Revisiting the Anomalous Relationship between Inflation and REIT Returns in Presence of Structural Breaks: Empirical Evidence from the USA and the UK

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Revisiting the Anomalous Relationship between Inflation and REIT Returns in Presence of Structural Breaks: Empirical Evidence from the USA and the UK

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Abstract

In this paper we have re-investigated the frequently observed anomalous negative relationship between inflation and REIT returns for two most important economies *viz.,* the USA and the UK by addressing two aspects of misspecification: inappropriate functional form and omission of relevant variable. We have found that the anomalous relationship between REIT and inflation appear to proxy for the significant effect of relative price variability on REIT returns in both the countries. Further, it is evidenced that the effect of relative price variability on real estate investment trust (REIT) returns is not stable over time in case of the USA while in the UK there is no structural change in the relationship.

Keywords: REITs; Relative price variability; Inflation; Structural breaks.

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1. Introduction

A number of papers have attempted to explain the anomalous relationship between real estate investment trust (REIT) returns and inflation. The relationship is anomalous in the sense that the effect of inflation has often been found to be negative though it was expected to be positive from theoretical consideration. Such an expectation was derived due to existence of positive relationship between residential real estate returns and inflation, and REIT being a securitized form of this traditional real estate investment, it was also expected to have positive association with inflation.

In this paper our aim is to resolve this anomalous relationship considering two important issues which the previous studies have failed to capture. The idea is that the anomalous nature of this relation is essentially due to what, in general econometrics terminology, can be called 'misspecification' of the underlying model. These two aspects of misspecification that appears relevant in this context are inappropriate functional form of the model and omission of relevant variables in the existing studies. Keeping this in mind we have considered firstly the non-linear modeling approach where structural break is explicitly considered not only for the variables concerned but also in the relationship involving the variables by using Qu and Perron (2007) methodology. Secondly, the inclusion of a relevant variable namely, relative price variability other than REIT returns and inflation. The inclusion of relative price variability has provided some new insights which have explained the existing anomalous relationship as it affects inflation directly as well as asset returns through the change in real economic activity. Barrow (1976) and Cukierman (1982) both have argued that increased relative price variability has negative impact on economic production which happens due to misallocation of resources caused by the increased relative price variability.

For our study, monthly data of the USA and the UK, covering the period from January 1990 to December 2014 and January 1996 to December 2014, respectively, have been used. The starting date of the UK data is on January 1996 as most of the individual price series which are required for the construction of relative price variability are available only after 1996. In this paper, we have found empirically in both the countries that the existing negative relationship between REIT returns and inflation appears to proxy for the significant effect of relative price variability on the REIT returns and inflation as well. Moreover, our results indicate that the relationship involving all the variables are not stable over the entire sample period for the USA while in case of the UK there is no significant structural change in the underlying relationship. The time points of the structural changes obtained for the USA are, however, found to coincide with the period of the Global Financial Crisis.

The paper is organized as follows: Section 2 provides extensive review of literature on this anomalous relationship. The details about data and methodology used in this study are discussed in the Section 3. Next Section presents the estimation results. The paper ends with some concluding remarks in Section 5.

2. Literature review

As discussed in the introduction section, our paper has contributed to an extensive body of literature studying on the anomalous negative relationship between REIT returns and inflation. Extant literatures tends to suggest that REIT returns have negative relationship with inflation while few studies, such as Chen and Tzang (1988), Liang et al. (1998), and Chatrath and Liang (1998) have indicated that REIT possesses some inflation hedging properties which establishes the positive relationship between REIT returns and inflation. Chen and Tzang (1988) documented that REIT has some ability to hedge expected component of inflation and found that REIT returns are closely related to interest rates. Liang et al. (1998) ruled out the possibility that a stock market-induced proxy effect is the cause for the apparent lack of relationship between REIT returns and inflation, and found that REIT returns are positively related to temporary or permanent components of inflation measures. Chatrath and Liang (1998) have empirically found the long-run co-movement between REITs and inflation. However, most of the empirical evidences tend to suggest the opposite i.e., REIT returns have negative relationship with inflation. Goebel and Kim (1989), and Park et al. (1990) have found negative relationship between REIT returns and 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. The characteristic of perverse hedging ability is quite common in the literature of the stock market as well. 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 the relationship between REIT and inflation (see, for instances, Glascock et al. 2002; Ewing and Payne 2005; Chang et al. 2011). Lu and So (2001) have empirically shown that the inflation does not Granger-cause REIT returns rather monetary policy does. There are other REIT studies which have focused on the sensitivity of REIT returns with respect to unexpected inflation show the importance of monetary policy to the 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 first discuss about the details on the relevant aspects of the data sets. The standard descriptive statistics values of these data sets are also presented and discussed. The sample period for all the time series used in this study ranges from January 1990 to December 2014 for the USA and January 1996 to December 2014 for the UK. Monthly data of the equity REIT returns for the USA has been taken from the National Association of Real Estate Investment Trust (NAREIT) *REIT Handbook,* whereas it has been taken from Data Stream for the UK. The price series used to construct a relative price variability measure called RPV_t, and as described below, involves the seasonally adjusted price indices of the components of the consumer price index (CPI) at the item/product level. As summarized in **Table 1**, the resulting series for both the USA and the UK which are available for 38 and 40 product categories, respectively, have 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 are required. This data have been obtained from the Federal Reserve Bank at St. Louis for both the countries. Relative price variability (RPV_t) is most often constructed by the weighted average of sub-aggregate inflation series using the standard deviation (s.d.).

Table 1. Weights of the individual price indices used for the calculation of relative price variability in the USA and the UK.

The U.S.			The UK	
1990:M1-2014:M12			1996:M1-2014:M12	
Item	Weight		Item	Weight
All items	100		All items	100
Cereals and bakery products	1.10		Bread and cereals	1.7
Beef and veal	0.63		Meat	2.2
Pork	0.41		Fish	0.4
Fish and seafood	0.34		Milk, cheese and eggs	1.4
Eggs	0.10		Fruits	0.9
Milk	0.29		Vegetables including potatoes tubers	1.5
Cheese and related products	0.25		Sugar, jam, syrup, chocolate and conf.	1.2
Fresh fruits	0.49		Non alcoholic beverages	1.4
Fresh vegetables	0.47		Alcoholic beverages	1.8
Nonalcoholic beverages	0.91		Tobacco	2.4
Other food at home	1.74		Clothing	5.6
Food away from home	5.99		Footwear including repairs	0.9
Alcoholic beverages	1.11		Rental for housing	6.4
Shelter	32.78		Regular maintenance & repair dwellin.	1.4
Fuel oil and other fuels	0.34		Other service relating to dwelling	1
Electricity	2.75		Furniture, furnishings, & decorations	2
Utility gas service	1.28		Household textiles	0.7
Household furnishings and operations	4.65		Household appliances	0.9
Men's apparel	0.70		Household utensils	0.5
Boy's apparel	0.19		Tools & equipment for house & garde.	0.5
Women's apparel	1.35		Goods & services for routine mainten.	1.5
Girls' apparel	0.24		Medical products, appliances and equi.	1
Men's footwear	0.23		Other recreational item, garden & pets	3.5
Women's footwear	0.36		Purchase of vehicles	4.3
New vehicles	4.98		Operation of personal transport equip.	8.9
Used cars and trucks	1.72		Transport service	3
Motor fuel	4.35		Telephone and tele-fax equip. & serv.	2.6
Motor vehicle parts and equipment	0.37		Audio visual equipment & products	2.3
Medical care commodities	1.45		Electricity, gas & other fuel	5.6
Medical care services	4.83		Recreational & cultural service	2.9
Sporting goods	0.67		Accommodation service	1.7
Photographic equipment and supplies	0.08		Personal care	2.8
Toys	0.25		Personal effects	1.3
Admissions	0.71		Catering	9.7
Educational books and supplies	0.20		Insurance	0.8
College tuition and fees	1.52		Financial services	2.3
School tuition and fees	0.41		Education	1.9
Other goods and services	3.48		Books, news papers & stationary	1.3
			Holiday package	2.4
			Other services	1.1

The primary measure of inflation used here is the monthly log-difference of the seasonally adjusted CPI.

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

where $\pi_{it} = \ln P_{it} - lnP_{i,t-1}$, $\bar{\pi}_t = \sum_{i=1}^{N} \omega_i \pi_{it}$, 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.[‡]

3.2. Summary Statistics

Table 2 shows the summary statistics of the three variables for both the countries under investigation, *viz.,* real estate investment trust returns (REIT), relative price variability (RPV), and inflation (INF). Note that REIT returns in both the countries have the highest standard deviation among the three variables, followed by relative price variability. The skewness value for RPV is highest in both the countries while the value is lowest for REIT returns in the USA and for inflation in the UK. It may be further noted that the distributions of REIT returns for both the countries along with the inflation series are skewed to the left in case of the USA.

Table 2 Statistical summary of real estate investment trust (REIT) returns, relative price variability (RPV), and inflation (INF) for the USA and the UK

	The USA			The UK		
	REITR	RPV	INF	REITR	RPV	INF
Mean	1.046	1.525	0.204	0.531	0.901	0.168
Median	1.293	1.127	0.208	0.632	0.808	0.152
Maximum	31.01	12.16	1.367	21.174	3.119	0.814
Minimum	-31.66	0.384	-1.786	-36.932	0.386	-0.602
Std. dev.	5.464	1.193	0.267	6.011	0.378	0.191
Skewness	-0.764	3.706	-1.384	-1.195	2.442	0.294
Kurtosis	11.42	26.14	15.16	10.414	12.136	4.666
J-B statistic	916.4	7380	1945	573.94	1028.64	29.54
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

Note: *p*-values are given in parentheses.

All the variables in both the countries have very high kurtosis values, and hence as seen from the J-B test statistic values, the null hypothesis of normality is rejected. It is evident from these plots given in **Figure 1** and **2** that these are likely to be stationary since REIT returns, and INF exhibit random fluctuations around some mean values. Of course, this has been confirmed by the augmented Dicky-Fuller test, as reported in **Table 3**. Further, the effect of the Global Financial Crisis around 2008 is more or less visible in all the series.

[‡] Given the nature of index data, the RPV measure adopted here should be read as relative inflation variability. In this paper, however, we have followed the tradition in the literature and referred to this measure as RPV. Another common formulation for RPV is the coefficient of variation (c.v.). Here we have chosen standard deviation (s.d.) as 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 important, c.v. is not easily defined when inflation is close to zero or even negative.

Fig.1. Time series plots of real estate investment trust returns (REITR), relative price variability (RPV), and inflation (INF) for the USA.

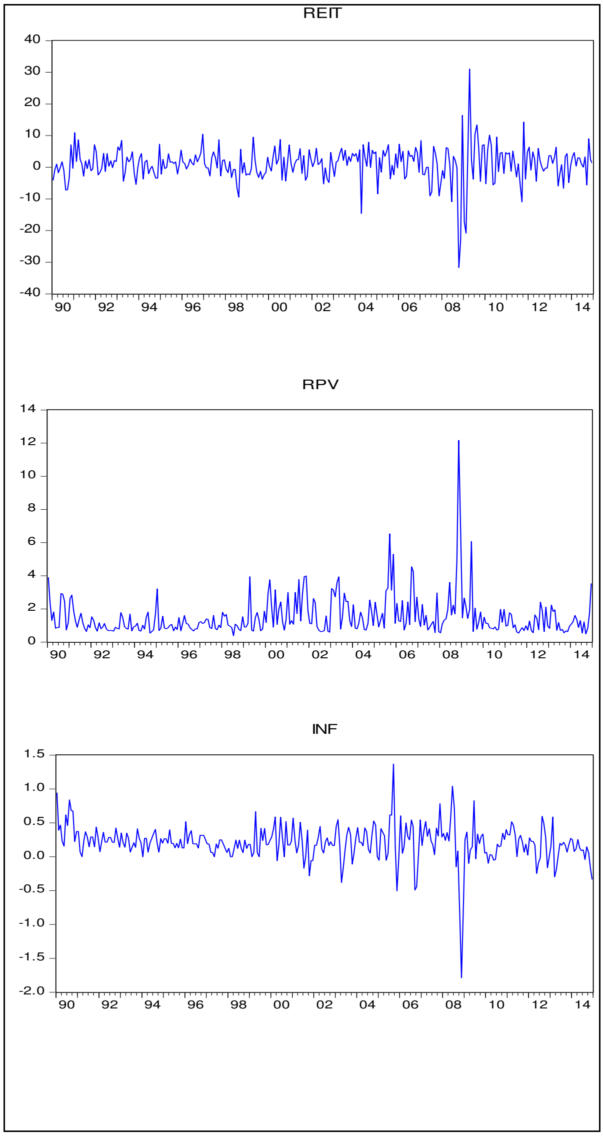
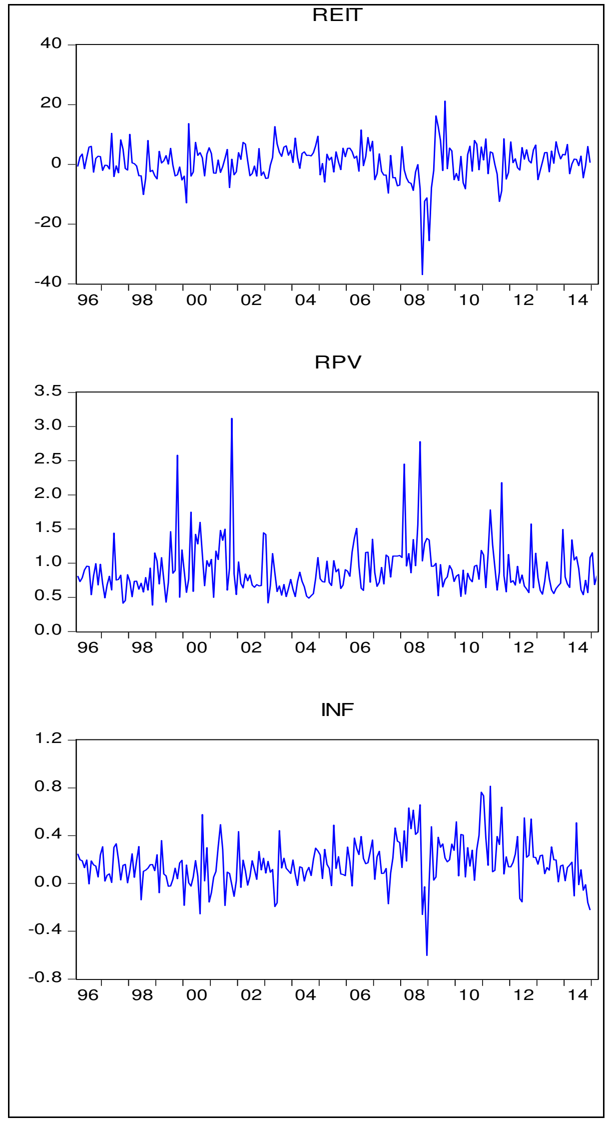


Fig.2. Time series plots of real estate investment trust returns (REITR), relative price variability (RPV), and inflation (INF) for the UK.



3.3. Methodology

Both the statistics and econometrics literature have a good deal of work on inferences on structural changes with unknown break dates, most of which are specifically designed for the case of a single change.[4] The issue of multiple structural changes has received more attention recently, and this is in the context of single regression model only (see, Bai and Perron 1998, 2003). However, work concerning structural changes in the context of a system of equations is only very recent and very few in number, and the important ones are Bai and Perron (1998), Hansen (2003), and Qu and Perron (2007).

The main advantages of Qu and Perron (2007) methodology is that it provides a comprehensive treatment of issues related to estimation, inference, and computation with multiple structural changes that occur at unknown points in linear multivariate regression models that include vector autoregressive (VAR) model, certain linear panel data models, and seemingly unrelated regression (SUR) model. Changes can occur in the parameters of the conditional mean, the covariance matrix of errors, or both, and the distribution of the regressors can also be allowed to change across regimes. It may be noted that for this methodology it is not required to assume that the regressors are independent of the errors at all leads and lags in presence of heteroskedasticity and/or autocorrelation. Let the variables of interest $Y_t = (Y_{1,t}\ Y_{2,t} \ldots Y_{n,t})'$ be an $(n \times 1)$ vector at time point t. The general model considered by Qu and Perron (2007) is as follows.

$$Y_t = (I \otimes x_t')S\varphi_j + u_t \tag{2}$$

where $Y_t = (Y_{1,t}\ Y_{2,t} \ldots Y_{n,t})'$ for n equations and T observations. The total number of structural changes in the system is m and the break dates are denoted by the $(1 \times m)$ vector $T = (T_1\ T_2 \ldots T_m)$, taking into account that $T_0 = 1$ and $T_{m+1} = T$. The subscript j indexes a regime where $(j = 1, 2, \ldots, m + 1)$, subscript t indexes the temporal observation $(t = 1, 2, \ldots, T)$, and i indexes the i^{th} equation where $i = 1, 2, \ldots, n$ to which a scalar dependent variable $Y_{i,t}$ is associated. The number of regressors is q and x_t is the $(q \times 1)$ vector which includes the regressors from all the equations i.e., $x_t = (x_{1,t}\ x_{2,t} \ldots x_{q,t})'$, and φ_j is the set of parameters in the model for the j^{th} regime. The selection matrix is denoted by S in the above equation, which involves elements that take the values 0 and 1, and thus indicate which regressors appear in each equation. When using a vector autoregressive model, we have $x_t = \left(1\ \ y_{1,t-1}\ y_{1,t-2} \cdots y_{1,t-q}\ y_{2,t-1}\ y_{2,t-2} \cdots y_{2,t-q}\ y_{3,t-1}\ y_{3,t-2} \cdots y_{3,t-q}\right)'$, which simply contains the lagged dependent variables including intercept term, and here S will be an identity matrix.

This general framework of VAR is adopted for the purpose of studying structural breaks in the relationships involved in this study, and to estimate the parameters thereafter for different regimes separately based on the Qu-Perron test. In our case, Y_t now consists of relative price variability, inflation, and REIT returns i.e., $Y_t = (RPV_t, INF_t, REIT)'$. The quasi maximum likelihood method is used to estimate the above model. Qu and Perron (2007) have proposed a number of test statistics for identifying multiple break points, and these are stated below.

[4] See, Perron (2006), for an extensive review.

(i) The $sup\ F_T(k)$ test i.e., a $sup\ F$-type test of the null hypothesis of no structural break versus the alternative of a fixed number of breaks(k).

(ii) The double maximum test, denoted as $UDmax$ test and $WDmax$ test, from consideration of having equal weighting scheme and unequal weighting scheme where weights depend on the number of regressors and the significance level of the tests. For these two tests, the alternative hypothesis is that the number of breaks is unknown, but up to some specified maximum[5].

(iii) The $sup\ F_T(l+1|l)$ test i.e., a sequential test of the null hypothesis of l breaks versus the alternative of $(l+1)$ breaks with the starting value of l being 1.

It should be quite obvious that size and power of these tests are important issues for final testing conclusions. Similar to Bai and Perron (1998, 2003), Qu and Perron have suggested the following useful strategy. First the $UDmax$ test and the $WDmax$ test are used to find if at least one break is present. If these indicate the presence of at least one break, then the number of breaks can be decided based upon the sequential examination of the $sup\ F_T(l+1|l)$ statistic which is constructed using global minimizers for the break dates. While applying these tests, we set the value of the trimming parameter to 0.15. Since the focus of this study is on the stability of the relationship among the variables of interest, we restrict our attention to tests for changes in the regression coefficients only. Once the tests for structural breaks have been carried out, the subsequent estimation of the relations involving these variables for each regime is done by VAR model whose explicit form is as follows:

$$\begin{bmatrix} y_{1t} \\ y_{2t} \\ y_{3t} \end{bmatrix} = \begin{bmatrix} \varphi_1 \\ \varphi_2 \\ \varphi_3 \end{bmatrix} + \begin{bmatrix} \varphi_1^{11} & \varphi_1^{12} & \varphi_1^{13} \\ \varphi_1^{21} & \varphi_1^{22} & \varphi_1^{23} \\ \varphi_1^{31} & \varphi_1^{32} & \varphi_1^{33} \end{bmatrix} \begin{bmatrix} y_{1t-1} \\ y_{2t-1} \\ y_{3t-1} \end{bmatrix} + \begin{bmatrix} \varphi_2^{11} & \varphi_2^{12} & \varphi_2^{13} \\ \varphi_2^{21} & \varphi_2^{22} & \varphi_2^{23} \\ \varphi_2^{31} & \varphi_2^{32} & \varphi_2^{33} \end{bmatrix} \begin{bmatrix} y_{1t-2} \\ y_{2t-2} \\ y_{3t-2} \end{bmatrix} + \cdots + \begin{bmatrix} \varphi_p^{11} & \varphi_p^{12} & \varphi_p^{13} \\ \varphi_p^{21} & \varphi_p^{22} & \varphi_p^{23} \\ \varphi_p^{31} & \varphi_p^{32} & \varphi_p^{33} \end{bmatrix} \begin{bmatrix} y_{1t-p} \\ y_{2t-p} \\ y_{3t-p} \end{bmatrix} + \begin{bmatrix} u_{1t} \\ u_{1t} \\ u_{1t} \end{bmatrix}$$

4. Empirical Results

We first report the results of the augmented Dickey and Fuller (1979) (ADF) test which has been applied to find if all the variables are stationary. This step is necessary as the usual unrestricted vector autoregressive model requires all the variables to be stationary. The optimum lag length for the ADF test has been chosen by the Schwarz information criteria (SIC).

Table 3. Results of the ADF test for stationarity and the Bai-Perron tests for multiple structural breaks

	The USA			The UK		
Test	REIT	RPV	INF	REIT	RPV	INF
ADF	-6.77**	-11.44**	-11.342**	-11.19**	-12.93**	-12.61**
WD_{max} (Up to one break)	26.57**	36.92**	18.53**	48.08**	30.94**	31.03**
$Sup\ F_T(2\|1)$	25.92*	19.09**	14.05*		25.10**	
$Sup\ F_T(3\|2)$						

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

It can be concluded from the test results, presented in **Table 3**, that all the variables are stationary at 1% level of significance for both the countries. In addition, the structural stability of each of

[5] The methodology of these two tests is same as that in Bai and Perron (1998).

the variables during the sample period has been examined by carrying out the Bai-Perron (1998, 2003a) multiple structural breaks test for both the countries. This test requires using $UDmax$ test, $WDmax$ test and then $\sup F_T(l+1|l)$ test, as described earlier. It is evident from the results of the tests presented in **Table 3** that at least one structural break is present in all the series of both the countries. The $WDmax$ test statistic values are found to be higher than the critical value of 12.81 at 5% level of significance for inflation series in the USA, and for all other series the values of this test statistic indicate significance at 1% level. Hence, the null hypothesis of 'no break' is rejected in favor of alternative of 'upto one break'. To detect further if there is more than one structural break, the sequential break test has been performed. This test also suggests that all the three series are structurally unstable. In fact, looking at $Sup\ F_T(3|2)$ test statistic values, it is evident that there are two breaks in all the series of the USA and RPV series of the UK. In case of RPV series in the USA, the estimated break dates are 1993:M08 and 2009:M07 while for the UK these are 2001:M11 and 2009:M02. The estimated break dates for REIT series in the USA are 2005:M04 and 2009:M03 while for UK it is 2007:M01. The break dates in case of INF series in the USA have been estimated as 2001:M07 and 2008:M08 while for the UK it is 2010:M11. Since all the series are found to be structurally unstable, any study of the relationship involving these variables cannot be taken to be of the fixed coefficient kind. These findings of structural stability of all the series provides justification for our approach of considering VAR model allowing for multiple structural breaks.

We now report the results of the Qu-Perron (2007) test for detecting breaks in the system of equations involving these three variables. The values of this test statistic are given in **Table 4**. It is clear that the test results indicate the presence of structural breaks in the relationship involving REIT returns, relative price variability and inflation for the USA while in case of the UK there is no structural change in the underlying relationship.

Table 4. Estimated multiple breaks in the relationship based on the Qu-Perron methodology

	$WDmax$ test (up to one break)	$supF_T(2\|1)$	$supF_T(3\|2)$	Break dates
The USA	42.01**	53.57**	31.26	2005:M05 and 2009:M05
The UK	21.67			

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

In case of the USA, the test statistic value of the $WDmax$ test is found to be 42.01, which is significant at 1% level of significance, and hence the null hypothesis of 'no break' is rejected in favor of the alternative of 'up to one break' in this system of equations. To detect further if there is more than one structural break, the sequential break test was carried out. By looking at the relevant entry of the table, we note that the test statistic value of $supF_T(2|1)$ is 53.57, which is significant at 1% level. So the test rejects the null hypothesis of 'one break' in favor of 'two breaks'. However, the sequential test for detecting more than two breaks i.e., $supF_T(3|2)$ test statistic yields that the underlying null hypothesis of 'two breaks' cannot be rejected in favor of 'three breaks'. Hence, no further test is required. Finally, the break points for the USA have been estimated following the procedure of Qu-Perron, and these are found to be May 2005 and May 2009.

In what follows we attempt at providing plausible economic explanations for the findings on the break dates for both the countries. For the USA, the first break date has been found to be close to the middle of the year 2005, which coincide with the period of bubble in the real estate market. In that period real estate price peaked its high, causing high fluctuations in all the series. The occurrence of second break in middle of 2009 can be attributed to the severe recession in the US economy which occurred as a result of busting of this bubble, causing huge fluctuations in those series again. In case of the UK, as already stated, there is no evidence of any structural break in the relationship involving these variables though it is obvious from the test results in **Table 3** that each of the individual series has one or more structural breaks. This may be due to the existence of 'co-breaking' in the variables which is defined as the cancellation of structural shifts across linear combinations of variables (see for details, Hendry and Mizon 1998; and Clements and Hendry 1999).

Table 5 reports the estimation results of the three-variate VAR models separately for each of the three regimes for the USA and from full sample period for the UK. The orders of lag in these VAR models have been selected on the basis of AIC and BIC criteria. Accordingly, the selected lag orders are 4, 2, and 2 for the first, second and third regimes respectively, while it is 3 for the UK. From the table, the results indicate that neither in the USA nor in the UK inflation affects REIT returns. On the other hand, relative price variability has significant effect on REIT returns in both the country. For instance, in the USA, RPV positively affects REIT returns in both first and third regimes while in the UK, RPV has negative effect on REIT returns. These findings suggest that the causal relationship between inflation and REIT returns is spurious, and the effect of inflation on REIT returns appears to proxy for the effect of relative price variability on REIT returns. However, it is important to note that the effect of RPV on REIT in both the countries is contrasting in nature. In case of the USA, this effect is positive and the coefficient values are 0.9 and 2.10 in first and third regimes 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. In contrast, in the UK this effect is negative and the coefficient value is -2.54. The negative effect of RPV on REIT returns is due to the adverse effect of RPV on economic production which in turn lowers the returns from REIT. The negative effect of relative price variability on economic production is due to misallocation of resources caused by the increased relative price variability (see for instance, Barrow 1976; and Cukierman 1982). Looking at the results in **Table 5** it is evidenced that significant negative relations between inflation and relative price variability exists in both the USA and the UK. Despite the existence of a large body of empirical studies reporting positive relationship (see, for example, Parks 1978; Lach and Tsiddon 1992; Parsley and Wei 1996; Debelle and Lamant 1997), a number of studies have supported a negative relationship between RPV and inflation. For instance, Reinsdorf (1994) found this relationship to be negative

Table 5. Estimated coefficients of the VAR model in different regimes in the USA and the UK

Parameter	The USA			The UK
	regime 1(i.e., *j=1*) (1990m01-2005m05)	regime 2(i.e., *j=2*) (2005m06-2009m05)	regime 3(i.e., *j=3*) (2009m06-2013m12)	full sample period (1990m01-2013m12)
φ_1	0.67**	1.58**	0.83**	0.612**
φ_1^{11}	0.36**	0.38**	0.02	0.10
φ_1^{12}	-0.34	-1.65**	-0.21	0.05
φ_1^{13}	0.00	-0.07**	0.00	-0.00
φ_2^{11}	-0.10	0.05	0.13	-0.01
φ_2^{12}	0.66	0.98	0.48	0.23
φ_2^{13}	0.00	0.09**	0.08**	-0.00
φ_3^{11}	0.08			0.19**
φ_3^{12}	-0.08			-0.08
φ_3^{13}	-0.00			-0.00
φ_4^{11}	-0.23**			
φ_4^{12}	-0.41			
φ_4^{13}	-0.00			
φ_2	0.19**	0.22	0.13*	0.07
φ_1^{21}	-0.04**	-0.03	-0.06	-0.04
φ_1^{22}	0.33**	0.53**	0.35*	0.15*
φ_1^{23}	-0.00	0.01	0.00	-0.00
φ_2^{21}	-0.02	0.00	0.04	0.03
φ_2^{22}	-0.15	-0.27	-0.12	0.13*
φ_2^{23}	0.00	0.00	0.00*	0.00*
φ_3^{21}	-0.01			0.03
φ_3^{22}	0.16*			0.08
φ_3^{23}	-0.00			0.00
φ_4^{21}	0.04**			
φ_4^{22}	0.02			
φ_4^{23}	-0.00			
φ_3	-0.18	0.61	-1.04	5.79**
φ_1^{31}	0.90*	0.28	2.10*	-2.54**
φ_1^{32}	-1.94	-2.67	-4.69	-0.59
φ_1^{33}	0.00	0.27*	-0.19	0.15*
φ_2^{31}	-0.46	-0.99	1.17	-2.00
φ_2^{32}	1.21	6.03	0.85	1.01
φ_2^{33}	0.08	-0.45**	-0.21*	0.06
φ_3^{31}	-0.03			-1.65
φ_3^{32}	-0.19			0.42
φ_3^{33}	-0.03			0.11
φ_4^{31}	0.54			
φ_4^{32}	0.37			
φ_4^{33}	-0.04			

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

during 1980s in the USA. Fielding and Mizen (2000) and Silver and Ioannidis (2001) also reported the same for several European countries. They have argued that this result is consistent with the fact that the law of one price tends to hold more strongly with higher inflation. In other words, if firms make adjustment to prices towards desired levels during inflationary process then price dispersion may fall. In that case relative price variability will be negatively related to inflation. Further, Rogers and Jenkins (1995) and Engel and Rogers (1998) support the hypothesis that there are frictions to the price setting process, justifying a negative relationship between price variability and inflation.

4.1. Impulse response analysis

In the standard VAR set-up measuring the relationship among REIT, RPV and INF, the REIT is kept last in order with the understanding that REIT reacts directly to the changes in RPV and INF. Figures 3 and 4 display the estimated impulse response of REIT returns to structural innovation of RPV, INF, and REIT returns itself in the USA for the different regimes and in the UK for the full sample period, respectively. In general, the main findings can be summarized as follows: In case of the USA, corresponding to one-standard deviation structural innovation of RPV, REIT returns increase and then fall, with the effect being less persistent. The effect is more or less same in the first and third regimes while in the second regime the immediate effect of RPV on REIT returns is negative and then rises sharply to reach its initial value after two months. In case of the UK, the effect of RPV shock on REIT returns is strong. REIT returns fall initially then rise steadily reaching the initial value after nine months. As regards the effect of structural one-standard deviation innovation of INF to REIT returns, it is observed from both the Figures 4 and 5 for the USA and the UK respectively, that the effect is quantitatively quite small except for the second regime in the USA. It may be noted that the effect is not very persistent in both the countries.

Fig. 3 Impulse response of REIT to structural one S.D. innovation ± 2 S.E. in different regimes in the USA

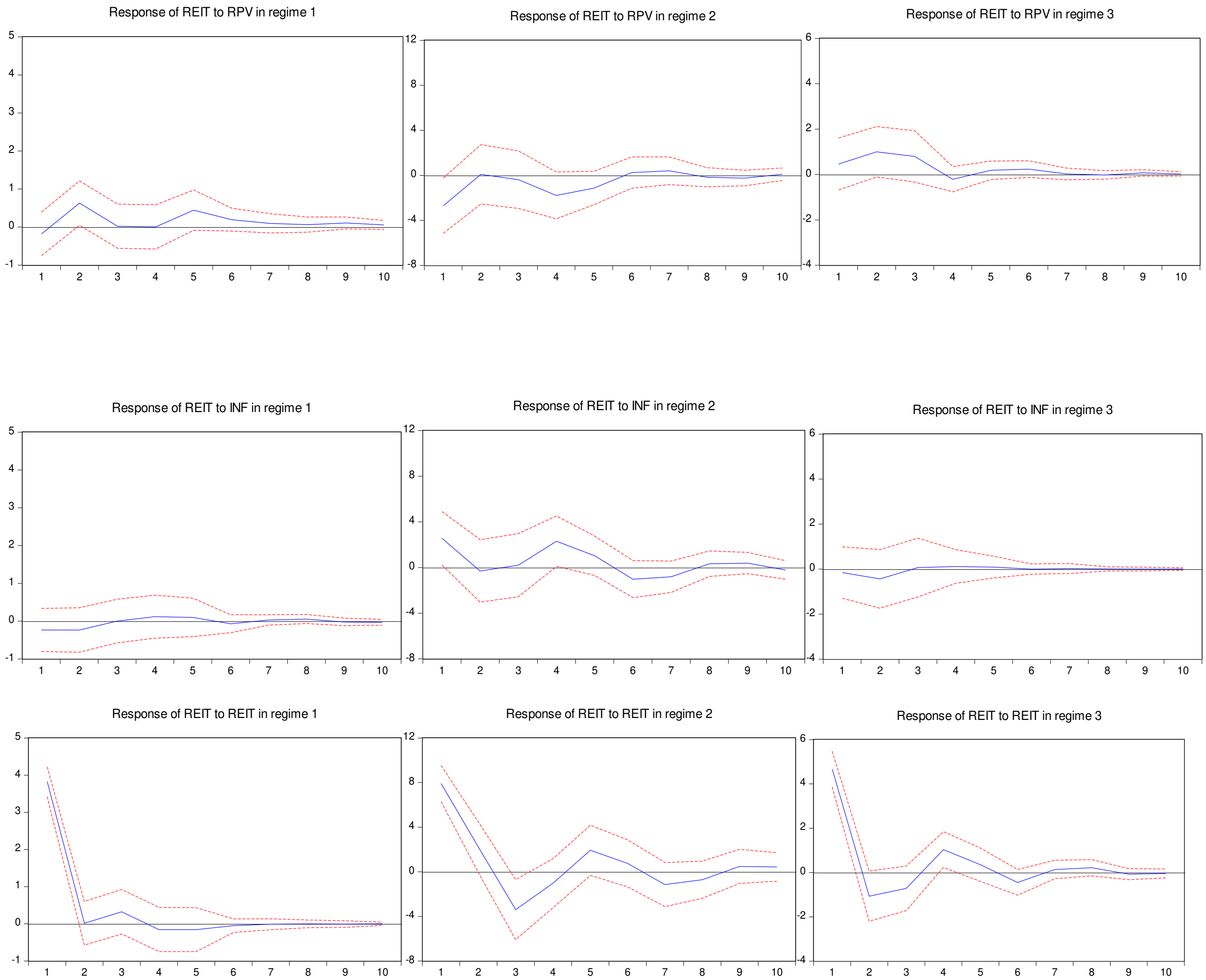
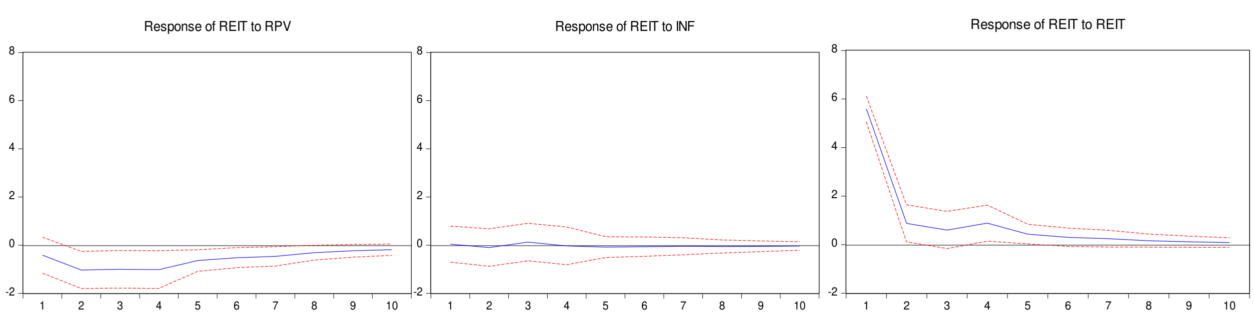


Fig. 4 Impulse response of REIT to structural one S.D. innovation ± 2 S.E. in the UK



5. Conclusions

In this paper, we have explored the effects of relative price variability and inflation on REIT returns and re-examined the spurious relationship between REIT returns and inflation. The evidence shows that the anomalous negative relation between REIT returns and inflation appear to proxy for the effectiveness of relative price variability on REIT returns. We have also found that the effect of relative price variability on REIT returns is positive and different across the different regimes in the USA while it has remained the same in the UK over the entire sample period. In other words, we have found multiple structural changes in the relationship involving REIT, RPV and inflation in the USA, whereas in the UK, there is no such structural change in this relationship. It is also important to note that relative price variability and inflation is negatively related in both the countries. Our findings have important policy implications. For instance, our finding of increased relative price variability having positive effect on REIT returns in the USA combined with the observation by Kaul and Seyhun (1990), *viz.*, that RPV affects stock returns negatively, suggests that investors can diversify their portfolios and maximize their returns by investing more on REIT market than on any other stock market.

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