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Understanding the Relationship between Public and Private Commercial Real Estate Markets

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Abstract

This paper studies the dynamic relationship between public and private commercial real estate market in the U.S. To do so, we propose a correlated unobserved component model with a common trend and Markov-Switching heteroscedasticity. This model addresses the dichotomy in the relationship between these two markets in the short-run and the long-run by allowing for a common long-run trend and correlated short-run cycles. To take into account the non-linearity in the commercial real estate dynamics, we also allow Markov regime-switching in shocks to the trend and the cycles. Consistent with the findings of the literature, we find almost one-for-one comovement in these two markets in the long-run. However, our results suggest significant difference in the correlation of the cycles in low volatility and high volatility regimes. We find high degree of correlation between private and public commercial real estate cycles only in the high volatility regime. This explains the low correlation in the return of these two markets as has been widely reported in the literature. Moreover, we also find that the past movements in public commercial real estate cycle predict future movement in private commercial real estate cycles reflecting the forward-looking nature of the public commercial real estate market.

JEL Codes: C51, E44, G10, R30.

Keywords: Commercial Real Estate, Unobserved Component Model, Markov-Switching.

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1 Introduction

The commercial real estate market has become a major player in the overall macroeconomy. According to the MSCI[1], the size of the professionally managed global real estate investment market was $7.4 trillion in 2016. According to the NAREIT[2], in 2016 there were 189 REITs listed on the New York Stock Exchange with a combined equity market capitalization of $986 billion. Commercial real estate investments come in two forms: private and public. In the private market, an investor can directly own a property such as an apartment building, manage the asset, and lease the units. The other option is to buy shares of publicly traded commercial real estate commonly referred to as real estate investment trust (REIT henceforth) to gain exposure to a professional company that owns and operates commercial real estate. REITs are companies that own and operate income producing real estate and do not have to pay federal corporate income tax if they distribute at least 90% of their taxable income as dividends to shareholders.[3]

In a frictionless world, public and private commercial real estate (PCRE henceforth) markets should be perfect substitutes from the perspective of an investor. However, several studies have found that investments in direct private real estate have produced lower average returns than comparable investments in publicly traded REITs. It should also be noted that return volatility on private real estate portfolios is lower than the volatility of returns on REIT portfolios. If one examines the correlation in returns across different time horizons, the contemporaneous correlation between the returns on public and private real estate investments is typically found to be weak over quarterly and annual horizons[4] In contrast, the

[1] Morgan Stanley Capital International.

[2] The National Association of Real Estate Investment Trusts (NAREIT) is an association representing real estate investment trusts and publicly traded real estate companies with an interest in U.S. real estate and capital markets.

[3] Though the first legislation permitting REITs in the United States was signed into law by President Eisenhower in 1960, it was not until the early 1990s that REITs became widely traded and that the firm structure began to be widely emulated in other countries. Many REITs are publicly owned and are openly traded on major stock exchanges. This makes them an attractive way for people to invest in the housing markets without actually buying physical property.

[4] See for example, Morawski, Rehkugler and Fuss, 2008; Boudry et al., 2012.

corresponding return correlation between equity REITs and stock returns have been found to be much stronger. Therefore, some investors expect REITs to deliver investment returns similar to those of small capstocks because of this high correlation, their relatively high dividend yields and their inclusion in several broader benchmarks of stock market performance. However, recent research suggests the correlation of equity REIT returns with those of other equities declines as the investment horizon lengthens, whereas the correlation of REIT returns with those of the private commercial real estate returns, increases as the investment horizon lengthens[5]. The increase in correlation at longer horizon is clearly evident in Table 1 where we find that the public and the private commercial real estate returns show very small correlation at short-horizons, whereas the correlation increases as the time horizon increases. Overall, while in the long-run a fundamental relationship between securitized and unsecuritized real estate seems to exist, in the short-run REIT returns do not follow those of the underlying property market.

There are three unifying themes about the dynamic relationship between public and private commercial real estate market that can be clearly observed in the data. First, the degree of correlation in returns varies with time horizon: the correlation is weakest at the short-horizon. Second, there is an evidence of long-run comovement among the level of public and private commercial real estate prices. Finally, there is an evidence of non-linearity in volatility of these time series especially during the financial crisis period of 2007-2010. To model these observed patterns, we propose to use an unobserved component (UC) model with Markov-Swiching error terms. This model decomposes the price level of individual series into a common trend and idiosyncratic cycles. The common trend between these variables captures the long-run comovement between the REIT prices and private commercial real estate prices. Unlike the conventional UC models, we also allow cross-cycle dynamics by modeling cycles as a VAR processes. To take into account heteroscedasticity, we also allow Markov-Switching in error terms in both the common trend and cyclical components. In

[5] See for example, Morawski et al., 2008; Boudry et al. 2012; Yunus, Hansz and Kennedy, 2012 among others.

addition, we also allow the cyclical components to be correlated with each other. Therefore, our model not only decomposes the movements in REIT and PCRE prices into a common trend and a cycle, but also allows the cycles to be correlated with each other and the degree of this correlation is allowed to change since the error terms are heteroscedastic. This modeling approach not only allows the long-run comovement in these two series, but also allows the correlation between cycles to vary across different variance states.

The results obtained in this paper provides new light on the relationship between REIT and PCRE markets. We do find evidence of long-run comovement among these two series which is consistent with the findings in the literature. Our results show that only during the high volatility period as identified by Markov-switching model, that the cycles of these two markets are highly correlated. In fact, the estimated correlation between shock to REIT and PCRE cycle is 0.82. We do not find significant variation in PCRE cycle in low volatility state implying no correlation between the shock to the cycles. This result can partly explain why the short-run correlation at monthly and quarterly frequency is very low. Since high volatility regime constitutes a relatively smaller portion of the overall sample, the low volatility regime with very small correlation dominates the full sample. The result that correlation peaks during the high volatility regime is consistent with widely reported findings about state dependent relationship in the financial market. For example, Hale (2012) has shown that the degree of comovement among financial institutions, while time-varying, is highest during the crisis periods. The dynamic interplay in the cyclical component shows that the past movements in REIT cycle predict the future movements in PCRE cycle. However, this is not the case for the PCRE cycle implying the forward looking nature of the REIT market. This result can be explained by the inherent characteristics of these two markets. Due to the higher liquidity, greater number of market participants, smaller transaction costs, and the existence of a public market place in the securitized market, the public real estate market is generally more informationally efficient than the PCRE market Therefore, it is not surprising that there is one-way Granger causality from REIT cycle to PCRE cycle.

The remainder of the paper is organized as follows: Section 2 discusses the related literature; Section 3 details the model specification followed in the paper. Section 4 provides a description of the data used in our empirical analysis; Section 5 discusses the empirical results; and Section 6 concludes.

2 Related Literature

Substantial amount of work has been done to understand the dynamics of commercial real estate markets. In this context, the literature has focused on mainly three issues. The first strand of literature has examined the role of commercial real estate in the context of portfolio theory, where commercial real estate is considered as a separate asset class. The second strand of literature has focused on the short-run predictive relationship between REITs and PCRE market. Finally, the absence of strong correlation in the short-run has brought attention to the existence of long-run comovement or cointegrating relationship between these two markets.

REITs have become popular as a separate vehicle for investment that can give investors access to real estate market without actually owning the property. Some papers have evaluated the benefit of commercial real estate in terms of portfolio diversification and the results are somewhat mixed. Ziering and Mcintosh (1997) found that only private real estate had low correlations with other asset classes implying little benefit of having REIT in a portfolio that contains stocks and bonds. Mueller and Mueller (2003) on the other hand found that inclusion of both private and public real estate leads to a more efficient portfolio. Seck (1996) found a low degree of substitutability between REITs and PCRE asset returns. Several studies have also examined the risk-return property of these two markets and found that investments in private real estate have produced lower average returns than comparable investments in publicly traded REITs, even after controlling for differences in financial leverage and fees (Riddiough et al. (2005), Tsai (2007)). Examining the behavioral aspect of investing, Ciochetti et al. (2002) showed a clientele effect in real estate investment with institutional investors, such as pension funds and other institutional investors having a preference for liquid class of asset like REITs. Pagliari et al. (2005) on the other hand showed that large institutional investors favored PCRE markets, whereas smaller institutional investors tend to prefer REITs.

The second strand of literature has focused on short-term correlation between REIT and PCRE market. These studies have focused on the dynamic interactions between these markets as well as with the stock and bond markets. The consensus seems to be that private and public commercial real estate display limited correlation over short-horizons. See for example, Giliberto (1990), Morawski et al. 2008, Boudry et al. 2012, Ling and Naranjo (2015) among others. Several studies have also argued that REITs behave more like a small cap stock than real estate. In one of the earlier studies, Gyourko and Keim (1992) found that REITs reflect equity market information. They also showed that equity returns had predictive power for REIT returns. In addition to the simple correlation analysis, several papers have also examined how information is transmitted between these two markets. The results overall seem to suggest that REIT returns tend to lead PCRE returns. See for example, Okunev et al. (2000), Li et al. (2009), Carlson et al. (2010), Hoesli et al. (2015) among others. One may expect non-linearity in the relationship in these two markets. Jinliang et al. (2009) confirmed the non-linearity hypothesis by finding a non-linear relationship between private and public real estate with information flowing from the REIT market into private commercial real estate.

The absence of high degree of correlation between the two commercial real estate markets have led the researchers to examine the long-run relationship between these two markets. Most of these studies have found long-run cointegrating relationship between private and public commercial real estate. This is not surprising since returns in both private and public CRE markets should be driven by the net cash flows derived from leasing space to tenants in property markets in the long-run. Notable studies that have shown long-run cointegrating relationship between these two markets are Morawski et al. 2008, Boudry et al. 2012, Hoelsi and Oikarinen, 2012 and Yunus et al. (2012).[6]

[6] There also some studies that have studied the long-run relationship between these two markets in international context. See Ong, 1994; Ong, 1995; and Yunus et al., 2010 among others.

This paper unifies these three aspects of the dynamics of public and private real estate markets. We propose a correlated common trend UC model with Markov-switching heteroscedasticity. This approach is able to model the long-run and short-run dynamics together. Moreover, the Markov-switching property of the error term allows the short-term correlation between the cyclical components to depend upon the regime. This class of models are really popular in macroeconomics and finance, but has not been applied to the commercial real estate market. These models have also been applied to model nonlinearity in business cycles and financial markets.[7]

3 Model Specification

To model the dynamics of REIT and PCRE prices, we need to take into account the observed features of the data. In particular, we need to model the short-run and the long-run feature of the data that also takes into account different volatility regimes. The preliminary analysis shows that REITs and the PCRE market do move together in the long-run. We do perform a cointegration analysis and results do confirm existence of a cointegrating relationship[8]. This is consistent with the results in the literature that find long-term comovement between REIT and PCRE market. To incorporate this feature of the relationship between these markets, we decompose the price movements into a common trend and individual cycles. To take into account, high volatility witnessed in these markets during the financial crisis, we also allow for break in variances of both the common trend and cycles of each market. Our model takes the following form:

$$y_{1t} = \tau_t + c_{1t}$$

$$y_{1t} = \mu + \alpha\tau_t + c_{2t}$$

[7]See for example, Chauvet,1998; Hamilton, 1989; Kim,1993a, 1993b, 1994; Kim and Nelson, 1998; Morley, Nelson and Zivot, 2003; Morley, 2007; Sinclair, 2009; Bhatt and Kishor, 2015 among others.

[8]The estimated cointegrating relationship takes the form: $\text{LREIT}_t = 0.44 + 1.14 * LPCRE_t$, where L represents log. The estimated cointegrating residual is stationary at all significance levels.

where y_{1t} and y_{2t} are the REIT and PCRE prices in log levels. τ_t is common trend and c_{it} (i=1,2) are individual cycles. α is the loading on trend in PCRE prices and μ captures the mean differences across the two time-series. The trend and the cycles have following representation:

$$\tau_t = g_{t-1} + \tau_{t-1} + v_t, v_t \tilde{} N(0, \sigma^2_{v,s_t})$$

$$g_t = g_{t-1} + w_t, w_t \tilde{} N(0, \sigma^2_{w,s_t})$$

$$c_{it} = \phi^1_{i1} c_{1,t-1} + \phi^1_{i2} c_{2,t-1} + \phi^2_{i1} c_{1,t-1} + \phi^2_{i2} c_{2,t-1} + e_{it}, e_{it} \tilde{} N(0, \sigma^2_{e_i,s_t})$$

The trend follows a random walk with a non-stationary mean. Time-variation in mean is allowed to capture the big decline in commercial real estate in 2008. This approach has been used to take into account the productivity slowdown of 1970s in the context of trend-cycle decomposition of GDP by Clark (1989). The cycles follow a parsimonious VAR(2) process. The model outlined above also allows for Markov-Switching heteroscedasticity in the disturbance term of the trend and the cycle equations. In particular, we assume a first-order two-state regime change model.

$$\sigma^2_{s_t} = \sigma^2_0 + (\sigma^2_1 - \sigma^2_0) S_t, \sigma^2_1 > \sigma^2_0$$

$$Pr[S_t = 1 | S_{t-1} = 1] = p_{11}, Pr[S_t = 0 | S_{t-1} = 0] = p_{00}$$

In addition, we also allow non-zero correlation between shocks to the cycles of two series. Since we allow for two regimes, the covariances in these two regimes are cov($e_{1t,0}, e_{2t,0}$) $= \sigma^0_{12}$ and cov($e_{1t,1}, e_{2t,1}$) $= \sigma^1_{12}$. Here superscripts 0,1 represent the two variance regimes. The state space representation of the above model specification is represented below.

Measurement Equation:

$$\begin{bmatrix} y_{1t} \\ y_{2t} \end{bmatrix} = \begin{bmatrix} 0 \\ \mu \end{bmatrix} + \begin{bmatrix} 1 & 0 & 1 & 0 & 0 & 0 \\ \alpha & 0 & 0 & 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} \tau_t \\ g_t \\ c_{1t} \\ c_{1t-1} \\ c_{2t} \\ c_{2t-1} \end{bmatrix}$$

Transition Equation:

$$\begin{bmatrix} \tau_t \\ g_t \\ c_{1t} \\ c_{1t-1} \\ c_{2t} \\ c_{2t-1} \end{bmatrix} = \begin{bmatrix} 1 & 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & \phi_{11}^1 & \phi_{11}^2 & \phi_{12}^1 & \phi_{12}^2 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & \phi_{21}^1 & \phi_{21}^2 & \phi_{22}^1 & \phi_{22}^2 \\ 0 & 0 & 0 & 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} \tau_{t-1} \\ g_{t-1} \\ c_{1t-1} \\ c_{1t-2} \\ c_{2t-1} \\ c_{2t-2} \end{bmatrix} + \begin{bmatrix} v_{s,t} \\ w_{s,t} \\ e_{s,1t} \\ 0 \\ e_{s,2t} \\ 0 \end{bmatrix}$$

The variance-covariance matrix of the transition equation takes the following form

$$\begin{bmatrix} \sigma_{v,s}^2 & 0 & 0 & 0 & 0 & 0 \\ 0 & \sigma_{w,s}^2 & 0 & 0 & 0 & 0 \\ 0 & 0 & \sigma_{e1,s}^2 & 0 & \rho_s \sigma_{e1,s} \sigma_{e2,s} & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & \rho_s \sigma_{e1,s} \sigma_{e2,s} & 0 & \sigma_{e2,s}^2 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

The model proposed here builds on Morley (2007), where he models the joint dynamics of consumption and income using an unobserved component model that allows for correlation between permanent and transitory shocks. In this paper, we introduce two novel features that take into account the behavior of commercial real estate markets since 2000. First, we allow two regimes in volatility of shocks that captures the increased volatility during the financial crisis. In addition, we also allow dynamic relationship among cycles by specifying the cycles to be a VAR process rather than univariate AR processes. This allows us to examine whether past movements in one cycle have predictive power for another. In our model, we allow for correlation between cyclical shocks (ρ_s). Since there are two regimes, the correlations among these shocks can differ in different regimes[9]. This will help us in

[9] For estimation details, see chapters 5 and 6 of Kim and Nelson (2000).

examining the hypothesis that asset markets tend to show higher degree of comovement in crisis periods than normal times.

4 Data Description

Our monthly sample period runs from 2000:12 through 2017:02. The choice of sample period is determined by the availability of private commercial real estate price data. The main source of REIT data for this paper was obtained from the National Association of Real Estate Investment Trusts. The monthly FTSE NAREIT REIT Index series were first created to help in the construction of index tracking funds and as a performance benchmark for other assets. REIT stocks included in this index are screened quarterly to insure that they are liquid and freely tradable. Since we are interested in tracking the price level of publicly traded commercial real estate, we use price index of all equity REITs.

For private commercial real estate price, we use Moodys/Real Capital Analytics (REAL) "all-property" index. The other measure of private commercial real estate that has been widely used in the literature is NCREIF NPI. Moodys/REAL Index is able to more precisely detect movements in the market than the NPI, not only because of its monthly frequency (compared to the NPI's quarterly frequency), but more importantly because a contemporaneous transactions-based index like the Moodys/REAL Index lacks the "smoothing" of an index constructed such as the NPI based on appraisals. The ability of the Moodys/REAL Index to detect market movements even in the index's early days when data was scarce is apparent in the noticeable response to the 2001 recession that is apparent in the Moodys/REAL Index but not in the NPI.

5 Estimation Results

Table 2 provides the maximum likelihood estimates of all the parameters. The corresponding standard errors are also reported in another column. We first report the results of the benchmark model used in this paper. In the next subsection, we compare the results of our benchmark model with a linear model. The results from our model show the advantages of applying the regime-switching framework to the common trend model of commercial real estate prices. Allowing for random walk mean in the trend is justified by the significance of the variance of shock (σ_{w_0} and σ_{w_1}) in both the regimes. The results also show that variance of the shocks to REIT cycle dominates the variance of the shocks to REIT trend. This pattern reverses for the PCRE market, where we find that the variance of the shocks to cycle is smaller in magnitude than the variance of the common trend shock. In fact, we find that in the low volatility regime, the variance of cyclical shock to PCRE prices is insignificant. This suggests that cyclical shocks are dominant in case of REIT prices, whereas the variations in the prices of PCRE market are dominated by permanent movements. This is especially true for the low volatility regime.

One of the attractive features of our model is that it also allows for the estimation of correlation between shocks to the cycles of the two variables. In theory, we can estimate this correlation in both the regimes. However, as discussed previously the variation in the cyclical component of PCRE market in low volatility regime is insignificant implying zero correlation between these two shocks. The result suggests a very high degree of correlation in high volatility regime. This implies that one of the reasons why it is difficult to find high degree of correlation in short-term movements in REIT returns and private real estate returns is that the correlation between these two series peaks up only during high volatility periods, whereas the lack of any variation in the PCRE market in the low volatility regime leads to no comovement with variations in the REIT market. This is a very interesting results and fits nicely with the findings in other strand of literature where researchers have found that asset markets tend to show high degree of comovement in crisis periods[10].

The parameters p_{00} and p_{11} represent the regime switching probabilities. p_{00} represents the probability of low volatility this period conditional on last period's low volatility regime, whereas p_{11} represents probability of being in high volatility this period conditional on last period's high volatility regime. The estimated parameters suggest that Markov-switching

[10] See for example, Hale (2012).

probability of low volatility regime is higher than high volatility. Figure 1 represents the smoothed probability of high volatility regime. The plotted smoothed probabilities show that our model picks up the high volatility period witnessed during 2007-2009 sample period. In addition to the financial crisis period, the high volatility regime is also present in some small sample periods. For example, the probability of being in high volatility regime is higher in the middle of 2013 when the commercial real estate market witnessed higher volatility. These smoothed probabilities do a very good job in distinguishing low and high volatility regime in the commercial real estate market.

Since we allow the model to have a common trend representation, the estimated loading on log of PCRE prices captures the cointegrating vector in the cointegration regression. In the absence of market frictions that includes regulatory regime, illiquidity and transaction costs, the estimated cointegrating vector should equal 1. Our estimated cointegrating vector (α) is 0.9657, which is very close to the theoretical value 1. It should be noted that if we estimate cointegrating vector between REIT prices and PCRE prices using a simple Engle-Granger method, the estimated value turns out to be 1.15. It can be argued, therefore, that using the UC model with regime-switching heteroscedasticity is better able to capture the cointegrating vector than the simple cointegration method. The estimated parameter, μ, captures the sample mean differences in these two series. This is estimated to be positive and significant.

The estimated parameters of cyclical dynamics also show interesting results. Our findings suggest that PCRE cycle ($\phi_{22}^1 + \phi_{22}^2$) is more persistent than REIT price cycle ($\phi_{11}^1 + \phi_{11}^2$). Unlike Morley (2007), our approach also allows lag interdependence among different cyclical components. ϕ_{ij}^k captures the effect of kth lag of jth variable on ith variable. The results suggest that past movements in PCRE cycle is jointly insignificant ($\phi_{12}^1 + \phi_{12}^2$), whereas the joint effect of the past movements in the cycle of REIT prices on current PCRE cycle is significant at all significance levels. This finding suggests that past movements in REIT cycle have predictive power for future movements in PCRE cycle, whereas this is not the case for the past movements in PCRE cycle. The results imply that short-term movements in REIT cycle leads PCRE cycle. This can be explained by the nature of public and private commercial real estate market. Since REIT securities are traded everyday and therefore, in theory should respond much more quickly to the news about commercial real estate market. Private commercial real estate market on the other hand on the other hand may be less responsive than REIT markets because of greater number of market participants, smaller transaction costs, and the existence of a public market place in the securitized market.

5.1 Trend-Cycle Decomposition

The common trend regime-switching model with correlated cycles also provides us estimates of the trends in the commercial real estate market. It also yields us the quantitative estimate of the cycles in the REIT and private commercial real estate markets. The plots are shown in Figures 2-4. Figure 2 plots the estimated trend along with log level of REIT prices. Note that the trend is common across the two series since REIT prices and PHPI are cointegrated with each other. Our approach of allowing a break in the mean can be clearly motivated by the significant decline in the level of REIT and PCRE prices at the beginning of the financial crisis. The trend started declining at the end of 2007, much before the collapse of the Lehman brothers in September 2008. The decline in trend was long-lasting and it took almost seven years for the level of trend to come back to its pre-crisis level. The decline in REIT prices were much more pronounced than the decline witnessed by the private commercial market as shown in Figure 3.

The plot of the cycles are shown in Figure 4. Not surprisingly, we find that the estimated cycle for REIT prices is much bigger in magnitude. At the height of the financial crisis almost all the variation in REIT prices were cyclical as shown by deep decline in the cyclical component. The estimated cycle suggests that REIT prices were below its trend level for almost 6-7 years, even though the trend itself declined during these years. The cyclical component of REIT prices, however, recovered sharply after the crisis. The sharp recovery in the cyclical component captures the significant jump in the REIT prices that took place after the crisis. This was partly driven by the fact that there was a disproportionate decline in REIT prices during the crisis and since active trading takes place in REIT securities, investors did find valuable buying opportunity in the REIT market. This was aided by extraordinary monetary policy stimulus by the Federal Reserve as has been documented in the financial press.

The overall pattern in the cyclical component of the private commercial real estate market follows the cyclical component of the public commercial real estate. However, it is much more persistent and smoother than REIT cycle. The peak and trough of this cycle is also much smaller than the REIT cycle. The results suggest that the big decline in the PCRE cycle started almost six months after the decline in REIT cycle during the financial crisis. This is consistent with the results of the previous section where we find that the past cyclical movements in REIT have predictive power for future movements in the cycle of PCRE. Overall, the results from the trend-cycle decomposition clearly shows that our common trend model with regime switch in volatility captures the dynamics of both the public and the private commercial real estate markets very well.

5.2 Comparison with a Linear Model

The premise of our modeling approach is that a Markov-switching model is more suitable in the current context than a linear common trend model of public and private commercial real estate. We examine this assumption by estimating two versions of the linear model: the first version allows for only univariate AR (2) dynamics in the cycle, whereas the second version considers the cross-cycle dynamics by allowing a VAR(2) model. The results are reported in Table 2. The results clearly suggest that modeling cycles of the private and commercial real estate as VAR process dominates the AR process. The likelihood ratio test will reject the null of univariate model at all significance levels. If we compare the Markov-switching model with the linear model with VAR cycles, we again reject the null of linearity at all significance levels. The rejection of the null hypothesis will still be valid even if one considers the non-standard nature of the test as the likelihood value for the Markov-switching model is 1535.31, whereas the corresponding value is only 1236.84 for linear VAR cycle model. If we compare the estimated parameters of the linear model with Markov-switching model, we clearly find that the variance in case of no regime change is somewhere in the middle of low and high volatility state as shown in the first panel of Table 2. Overall, the results quite clearly show the dominance of non-linear Markov-switching model over different versions of the linear model.

6 Conclusion

One of the consistent findings in the literature on the commercial real estate market is dichotomous short-run and long-run relationship between public (REIT) and private commercial real estate markets. Public commercial real estate returns behave more like a small cap stock returns than private commercial real returns, whereas they do tend to move together in the long-run. This paper addresses this contrasting relationship by modeling the short-run and the long-run dynamics in these two markets jointly. Moreover, it also captures the non-linearity in shocks in these markets as was evident during the financial crisis of 2008-09. Our proposed state space model decomposes the movements in public and private commercial real estate prices into a common trend and idiosyncratic cycles that are contemporaneously correlated with each other. Moreover, the vector auto regression property of the cycles allow cross-cycle dynamics and examines Granger causality in these two cycles. In addition, Markov-switching in shocks allow the contemporaneous correlation in public and private commercial real estate cycle to be regime dependent.

Our results shed new light on the dynamic relationship between public and private commercial real estate market in the U.S. Our results confirm the earlier findings in the literature about long-run comovement in these markets. However, we find that the low short-run correlation observed between these two markets may be mainly due to the absence of correlation in the normal times. Our model suggests that during the high volatility period, the correlation between the cyclical components of public and private commercial real estate cycles are high. Therefore not taking into account different volatility regimes masks the richer dynamics that is present in these markets. Moreover, we also find that the past movements in the cyclical component of the public commercial real estate prices do have predictive power for the future movements in the private commercial real estate cycle. This shows the forward-looking behavior of the publicly traded commercial real estate.

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Table 1. Correlation between Private and Public Commercial Real Estate Returns at Different Horizons

Horizon	Correlation
1	0.13
2	0.18
3	0.23
6	0.32
9	0.41
12	0.49
24	0.61

Table 2. Estimated Hyperparameters

	Markov-Switching Model		**Linear Model** *(AR Cycle)*		**Linear Model** *(VAR Cycle)*	
Parameters	Estimate	S.E.	Estimate	S.E	Estimate	S.E
σ_{v_0}	0.0004	0.0004	0.0020	0.0005	0.0024	0.0006
σ_{v_1}	0.0076	0.0014				
σ_{w_0}	0.0016	0.0002	0.0028	0.0006	0.0021	0.0005
σ_{w_1}	0.0023	0.0001				
$\sigma_{e_{10}}$	0.0426	0.0027	0.0621	0.0032	0.0625	0.0031
$\sigma_{e_{11}}$	0.1371	0.0213				
$\sigma_{e_{20}}$	0.0000	0.0000	0.0000	0.0001	0.0000	0.0001
$\sigma_{e_{21}}$	0.0027	0.0013				
ρ_{12}^0	0.0821	0.2231				
ρ_{12}^1	0.8209	0.1656				
p_{00}	0.9353	0.0200				
p_{11}	0.8404	0.071				
α	0.9657	0.0218	1.0276	0.2269	1.0001	0.2442
μ	1.0152	0.1096	1.3002	1.0723	1.1728	1.1979
ϕ_{11}^1	0.8752	0.0236	1.0124	0.0271	1.0252	0.0510
ϕ_{11}^2	0.0157	0.0022	-0.0910	0.0001	-0.0497	0.0633
ϕ_{12}^1	0.9260	0.1712			-0.5605	0.1394
ϕ_{12}^2	-0.8978	0.1480			0.5181	0.2312
ϕ_{21}^1	0.0038	0.0015			0.0106	0.0049
ϕ_{21}^2	0.0056	0.0011			0.0020	0.0055
ϕ_{22}^1	1.7438	0.0347	1.7754	0.0438	1.7077	0.0401
ϕ_{22}^2	-0.7602	0.0303	-0.7880	0.0388	-0.7291	0.0343
Log Likelihood Value	1535.31		1220.27		1236.84	

Notes:

0 refers to the regime with low volatility and 1 refers to the regime with high volatility.

Figure 1: Smoothed Probabilities of High Volatility State

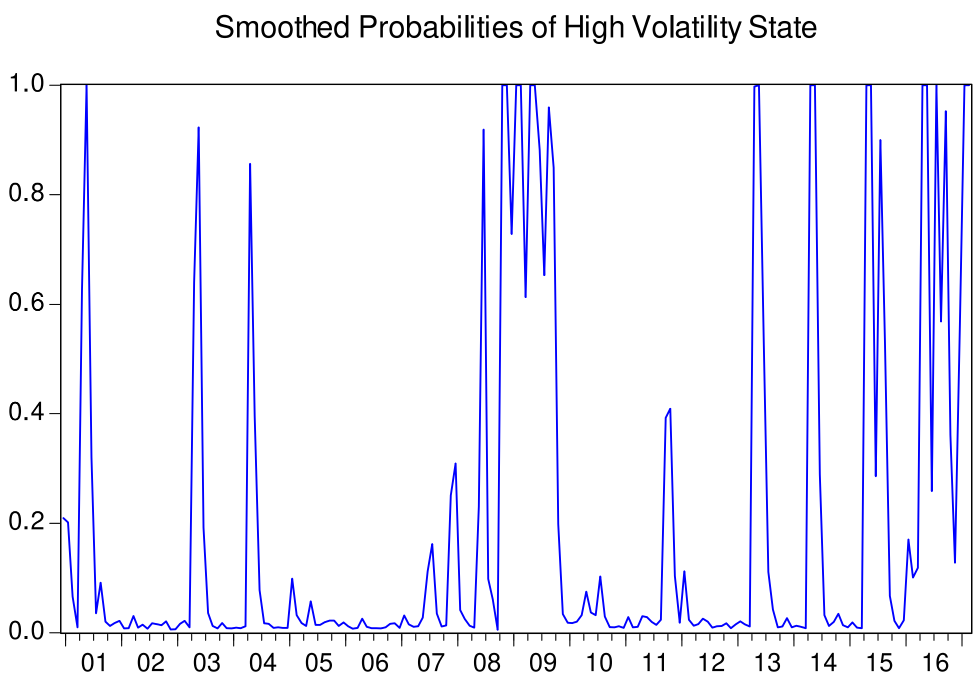

Figure 2: REIT Prices and Trend

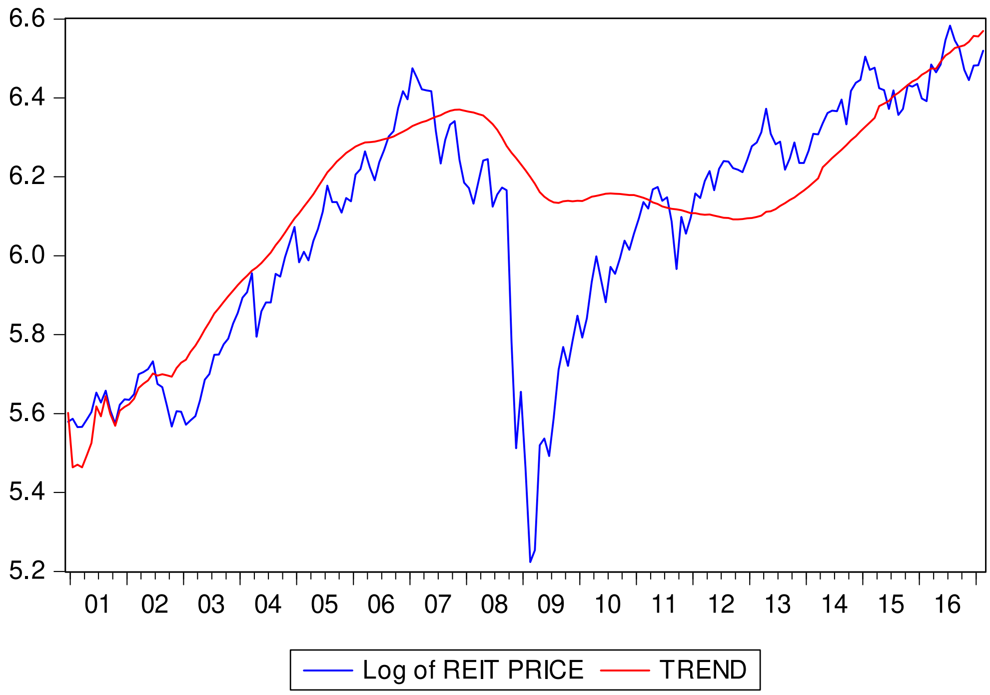

Figure 3: PHPI and Estimated Trend

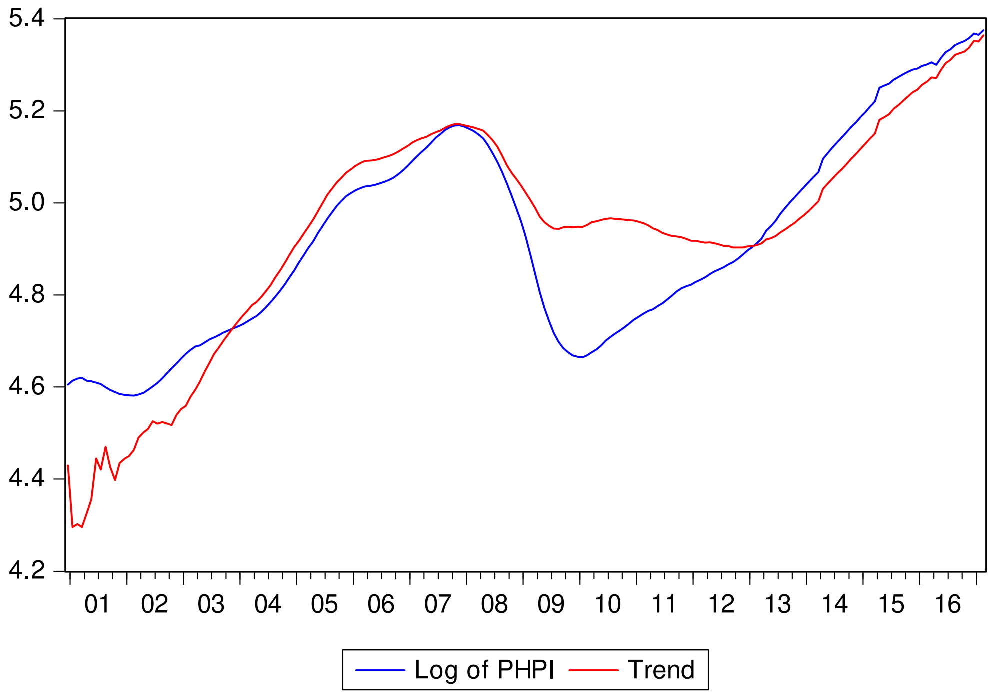

Figure 4: Estimated Cycles