Const. | Mkt. $Ret_t$ | $CF_t$ | Appr. $Yld_t$ | REIT $Ret_t$ | Appr. $Ret_t$ | Adj $R^2$ | RMSE |
| Mkt. $Ret_{t+1}$ | | | | | | | | |
| Ave. | 0.044 | 0.144 | -0.300 | 0.267 | 0.322 | -0.169 | -0.151 | 0.085 |
| | (0.279) | (0.463) | (-0.217) | (0.205) | (1.741) | (-0.386) | | |
| Std. | 0.019 | 0.070 | 0.987 | 1.988 | 0.137 | 0.224 | 0.080 | 0.018 |
| | (0.126) | (0.226) | (0.577) | (0.773) | (0.522) | (0.409) | | |
| Cash $Flow_{t+1}$ | | | | | | | | |
| Ave. | 0.051 | 0.071 | 1.052 | -0.750 | 0.021 | -0.074 | 0.657 | 0.019 |
| | (2.8) | (2.203) | (5.828) | (-2.945) | (1.048) | (-1.496) | | |
| Std. | 0.003 | 0.006 | 0.097 | 0.195 | 0.016 | 0.011 | 0.040 | 0.009 |
| | (0.939) | (0.285) | (0.466) | (0.576) | (0.748) | (0.338) | | |
| Appr. $Yld_{t+1}$ | | | | | | | | |
| Ave. | 0.044 | 0.057 | 0.043 | 0.450 | 0.012 | -0.141 | 0.525 | 0.010 |
| | (3.804) | (2.554) | (0.332) | (2.644) | (0.857) | (-4.062) | | |
| Std. | 0.003 | 0.005 | 0.074 | 0.160 | 0.011 | 0.012 | 0.113 | 0.004 |
| | (0.236) | (0.344) | (0.563) | (1.042) | (0.806) | (0.655) | | |
| REIT $Ret_{t+1}$ | | | | | | | | |
| Ave. | 0.504 | -0.388 | -7.241 | 7.554 | -0.439 | -0.497 | 0.106 | 0.215 |
| | (2.639) | (-0.985) | (-3.445) | (2.554) | (-2.025) | (-0.856) | | |
| Std. | 0.082 | 0.127 | 1.621 | 2.200 | 0.214 | 0.301 | 0.174 | 0.039 |
| | (0.76) | (0.269) | (1.069) | (0.853) | (0.995) | (0.539) | | |
| Appr. $Ret_{t+1}$ | | | | | | | | |
| Ave. | 0.018 | 0.058 | -0.120 | 0.107 | 0.129 | 0.532 | 0.478 | 0.043 |
| | (0.279) | (0.463) | (-0.217) | (0.205) | (1.741) | (2.712) | | |
| Std. | 0.008 | 0.028 | 0.395 | 0.795 | 0.055 | 0.090 | 0.028 | 0.016 |
| | (0.126) | (0.226) | (0.577) | (0.773) | (0.522) | (0.177) | | |

Notes: All data are annual (4th quarter to 4th quarter) in nominal terms. Observations 1979-2003

Summary statistics of regression coefficients are given by the first line of each row, while statistics of the z-ratio are given in parenthesis in the second row. Rolling regression technique using data from 1979 to time t is employed in order to analyze out-of-sample predictions between 1993 and 2003.

VAR Model(1-2 year lags) estimation results. Estimated coefficients - Washington DC MSA

| | Independent Variables | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dep. Var. | Const. | Mkt. $Ret_t$ | Mkt. $Ret_{t+1}$ | $CF_t$ | $CF_{t+1}$ | Appr. $Yld_t$ | Appr. $Yld_{t+1}$ | REIT $Ret_t$ | REIT $Ret_{t+1}$ | Appr. $Ret_{t+1}$ | Adj $R^2$ | RMSE |
| Mkt. $Ret_{t+2}$ | | | | | | | | | | | | |
| Ave. | -0.101 | -0.084 | 0.182 | 2.036 | -5.049 | 4.678 | 1.660 | 0.276 | -0.014 | 0.011 | 0.675 | 0.105 |
| | (-0.916) | (-0.694) | (1.13) | (0.341) | (-0.905) | (0.658) | (0.175) | (3.296) | (-0.213) | (0.061) | | |
| Std. | 0.102 | 0.044 | 0.057 | 3.018 | 2.847 | 5.002 | 3.750 | 0.084 | 0.069 | 0.376 | 0.124 | 0.051 |
| | (0.982) | (0.268) | (0.364) | (0.619) | (0.494) | (0.794) | (0.522) | (0.826) | (0.738) | (0.533) | | |
| Cash $Flow_{t+1}$ | | | | | | | | | | | | |
| Ave. | 0.088 | 0.055 | 0.111 | 1.308 | -0.306 | -1.358 | 0.255 | 0.028 | -0.007 | -0.203 | 0.757 | 0.015 |
| | (4.526) | (2.92) | (4.177) | (1.504) | (-0.33) | (-1.058) | (0.199) | (1.967) | (-0.547) | (-1.671) | | |
| Std. | 0.014 | 0.006 | 0.024 | 0.530 | 0.412 | 0.990 | 0.595 | 0.018 | 0.018 | 0.079 | 0.051 | 0.006 |
| | (0.571) | (0.642) | (1.227) | (0.623) | (0.477) | (0.76) | (0.496) | (1.15) | (1.222) | (0.708) | | |
| Appr. $Yld_{t+1}$ | | | | | | | | | | | | |
| Ave. | 0.064 | 0.009 | 0.075 | 0.105 | -0.117 | 0.260 | 0.028 | 0.018 | -0.005 | -0.175 | 0.762 | 0.012 |
| | (5.138) | (0.786) | (4.425) | (0.203) | (-0.198) | (0.291) | (0.042) | (1.928) | (-0.554) | (-2.249) | | |
| Std. | 0.010 | 0.004 | 0.016 | 0.357 | 0.283 | 0.671 | 0.411 | 0.012 | 0.012 | 0.055 | 0.044 | 0.005 |
| | (0.775) | (0.442) | (1.431) | (0.657) | (0.527) | (0.798) | (0.545) | (1.246) | (1.226) | (0.858) | | |
| REIT $Ret_{t+1}$ | | | | | | | | | | | | |
| Ave. | 1.233 | -0.456 | 0.202 | 12.534 | -23.232 | -20.673 | 27.763 | -0.727 | -0.569 | -3.143 | 0.197 | 0.254 |
| | (5.463) | (-2.008) | (0.746) | (1.449) | (-2.443) | (-1.56) | (2.109) | (-4.505) | (-2.855) | (-2.371) | | |
| Std. | 0.359 | 0.089 | 0.224 | 10.155 | 11.821 | 15.673 | 15.093 | 0.374 | 0.168 | 1.545 | 0.402 | 0.079 |
| | (3.474) | (1.043) | (0.861) | (1.612) | (2.109) | (1.668) | (1.904) | (3.228) | (1.227) | (2) | | |
| Appr. $Ret_{t+1}$ | | | | | | | | | | | | |
| Ave. | -0.040 | 0.207 | 0.073 | 0.814 | -2.020 | 1.871 | 0.664 | 0.111 | -0.006 | 0.364 | 0.857 | 0.040 |
| | (-0.916) | (4.606) | (1.13) | (0.341) | (-0.905) | (0.658) | (0.175) | (3.296) | (-0.213) | (1.286) | | |
| Std. | 0.041 | 0.018 | 0.023 | 1.207 | 1.139 | 2.001 | 1.500 | 0.034 | 0.028 | 0.150 | 0.056 | 0.018 |
| | (0.982) | (1.364) | (0.364) | (0.619) | (0.494) | (0.794) | (0.522) | (0.826) | (0.738) | (0.7) | | |

Notes: All data are annual (4th quarter to 4th quarter) in nominal terms. Observations 1979-2003

Summary statistics of regression coefficients are given by the first line of each row, while statistics of the z-ratio are given in parenthesis in the second row. Rolling regression technique using data from 1979 to time t is employed in order to analyze out-of-sample predictions between 1994 and 2003.

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