# Real Estate Investment Performance: the Test of the Impact of Additional Interest Rate Information from CIR Model

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## Abstract

*To explain the performance of real estate investment in capital market better, this study incorporated Cox–Ingersoll–Ross model (CIR model) into the test of interest rate proxies which affected the return of the investment in Equity Real Estate Investment Trusts (Equity REITs). The information on current short-term rate, long-run interest rate, interest rate volatility, and interest rate reversion were counted through the CIR's predicted term structure of interest which is used as a part of interest rate proxies to explain Equity REIT's return. The regression analysis showed that the additional information in CIR model does not improve explanatory power of the OLS. The result suggested that capital market gave no value to the additional information provided by CIR model or CIR's interest rate information might have already be counted in the traditional interest rate information.*

**Key words:** Equity REIT, Cox–Ingersoll–Ross model, long-run interest rate, interest rate volatility, and interest rate reversion.

## *1. Introduction*

A lot of researches such as studies of Sanders (1997), He, Webb, & Myer (2003), and Bredin, O'Reilly, & Stevenson (2007) have shown that the performance of the investment in real estate in capital market was affected by interest rate. Equity Real Estate Investment Trust, Equity REIT was used as a proxy for real estate investment since it raised funds from investors to purchase real properties and rent them for income to be distributed back to investors. These real properties might be sold sometimes to make profit for investors.

Equity REIT's cash flows are highly predictable. Most of its income is from rental income which is highly stable and at least 90% of income is required to distribute back to investors. Few retained earnings are left to reinvest. Therefore; the change in value of Equity REIT is dependent on interest rate which is its discount rate. Its return, hence, should be sensitive to the change in interest rate like a bond's return.

However, Equity REIT's return is less sensitive to interest rate than bond's return because the change in interest rate does not affect only its discount rate but also its cash flows. In general, higher interest rate makes investors need more return from their investment and pay less today money to buy the same expected future cash flow. In case of Equity REIT, higher interest rate also brings more cash flows to investors. Most real estate purchases are highly leveraged and the change in interest rate could affect buyers' purchasing decision as shown in Childs, Ott, & Riddiough (1996) that the uncertainty in interest rate and the expectation on future levels of interest rate affected mortgage loan decision. Higher interest means higher financing cost. People might delay their purchase causing demand for renting real estate to increase. Then, the occupancy rate and the rent price will increase.

In addition, if the increase in interest rate is caused by inflation, the real properties price will increase too. Hence, Equity REIT's income will increase together with its discount rate.

Many studies use yields of government securities to calculate proxies for examining interest impact on Equity REIT's return. These yields, in theories such as Pure Expectation Theory, informed investors the market consensus on expected future short-term rates. However, some important information such as long run interest rate and the reversion of the interest rate might not be counted.

Cox–Ingersoll–Ross model (CIR model) from Cox, Ingersoll Jr, & Ross (1985) proposed formula which incorporates current information of short-term rate, its long-run rates, the fluctuation of short-term rate, and the idea of the mean reversion to the long-run rate to build term structure of interest. This research uses term structure of interest calculated from CIR model for the proxies of yields of government security to incorporate the important missing information to better understand the impact of interest rates on Equity REIT's return. The regression results indicated that Equity REIT's return could be better explained by interest rates when information of current short-term rate, long-run rate, interest rate fluctuation, and the mean reversion to the long-run rate were included in the analysis. Hence, to improve return on Equity REIT investment, investors should consider the mentioned information when setting their investment strategy.

## *2. Literature Review*

Among the important characteristics of Equity REIT, the return predictability is often mentioned. Liu & Mei (1992) paper discovered that when compared to common stock's return, E-REITs' return is more predictable. Nelling & Gyourko (1998) and Cooper, Downs, & Patterson (2000) supported this previous study with the evidence showing the predictability of E-REITs' monthly returns.

The sensitivity in the return of E-REIT to interest rate is fixed income like characteristic which makes many investors viewed E-REIT investment similar to bond investment. Murphy & Kleiman (1989)'s study showed the negative relationship between return of E-REITs and both unexpected and expected inflation over monthly holding period. Since expected inflation is a part of interest rate, this could imply that the interest rates affected E-REITs' return. (McCue & Kling, 1994) also discovered in the same way that nominal interest rate was an important macro-economic variable which influenced REIT's return. Mei & Saunders (1995) study's result confirmed the previous findings about the effect of interest rate and pointed out that there was negative relationship between term spread and REIT's return. Sanders (1997) paper also confirmed that REITs' return could be affected by interest rate. After 1990s, the interest rate effect on Equity REIT is still an importance topic in real estate investment researches and the results of studies still confirmed that interest rate was an important determinant of Equity REIT's return. Chan, Erickson, & Wang (2003) suggested that REIT stock and real estate investment performance were partly related to interest rates. He, Webb, & Myer (2003) and Bredin, O'Reilly, & Stevenson (2007) provided evidence to supported that interest rate affected REIT's return and Nishigaki (2007) study found that in long run, the relationship between Equity REIT Index and inflation is negative.

There were also many studies which investigated the influence of interest rate on Equity REIT in details. A group of studies such as Chen & Tzang (1988) and Liang, Prudential, & Webb (1995), compared Equity REIT to Mortgage REIT, the REIT which invested its funds only in mortgages and found that Equity REIT is less sensitive to interest rate change. They explained that the lower sensitivity on interest rate was due to Equity REIT's shorter duration. However, the later study by Allen, Madura, & Springer (2000) claimed that the difference in interest rate sensitivity might be related to debt level of each REIT. Moreover, the study by Chang, Chen, & Leung (2008) found that the relationship between interest rate and Equity REIT might not be linear and showed evidence of the nonlinear relationship between Equity REIT and both federal fund rate and interest rate spread.

In addition, characteristics of interest rate itself could affect Equity REIT's return. Devaney (2001) indicated that Equity REIT investment performance was affected by interest rate volatility. The evidence showed that Equity REIT's excess return is negatively affected by interest rate and its conditional variance. Equity REIT's return and interest rate were found to have a similar interesting characteristic, the mean reversion. Cooper et al. (2000) discovered the total return reversion in Equity REIT with conditioning on volume. The later study by (Capozza & Israelsen, 2007) showed evidence to support the mean reversion in REIT and the sample data of this study also showed mean reversion of YTM of 30 year zero coupon U.S. government security and of the return calculated from FTSE NAREIT All Equity REITS Total Return Index during January, 2000 to December 2011 (see Figure 1).

Cox et al. (1985) proposed Cox, Ingersoll, and Ross model called CIR model which uses short-term rate, its long-run mean and its volatility to build the term structure of interest under the assumption on mean reversion. This stochastic model corrected the chance of negative interest rate which was an important drawback of previous models. The CIR model was supported by later studies such as Gibbons & Ramaswamy (1993) which suggested that the model perform well with the information from treasury bill. However, there were rare studies using CIR model to build term structure of interest used to test the influence of interest rate on Equity REIT.

## *3. Methodology and Data*

This study uses time series data over the period of January, 2000 to December, 2011 to eliminate the impact from the REIT Modernization Act (RMA) which was introduced in 1999. Under this act, REITs could set up their taxable REIT subsidiary (TRS) to provide services to their tenants and others so that they would be able to compete with other owners of commercial real estate. The interest rate proxies for this study followed the proxies used in the study of He et al. (2003). These proxies were claimed to be widely used by many previous studies. They included monthly holding period returns on long-term U.S. government bonds and high-grade corporate bonds, the percentage changes in yield for long-term U.S. government bonds and high-yield (Baa) corporate bonds, the difference between returns on long-term U.S. government bonds and T-bill rates, the spread between yields on high-yield (Baa) corporate bonds and returns on long-term U.S. government bonds, and the spread between returns on high-grade corporate bonds and returns on long-term U.S. government bonds.

BOND = the monthly returns on long-term U.S. government bonds (Calculation using 10 year and over U.S. government bond's total return index from Bloomberg);
BONDCIR = the monthly returns on long-term U.S. government bonds (Calculation using the change in the estimated 30 year U.S. government bond's YTM from CIR model);
CORP = the monthly returns on long-term U.S high-grade corporate bonds (Calculation from Change in YTM of Moody's Aaa bond from Bloomberg);
LONG = the percentage changes of monthly yields on long-term U.S. government bonds (Bloomberg);
LONGCIR = the percentage changes of monthly yields on long-term U.S. government bonds (from CIR calculation);
HIGH = the percentage changes of monthly yields on U.S high-yield (Baa) corporate bonds (Bloomberg);
T-bill = the one monthly treasury bill rate observed at the beginning of the month (Bloomberg);
TERM = BOND minus T-bill (a measure of unexpected returns on long-term government bonds);
TERMCIR = BONDCIR minus T-bill (a measure of unexpected returns on long-term government bonds);
DEF = yields on high-yield (Baa) corporate bonds minus BOND (a default risk measure);
DEFCIR = yield on high-yield (Baa) corporate bonds minus BONDCIR (a default risk measure);
DEFL = CORP minus BOND (a measure of default risk from Fama & French (1993));
DEFLCIR = CORP minus BONDCIR (a measure of default risk));
MKT = the monthly returns on the NYSE value weighted index for U.S (Bloomberg);
MKTE = MKT minus T-bill (a measure of the overall stock market risk);
EREIT = the monthly returns for Equity REITs (FTSE NAREIT All Equity REIT index from Bloomberg);
EREITE = EREIT minus T-bill (the monthly excess returns for Equity REITs)

**Cox–Ingersoll–Ross model (CIR model)**

Cox–Ingersoll–Ross model (CIR model) assumes the dynamics short term rate in the stochastic way under wiener process. The interest is assumed to move toward its long term mean at a speed of reversion. The model variance varies with the size of interest rate which is controlled to be positive only. The short term rate process could be shown in the following equations:

$$dr = a(b-r)dt + \sigma\sqrt{r}\, dW \quad (1)$$

Where
*dr* is change in short-term rate, r ; *a* is speed of adjustment; *b* is long run value of short term rate;
σ is standard deviation of the short-term rate; *dW* is the change in W, a Wiener process modeling the random market risk factor.

The price of zero coupon bond, *P(t, T),* is explained in the equation

$$P(t, T) = A(t, T)e^{-B(t,T)r} \quad (2)$$

where

$$B(t,T) = \frac{2(e^{\gamma(T-t)}-1)}{(\gamma+a)(e^{\gamma(T-t)}-1)+2\gamma} \quad (3)$$

$$A(t,T) = \left(\frac{2\gamma e^{(a+\gamma)(T-t)/2}}{(\gamma+a)(e^{\gamma(T-t)}-1)+2\gamma}\right)^{2ab/\sigma^2} \quad (4)$$

$$\gamma = \sqrt{a^2+2\sigma^2} \quad (5)$$

The long term interest rate, then, will be calculated from the bond price. Equity REIT value could be calculated by bootstrapping dividend cash flows and value of real property at the end of holding period as a pack of zero coupon securities. Then, each cash flow will be discounted at appropriate discount rate for each maturity. Each appropriate discount rate is composed of the based interest rate from CIR model plus risk premium as following equation:

$$V = \frac{CF_1}{(1+r_1+p)^1} + \frac{CF_2}{(1+r_2+p)^2} + \frac{CF_3}{(1+r_3+p)^3} + \cdots + \frac{CF_n+Prop_n}{(1+r_n+p)^n} \quad (6)$$

Where

V is value of Equity REIT; $CF_n$ is Cash flows at the end of period n; $r_n$ is YTM of n-periods zero coupon government bond calculated by CIR model; p is risk premium; $Prop_n$ is real property value at time n. However, to match the information from CIR with the study's interest rate proxies which were widely used in many previous researches, this study used only the CIR's estimated YTM of 30 year zero coupon government bond to derive interest rate proxies.

The Ordinary Least Square (OLS) regression was used in this study to investigate the impact and the statistical significance of each proxy which might affect Equity REIT's return or excess return as the following equation:

$$Y_n = B_o + B_1X_1 + \ldots + B_nX_n \quad (7)$$

The study also compare the results of OLS used interest rate proxies from market data and the results of OLS used interest rate proxies derived from CIR model to analyze whether CIR model could contribute more information for Equity REIT investors.

## *4. Empirical Results*

### 4.1 Descriptive Summary

The descriptive summary in Table 1 showed that from January 2000 to December 2011, Equity REIT performed better than both bond and stock markets. Equity REIT's mean monthly return was 1.18% while the long-term government bond and stock market's mean monthly return were 0.8% and 0.33% respectively. For return fluctuation, Equity REIT's return the highest highest volatility with standard deviation of 6.93%, compared to long-term government bond and stock market's standard deviation of 3.08% and 4.8%. However, if the monthly mean returns were computed relatively to standard deviation, Equity REIT's performance would be worse than long-term government bond but better than stock market. The ratio of Equity REIT, long-term government bond, and stock market's monthly mean return per standard deviation are 0.17, 0.26, and 0.07, respectively.

For the correlation among interest rate proxies, there were some variables which were highly interconnected. The high correlation among these interest rate proxies might create multicollinearity problem in OLS test. BOND was highly correlated with many variables including LONG (at -0.87), TERM (at 0.85), DEF (at -0.96), and DEFL (at -0.81). Other pairs with high correlation coefficient were LONG and DEF with correlation of 0.86 and the pair between CORP and DEFL with the correlation of 0.95.

The correlation between EREIT and BOND/CORP/HIGH/TERM/DEFL were negative. This could be explained by the inverse relationship between return and change in interest rate. The positive sign of the correlation between EREIT and MKT suggested that Equity REIT and stock market were integrated and affected by macro variables in the same way. The positive relationship between EREIT and LONG and correlation between EREIT and DEF were different from the study's expectation but the magnitude was low. For the excess return, EREITE, the correlation between excess return and most interest rate proxies were similar to the correlation between return and interest rate proxies, except the correlation between EREITE and TERM which was positive.

However, the change in the sign is not economically significant. The correlation value was only 0.03. When CIR's estimated YTMs of zero coupon bonds were used to derived interest rate proxies. BOND, LONG, TERM, DEF and DEFL were changed to BONDCIR, LONGCIR, TERMCIR, DEFCIR, and DEFLCIR as shown in Panel B of Table 1. Most of the pair of variables with high correlation still maintained their high correlation. Only correlation between BONDCIR and DEFLCIR dropped to -0.48. The correlation between EREIT and BONDCIR and the correlation between EREIT and TERMCIR were positive and against the study's expectation. However, the correlation sign between EREIT and DEFCIR became negative and matched the inverse relationship of the change in interest rate and the return. When the relationship between excess return and interest rate proxies were examined, the correlation signs were the same. However, the value of correlation between EREITE and BONDCIR was nearly zero. The correlation between EREITE and TERMCIR and the correlation between EREITE and DEFCIR were 0.14 and -0.12, compared to the correlation of EREIT and TERMCIR and the correlation between EREIT and DEFCIR at 0.06 and -0.07 respectively. Other correlation values were slightly changed.

**4.2 Regression Analysis**

The regression analysis based on published market's interest rate information in Table 2 indicated that when each interest rate proxy was regressed on EREIT individually, CORP, HIGH, and DEFL were statistically significant at the level of 1%. After BOND was removed due to its high correlation with LONG/TERM/DEF/DEFL, DEF was removed due to its high correlation with LONG, and DEFL was removed due to its high correlation with CORP, the OLS showed that only CORP was statistically significant at level of 5%. When LONG was replaced by DEF, the regression still confirmed that CORP was the only statistically significant variables at the level of 5% and when the OLS was run on CORP and HIGH which were individually statistically significant, the result turned out that only CORP was statistically at the 10% level of significance. EREITE and MKTE replaced EREIT and MKT to analyze Equity REIT's excess return. The OLS showed the same results as the previous analysis that CORP, HIGH, and DEFL were the same three significant variables at 1% level of significance when each of them was regressed separately. Once BOND was removed due to its high correlation with LONG/TERM/DEF/DEFL, DEF was removed due to its high correlation with LONG, and DEFL was removed due to its high correlation with CORP, the OLS regression also gave the same result as return analysis that CORP was the only significant variable but the level of significance was changed from 5% to 10%. When DEF replaced LONG, the regression indicated that CORP was still the only statistically significant variables at the significant level of 5% and when the OLS was run on CORP and HIGH, the individually statistically significant variables, the OLS indicated that CORP is the only significant variable at the 10% level of significance.

The finding suggested that Equity REIT's performance were insensitive to the change in BOND, the monthly return on U.S. government bond. This was similar to He et al. (2003) finding but the percentage changes in yields for long-term U.S. government bonds, LONG did not significantly affect Equity REIT. The shorter duration of Equity REIT might be a part of the reason. Inconsistent with Chen & Tzang (1988) and He et al. (2003), the finding on HIGH, the percentage change in yield for high yield (Baa) corporate bond did not significantly affect Equity REIT's performance. Similar to He et al. (2003), the difference between returns on long-term U.S. government bonds and T-bill rates, TERM which measured the unexpected returns on long-term government bonds was insensitive to Equity REIT. The spread between yields on high-yield (Baa) corporate bonds and monthly return on U.S. government bond, DEF and the spread between monthly holding period return on high grade corporate bond and the monthly return on U.S. government bond, DEFL did not significant influence Equity REIT's return. This insignificance of default risk on Equity REIT's performance implied that investors might view default risk of Equity REIT different from ordinary fixed income securities. The Equity REIT investors are different from bond's holder by nature. They are not trust's creditors like bondholders. They are similar to common stockholders for their claim on the REIT's income and asset. CORP, monthly holding period return on high grade corporate bond, was the only interest rate proxy which was consistent with theory in both significance and impact. The negative sign suggested that Equity REIT was influenced by the same fundamentals in the same way as other fixed income securities.

The CIR model was used to generate yield to maturity of zero coupon 30 year treasury security. This estimated yield was used in the calculation of BONDCIR, LONGCIR, TERMCIR, DEFCIR, and DEFLCIR which replaced BOND, LONG, TERM, DEF, and DEFL. The OLS analysis was done on Equity REIT's return, EREIT and Equity REIT's excess return, EREITE with the results shown in Table 3.

In overall, the results were similar to the analysis by using interest rate proxies' data from market. For EREIT, the OLS on each interest rate proxy separately showed that CORP, HIGH, and DEFLCIR were the same significant variables with 1% level of significance as when the market's interest rate proxies were used. Then, BONDCIR was removed due to its high correlation with LONGCIR, TERMCIR, and DEFCIR. LONGCIR was removed for its high correlation with DEFCIR. And DEFLCIR was removed for its high correlation with CORP. The OLS showed that CORP was the only significant variable at the 10% level of significance. When DEFCIR was removed instead of LONGCIR, the OLS confirmed that CORP was the only significant variable with 10% level of significance. However when CORP and HIGH, the two individually significantly proxies with no multicollinearity were used, the OLS still confirmed that CORP was the only significant variable with 10% level of significance. For the analysis of Equity REIT's excess return, when each interest rate proxy was run separately on EREITE, the CORP, HIGH and DEFLCIR were significant variable at 1% level of significance. When BONDCIR, LONGCIR, and DEFLCIR were removed to prevent multicollinearity problem, CORP was the only significant variable at the level of significance of 10%. When LONGCIR replaced DEFCIR, the OLS still showed the same significance of CORP while other proxies were the same insignificant. When OLS was run with individually significant proxies except DEFLCIR which would cause multicollinearity problem, the result confirmed that CORP was the only significant variable at the 10% level of significance. In overall, the OLS results did not showed any evidence to support that CIR model could generate better information than the market's provided information. With or without CIR's data, the explanatory powers of regressions were quite similar, around 54% for Equity's return and 57% for Equity's excess return. CORP was the only significant variable.

## *5. Concluding Remarks*

Besides examined the interest rate sensitivity of Equity REITs, this study examined the influence of the possible missing information about interest rate incorporated in Cox–Ingersoll–Ross model (CIR model) including long-run mean of short-term rate, its volatility, the mean reversion of interest rate on the Equity. The long-term yield to maturity of government securities was built by CIR model and interest rate proxies were created from the long-term yield to maturity. The regression results showed that over the past 12 years from 2000 to 2011, CIR model did not provide better information of interest rate proxies than the traditional information of interest rate proxies announced in the market. Equity REIT's return and excess return were not statistically significantly sensitive to most interest rate proxies: monthly holding period returns on long-term U.S. government bonds, the percentage changes in yield for long-term U.S. government bonds and high-yield (Baa) corporate bonds, the difference between returns on long-term U.S. government bonds and T-bill rates, the spread between yields on high-yield (Baa) corporate bonds and returns on long-term U.S. government bonds, and the spread between returns on high-grade corporate bonds and returns on long-term U.S. government bonds. The monthly return on long-term U.S high-grade corporate bonds was the only statistically significant interest rate proxy which affected Equity REIT's performance. The OLS result suggested that capital market might give no value to the additional information provided by CIR model or CIR's interest rate information might have already been counted in a part of the traditional interest rate information provided in financial market. There is some limitation worth to mention here. This study use CIR model to convey additional information on interest rate but did not examine the impact of the information directly. The further study on the impact of interest rate volatility or mean reversion on Equity REIT's return and excess return would contribute more to the understanding of Equity REIT's performance.

## *6. References*

Allen, M. T., Madura, J., & Springer, T. M. (2000). REIT Characteristics and the Sensitivity of REIT Returns. *The Journal of Real Estate Finance and Economics, 21*(2), 141-152.

Bredin, D., O'Reilly, G., & Stevenson, S. (2007). Monetary shocks and REIT returns. *The Journal of Real Estate Finance and Economics, 35*(3), 315-331.

Capozza, D. R., & Israelsen, R. D. (2007). Predictability in equilibrium: The price dynamics of real estate investment trusts. *Real Estate Economics, 35*(4), 541-567.

Chan, S. H., Erickson, J., & Wang, K. (2003). *Real estate investment trusts: Structure, performance, and investment opportunities*: Oxford University Press, USA.

Chang, K. L., Chen, N. K., & Leung, C. K. Y. (2008). Monetary Policy, Term Structure and Real Estate Return: What are the difference between the REITs and Housing? preliminary and incomplete.

Chen, K., & Tzang, D. D. (1988). Interest-rate sensitivity of real estate investment trusts. *Journal of Real Estate Research*, *3*(3), 13-22.

Cooper, M., Downs, D. H., & Patterson, G. A. (2000). Asymmetric information and the predictability of real estate returns. *The Journal of Real Estate Finance and Economics*, *20*(2), 225-244.

Cox, J. C., Ingersoll Jr, J. E., & Ross, S. A. (1985). A theory of the term structure of interest rates. *Econometrica: Journal of the Econometric Society*, 385-407.

Devaney, M. (2001). Time varying risk premia for real estate investment trusts: A GARCH-M model. *The Quarterly Review of Economics and Finance*, *41*(3), 335-346.

Fama, E. F., & French, K. R. (1993). Common risk factors in the returns on stocks and bonds. *Journal of financial economics*, *33*(1), 3-56.

Gibbons, M. R., & Ramaswamy, K. (1993). A test of the Cox, Ingersoll, and Ross model of the term structure. *Review of Financial Studies*, *6*(3), 619-658.

He, L. T., Webb, J. R., & Myer, F. C. N. (2003). Interest rate sensitivities of REIT returns. *International Real Estate Review*, *6*(1), 1-21.

Liang, Y., Prudential, W. M. I., & Webb, J. R. (1995). Intertemporal changes in the riskiness of REITs. *Journal of Real Estate Research*, *10*(4), 427-443.

Liu, C. H., & Mei, J. (1992). The predictability of returns on equity REITs and their co-movement with other assets. *The Journal of Real Estate Finance and Economics*, *5*(4), 401-418.

McCue, T. E., & Kling, J. L. (1994). Real estate returns and the macroeconomy: some empirical evidence from real estate investment trust data, 1972-1991. *Journal of Real Estate Research*, *9*(3), 277-287.

Mei, J., & Saunders, A. (1995). Bank risk and real estate: An asset pricing perspective. *The Journal of Real Estate Finance and Economics*, *10*(3), 199-224.

Murphy, J., & Kleiman, R. (1989). The inflation-hedging characteristics of equity reits: An empirical study. *Quarterly Review of Economics and Business*, *29*(3), 95-101.

Nelling, E., & Gyourko, J. (1998). The predictability of equity REIT returns. *Journal of Real Estate Research*, *16*(3), 251-268.

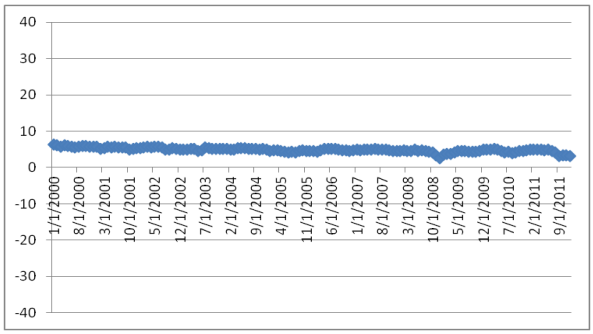
Nishigaki, H. (2007). An analysis of the relationship between US REIT returns. *Economics Bulletin*, *13*(1), 1-7.

Sanders, A. B. (1997). The historical behavior of REIT returns. *Real estate investment trusts: structure, analysis, and strategy*, 277.

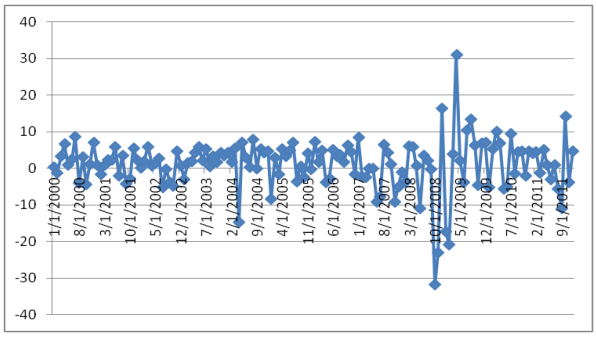
## *7. Table and Figures*

**Figure 1 Mean Reversion in Yield to Maturity of 30 Years Zero Coupon U.S. Government Bond and Return Calculated from FTSE NAREIT All Equity REITS Total Return Index**

YTM of 30 Years Zero Coupon U.S. Government Bond, % from January, 2000 to December, 20012




Return Calculated from FTSE NAREIT All Equity REITS Total Return Index from January, 2000 to December 2011




**Source: Bloomberg**

**Table 1 Summary Statistics for the Monthly Returns in Percent (from January 2000 to December 2011)**
**Panel A: All Variables' data were collected from financial markets.**

| Variable | Mean | Std. Dev. | Correlations | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | EREIT | EREITE | BOND | CORP | LONG | HIGH | TERM | DEF | DEFL | MKT | MKTE |
| EREIT | 1.18 | 6.93 | 1.00 | 0.96 | -0.13 | -0.25 | 0.10 | -0.34 | -0.11 | 0.12 | -0.13 | 0.69 | 0.64 |
| EREITE | -0.98 | 7.17 | 0.96 | 1.00 | -0.12 | -0.26 | 0.10 | -0.35 | 0.03 | 0.09 | -0.14 | 0.66 | 0.71 |
| BOND | 0.80 | 3.08 | -0.13 | -0.12 | 1.00 | -0.58 | -0.87 | -0.38 | 0.85 | -0.96 | -0.81 | -0.28 | -0.26 |
| CORP | -0.73 | 5.65 | -0.25 | -0.26 | -0.58 | 1.00 | 0.46 | 0.79 | -0.52 | 0.53 | 0.95 | -0.02 | -0.04 |
| LONG | -0.29 | 6.53 | 0.10 | 0.10 | -0.87 | 0.46 | 1.00 | 0.22 | -0.74 | 0.86 | 0.67 | 0.23 | 0.21 |
| HIGH | -0.26 | 3.32 | -0.34 | -0.35 | -0.38 | 0.79 | 0.22 | 1.00 | -0.36 | 0.34 | 0.72 | -0.17 | -0.19 |
| TERM | -1.36 | 3.63 | -0.11 | 0.03 | 0.85 | -0.52 | -0.74 | -0.36 | 1.00 | -0.85 | -0.71 | -0.25 | -0.03 |
| DEF | 6.11 | 3.12 | 0.12 | 0.09 | -0.96 | 0.53 | 0.86 | 0.34 | -0.85 | 1.00 | 0.76 | 0.24 | 0.19 |
| DEFL | -1.53 | 7.84 | -0.13 | -0.14 | -0.81 | 0.95 | 0.67 | 0.72 | -0.71 | 0.76 | 1.00 | 0.10 | 0.07 |
| MKT | 0.33 | 4.80 | 0.69 | 0.66 | -0.28 | -0.02 | 0.23 | -0.17 | -0.25 | 0.24 | 0.10 | 1.00 | 0.93 |
| MKTE | -1.83 | 5.14 | 0.64 | 0.71 | -0.26 | -0.04 | 0.21 | -0.19 | -0.03 | 0.19 | 0.07 | 0.93 | 1.00 |

**Panel B: BOND and LONG were Calculated by Using U.S. Government's Long-Term Yield to Maturity from CIR Model.**

| Variable | Mean | Std. Dev. | Correlations | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | EREIT | EREITE | BONDCIR | CORP | LONGCIR | HIGH | TERMCIR | DEFCIR | DEFLCIR | MKT | MKTE |
| EREIT | 1.18 | 6.93 | 1.00 | 0.96 | 0.06 | -0.25 | 0.09 | -0.34 | 0.06 | -0.07 | -0.26 | 0.69 | 0.64 |
| EREITE | -0.98 | 7.17 | 0.96 | 1.00 | 0.00 | -0.26 | 0.01 | -0.35 | 0.14 | -0.02 | -0.23 | 0.66 | 0.71 |
| BONDCIR | -0.84 | 3.33 | 0.06 | 0.00 | 1.00 | 0.05 | 0.95 | 0.08 | 0.84 | -0.96 | -0.48 | 0.06 | -0.03 |
| CORP | -0.73 | 5.65 | -0.25 | -0.26 | 0.05 | 1.00 | 0.06 | 0.79 | 0.01 | -0.08 | 0.85 | -0.02 | -0.04 |
| LONGCIR | -0.96 | 4.11 | 0.09 | 0.01 | 0.95 | 0.06 | 1.00 | 0.08 | 0.77 | -0.89 | -0.44 | 0.07 | -0.04 |
| HIGH | -0.26 | 3.32 | -0.34 | -0.35 | 0.08 | 0.79 | 0.08 | 1.00 | 0.03 | -0.10 | 0.66 | -0.17 | -0.19 |
| TERMCIR | -3.00 | 3.41 | 0.06 | 0.14 | 0.84 | 0.01 | 0.77 | 0.03 | 1.00 | -0.85 | -0.42 | 0.05 | 0.17 |
| DEFCIR | 7.76 | 3.41 | -0.07 | -0.02 | -0.96 | -0.08 | -0.89 | -0.10 | -0.85 | 1.00 | 0.43 | -0.10 | -0.03 |
| DEFLCIR | 0.11 | 6.41 | -0.26 | -0.23 | -0.48 | 0.85 | -0.44 | 0.66 | -0.42 | 0.43 | 1.00 | -0.05 | -0.02 |
| MKT | 0.33 | 4.80 | 0.69 | 0.66 | 0.06 | -0.02 | 0.07 | -0.17 | 0.05 | -0.10 | -0.05 | 1.00 | 0.93 |
| MKTE | -1.83 | 5.14 | 0.64 | 0.71 | -0.03 | -0.04 | -0.04 | -0.19 | 0.17 | -0.03 | -0.02 | 0.93 | 1.00 |

EREIT=Monthly returns for equity REITs
EREITE=Monthly returns for equity REITs minus U.S. Treasury-bill rate
BOND=Monthly returns on long-term U.S. government bonds.
BONDCIR=Estimated monthly returns on long-term U.S. government bonds from CIR model.
CORP=Monthly returns on U.S. Aaa long-term corporate bonds.
LONG=Percentage changes in long-term U.S. government bond yields.
LONGCIR = Percentage changes in CIR model's estimated long-term U.S. government bond yields.
HIGH=Percentage changes in U.S. Baa corporate bond yields.
TERM=BOND minus Treasury-bill rate.
TERMCIR=BONDCIR minus Treasury-bill rate.
DEF=Monthly yields on U.S. Baa corporate bonds minus BOND.
DEFCIR=Monthly yields on U.S. Baa corporate bonds minus BONDCIR.

DEFL=CORP bonds minus BOND
DEFLCIR=CORP bonds minus BOND
MKT=NYSE monthly value-weighted returns.
MKTE=NYSE monthly value-weighted returns minus Treasury-bill rate.

**Table 2 OLS Regression Results (From January, 2000 to December 2011 samples)**

| CONSTANT | MKT | BOND | CORP | LONG | HIGH | TERM | DEF | DEFL | R-SQUARE |
|---|---|---|---|---|---|---|---|---|---|
| | | | Dependent Variable is EREIT | | | | | | |
| 0.72 | 1.02 | 0.16 | | | | | | | 0.48 |
| (1.64) | (11.19)* | (1.11) | | | | | | | |
| 0.64 | 0.99 | | -0.29 | | | | | | 0.53 |
| (1.60) | (11.87)* | | (-4.15)* | | | | | | |
| 0.83 | 1.01 | | | -0.06 | | | | | 0.48 |
| (1.97)*** | (11.25)* | | | (-0.97) | | | | | |
| 0.75 | 0.94 | | | | -0.48 | | | | 0.53 |
| (1.87)*** | (11.02)* | | | | (-3.86)* | | | | |
| 1.00 | 1.02 | | | | | 0.11 | | | 0.48 |
| (2.23)** | (11.21)* | | | | | (0.94) | | | |
| 1.50 | 1.01 | | | | | | -0.11 | | 0.48 |
| (1.60) | (11.17)* | | | | | | (-0.77) | | |
| 0.58 | 1.02 | | | | | | | -0.18 | 0.51 |
| (1.34) | (12.01)* | | | | | | | (-3.38)* | |
| 0.34 | 0.93 | | -0.27 | -0.01 | -0.19 | -0.21 | | | 0.54 |
| (0.72) | (10.33)* | | (-2.07)** | (-0.01) | (-0.9) | (-1.18) | | | |
| -0.80 | 0.92 | | -0.30 | | -0.17 | -0.05 | 0.22 | | 0.54 |
| (-0.57) | (10.28)* | | (-2.31)** | | (-0.84) | (-0.25) | (0.88) | | |
| 0.67 | 0.97 | | -0.20 | | -0.19 | | | | 0.54 |
| (1.65) | (11.23)* | | (-1.73)*** | | (-0.96) | | | | |

| CONSTANT | MKTE | BOND | CORP | LONG | HIGH | TERM | DEF | DEFL | R-SQUARE |
|---|---|---|---|---|---|---|---|---|---|
| | | | Dependent Variable is EREITE | | | | | | |
| 0.76 | 1.02 | 0.16 | | | | | | | 0.51 |
| (1.67) | (12.03)* | (1.09) | | | | | | | |
| 0.61 | 0.99 | | -0.29 | | | | | | 0.56 |
| (1.42) | (12.64)* | | (-4.15)* | | | | | | |
| 0.86 | 1.01 | | | -0.06 | | | | | 0.51 |
| (1.93)*** | (12.08)* | | | (-0.97) | | | | | |
| 0.62 | 0.94 | | | | -0.48 | | | | 0.56 |
| (1.44) | (11.77)* | | | | (-3.87)* | | | | |
| 1.00 | 1.00 | | | | | 0.11 | | | 0.51 |
| (2.23)** | (12.17)* | | | | | (0.93) | | | |
| 1.52 | 1.01 | | | | | | -0.11 | | 0.51 |
| (1.55) | (12.06)* | | | | | | (-0.77) | | |
| 0.61 | 1.02 | | | | | | | -0.18 | 0.55 |
| (1.41) | (12.80)* | | | | | | | (-3.38)* | |
| 0.82 | 0.91 | | -0.81 | -0.11 | -0.21 | 0.02 | | | 0.58 |
| (1.29) | (9.84)* | | (-1.88)*** | (-0.84) | (-1.04) | (0.09) | | | |
| -1.20 | 0.93 | | -0.29 | | -0.17 | 0.01 | 0.28 | | 0.58 |
| (-0.79) | (10.99)* | | (-2.27)** | | (-0.83) | (0.06) | (1.04) | | |
| 0.59 | 0.96 | | -0.20 | | -0.20 | | | | 0.57 |
| (1.37) | (11.97)* | | (-1.73)*** | | (-0.98) | | | | |

EREIT=Monthly returns for equity REITs.
EREITE=Monthly returns for equity REITs minus U.S. Treasury-bill rate.
BOND=Monthly returns on long-term U.S. government bonds.
CORP=Monthly returns on U.S. Aaa long-term corporate bonds.
LONG=Percentage changes in long-term U.S. government bond yields.
HIGH=Percentage changes in U.S. Baa corporate bond yields.
TERM=BOND minus Treasury-bill rate.
DEF=Monthly yields on U.S. Baa corporate bonds minus BOND.
DEFL=CORP bonds minus BOND.
MKT=NYSE monthly value-weighted returns.
MKTE=NYSE monthly value-weighted returns minus Treasury-bill rate.
*** represents the significance at the ten percent level.

** represents the significance at the five percent level.
* represents the significance at the one percent level.

**Table 3 OLS Regression Results of Data Derived from CIR Model (From January, 2000 to December 2011 samples)**

| CONSTANT | MKT | BONDCIR | CORP | LONGCIR | HIGH | TERMCIR | DEFCIR | DEFLCIR | R-SQUARE |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Dependent Variable is EREIT | | | | | |
| 0.89 | 0.99 | 0.04 | | | | | | | 0.48 |
| (2.04)** | (11.25)* | (0.32) | | | | | | | |
| 0.64 | 0.99 | | -0.29 | | | | | | 0.53 |
| (1.60) | (11.87)* | | (-4.15)* | | | | | | |
| 0.92 | 0.99 | | | 0.07 | | | | | 0.48 |
| (2.12)** | (11.25)* | | | (0.66) | | | | | |
| 0.75 | 0.94 | | | | -0.48 | | | | 0.53 |
| (1.87)*** | (11.02)* | | | | (-3.86)* | | | | |
| 0.98 | 0.99 | | | | | 0.042 | | | 0.48 |
| (1.74)*** | (11.26)* | | | | | (0.33) | | | |
| 0.90 | 0.99 | | | | | | -0.01 | | 0.47 |
| (0.85) | (11.23)* | | | | | | (-0.05) | | |
| 0.89 | 0.98 | | | | | | | -0.24 | 0.52 |
| (2.20) | (11.64)* | | | | | | | (-3.38)* | |
| 1.05 | 0.96 | | -0.20 | | -0.20 | 0.02 | -0.04 | | 0.54 |
| (0.81) | (11.00)* | | (-1.71)*** | | (-0.98) | (0.09) | (-0.19) | | |
| 0.53 | 0.95 | | -0.20 | 0.16 | -0.21 | -0.10 | | | 0.54 |
| (0.87) | (11.06)* | | (-1.72)*** | (1.06) | (-1.04) | (-0.53) | | | |
| 0.67 | 0.97 | | -0.20 | | -0.19 | | | | 0.54 |
| (1.65) | (11.22)* | | (-1.73)*** | | (-0.96) | | | | |

| CONSTANT | MKTE | BONDCIR | CORP | LONGCIR | HIGH | TERMCIR | DEFCIR | DEFLCIR | R-SQUARE |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Dependent Variable is EREITE | | | | | |
| 0.88 | 1.00 | 0.04 | | | | | | | 0.51 |
| (1.92) | (12.12)* | (0.32) | | | | | | | |
| 0.61 | 0.98 | | -0.29 | | | | | | 0.53 |
| (1.42) | (12.64)* | | (-4.15)* | | | | | | |
| 0.92 | 1.00 | | | 0.07 | | | | | 0.51 |
| (1.99)** | (12.15)* | | | (0.65) | | | | | |
| 0.62 | 0.94 | | | | -0.48 | | | | 0.56 |
| (1.44) | (11.77)* | | | | (-3.87)* | | | | |
| 0.97 | 0.99 | | | | | 0.043 | | | 0.51 |
| (1.70)*** | (11.88)* | | | | | (0.34) | | | |
| 0.89 | 1.00 | | | | | | -0.01 | | 0.51 |
| (0.84) | (12.10)* | | | | | | (-0.04) | | |
| 0.86 | 0.99 | | | | | | | -0.24 | 0.56 |
| 0.79 | 0.96 | | | | | | | (-3.80)* | |
| (0.59) | (11.35)* | | -0.20 | | -0.21 | 0.06 | -0.00 | | 0.57 |
| (-0.56) | (11.41)* | | (-1.69)*** | | (-1.01) | (0.26) | (-0.02) | | |
| 0.51 | 0.97 | | -0.21 | 0.15 | -0.20 | -0.08 | | | 0.57 |
| (0.84) | (11.45)* | | (-1.75)*** | (0.92) | (-0.99) | (-0.40) | | | |
| 0.59 | 0.96 | | -0.20 | | -0.20 | | | | 0.57 |
| (1.37) | (11.97)* | | (-1.73)*** | | (-0.98) | | | | |

EREIT=Monthly returns for equity REITs
EREITE=Monthly returns for equity REITs minus U.S. Treasury-bill rate
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MKTE=NYSE monthly value-weighted returns minus Treasury-bill rate.
*** represents the significance at the ten percent level.
** represents the significance at the five percent level.
* represents the significance at the one percent level.