Олон Улс Судлал №4, 2014 он: *хуудас* 163-193.

MULTI-PERIOD STRATEGIC ASSET ALLOCATION AND INTERTEMPORAL HEDGING DEMANDS FOR REITS

Libo Yin *
Liyan Han **

Abstract: *This paper investigates the benefits of investing in REITs in the context of multi-period portfolio choice and dynamic asset allocation using the methodology of Campbell et al. (2003). We compute the total and intertemporal hedging demand for REITs by solving the multi-period asset allocation problem for an investor with an infinite horizon and Epstein-Zin utility, and then compare the utility benefits improved by adding REITs in an existing portfolio. Our results document significantly sizable mean total and intertemporal hedging demands for REITs. Furthermore, these demands are relatively stable and permanent in magnitude under various settings of intertemporal substitution and the relative risk aversion. Furthermore, we find that the investment benefits improved by REITs are considerable, and far more suitable for conservative investors with relatively high risk aversion.*

Keywords: Multi-period portfolio choice; Strategic asset allocation; REITs; Intertemporal hedging demand; Return predictability

JEL: G11; G12

* Corresponding author. School of Finance, Central University of Finance and Economics.
Address: School of Finance, Central University of Finance and Economics, 39 South College Road, Haidian District, Beijing, 100081, China. E-mail: yinlibowsxbb@126.com.
** School of Economics and Management, Beihang University.
Address: A1101, New Main Building, School of Economics and Management, Beihang University, 37 Xueyuan Road, Haidian District, Beijing, 100191, China. E-mail: hanly1@163.com.

1. Introduction

The real estate industry has grown dramatically in size and importance, and it has attracted considerable interest as an alternative investment tool over the last years[1] . Some evidence calls into question the investment benefits of REITs in diversifying portfolio risks.

On one hand, considering REITs as a type of equity asset class, it has been concluded that "diversification across equity asset classes with dissimilar patterns of returns mitigated downside risk without resorting to diversification into asset classes with lower expected returns" (Gibson, 2008). A summary of existing research on the benefits of investing in real estate is presented by Worzala and Sirmans (2003). Further analyses have been conducted by Bond et al. (2003), Brounen and Eichholtz (2003), Lee (2005), Lee and Stevenson (2005), Waggle and Agrrawal (2006), Imperiale (2006), Cheng and Roulac (2007), Idzorek et al. (2007), Jin et al. (2007), Jinzhao (2007), Fugazza et al. (2008, 2009), Yat-Hung et al. (2008), Sebastian and Sturm (2009), Basse et al. (2009), Lee (2010), Niskanen and Falkenbach (2010) and Wong et al. (2012), etc.

On the other hand, Titman and Warga (1986) show that while the performance rankings of REITs are not very sensitive to the risk-adjustment model like single index (i.e., CAPM) and multiple index (i.e., APT) model, the actual performance measures do sometimes differ substantially. In addition, they find out that because of the high volatility of REITs investments, the differences in investment performance across REITs generally are not statistically significant. Liow et al. (2009) evidence the international correlation structure of real estate securities and the broader stock market are linked to each other, providing economic motivations regarding the potential integration of international real estate securities markets.

Therefore, the purpose of this paper is to restudy the benefits of investment in REITs. Our interest lies in the following aspects. First, we attempt

[1]This trend is accompanied by the introduction of real estate investment trust (REIT) legislation in several countries worldwide, such as Belgium (1995), France (2003), Germany (2007), Hong Kong (2003), Italy (2007), Japan (2000), Singapore (1999), and Great Britain (2007); see, EPRA (2008) and Ooi et al. (2006). Other countries, such as the US and Australia, have had this type of legislation or its equivalent for a long time, and represent the leading securitized real estate markets according to the market capitalization that is related to their GDP. There are approximately 150 publicly traded REITs in the U.S. today, with a combined equity market capitalization of about $390 billion; see, http://www.reit.com.

to obtain the quantitative demand of asset allocation across traditional assets (stocks and bonds in this study) and REITs. The interpretations of the importance of REITs hence can be explained in terms of the striking total and inter-temporal hedging demand for REITs. Second, the potential utility benefits of long-term investors under combinations of various asset classes with or without including REITs as an asset class can then be derived out by calculation of the unconditional mean of the value function, which is later used to compare the utility improvement. Third, we enable quantized examining what type of investors REITs should appeal to by repeating the analysis for different value of relative risk aversion coefficients. For example, REITs may appear to be an asset class for the more adventurous investors with higher risk tolerance. Relevant results can provide empirical support for policy makers and investors.

The rest of this paper is organized as follows. Section 2 reviews the literature. Section 3 outlines the framework of empirical methodology. Section 4 describes the dataset. Section 5 presents our empirical results and analyses why investors have a strong inter-temporal hedging demand for REITs. Section 6 concludes.

2. Literature review

Two approaches can be categorized so far in the literature concerning the benefits of investing in REITs. Firstly, lots of studies evidence appealing properties of REITs as an attractive asset class, in terms of reduced risk without sacrificing return or increased Sharpe ratio. However, such evidence is based on the simple statistics such as returns of REITs and correlations with other asset classes without even attempting any construction of optimal portfolios. While these statistics play an important role in determining the risk-return characteristics of a portfolio, conclusions regarding the desirability of REITs must be based on the risk-return characteristics of the resulting portfolio since it is ultimately the portfolio that matters. Moreover, correlation coefficients analysis captures only the short-term dependence between asset returns, even though investors are usually interested in long-term interrelation and linkages between prices. Secondly, existing studies concerning the role of REITs mostly focus on static asset allocation setting such as one-period mean-variance (MV) framework. Despite the relative success of these studies for providing unanimous evidence that the investor is better off by including REITs in the portfolio, there are some shortcomings that preclude a quick and easy conclusion. The first one is that the MV specification does not reflect accurately the benefits from REITs investments due to two nonrealistic assumptions (i.e. the distribution of the asset returns is normal; investor's preferences are described by a quadratic utility function) [2]. As shown by Brounen et al. (2008), Liow and Sim (2006), and Liow (2007), this assumption does not hold for real estate returns. The second one is that static one-period setting fails to examine the role of REITs in multi-period strategic asset allocation dynamically across the non-traditional REITs and traditional assets. That is, a considerable reduction in risk to long-horizon investors derived from time diversification may exploit non-zero intertemporal hedging demand. REITs may become more desirable to investors for intertemporal hedging in the long-run since their returns have negative conditional correlation with expected stock and bonds returns. Three recent studies (Schindler 2011; Yunus 2009; Gallo and Zhang 2009) may be the only exceptions due to long-term consideration by applying a co-integration methodology, while they concentrate mainly on co-movements between real estate stock markets based on co-integration and correlation analyses. The third one is that most of the conclusions obtained in existing papers are based on the visual inspection of the relative position of efficient frontiers, telling little about the quantitative demand of REITs in an existing portfolio.

In light of the previously mentioned shortcomings, we therefore concentrate on the long-term benefits from investing REITs, in the context of multi-period portfolio choice and dynamic asset allocation. To this end, we take advantage of the approach proposed by Campbell, Chan and Viceira (2003; henceforth, CCV), considering a multi-period portfolio choice problem of an infinitely long-lived investor with Epstein-Zin utility who faces a set of asset returns described by a vector auto regression in returns and state variables, considering the time and risk diversification properties.

CCV method departs from the previous literature significantly in three

[2] As to the normal distribution assumption, ample empirical evidence calls in question. A quadratic utility function exhibits negative marginal utility after a certain finite wealth level and increasing absolute risk aversion with respect to wealth.

aspects. First, CCV model focuses on a multi-period portfolio choice problem of an infinitely long-lived investor with Epstein-Zin utility, which can overcome the weaknesses pointed out in previous literature. Second, potential return predictability is contained in CCV which is described by an unrestricted first order vector autoregressive (VAR (1)) process in state variables and return predictors. This simplicity allows us to break the total demands for REITs into myopic demand which focus solely on a single period forward and intertemporal hedging demand which aim to look multi-period ahead to hedge against adverse shocks in time varying investment opportunities. Further on, intertemporal hedging demands can be divided into components associated with individual state variables, allowing us to investigate the sensitivity of the optimal investment in REITs to changes in state variables. This demand decomposition further gains some insights on the level and related factors that affect the dynamics of intertemporal hedging demand for REITs. Third, CCV method can accommodate multi-period portfolio choice problems with a relatively large number of asset classes and state variables at relatively low computation effort. Thus, we can substantially expand asset classes beyond traditional Treasury bills, stocks and long-term bonds conveniently without making additional assumptions such as completeness of markets (Wachter 2002) and returns distributions.

3. Empirical approach

In the following, we mainly outline the formulation of the multi-period portfolio choice problem faced by the investor who can allocate after-consumption wealth to n risky assets. To be consistent, we summarize the empirical approach using the same symbols as CCV; detailed discussions of the methodology are provided in Section 2 and 3 of CCV.

3.1 Dynamics of state variables

Let $R_{1,t+1}$ be the real return on a benchmark asset (usually a 3-month Treasury bill) from time t to time $t+1$, and let $R_{i,t+1}, i = 2,\cdots,n$, be the real returns on the $n-1$ additional assets. The real return on the investor's portfolio can be written as:

$$R_{p,t+1} = R_{1,t+1} + \sum_{i=2}^{n} \alpha_{i,t}\left(R_{i,t+1} - R_{1,t+1}\right), \tag{1}$$

$$\mathbf{x}_{t+1} = \left[r_{2,t+1} - r_{1,t+1}, \cdots, r_{n,t+1} - r_{1,t+1}\right]', \tag{2}$$

where $\alpha_{i,t}$ is the weight on asset i at time t, the weight on the benchmark at time t is $1 - \sum_{i=2}^{n} \alpha_{i,t}$.

The vector of log excess returns for n risky assets can then be expressed as:

where $r_{i,t+1} = \log(R_{i,t+1}), i = 1,2,\cdots,n$. In addition, the system includes other three state variables (namely, nominal short-term interest rate, the dividend-price ratio and the term spread), which are defined as a whole in instruments vector $\mathbf{s}_{t+1}$. Thus, the whole system of state variables can be described as:

$$\mathbf{z}_{t+1} = \left[r_{1,t+1}, \mathbf{x}_{t+1}, \mathbf{s}_{t+1}\right]' \tag{3}$$

CCV approach assume that the dynamics of the variables system (or potential return predictability) can be well described by an unrestricted first order vector autoregressive (VAR (1)) process in state variables (i.e., real short-term interest rates, excess stock returns, excess bond returns, excess REITs returns) as well as return predictors (i.e., nominal short-term interest rate, the dividend-price ratio and the term spread).thus the dynamics of the state vector $\mathbf{z}_{t+1}$ can be given by

$$\mathbf{z}_{t+1} = \mathbf{\Phi}_0 + \mathbf{\Phi}_1 \mathbf{z}_t + \mathbf{v}_{t+1}, \tag{4}$$

where $\mathbf{\Phi}_0$ is the $m \times 1$ vector of intercepts, $\mathbf{\Phi}_1$ is the $m \times m$ matrix of slope coefficients, and $\mathbf{v}_{t+1}$ is the $m \times 1$ vector of innovations that are independently and homoskedastic distributed as $N(\mathbf{0}_{m\times1}, \mathbf{\Sigma}_v)$. . The variance-covariance matrix $\mathbf{\Sigma}_v$ satisfies the following partition:

$$\mathbf{\Sigma}_v = Var_t(\mathbf{v}_{t+1}) = \begin{bmatrix} \sigma_1^2 & \boldsymbol{\sigma}'_{1x} & \boldsymbol{\sigma}'_{1s} \\ \boldsymbol{\sigma}_{1x} & \mathbf{\Sigma}_{xx} & \mathbf{\Sigma}'_{xs} \\ \boldsymbol{\sigma}_{1s} & \mathbf{\Sigma}_{xs} & \mathbf{\Sigma}_{ss} \end{bmatrix}, \tag{5}$$

where σ_1^2 is the variance of the innovation to the benchmark asset return; $\boldsymbol{\sigma}_{1x}$ is the $(n-1)\times 1$ vector of covariance between innovations to the benchmark asset returns and to the excess returns of additional assets; $\boldsymbol{\sigma}_{1s}$ is the $(m-n)\times 1$ vector of covariance between innovations to the benchmark asset returns and to the instrumental variables; $\boldsymbol{\Sigma}_{xx}$ is the $(n-1)\times(n-1)$ variance-covariance matrix for the innovations to the excess returns; $\boldsymbol{\Sigma}_{xs}$ is the $(m-n)\times(n-1)$ matrix of covariance between innovations to the excess returns and to the instrumental variables; $\boldsymbol{\Sigma}_{ss}$ is the $(m-n)\times(m-n)$ variance-covariance matrix for the innovations to the instrumental variables. Thus, the stochastic evolution of expected returns of various assets on the past histories as well as other predicative variables is conveniently derived.

3.2 Utility function

CCV model assumes that the investor maximizes the recursive Epstein-Zin utility over an infinite horizon, which can be expressed by

$$U[C_t, E_t(U_{t+1})] = \left\{(1-\delta)C_t^{(1-\gamma)/\theta} + \delta\left[E_t\left(U_{t+1}^{1-\gamma}\right)\right]^{1/\theta}\right\}^{\theta/(1-\gamma)}, \quad (6)$$

where C_t is the consumption at time t, $E_t(\cdot)$ is the conditional expectation operator, $\delta \in (0,1)$ is the time discount factor, $\gamma > 0$ is the coefficient of constant relative risk aversion (CRRA), $\theta \equiv (1-\gamma)/(1-\psi^{-1})$, and $\psi > 0$ is the elasticity of intertemporal substitution (EIS). As emphasized by CCV, Epstein-Zin utility has a desirable property that the notion of CRRA is separated from that of EIS. The expression reduces to popular time-separable power utility function, in which $\gamma = \psi^{-1}$, and log utility function, in which $\gamma = \psi^{-1} = 1$.

3.3 Solving the approximate model

At time t, the investor uses all relevant information and makes optimal consumption as well as portfolio choice decisions in order to maximize the Epstein-Zin utility function, subject to the intertemporal budget constraints:

$$W_{t+1} = (W_t - C_t)R_{p,t+1}, \quad (7)$$

where C_t is the consumption and W_t is the wealth at time t.

Under time-varying investment opportunities, CCV solve the investor's optimal asset allocation and consumption decision by applying an extension of the approximate analytical solution with a relatively simple numerical procedure and three key approximations. Detailed derivations for this solution are provided in the appendix of Campbell et al. (2003).

3.4 Optimal portfolio choice

The solution can be expressed in terms of optimal portfolio choice and consumption rules for $\boldsymbol{\alpha}_t$ and $c_t - w_t$, where optimal asset allocation $\boldsymbol{\alpha}_t$ can be divided into two components:

$$\boldsymbol{\alpha}_t = \left[\frac{1}{\gamma}\boldsymbol{\Sigma}_{xx}^{-1}\left(\mathbf{H}_x\boldsymbol{\Phi}_0 + \frac{1}{2}\boldsymbol{\sigma}_x^2 + (1-\gamma)\boldsymbol{\sigma}_{1x}\right) + \frac{1}{\gamma}\boldsymbol{\Sigma}_{xx}^{-1}\mathbf{H}_x\boldsymbol{\Phi}_1\mathbf{z}_t\right]$$

$$+\left[\left(1-\frac{1}{\gamma}\right)\boldsymbol{\Sigma}_{xx}^{-1}\left(-\frac{\boldsymbol{\Lambda}_0}{1-\psi}\right) + \left(1-\frac{1}{\gamma}\right)\boldsymbol{\Sigma}_{xx}^{-1}\left(-\frac{\boldsymbol{\Lambda}_1}{1-\psi}\right)\mathbf{z}_t\right], \qquad (8)$$

where $\mathbf{H}_x$ is a selection matrix that selects the vector of excess returns from the full state vector, $\boldsymbol{\Lambda}_0$ and $\boldsymbol{\Lambda}_1$ are coefficient matrices that depend on b_0, $\mathbf{B}_1$ and $\mathbf{B}_2$, as well as γ, ψ, δ, ρ, $\boldsymbol{\Phi}_0$, $\boldsymbol{\Phi}_1$ and $\boldsymbol{\Sigma}_v$.

The first item is the myopic component of asset demand, which focuses solely on a single period forward. It essentially conform to static Markowitz problem, while investors with $\gamma \neq 1$ adjust his allocation by the term $(1-\gamma)\boldsymbol{\sigma}_{1x}$ when the benchmark is risky. The second item is the intertemporal hedging demand arising in multi-period portfolio problem. Following Merton (1969, 1971), the investor with more risk averse than a logarithmic investor or time varying investment opportunities may look ahead and hedge against adverse shocks in asset returns. As reflected in the second term in equation (8), the effect of intertemporal hedging demand affects not only the mean optimal portfolio allocation to risky asset, but also the sensitivity of the optimal portfolio allocation to changes in state variables.

3.5 Value function

By solving for the optimal consumption-wealth ratio, the value function (i.e., the maximized utility function per unit of wealth) can be given by

$$V_t = (1-\delta)^{-\psi/(1-\psi)}\left(\frac{C_t}{W_t}\right)^{1/(1-\psi)}$$

$$= \exp\left\{-\frac{\psi}{1-\psi}\log(1-\delta)+\frac{b_0}{1-\psi}+\frac{\mathbf{B}_1'}{1-\psi}\mathbf{z}_t+\mathbf{z}_t'\frac{\mathbf{B}_2}{1-\psi}\mathbf{z}_t\right\}. \quad (9)$$

We can use these results to calculate the unconditional mean of the value function $E(V_t)$, then to calculate the utility of long-term investors who have access to REITs.

4. Data description

The calibration results are based on monthly data for the U.S. market. We employ a rich dataset spanning the period June 1972 to December 2010. This includes bearish and bullish periods in REITs prices, the 2000-2007 REITs booms, and recent 2007-2010 subprime credit crisis, as well as the increasing presence of index investment in REITs markets and potential markets integration.

The proxies for the U.S. domestic equity markets as well as domestic government bonds are monthly total returns series of S&P500 and 10-year government bond. The real return on Treasury bills is defined as the log return on a 3-month Treasury bill minus the log difference of the rate of inflation. The log excess stock return is the log return on the S&P500 stock index minus the log return on the 3-month Treasury bills. The log excess bond return is the log return on the 10-year government bonds minus the log return on the 3-month Treasury bills. The nominal yield on Treasury bills is the log yield on a 3-month treasury bills. The nominal yield is the difference between the yields on a 10-year government bond and 3-month treasury bill. The log excess REITs return is defined as the log difference of the FTSE NAREIT Equity REIT Index returns.

The data for S&P 500 index returns and dividends are from Center for Research in Security Press (CRSP) and the S&P Corporation. The data on

10-year government bonds as well as the 3-month T-bill come from the Federal Reserve Bank of St. Louis database (FREDIIR®). The inflation rate is measured as the continuously compounded rate of change of the consumer price index for all urban consumers, are from the Bureau of Labor Statistics. We use FTSE NAREIT All Equity REIT Index returns from the NAREIT website (www.reit.com) to proxy for the U.S. public real estate asset class, including both capital gains and income return components.

Table 1 contains the descriptive statistics for each asset class. Confirming the results reported in the studies mentioned earlier, REITs have mean monthly excess returns of about 0.32%, and a little high than the U.S. equities. Although REITs have higher volatility than bonds, its Sharpe ratio is the highest. REITs also have fewer correlations with bonds than domestic equities. On the basis of the above commonly reported evidence, REITs have been accepted as an asset class that will add diversification benefits to investors.

Table 1. Summary statistics of monthly total returns on different assets a.

	rbt	*xr*	*xb*	*xc*	*y*	*div*	*spr*
Mean(%)	2.2265	0.1247	-0.1609	0.3151	5.5604	0.0979	0.6910
Std. dev(%)	1.2932	2.3907	1.9856	2.2154	3.1688	2.2924	0.5478
Skew	0.5225	-0.7201	-0.1972	-0.5552	0.6278	0.0224	-0.4785
Sharpe ratio		0.0522	-0.0810	0.1422			
Correlation							
rtb	1.0000	-0.0150	0.0382	-0.0312	0.9997	-0.0359	-0.5515

xr	-0.0150	1.0000	-0.0327	0.5889	-0.0172	0.0043	0.0517
xb	0.0382	-0.0327	1.0000	-0.0403	0.0389	-0.1086	-0.0300
xc	-0.0312	0.5889	-0.0403	1.0000	-0.0324	0.0447	0.0899
y	0.9997	-0.0172	0.0389	-0.0324	1.0000	-0.0360	-0.5506
div	-0.0359	0.0043	-0.1086	0.0447	-0.0360	1.0000	-0.0247
spr	-0.5515	0.0517	-0.0300	0.0899	-0.5506	-0.0247	1.0000

a rtb = ex post real Treasury bill rate, xr = excess stock return, xb = excess bond return, xc = excess REITs return, y = nominal Treasury bill yield, div = log dividend yield, spr = yield spread.

Table 2 reports the estimation results for the VAR system. The top section of each panel reports coefficients estimates and the R-squared statistics (with the t-statistics in the square brackets) for each equation in the VAR system. The lagged REITs return has insignificant negative coefficients in the first and second row of the table corresponding to the real bill return and the excess domestic stock return equation, respectively, while significant negative coefficient for the lagged REITs return. The fourth row reports the results for the equation of REITs, with all the coefficients insignificant. These results imply that there are few correlations between REITs and other risky assets. This possibly implies REITs could be an important component of asset allocation.

Table 2. VAR estimation results b.

VAR estimation results	rtb_{t-1}	xr_{t-1}	xb_{t-1}	xc_{t-1}	rtb_{t-1}	y_{t-1}	div_{t-1}	spr_{t-1}	R^2
rtb_t	0.3233	-0.0015	-0.1421	-0.0062	0.6559	-0.1501	0.2542	-0.0002	0.9618
	[3.684]	[-0.257]	[-2.408]	[-1.227]	[6.873]	[-3.787]	[3.985]	[-0.169]	
xr_t	1.4112	0.0445	0.4998	-0.0319	-2.3643	0.7547	-0.6206	-0.0053	0.2798
	[1.939]	[0.929]	[1.021]	[-0.766]	[-2.987]	[2.296]	[-1.173]	[-0.586]	
xb_t	0.0099	-0.0034	1.2218	-0.0002	0.0295	0.0732	-0.2809	-0.0016	0.9451
	[0.140]	[-0.734]	[25.69]	[-0.038]	[0.384]	[2.291]	[-5.465]	[-1.849]	
xc_t	-0.8567	0.0141	1.3522	0.2564	1.3582	-1.1778	-0.8749	-0.0256	0.2048
	[-1.080]	[0.271]	[2.533]	[5.649]	[1.574]	[-3.287]	[-1.517]	[-2.601]	
y_t	-0.1088	0.0025	-0.2698	-0.0016	1.0571	-0.0981	0.3109	0.0025	0.9708
	[-1.347]	[0.465]	[-4.965]	[-0.340]	[12.03]	[-2.690]	[5.293]	[2.449]	
div_t	-0.0533	-0.0013	-0.0132	0.0001	0.0549	0.9729	0.0131	0.0004	0.9850
	[-2.067]	[-0.782]	[-0.760]	[0.040]	[1.959]	[83.58]	[0.699]	[1.125]	

spr $_t$	-0.1071 [-1.674]	-0.0006 [-0.153]	0.2471 [5.739]	-0.0003 [-0.082]	0.1478 [2.123]	0.0756 [2.617]	0.7014 [15.07]	-0.0021 [-2.592]	0.9076

Cross-correlation of residuals

	rtb	***xr***	***xb***	***xc***	***y***	***div***	***spr***
rtb	1.0000	-0.1819	-0.7698	-0.0553	0.8720	0.1511	-0.7116
xr	-0.1819	1.0000	0.0888	0.0800	-0.2529	-0.9097	0.1210
xb	-0.7698	0.0888	1.0000	-0.0052	-0.8695	-0.0517	0.8826
xc	-0.0553	0.0800	-0.0052	1.0000	-0.0156	-0.0714	-0.0068
y	0.8720	-0.2529	-0.8695	-0.0156	1.0000	0.2218	-0.7766
div	0.1511	-0.9097	-0.0517	-0.0714	0.2218	1.0000	-0.0871
spr	-0.7116	0.1210	0.8826	-0.0068	-0.7766	-0.0871	1.0000

b rtb = ex post real Treasury bill rate, xr = excess stock return, xb = excess bond return, xc = excess REITs return, y = nominal Treasury bill yield, div = log dividend yield, spr = yield spread.

The bottom section of each panel reports the cross-correlation matrix of the innovations in the VAR system. Unexpected log excess stock returns has very low correlation with REITs returns, while highly negative correlation with shocks to the log dividend yield, which is consistent with previous empirical evidence (Campbell, 1991; Stambaugh, 1999). Unexpected log excess bond returns have highly negative correlation with shocks to real Treasury bill rate, nominal Treasury bill yield, spread yield and REITs return and positive correlation with the log excess stock return, while relatively low negative correlation with REITs returns. Altogether, the correlations between REITs and stock and bond returns suggest that REITs could play an important role in the process of strategic asset allocation. We will further explore their implications for optimal multiple-period portfolio choice.

From the simple calculation of the common measures of the corresponding realized returns in Table 1 and Table 2, we can tentatively gain some insights into the economic interpretations for REITs' significance in asset allocation.

One explanation might be based on modern portfolio theory, indicating that the interaction of asset classes with each other provides aspiration for diversification. The REITs return has less correlation with domestic bond markets than domestic stock markets, exhibiting available risk diversifying property. This property suggests REITs should be attractive for portfolios diversification. Furthermore, the correlation between innovations to stock or bond and REITs returns are considerably small compared to those of themselves and other states and predictability variables. Consequently, the large positive intertemporal hedging demand for stocks does not reduce the demand for REITs, which may explain why the positive demand for REITs is significant during the long horizons.

The second tentative explanation is from the aspect of the return distributions. It is a well established fact that traditional asset returns, for example, the distribution of REITs returns is less negatively skewed than stock returns. Therefore, the less negative skewness of REITs return together with its lower volatility relative to stock return, imply that REITs has lower downside risk compared to traditional risky assets. If the tail events happen simultaneously for the two asset classes, REITs can provide substantial diversification benefits for portfolio allocation.

Another explanation comes from the correlation between REITs returns and inflation. This is because the ultimate goal of portfolios' value is for consumption. Thus, investors should consider the real purchasing power of assets returns; that is, capability of hedging against inflation risk. Traditional asset classes such as stocks and bonds are negatively correlated with inflation and are not good asset classes for hedging against inflation. However, REITs may help in hedging inflation risk in that: (i) they are positively correlated with inflation in the long run (around 0.1879); (ii) REITs prices are directly linked to unexpected inflation shocks, which is an important component of inflation.

5. Results and discussions

CCV method indicates that the optimal portfolio asset allocation to bills, stocks, bonds and REITs futures is linear in the vector of state variables, thus changing over time. One way to characterize this policy is to examine its mean and volatility.

5.1 Level of assets demands

To analyze the level effect, we compute the mean allocation to each asset as well as the mean hedging demand for five different specifications of the vector of state variables. The fist VAR system only has a constant term in each regression, corresponding to the case in which risk premium are constant and realized returns on all assets are i.i.d, including the short-term real interest rate. The second system includes an intercept term, the ex post real bill rate, and log excess returns on stocks, bonds and REITs. We then add sequentially the nominal bill rate, the dividend yield, and the yield spread. By comparing numbers within each column, we can examine the incremental effects of the state variables on asset allocation.

5.1.1 Mean demands of stocks, Treasury bills, bonds and REITs

We first make the analysis by allowing the investors to include REITs in his investment portfolio. In this case, the investment opportunities include T-bills, long-term nominal bonds, domestic stocks and REITs. We therefore estimate the expanded VAR system and apply the CCV approach to compute the mean total, myopic and intertemporal hedging demands for each asset.

Table 3 reports the mean total, myopic, and intertemporal hedging demands (in percentages) for domestic treasury bills, bonds, stocks and REITs with unit elasticity of intertemporal substitution, time discount factor equal to 0.92 at an monthly frequency, and coefficients of relative risk aversion equal to 1, 4, 7, and 10. The entries in each column are mean demands in percentage points when the explanatory variables describing investment opportunities in the VAR system added sequentially. The expanding VAR system include the state variables in the column heading and those to the left of it: Constant=VAR system only has a constant term in each regression; AR t = real returns on T-bills, excess returns on stocks, excess returns on bonds, and excess returns on REITs; y_t = nominal yield on T-bills; $d_t - p_t$ = log dividend-price ratio; and spr_t = yield spread.

We note that the total mean demands across the four assets sum to 100; the mean myopic demands across assets also sum to 100, while the mean hedging demands sum to 0.

Table 3. Mean demands of domestic assets for nominal T-bills, nominal bonds, stocks and REITs.

State variables:		Constant	AR_t	y_t	$d_t - p_t$	spr_t
$\gamma = 1, \quad \psi = 1, \quad \delta = 0.92^{1/12}$						
Stock:	Total demand	572.23	2245.17	2358.30	2368.23	2377.04
	Myopic demand	572.23	2245.17	2358.30	2368.23	2377.04
	Hedging demand	0.00	0.00	0.00	0.00	0.00
Bond:	Total demand	555.79	2463.98	2532.82	2509.25	2488.35
	Myopic demand	555.79	2463.98	2532.82	2509.25	2488.35

	Hedging demand	0.00	0.00	0.00	0.00	0.00
RE-ITs:	Total demand	246.89	1056.42	1069.40	1058.03	1047.95
	Myopic demand	246.89	1056.42	1069.40	1058.03	1047.95
	Hedging demand	0.00	0.00	0.00	0.00	0.00
Cash:	Total demand	-1274.91	-5665.57	-5860.52	-5835.51	-5813.34
	Myopic demand	-1274.91	-5665.57	-5860.52	-5835.51	-5813.34
	Hedging demand	0.00	0.00	0.00	0.00	0.00
$\gamma = 4,\quad \psi = 1,\quad \delta = 0.92^{1/12}$						
Stock:	Total demand	123.76	554.48	469.66	445.40	421.14
	Myopic demand	123.76	549.67	351.63	301.14	250.65
	Hedging demand	0.00	4.81	118.03	144.26	170.49
Bond:	Total demand	115.09	576.50	616.94	603.23	589.51
	Myopic demand	115.09	613.00	630.28	624.42	618.55
	Hedging demand	0.00	-36.50	-13.34	-21.19	-29.04
RE-ITs:	Total demand	69.72	78.58	143.29	136.31	204.72
	Myopic demand	69.72	53.93	75.40	56.04	107.10

	Hedging demand	0.00	24.65	67.89	80.27	97.62
Cash:	Total demand	-208.57	-1109.56	-1129.89	-1084.93	-1115.37
	Myopic demand	-208.57	-1116.60	-957.31	-881.59	-876.30
	Hedging demand	0.00	7.04	-172.58	-203.34	-239.07
$\gamma = 7$, $\psi = 1$, $\delta = 0.92^{1/12}$						
Stock:	Total demand	59.70	312.05	257.98	244.70	228.47
	Myopic demand	59.70	305.64	181.21	153.83	120.37
	Hedging demand	0.00	6.41	76.77	90.87	108.10
Bond:	Total demand	52.14	325.73	349.13	341.68	332.57
	Myopic demand	52.14	348.57	358.49	355.32	351.44
	Hedging demand	0.00	-22.84	-9.36	-13.64	-18.87
RE-ITs:	Total demand	37.27	49.40	76.34	72.24	74.32
	Myopic demand	37.27	33.93	35.53	9.70	-4.17
	Hedging demand	0.00	15.47	40.81	62.53	78.49
Cash:	Total demand	-49.11	-587.18	-583.45	-558.61	-535.36
	Myopic demand	-49.11	-588.14	-475.23	-418.85	-367.64

	Hedging demand	0.00	0.96	-108.22	-139.76	-167.72
$\gamma = 10$, $\psi = 1$, $\delta = 0.92^{1/12}$						
Stock:	Total demand	34.07	218.15	178.55	168.33	156.81
	Myopic demand	34.07	214.18	123.52	102.63	79.07
	Hedging demand	0.00	3.97	55.03	65.70	77.74
Bond:	Total demand	26.95	226.34	242.80	237.12	230.72
	Myopic demand	26.95	242.80	249.77	247.34	244.60
	Hedging demand	0.00	-16.46	-6.97	-10.22	-13.88
RE-ITs:	Total demand	26.29	36.92	48.11	54.96	61.18
	Myopic demand	26.29	25.41	16.69	6.53	9.04
	Hedging demand	0.00	11.51	31.42	48.43	52.14
Cash:	Total demand	12.69	-381.41	-369.46	-360.42	-348.71
	Myopic demand	12.69	-382.39	-289.98	-256.50	-232.71
	Hedging demand	0.00	0.98	-79.48	-103.92	-116.00

With respect to the results in Table 3, the introduction of REITs causes investors to move money from equities into REITs much strongly. This appears to reflect that stocks and REITs are relatively closer substitutes. The most striking result is the mean intertemporal hedging as well as the mean total and myopic demand for REITs are positive and considerably large, though the magnitude is still much less than stocks and bonds. Furthermore, the intertemporal hedging demand for REITs is fairly stable in a certain degree, even after investors can invest equities. This result verifies that the REITs is an attractive and effective asset class which should be seriously concerned in strategic and portfolio choice.

To check for the robustness of the estimated demand for REITs, we expand the analysis by allowing various value of risk aversion and elasticity of intertemporal substitution. By comparing numbers within any row, we can study how total asset allocation and intertemporal hedging demand vary with risk aversion. As we would expect, the mean total, myopic and hedging demands for all the risky assets decrease as γ increases. Even for the most risk adverse investor, there are still significantly positive demands for REITs, providing powerful evidence for considering REITs in strategic asset allocation. Moreover, for investors with more risk aversion, the magnitude of the mean total and hedging demands for REITs increase gradually.

We also compute the demands for assets by setting different values of elasticity of intertemporal substitution ψ. We do not report the results for space reservation. Both the mean total and hedging demand for REITs do not change very much, and somewhat significantly positive as the value of ψ increases. The stable mean total and hedging demands for REITs over various value of ψ provide strong support for REITs as an attractive asset class in multi-period asset allocation. Our result also comply with the recent theoretical work conducted by Bhamra and Uppal (2006), who suggest that the elasticity of intertemporal substitution ψ can only effect the magnitude, but not the sign, of the intertemporal hedging demand for the risky asset.

5.1.2 Mean demands of Treasury bills, bonds and REITs for investors

We also study the mean demands of REITs for the investors who can only have access to more steady assets like long-term bonds. Table 4 reports mean total, myopic and intertemporal hedging demands for nominal long-term bonds, nominal T-bills (or cash) and REITs with unit elasticity of intertemporal substitution, time discount factor equal to 0.921/12 at an monthly frequency, and coefficients of relative risk aversion equal to 1, 4, 7, and 10. The entries in each column are mean demands in percentage points when the explanatory variables describing investment opportunities in the VAR system added sequentially.

For the U.S. investors in Table 4, the most striking results is the moderately large mean total and intertemporal hedging demands for REITs for each reported γ value, though the magnitudes of total and hedging demand for REITs are much lower than bonds for the first two columns. This is consistent with the theory that there is higher demand for the asset with larger Sharpe ratio. However, the mean hedging demand for bonds is negative and fairly large in magnitude for the last three columns, contributing to the smaller total demands for bonds versus REITs. There are significantly substantial mean total and intertemporal hedging demands for REITs, which is much larger than bonds. The mean total demand for bills is negative for each reported γ, indicating the investors typically short bills.

Table 4. Mean demands of domestic assets for nominal bonds, nominal T-bills and REITs.

State variables:		Constant	AR_t	y_t	$d_t - p_t$	spr_t
$\gamma = 1, \quad \psi = 1, \quad \delta = 0.92^{1/12}$						
REITs:	Total demand	383.21	2289.71	3228.54	3226.67	3242.45
	Myopic demand	383.21	2289.71	3228.54	3226.67	3242.45
	Hedging demand	0.00	0.00	0.00	0.00	0.00
Bond:	Total demand	681.12	2544.13	2745.19	2747.35	2743.95
	Myopic demand	681.12	2544.13	2745.19	2747.35	2743.95
	Hedging demand	0.00	0.00	0.00	0.00	0.00
Cash:	Total demand	-964.33	-4733.84	-5873.73	-5874.02	-5886.40

	Myopic demand	-964.33	-4733.84	-5873.73	-5874.02	-5886.40
	Hedging demand	0.00	0.00	0.00	0.00	0.00
$\gamma = 4,\ \psi = 1,\ \delta = 0.92^{1/12}$						
REITs:	Total demand	63.30	449.15	1221.69	1169.96	1162.76
	Myopic demand	63.30	333.24	808.21	807.79	811.58
	Hedging demand	0.00	115.91	413.48	362.17	351.18
Bond:	Total demand	142.20	602.86	754.76	738.77	752.14
	Myopic demand	142.20	633.38	824.06	791.57	819.12
	Hedging demand	0.00	-30.52	-69.30	-52.80	-66.98
Cash:	Total demand	-105.50	-952.01	-1876.45	-1808.73	-1814.90
	Myopic demand	-105.50	-866.62	-1532.27	-1499.36	-1530.70
	Hedging demand	0.00	-85.39	-344.18	-309.37	-284.20
$\gamma = 7,\ \psi = 1,\ \delta = 0.92^{1/12}$						
REITs:	Total demand	17.60	245.50	731.63	700.87	695.80
	Myopic demand	17.60	172.33	462.45	462.24	464.32
	Hedging demand	0.00	73.17	269.18	238.63	231.48
Bond:	Total demand	65.21	340.39	433.79	425.28	434.30
	Myopic demand	65.21	320.37	476.36	459.07	477.57

	Hedging demand	0.00	20.02	-42.57	-33.79	-43.27
Cash:	Total demand	17.19	-485.89	-1065.42	-1026.15	-1030.10
	Myopic demand	17.19	-392.70	-838.81	-821.31	-841.89
	Hedging demand	0.00	-93.19	-226.61	-204.84	-188.21
$\gamma = 10, \psi = 1, \delta = 0.92^{1/12}$						
REITs:	Total demand	0.68	165.33	525.81	503.95	499.73
	Myopic demand	0.68	110.54	324.15	324.01	325.42
	Hedging demand	0.00	54.79	201.66	179.94	174.31
Bond:	Total demand	34.41	236.84	305.43	299.77	307.09
	Myopic demand	34.41	222.45	337.35	325.85	340.79
	Hedging demand	0.00	14.39	-31.92	-26.08	-33.70
Cash:	Total demand	64.91	-302.17	-731.24	-703.72	-706.82
	Myopic demand	64.91	-232.99	-561.50	-549.86	-566.21
	Hedging demand	0.00	-69.18	-169.74	-153.86	-140.61

The reason for significant intertemporal hedging demand for REITs may lies in that REITs return has low and negative correlations with traditional asset classes, while having a lower downward risk by having less negative skewness. In addition, the surprisingly significant intertemporal hedging demand for REITs seems to come through its increased ability to hedge against the unexpected future inflation, compared to traditional assets.

5.2 Variability of asset demands

We now turn to the analysis of the variability of asset demands. Fig. 1 illustrates the estimated total demands for stocks, bonds and REITs graphically, along with the myopic and hedging components. The upper, middle and lower panel in the figure plots time series of total optimal allocations, myopic demands and intertemporal demands, respectively, in percentage points of investors with unit elasticity of intertemporal substitution, time discount factor to 0.92 at an annual frequency, and relative risk aversion coefficient equal to 5.

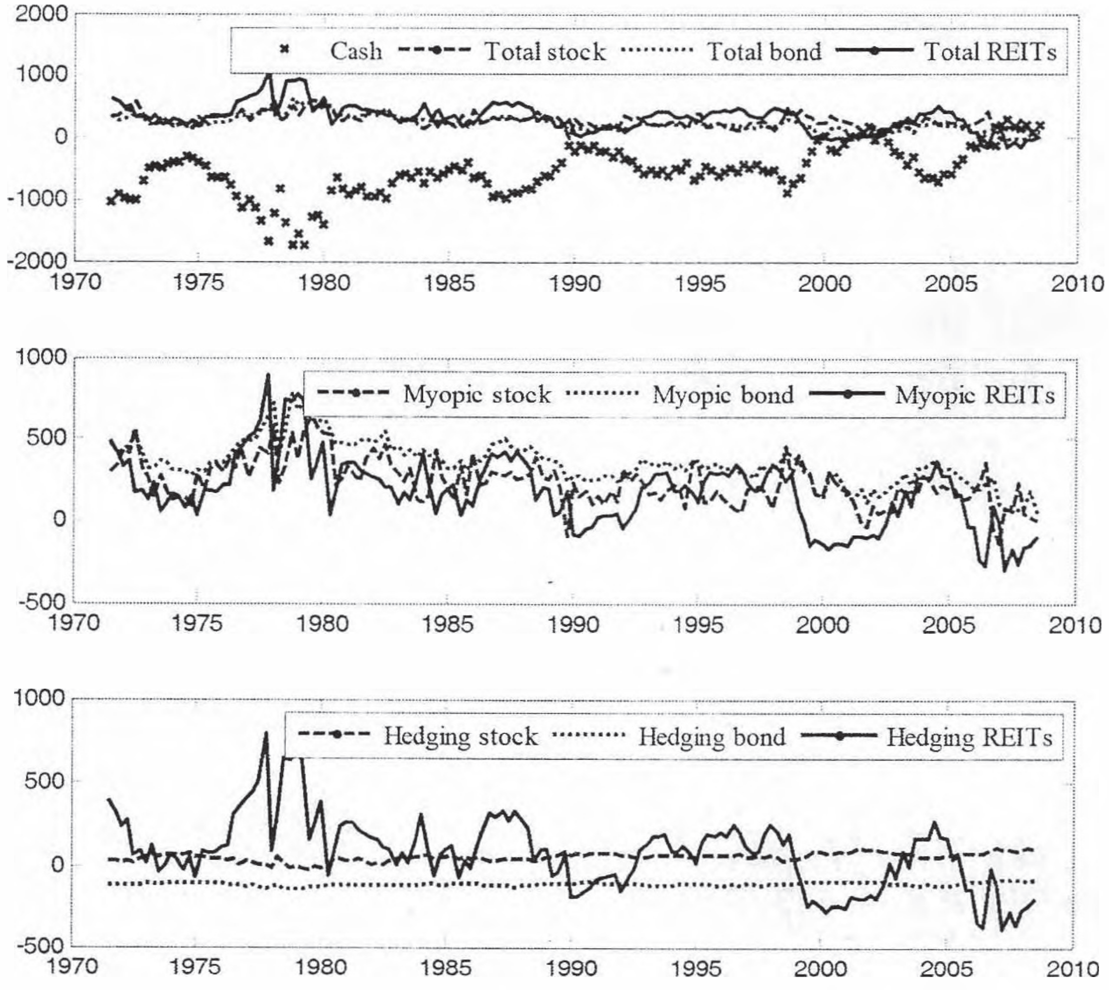

Fig. 1 History of asset allocations for stocks, bonds and REITs for investors.

For all three assets, hedging demands considerably less volatile than myopic demands, which are consistent with the explanation provided by Kim and Omberg (1996) and Campbell and Viceira (1999). Overall, the hedging demands for REITs appears to be the most volatile compared with those for stocks and bonds. Moreover, the hedging demands for REITs are comparatively larger than the hedging demands for stocks during real estate bull markets, while considerably lower than those for stocks during real estate bear markets. However, the hedging demands for REITs are well above the hedging demand for bonds over most of the sample period.

The results are similar when investors can only have access to Treasury bills, bonds and REITs, as illustrated in Fig. 2. Also, the hedging demands for REITs are well above the hedging demand for bonds over most of the sample period, apart from the periods of subprime crisis.

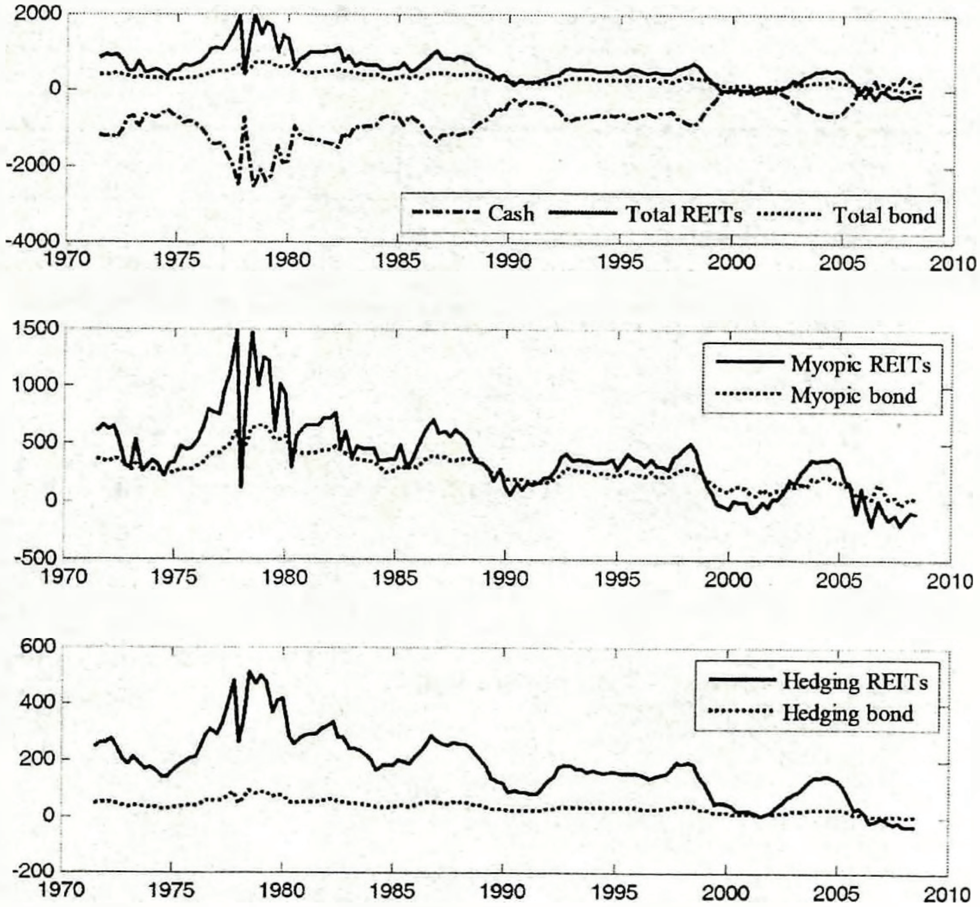

Fig. 2 History of asset allocations for bonds and REITs for investors.

5.3 The utility benefits from including REITs

Another way to investigate the importance of the REITs asset class is to compare the utility of an investor who has access to REITs with the utility of an investor who does not.

In Table 5 we carry out this comparison. The table reports the mean value function for values of the relative risk aversion γ are set to 1, 4, 7, and 10. For investor, Panel A compares the mean value function when investors can allocate across stocks, bonds and Treasury bills. Panel B compares the mean value function when investors have access to REITs, bonds and Treasury bills. Panel C compares the mean value function when investors have access to stocks, REITs, bonds and Treasury bills. The value function is normalized so that a doubling from one asset menu to another implies that an investor would require twice as much as wealth to reach the same utility with the worse asset menu than with the better one.

Table 5. Mean value function c.

γ	$E[V_t]$		
Panel A: Stocks and bonds			
	Nominal bonds	Real consol bonds	Nominal bonds and real consol bonds
1	4.7626	1.4125	14.5671
4	0.7453	0.2870	2.6453
7	0.0692	0.0341	0.1303
10	0.0200	0.0103	0.0257
Panel B: REITs and bonds			
	Nominal bonds	Real consol bonds	Nominal bonds and real consol bonds
1	4.0686	1.2701	13.3928
4	0.6340	0.2582	2.2630
7	0.0433	0.0201	0.2325
10	0.0108	0.0093	0.0190

Panel C: REITs , Stocks and bonds

	Nominal bonds	Real consol bonds	Nominal bonds and real consol bonds
1	12.8712	5.6990	73.2932
4	0.8378	0.3018	4.5688
7	0.0952	0.0494	0.1824
10	0.0272	0.0115	0.0280

[c] This table shows the mean value function implied by the monthly dataset for investors with unit elasticity of intertemporal substitution ψ, time discount factor equals to 0.921/12 at an monthly frequency, and coefficients of relative risk aversion equal to 1, 4, 7, and 10. Each panel considers a different asset menu available to the investor. To make all asset menus fully comparable, all mean value functions are based on the same VAR. The value function is normalized so that a doubling from one asset menu to another implies that the investor would require twice as much wealth to obtain the same utility with the worse asset menu than with the better one.

For the U.S. investors, a comparison of the asset menu in Panel A in which REITs are no available with the asset menu in Panel C shows that REITs generate large welfare gains for all investors. Aggressive investors gain by having access to REITs with less negative skewed expected excess returns, and by the ability to use REITs to hedge long positions in domestic stocks. Conservative investors gain by having access to REITs that hedge the risk of variation in real interest risk.

One can draw the same conclusion by comparing two asset menus in panel B. Results are somewhat moderately favorable when REITs are added to long-term bonds. Both aggressive and conservative investors gain by allocating some weights to REITs, which can help hedge against the long positions in long-term bonds and inflation risk of real interest rates.

In summary, the three tentative explanations in Section 3 together with the significant total and intertemporal hedging demand for REITs as well as improved utility benefits suggest that REITs can be an attractive asset class for portfolio diversification, compared to traditional assets such as stocks and bonds.

6. Conclusions

This paper explores the unresolved issues concerning whether an long-term investor is made better off by including REITs in a portfolio that consists of traditional assets like stocks, bonds and cash. To this end, we take a well-accepted theoretical CCV model, rather than the static single-period mean-variance setting followed by previous literature, to explore the benefits of REITs investment in the context of multi-period dynamic asset allocation.

We show that the alleged benefits in investing REITs exist. Our results document considerably strong and stable mean total and intertemporal hedging demands for REITs. We also show that with varying intertemporal substitution and relative risk aversion, the intertemporal hedging demand for REITs are relatively stable and permanent in magnitude. Moreover, some tentative interpretations are provided to answer the question that why investors have a strong intertemporal hedging demand for REITs based on modern portfolio theory, return characteristics, as well as the ability of hedging against inflation. Finally, we show that REITs is an asset class far more suitable for conservative investors with relatively high risk aversion.

Acknowledgement

This research is financially supported by the National Natural Science Foundation of China under project No. 71401193 and No. 71173008.

References

Bond, S.A., Karolyi, G.A., Sanders, A.B. (2003). International real estate returns: A multifactor, multicounty approach. Real Estate Economics, 31(3), 481-500.

Brounen, D., Eichholtz, P.M.A. (2003). Property, common stock, and property stock-Increased potential for diversification. Journal of Portfolio Management, 30, 129-137.

Basse, T., Friedrich, M., Vazquez Bea, E. (2009). REITs and the financial crisis: Empirical evidence from the US. International Journal of Business and Management, 4, 3-10.

Bhamra, H.S., Uppal, R. (2006). The role of risk aversion and intertemporal substitution in dynamic consumption-portfolio choice with recursive utility. Journal of Economic Dynamics and Control, 30 (6), 967-991.

Brounen, D., Prado, M.P., Stevenson, S. (2008). Kurtosis and consequences-The case of international property shares. Working paper.

Campbell, J.Y., Viceira, L.M. (1999). Consumption and portfolio decisions when expected returns are time varying. Quarterly Journal of Economics, 114, 433-495.

Campbell, J.Y. (1991). A variance decomposition for stock returns. Economic Journal, 101, 157-179.

Campbell, J.Y., Chan, Y.L., Viceira, L.M. (2003). A multivariate model of strategic asset allocation. Journal of Financial Economics, 67 (1), 41-80.

Cheng, P., Roulac, S.E. (2007). Measuring the effectiveness of geographical diversification. Journal of Real Estate Portfolio Management, 13(1), 29-44.

EPRA. (2008). A Comparison of the Major REIT Regimes around the World. EPRA Global REIT Survey, Amsterdam.

Fugazza, C., Guidolin, M., Nicodano, G. (2008). Diversifying in public real estate: The Ex-post performance. Journal of Asset Management, 8(6), 361-373.

Fugazza, C., Guidolin, M., Nicodano, G. (2009). Time and risk diversification in real estate investments: Assessing the ex post economic value. Working paper, Center for Research on Pensions and Welfare Policies.

Gallo, J. G., Zhang, Y. (2009). Global property market diversification. Journal of Real Estate Finance and Economics, 41(4), 458-485.

Idzorek, T.M., Barad, M., Meier, S.L. (2007). Global commercial real estate-A strategic asset allocation study. Journal of Portfolio Management, 33, 37-52.

Jin, C., Grissom, T.V., Ziobrowski, A.J. (2007). The mixed asset portfolio for Asia-Pacific markets. Journal of Real Estate Portfolio Management, 13(3), 249-256.

Kim, T.S., Omberg, E. (1996). Dynamic nonmyopic portfolio behavior. Review of Financial Studies, 9, 141-161.

Lee, S.L. (2005). The return due to diversification of real estate to the U.S. mixed-Asset Portfolio. Journal of Real Estate Portfolio Management, 11(1), 19-28.

Lee, S.L. (2010). The changing benefit of REITs to the mixed-asset portfolio. Journal of Real Estate Portfolio Management, 16(3), 201-215.

Lee, S.L., Stevenson, S. (2005). The case for REITs in the mixed-asset portfolio in the short and long run. Journal of Real Estate Portfolio Management, 11(1), 55-80.

Liow, K.H., Sim, M.C. (2006). The risk and return profile of Asian real estate stocks. Pacific Rim Property Research Journal, 12(3), 283-310.

Liow, K.H. (2007). The dynamics of return volatility and systematic risk in international real estate security markets. Journal of Property Research, 24(1), 1-29.

Liow, K.H., Ho, K.H.D., Ibrahim, M.F., Chen, Z. (2009). Correlation and volatility dynamics in international real estate securities markets. The Journal of Real Estate Finance and Economics, 39(2), 202-223.

Niskanen, J., Falkenbach, H. (2010). REITs and correlations with other asset classes: A European perspective. Journal of Real Estate Portfolio Management, 16(3), 227-239.

Ooi, J.T.L., Newell, G., Sing, T. F. (2006). The growth of REIT markets in Asia. Journal of Real Estate Literature, 14(2), 203-222.

Schindler, F. (2011). Long-Term benefits from Investing in international securitized real estate. International Real Estate Review, 14(1), 27-60.

Sebastian, S., Sturm, M. (2009). Investor outreach study-Correlations of property stocks with other asset classes. Working paper, EPRA-Paper.

Stambaugh, R.F. (1999). Predictive regressions. Journal of Financial Economics, 54, 375-421.

Titman, S., Warga, A. (1986). Risk and the performance of real estate investment trusts: A multiple index approach. Real Estate Economics, 14(3), 414-431.

Wachter, J. (2002). Portfolio and consumption decisions under mean-reverting returns: An exact solution for complete markets. Journal of Financial and Quantitative Analysis, 37 (1), 69-91.

Waggle, D., Agrrawal, P. (2006). The Stock-REIT relationship and optimal asset allocation. Journal of Real Estate Portfolio Management, 12(3), 209-221.

Wong, A., Tong, C., Keow, Y.M. (2012). Performance and role of Singapore REITs in multi-asset class investment portfolios. Journal of Management Research, 4(1), 1-27.

Worzala, E., Sirmans, C.F. (2003). Investing in international real estate stocks: A Review of the Literature. Urban Studies, 40(5-6), 1115-1149.

Yat-Hung, C., Joinkey, S.C.-K., Bo-Sin, T. (2008). Time-Varying performance of four Asia-Pacific REITs. Journal of Property Investment and Finance, 26(3), 210-231.

Yunus, N. (2009). Increasing convergence between U.S. and international securitized property markets: Evidence based on cointegration tests. Real Estate Economics, 37(3), 383-411.