Re-investigating the anomalous relationship between inflation and equity REIT returns: A regime-switching approach

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Re-investigating the anomalous relationship between inflation and equity REIT returns: A regime-switching approach

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Abstract

This paper re-investigates the anomalous relationship between inflation and equity REIT returns in the USA by introducing regime consideration in the modeling approach and including additional relevant variables *viz.*, relative price variability and output growth in the relationship. By applying both the observed and unobserved regime switching vector autoregressive model, this paper makes an attempt to explain the hitherto observed anomalous negative relationship between REIT returns and inflation. It is evident from the results that this negative relationship between REIT returns and inflation is merely a proxy for the effectiveness of relative price variability and output growth on REIT returns.

Keywords: REITs; Relative price variability; Inflation; TVAR; MSVAR

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1. Introduction

The issue of inflation hedging ability of traditional real estate market and real estate investment trust (REIT) returns has been studied quite well. For instance, Fama and Schwert (1977) found residential real estate to be an excellent hedge against both expected and unexpected inflation. Bond and Seiler (1998) empirically analyzed the inflation hedging effectiveness of residential real estate and showed that residential real estate investment provides significant hedge against both expected and unexpected inflation. In general, there is a consensus that traditional real estate investment is able to hedge against inflation. However, empirical results about REIT's ability to hedge inflation are mixed. Only a few studies, such as Chen and Tzang (1988), indicate that REIT possesses some inflation hedging properties. However, extant evidence tends to suggest that REIT returns have negative relationship with inflation.

This paper re-examines this negative relationship, which may be termed as 'anomalous', between REIT returns and inflation in the USA using monthly data covering the sample period 1990-2013, with the view to understand the role of fundamental economic activities such as industrial production in this relationship. To be more specific, the purpose of this study is to examine whether fundamental economic activities, such as industrial production, contribute to this negative relationship through the effects of relative price variability on industrial production and REIT returns. This consideration to relative price variability is pertinent for the explanation of the REIT returns-inflation relationship. First, relative price variability may have adverse effects on the economy and second, it may be positively related to both unexpected and expected inflation (see, for instance, Kaul, 1990). Further, this study employs nonlinear modeling approach considering different market conditions depending on the nature of REIT returns since it has been found that REIT returns are often linked to macroeconomic variables in a nonlinear fashion (see, for details, Chang, 2011; Chang et al., 2011; Chang 2017; Pierdzioch et al., 2018).

To accomplish our objectives of this study, we employ both the observed and unobserved regime switching models, namely, threshold VAR (TVAR) model and the Markov Switching VAR (MSVAR) model. The TVAR model is in line with the fact that movements in the REIT returns could alter the interactions among the variables. Here, we take average of few past REIT returns as the threshold variable. On the other hand, Markov-switching structure allows characterization of the time series dynamics in different states with unobserved switching variable.

Our overall findings from estimation of both the observed and unobserved regime-switching models show that the negative relationship between REIT returns and inflation appears to proxy for the significant effect of relative price variability on industrial production and REIT returns. Further, the direction and magnitude of the causal relationship among the variables are different across the different regimes.

This paper is organized as follows: Section 2 discusses the literature review. Section 3 provides description about the data and the methodology. The estimation results are presented and discussed in Section 4. The paper ends with some concluding remarks in Section 5.

2. Literature Review

The evidence of hedging ability of traditional real estate investment and REITs is sharply divided. There are extant studies on traditional real estate investment that support the fact of inflation hedging (see, for example, Sirmans and Sirmans, 1987; Brueggeman, Chen and

Thibodeau, 1984; Miles and Mc Cue, 1982; Hartzell, Hekman and Miles, 1986). On the other hand, studies like the one done by Gyourko and Linnenman (1988) found that the appreciation in property returns and owner occupied homes are positively associated with inflation while REIT returns tend to be strongly negatively related with unexpected inflation. As the underlying assets of REIT are primarily real estates, REIT is expected to be inflation hedge as well. Chen and Tzang (1988), and Liang et al. (1998), have indicated that REIT possesses some inflation hedging properties. Chen and Tzang (1988) documented that REIT has some ability to hedge expected component of inflation. However, extant evidence tends to suggest that REIT returns are negatively related with inflation. Chan et al. (1990) analyzed monthly returns on equity REIT that were traded on major stock exchanges over the period of 1973-87 and concluded that returns from REIT is not a hedge against unexpected inflation. Liu et al. (1997) examined whether real estate securities continue to act as perverse inflation hedges from a global perspective in countries like Australia, France, South Africa, Switzerland, the UK and the USA. With few exceptions, the results were found to be consistent with negative inflation hedging ability of REIT returns (see, for instance, Goebel and Kim, 1989; and Park et al., 1990). Chen and Tzang (1988) found that REIT returns are closely related to interest rates. In a study, Darat and Glascock (1989) argued that federal deficits have important wealth effects on REIT returns, and hence, macroeconomic shocks will have considerable impacts on REIT markets (e.g., Glascock et al., 2002; Ewing and Payne, 2005; Chang et al., 2011). The other REIT studies focusing on the sensitivity of REIT returns with respect to unexpected inflation show the importance of monetary policy for REIT returns (see, for example, Simpson et al., 2007; Chang et al., 2011; Pierdzioch et al., 2018).

3. Data and Methodology

3.1. *About the data*

In this section, we discuss about the data considered in our study. The sample period for all the time series used in this study ranges from January 1990 to December 2013. Monthly data of returns on equity REITs for the USA has been taken from the National Association of Real Estate Investment Trust (NAREIT) *REIT Handbook.* The price series used to construct a relative price variability measure, called the RPV, as described below involves the seasonally adjusted price indices of the component of the consumer price index (CPI) at the item/product level. As summarized in **Table 1**, the resulting series which is available for 38 product categories, has been taken from CEIC data source. For the purpose of computation of inflation rate, data on seasonally adjusted consumer price index (CPI) for all items has been considered. This data set as well as the seasonally adjusted total industrial production index has been obtained from the website of Federal Reserve Bank at St. Louis.

Relative price variability (RPV) is most often constructed by the weighted average of sub-aggregate inflation series using the standard deviation (s.d.). The primary measure of inflation used here is the monthly log-difference of the seasonally adjusted CPI.

Table 1. Weights of the 38 product categories used for the computation of relative price variability in the USA

Item	Weight
All items	100
Cereals and bakery products	1.10
Beef and veal	0.63
Pork	0.41
Fish and seafood	0.34
Eggs	0.10
Milk	0.29
Cheese and related products	0.25
Fresh fruits	0.49
Fresh vegetables	0.47
Nonalcoholic beverages	0.91
Other food at home	1.74
Food away from home	5.99
Alcoholic beverages	1.11
Shelter	32.78
Fuel oil and other fuels	0.34
Electricity	2.75
Utility gas service	1.28
Household furnishings and operations	4.65
Men’s apparel	0.70
Boy’s apparel	0.19
Women’s apparel	1.35
Girls’ apparel	0.24
Men’s footwear	0.23
Women’s footwear	0.36
New vehicles	4.98
Used cars and trucks	1.72
Motor fuel	4.35
Motor vehicle parts and equipment	0.37
Medical care commodities	1.45
Medical care services	4.83
Sporting goods	0.67
Photographic equipment and supplies	0.08
Toys	0.25
Admissions	0.71
Educational books and supplies	0.20
College tuition and fees	1.52
School tuition and fees	0.41
Other goods and services	3.48

Thus RPV at time t is obtained as

$$\text{RPV}_t = \sqrt{\sum_{i=1}^{N} \omega_i (\pi_{it} - \bar{\pi}_t)^2}\ ,$$

where $\pi_{it} = \ln P_{it} - \ln P_{i,t-1}$, $\bar{\pi}_t = \sum_{i=1}^{N} \omega_i \pi_{it}$, P_{it} is the price index of i^{th} good at time t and ω_i denotes the fixed expenditure weight of the i^{th} product that sums to unity over all the products, and N is total number of items.[‡] The growth rate of output, IIPG, is measured as the first difference in the logarithms of the levels of the index of industrial production (IIP).

3.2. Summary statistics

The summary statistics of all the four variables under investigation *viz.,* returns on real estate investment trust (REIT), relative price variability (RPV), inflation (INF), and growth in industrial production (IIPG) are presented in **Table 2**. Note that relative price variability has the highest standard deviation, followed by returns on REIT. As variance itself is a source of information (see, Ross, 1989), the finding of high standard deviation and hence high variance for REIT returns as well as for relative price variability imply that these variables have greater information content than the other two economic variables *viz.,* INF and IIPG. The skewness value for REIT returns is the lowest among the four while for RPV it is the highest. It may be further noted that the distributions for REIT returns, INF and IIPG are skewed to the left. All the four variables have very high kurtosis values, and hence as seen from the J-B test statistic values, normality is rejected for all the four time series.

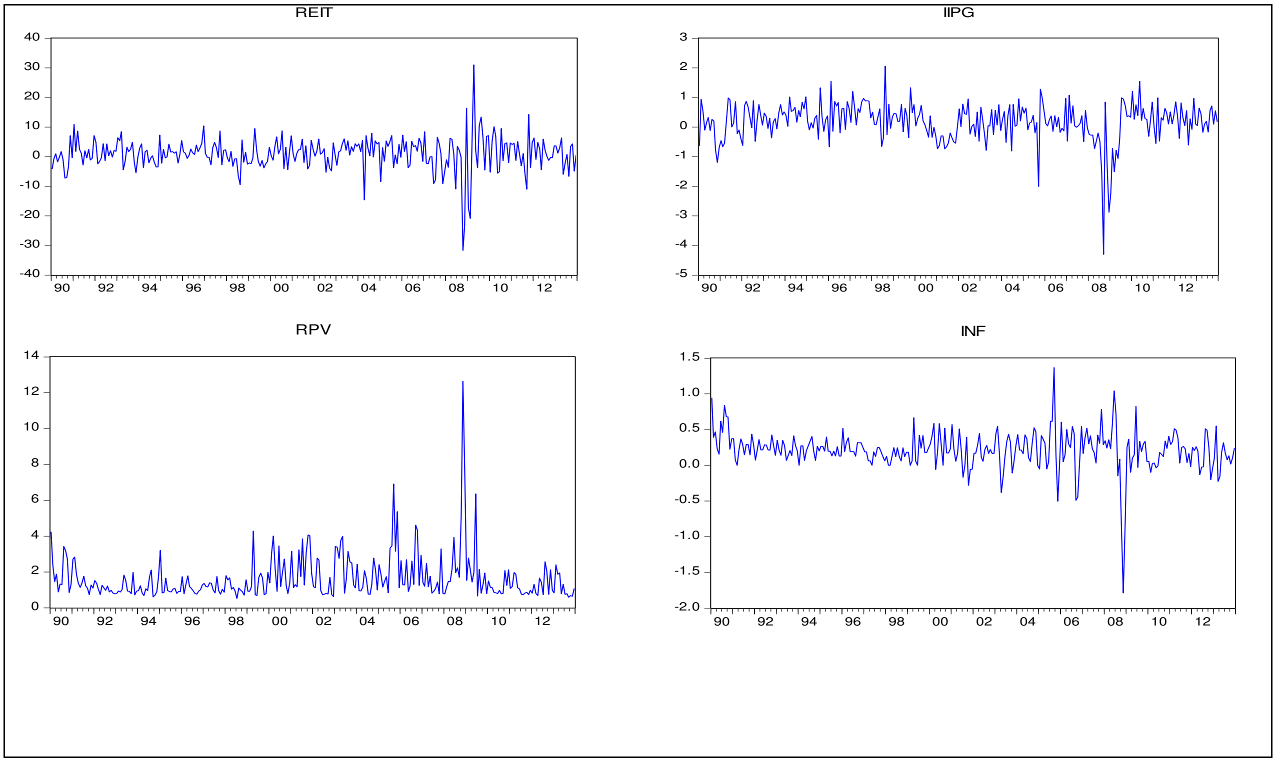
Table 2. Statistical summary of the time series of real estate investment trust returns (REIT), relative price variability (RPV), industrial production growth (IIPG), and inflation (INF), in the USA during 1990:M01-2013:M12

	REIT	RPV	IIPG	INF
Mean	1.001	1.643	0.172	0.214
Median	1.262	1.227	0.221	0.213
Maximum	31.019	12.63	2.059	1.367
Minimum	-31.668	0.520	-4.298	-1.786
Std. dev.	5.533	1.249	0.653	0.268
Skewness	-0.748	3.688	-1.755	-1.448
Kurtosis	11.276	25.764	11.938	15.735
J-B statistics	848.89	6871.66	1106.79	2046.89
p-value	(0.000)	(0.000)	(0.000)	(0.000)

[‡] Given the nature of index data, RPV measure adopted here should be read as relative inflation variability. In this paper, however, following others, we have referred to this measure as RPV. Another common formulation for RPV is the coefficient of variation. Here we have chosen standard deviation (s.d.) as the RPV measure for two reasons that have been documented in the literature (e.g., Choi 2010). First, the overwhelming majority of extant studies have employed s.d. as the measure of RPV and hence this facilitates comparisons with the earlier studies. Second and more importantly, coefficient of variation (CV) is not easily defined when average inflation is close to zero or even negative.

Finally, the time series plots of these four variables are given in **Figure 1**. It is evident from these plots that these are likely to be stationary since REIT returns, IIPG, and INF exhibit random fluctuations around 0 while RPV has fluctuations around the value of 2.

Figure 1. Time series plots of real estate investment trust returns (REITR), relative price variability (RPV), industrial production growth (IIPG), and inflation (INF) in the USA



3.3. Methodology

3.3.1. Threshold Vector Autoregressive (TVAR) Model

This study uses the approach following by Balke (2000) along with Li and St-Amant (2008) in order to estimate a Threshold Vector Autoregressive (TVAR) model. The TVAR model allows us to capture the asymmetric response to external shocks or the possibility of multiple equilibria. It also facilitates to distinguish the effect of the variables under different regimes. The TVAR model can be defined as

$$Y_t = \begin{cases} C_1 + A_1^1 Y_{t-1} + A_2^1 Y_{t-2} + \cdots + A_p^1 Y_{t-p} + U_{1t} & if \quad \bar{r}_t^k \leq 0 \\ C_2 + A_1^2 Y_{t-1} + A_2^2 Y_{t-2} + \cdots + A_p^2 Y_{t-p} + U_{2t} & if \quad \bar{r}_t^k > 0 \end{cases}$$

where Y_t represents a $(n \times 1)$ vector of endogenous variable, C_j $(j = 1,2)$ represents $(n \times 1)$ vector of constant, A_i^j $(i = 1, \dots, p; j = 1,2)$ is the $(n \times n)$ parameter matrix, U_{jt} $(j = 1,2)$ is the $(n \times 1)$ vector of random disturbance term and $\bar{r}_t^k$ is the threshold variable. $\bar{r}_t^k$ is defined as the average of the past k values of REIT returns i.e., $\bar{r}_t^k = \frac{\sum_{i=1}^{k} r_{t-i}}{k}$, as suggested by Chen (2009). Obviously, appropriate choice of k is a relevant issue. We make several choices of k and then choose that one for which the AIC and/or BIC values are minimum.

3.3.2. The Marrkov-switching Vector Autoregressive (MSVAR) Model

The MSVAR, as proposed by Hamilton (1994), allows the structural coefficients and the covariance matrix of the model to be dependent on an unobserved state variable S_t which is assumed to follow a first order Markov chain. The general framework is described by the following equation:

$$\begin{cases} y_t = x_t \, . \, \beta_{S_t} + u_t & t = 1, \ldots \ldots, T \\ u_t | \, S_t \sim N\left(0, \sum_{S_t}\right) & S_t = \{0,1\} \end{cases} \quad (1)$$

where y_t, as before, $(n \times 1)$ vector of endogenous variables with n as the number of variables of interest, x_t is a $(n \times \overline{np+1})$ vector of p lagged endogenous variables including the intercept term, S_t is an unobserved state (or regime) taking two values, $\beta_{S_t}$is a $(\overline{np+1} \times 1)$ vector of parameters, T is the sample size. The covariance matrix $\sum_{S_t}$ takes the form:

$$\textstyle\sum_{S_t} = \sigma_S^2(S_t) \, . \, I_p \quad (2)$$

Following Hamilton (1994), the transition probability matrix, denoted as P, is defined as,

$$P = \begin{bmatrix} \mathbb{P}(s_t = 0 \, | s_{t-1} = 0) & \mathbb{P}(s_t = 1 \, | s_{t-1} = 0) \\ \mathbb{P}(s_t = 0 \, | s_{t-1} = 1) & \mathbb{P}(s_t = 1 \, | s_{t-1} = 1) \end{bmatrix}$$

$$= \begin{bmatrix} p_{00} & p_{01} \\ p_{10} & p_{11} \end{bmatrix}.$$

Let $\mathcal{Y}^t = \{y_t, y_{t-1}, \ldots \ldots, y_1\}$ denote the collection of all observed variables up to time t, which represents the information set at time t. Then $\mathcal{Y}^T$ is the information set based on the full sample. Suppose θ denote the vector of parameters. To assess the likelihood of the state variable s_t, it is important to evaluate its optimal forecast (conditional expectations) of $s_t = i, i = 0, 1,$ based on different information sets. These forecasts include the smoothing probabilities $\mathbb{P}(s_t = i \mid \mathcal{Y}^T; \theta)$ which are based on full sample information. By deriving the algorithms of these probabilities, it is also possible to obtain the quasi-log likelihood function as a by-product, from which the quasi-maximum likelihood estimates (QMLE) can be obtained.

4. Empirical Results

We first report the results of the ADF and PP tests which have been carried out to find if all the variables are stationary. This step is necessary as the usual unrestricted vector autoregressive (VAR) model requires all the variables to be stationary. The test results, given in **Table 3,** clearly conclude that all the variables are stationary at 1% level of significance.

Table 3. Results of unit root tests

Variable	ADF test	PP test
REIT	-6.77***	-15.71***
RPV	-10.87***	-11.17***
IIPG	-4.45***	-15.58***
INF	-11.35***	-10.68***

Note: i) The optimal lag orders of the variables in ADF regressions are selected by the Schwarz Information Criterion.
ii) '***' denotes significance at 1% level.

4.1. Results of TVAR model

The threshold VAR (TVAR) model uses the threshold variable which is averages of the past values of REIT returns as a threshold variable. Depending on the value of the threshold variable whether it is positive and non-positive these two regimes have been identified as bull and bear market respectively. In order to determine whether there is at all any nonlinearity present in the relationship, the linearity test has been conducted. The result of this test rejects linearity in favor of the nonlinear model with two regimes. The test statistic value is 61.17, and the null hypothesis of a single linear VAR model is rejected against the alternative of a two-regime VAR model with p-value being 0.0004. The two regimes are then classified as Bull market and Bear market depending on whether the past mean values of REIT returns is positive or non-positive. Estimated parameters from the TVAR model has been given in Table 4. The lag length, p, of the estimated TVAR model has been chosen to be 2 based on the AIC and/or BIC criteria. The first column of the table depicts the scenario of bear market where the past mean values of REIT returns is non-positive and the second column shows the bull market situation where the past mean returns is positive. The bear market regime reveals that output growth affects REIT returns positively and significantly. In this bear market situation, investors are beginning to move their money out from REIT equities and into fixed-income securities until there is a positive sign from the market. If output growth increases, it gives a positive indication to the potential investors. Accordingly, demand for commercial real estate increases and so does for REIT securities as investors wish to buy REIT securities in that favorable situation. This causes the REIT price to increase with the increase in output growth in the bear market condition.

In case of bull market condition where the past mean values of REIT returns are positive, there is no significant effect of output growth on the REIT returns. It may be due to the fact that investors have a tendency to demand more REIT equities in the bull market situation even if output growth does not change. But the effect of relative price variability on REIT returns is positive and significant in this regime. In this situation, increased relative price variability may give negative signal to the investors of other equity markets as increased relative price variability has a negative impact on output growth due to the misallocation of resources (see for example, Barro, 1976 and Cukierman, 1982). This creates more demand in the REIT equity market. Hence REIT returns increases with the increase in relative price variability in the bull market regime. Another important finding is that the effect of inflation on REIT returns is insignificant in both the regimes. This finding supports the view of Glascock et al. (2002) who showed that effect of inflation is negative if fundamental economic activities are not taken into account while this effect is insignificant if these are included in the analysis. In our study, because of inclusion of output growth and relative price variability, the effect of inflation on REIT returns has been found to be insignificant.

Table 4 . Estimated coefficients of the TVAR(2) model for the USA

parameter	regime 1	regime 2
C_1	-0.01	0.25
a_1^{11}	0.12	-0.03
a_1^{12}	0.74	0.77**
a_1^{13}	1.31**	0.63
a_1^{14}	-1.82	-2.28
a_2^{11}	-0.23***	-0.03
a_2^{12}	-0.77	0.05
a_2^{13}	2.324***	-0.05
a_2^{14}	3.40	1.25
C_2	1.44**	0.85***
a_1^{21}	-0.03***	0.00
a_1^{22}	0.59***	0.21***
a_1^{23}	0.10	-0.18
a_1^{24}	-1.41**	-0.28
a_2^{21}	0.06***	0.03***
a_2^{22}	-0.24***	0.13**
a_2^{23}	-0.65***	-0.30***
a_2^{24}	0.39	0.70***
C_3	0.49***	0.19**
a_1^{31}	-0.01***	0.00
a_1^{32}	-0.19***	-0.02
a_1^{33}	0.10	0.05
a_1^{34}	0.71***	0.00
a_2^{31}	0.00	0.01
a_2^{32}	-0.10**	0.01
a_2^{33}	0.23***	0.16***
a_2^{34}	-0.88***	-0.15
C_4	0.03	0.24***
a_1^{41}	0.00***	-0.00
a_1^{42}	-0.01	-0.05***
a_1^{43}	0.03	-0.04
a_1^{44}	0.50***	0.03***
a_2^{41}	0.00**	0.00
a_2^{42}	0.07**	0.01
a_2^{43}	0.12***	0.00
a_2^{44}	0.00	-0.24***

Note: ‘**’ and ‘***’ indicate significance at 5% and 1% levels, respectively.

4.2. Results of MSVAR model

In this paper we have imposed switching specification in a VAR framework. Hence it is important to test explicitly whether or not we can reject the null hypothesis of a single linear model in favor of the Markov switching model. Though in this work the specification of regime switching is used in a VAR framework, this test is available at the univariate level only. The null hypothesis sets the equality of the intercept and autoregressive parameters across all the assumed regimes. It is noteworthy that the usual likelihood ratio (LR) test has a problem because of the presence of nuisance parameters. To be specific, the parameters p_{11} and p_{22} are not identified under null hypothesis, and hence the conventional LR test does not yield the standard asymptotic distribution although many researchers continue to use the LR test to draw their conclusions. We have, however, used the Hansen (1992, 1996) approximation of the test statistic. The test requires computing the constrained estimates of the likelihood function over a grid of possible values for the set of parameters which do not converge to any fixed population parameters under the null hypothesis of a single linear model.

Results of testing for the Markov switching model for each of the four variables are presented in **Table 5**. The values of standardized likelihood ratio statistic show that the null hypothesis of a single linear AR model is rejected in favor of the Markov switching model for all the variables except inflation. For the RPV series, the model under the null i.e., an AR(1) model is rejected at 1% level of significance whereas for REIT and IIPG the null model of AR(2) is rejected at 5% and 10% levels of significance, respectively.

Table 5. Results of test for the Markov switching model

Variable	Model under null	Switching parameters	Standardized likelihood ratio statistic value	p-value
REIT	AR(2)	(μ, φ_2)	2.992	0.05
RPV	AR(1)	(μ, φ_1)	9.644	0.00
IIPG	AR(2)	(μ, φ_1)	2.785	0.09
INF	AR(1)	(μ, φ_1)	2.211	0.31

Note: The intercept term, μ, is constant, and φ_1 *and* φ_2 are the first and second order autoregressive coefficients, respectively.

We now present our findings on the relationship involving the variables considered in this study. The estimation results of the four-variate VAR model under a two-state Markov switching model are given in **Table 6.** And the smoothed probabilities based on this model are plotted in **Figure 2.** The order of the MSVAR process has been found to be 1 by both the AIC and BIC criteria. From the estimated variance-covariance matrices of the two states which are presented in **Table 7**, the first regime is identified as the low variance regime and the second one as the high variance regime since the estimated variance of each of the four variables is higher in state 2 than in state 1. It is estimated that the expected duration of first regime is 7.88 time periods, whereas it is 2.39 time periods for the second regime. The transition probability matrix is estimated to be

$$\hat{P} = \begin{bmatrix} \widehat{p_{11}} & \widehat{p_{12}} \\ \widehat{p_{21}} & \widehat{p_{22}} \end{bmatrix} = \begin{bmatrix} 0.87 & 0.42 \\ 0.13 & 0.58 \end{bmatrix}.$$

This indicates that the first state is very persistent while the degree of persistence in the second regime is moderate. It is evident from the results on the significance or otherwise of the coefficients in the two regimes, as reported in **Table 6**, that relative price variability has differential effects on REIT returns. In the first state, characterized by low variance, RPV has significant positive effect whereas it is insignificant in the second regime where the variance is high. It is important to note that in the context of observed regime-switching model, RPV also has significant positive effect on REIT returns in the bull market regime.

Table 6. The estimated coefficients of the MSVAR (1) model

parameter	regime 1	regime 2
C_1	-0.14	4.65**
β_1^{11}	-0.02	0.15
β_1^{12}	1.07***	-1.28
β_1^{13}	0.79	3.19***
β_1^{14}	-1.79	2.11
C_2	0.94***	3.10***
β_1^{21}	-0.02**	-0.07**
β_1^{22}	0.31***	0.08
β_1^{23}	-0.08	0.50**
β_1^{24}	-0.58***	-0.22
C_3	0.51***	-0.04
β_1^{31}	0.01	-0.00
β_1^{32}	-0.19***	0.06
β_1^{33}	0.16	-1.33
β_1^{34}	-0.02	0.12
C_4	0.19***	0.23**
β_1^{41}	-0.00	0.01**
β_1^{42}	-0.04***	-0.02
β_1^{43}	0.34***	0.06***
β_1^{44}	-0.03	0.06

Note: '*' and '**' indicate significance at 5% and 1% levels, respectively.

Eaton (1980) has argued that RPV may have positive effect on the return of an asset if the elasticity of demand of this asset and marginal propensity to consumption from the returns of this asset are large. Since returns from real estate asset have some impact on the level of future consumption (see, for instance, Brayton and Tinsley, 1996), it is expected to have positive relationship between RPV and REIT returns. On the other hand output growth (IIPG) has positive and significant effect on REIT returns in the second regime i.e., the high variance regime. In case of observed regime we have similar kind of result in the bear market condition.

Table 7. Estimated variance-covariance matrix

State 1					State 2			
16.11***	0.00	0.00	0.00		68.11***	0.00	0.00	0.00
0.00	0.21***	0.00	0.00		0.00	2.35***	0.00	0.00
0.00	0.00	0.01***	0.00		0.00	0.00	0.16***	0.00
0.00	0.00	0.00	0.22***		0.00	0.00	0.00	1.43***

Note: '***' indicates significance at 1% level.

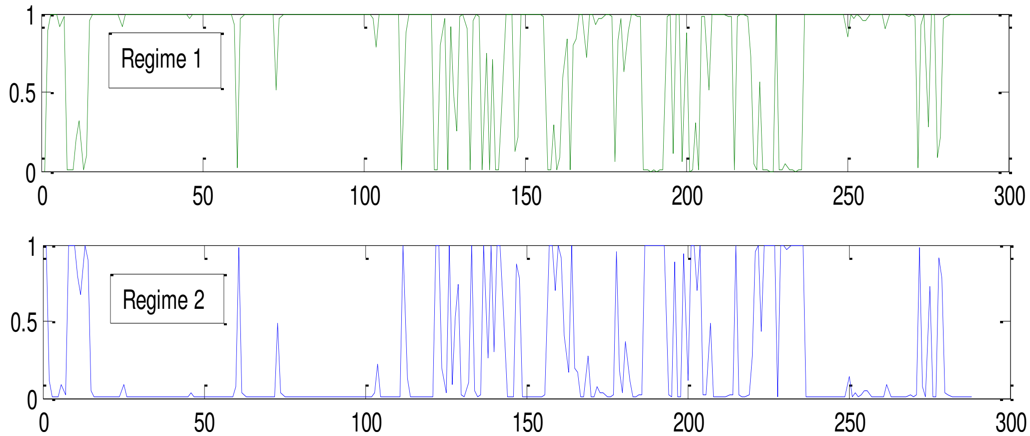


Figure 2. Smoothed probabilities for the MSVAR (1) model with REIT, RPV, IIPG, and INF

From the entries in **Table 6**, it is also evident that RPV has an adverse effect on output growth (IIPG) in state 1 since the coefficient value is negative and significant. But this effect in case of state 2 is positive and insignificant. This significant negative effect in state 1 arises mainly because of misallocation of resources and efficiency loss due to this misallocation. This has, in fact, been stated, *inter alia*, by Barro (1976) and Cukierman (1982) who showed analytically that increased relative price variability causes efficiency loss to the extent that it leads to increase in the dispersion of actual output around the full employment output level. Empirical evidence shows that the relationship is indeed negative which tends support to the theory. However, the causal relationship between RPV and IIPG is not unidirectional. Output growth also has the significant positive effect on RPV in the second state while in the first state the effect is insignificant. In other words, IIPG has differential effects on RPV.

Finally, it is important to note that the effect of inflation on REIT returns is insignificant. A number of studies have reported that the effect of inflation on REIT returns is spurious. It is evident from this study that the observed negative relationship between REIT returns and inflation appears to proxy for the significant effect of RPV on both output growth and REIT returns. It is also worth mentioning that unlike some of the previous studies, this study finds that the relationship between relative price variability and inflation is negative and that it is not stable over the entire sample period.

5. Conclusions

This paper re-examined the negative relationship between inflation and REIT returns in a regime-switching modeling setup with the inclusion of additional macroeconomic variables of relevance and importance *viz.,* output growth and relative price variability. The evidence shows that the anomalous negative relationship between REIT returns and inflation appear to proxy for the effectiveness of relative price variability and output growth on REIT returns. We have also found that the overall relationship involving these variables is non-linear in nature. It is evident from both TVAR and MSVAR models that output growth has positive impact on REIT returns in a bear market condition where the mean value of the past returns of REIT is non-positive and variance is high. On the other hand, in bull market situation, effect of RPV on REIT returns is positive and significant where the mean values of the past returns of REIT is positive with low variance.

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Note: The MATLAB codes used for this MSVAR estimation have been taken from the official website of Marcelo Perlin. (https://sites.google.com/site/marceloperlin/).

The GAUSS codes used for the testing linearity against Markov-switching AR model have been taken from official website of B.E. Hansen. (http://www.ssc.wisc.edu/~bhansen/progs/).

The R codes used for TVAR estimation have been taken from the official website of Matthieu Stigler. (https://github.com/MatthieuStigler/tsDyn/blob/master/tsDyn/R/TVAR.sim.R)