

Do Momentum-Based Strategies Work in Real Estate Investment Trust?

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Abstract: Research on the time series momentum for the Real Estate Investment Trust (REIT) is rare in the existing literature. This paper aims to contribute to the literature by examining whether time series momentum works for the United States REIT market. We also compare profitability with the standard price momentum for REITs, especially with more recent data during the zero-interest-rate period from 2008 to 2015. It is found that taking long positions by employing momentum strategies can generate an average monthly return of about 0% to 5% for the REITs in the United States. The momentum profits do fluctuate across the sample period but do not diminish over time.

Keywords: Momentum Strategies; Time Series Momentum; REITs.

1. Introduction

There is considerable evidence in the literature supporting the effectiveness of momentum strategies. Jegadeesh and Titman (1993) examine various momentum strategies for the US stock market and document that strategies which buy stocks with high returns over the previous 3 to 12 months and sell stocks with poor returns over the same period earn profits of about 1% per month for the following 3 to 12 months. They argue that the market underreacts to firm-specific information. Jegadeesh and Titman (2001) find momentum strategies profitable, and that past winners outperform past losers by about the same magnitude as earlier periods. Novy-Marx (2012) sheds new light on the term structure of momentum. It is shown that for the US stock markets, momentum strategies that rely on returns from the past 7 to 12 months perform better than using recent past returns of 2 to 6 months. In other words, strategies based on relatively intermediate past performance outperform strategies based on relatively recent performance. Similar results can be obtained in international stock market indices, foreign exchange and commodities. Moskowitz *et al.* (2012) introduce the concept of time series momentum, where an asset's own historical returns can predict its future returns. In traditional price momentum strategies, researchers sort winners and losers by relative performance and will consequently long the relative winners and short the relative losers. In the work of Moskowitz *et al.* (2012), within a particular

segment they calculate the returns on assets over the past 1 to 48 months. Instead of taking long-short positions according to relative performance, they long all securities that have positive returns and short all that have negative returns. They discern that this time series momentum can be found in stock market indices, foreign exchange, bonds as well as commodities.

This approach of sorting and trading all the stocks in a market is not practical empirically. Ordinary investors will not engage in such strategies. Instead, investors tend to be interested in a particular segment of the markets. In recent years, a number of studies have focused on Real Estate Investment Trust (REIT) markets. Chui *et al.* (2003) find that price momentum generates positive profits in the REIT market over the period from 1982 to 2000, in which the returns are higher from 1993 to 2000. Hung and Glascock (2008) find that REIT momentum returns are higher during up markets and are positively correlated with the difference between the dividend-price ratios of winners and losers. In 2010, their further research found that momentum profits for REITs are higher when there is higher volatility.

However, no studies on time series momentum strategies for REITs have been reported in the literature. In this paper, we investigate whether time series momentum exists in the US REIT market. We will compare profitability with the standard price momentum for REITs, especially with more recent data during the zero-interest-rate period from 2008 to 2015. In addition, we will check if there is term-structure momentum, as described by Novy-Marx (2012).

The remainder of this paper is organized as follows. Section 2 describes the data and discusses the research methodology. Section 3 reports the empirical results of price momentum strategies. Section 4 details the performance of time series momentum strategies. Section 5 concludes the paper.

2. Data and Methodology

In our study, end-of-month closing price data were obtained from the Thomson Reuters Eikon (Datastream). We studied all 148 constituents of the MSCI US REIT Index (RMZ) as at June 2016, over the period from January 1997 to July 2016, excluding those that were delisted and had trading suspended. The MSCI US REIT Index represents about 99% of the universe of US REIT markets, according to the Global Industry Classification Standard (GICS).

Table 1 provides the descriptive statistics of the average monthly price returns for each of these 148 REIT constituents. For the whole sample, the maximum average monthly return is 3.911%, while the minimum is -2.165%. We observe that 136 of the 148 REITs experienced positive monthly returns on average, and only a minority of 12 suffered negative average monthly returns. The average monthly return of all REITs is 0.848%. These imply that investors taking long positions for REITs enjoyed profits in general.

Table 1: Descriptive Statistics, Average Monthly Returns of US REITs

<i>Company Name</i>	<i>Ticker</i>	<i>Average Monthly Returns</i>
Acadia Realty Trust	AKR	0.787%
Agree Realty Corp	ADC	0.712%
Alexander's Inc	ALX	1.135%
Alexandria Real Estate Equities Inc	ARE	1.037%
American Assets Trust Inc	AAT	1.313%
American Campus Communities Inc	ACC	0.991%
American Homes 4 Rent Class A	AMH	1.036%
Apartment Investment & Management Co	AIV	0.869%
Apple Hospitality REIT Inc	APLE	0.818%
Ashford Hospitality Prime Inc	AHP	-0.525%
Ashford Hospitality Trust Inc	AHT	1.115%
AvalonBay Communities Inc	AVB	0.951%
Boston Properties Inc	BXP	0.981%
Brandywine Realty Trust	BDN	0.631%
Brixmor Property Group Inc	BRX	1.135%
Camden Property Trust	CPT	0.754%
Care Capital Properties Inc	CCP	-0.497%
CareTrust REIT Inc	CTRE	-1.017%
CBL & Associates Properties Inc	CBL	1.173%
Cedar Realty Trust Inc	CDR	1.286%
Chatham Lodging Trust	CLDT	0.577%
Chesapeake Lodging Trust	CHSP	0.594%
Colony Starwood Homes	SFR	0.529%
Columbia Property Trust Inc	CXP	0.402%
CoreSite Realty Corp	COR	2.592%
Corporate Office Properties Trust	OFC	1.046%
Corrections Corp of America	CXW	1.182%
Cousins Properties Inc	CUZ	0.233%
CubeSmart	CUBE	1.117%
CyrusOne Inc	CONE	2.477%
DCT Industrial Trust Inc	DCT	0.429%
DDR Corp	DDR	0.828%
DiamondRock Hospitality Co	DRH	0.579%
Digital Realty Trust Inc	DLR	1.820%
Douglas Emmett Inc	DEI	0.834%
Duke Realty Corp	DRE	0.645%
DuPont Fabros Technology Inc	DFT	2.102%
Easterly Government Properties Inc	DEA	1.496%
EastGroup Properties Inc	EGP	0.806%
Education Realty Trust Inc	EDR	0.482%
Empire State Realty Trust Inc	ESRT	1.337%
EPR Properties	EPR	1.049%
Equinix Inc	EQIX	3.911%
Equity Commonwealth	EQC	0.021%
Equity LifeStyle Properties Inc	ELS	1.050%

contd. table 1

<i>Company Name</i>	<i>Ticker</i>	<i>Average Monthly Returns</i>
Equity One Inc	EQY	0.748%
Equity Residential	EQR	0.785%
Essex Property Trust Inc	ESS	1.109%
Extra Space Storage Inc	EXR	1.632%
Federal Realty Investment Trust	FRT	0.985%
FelCor Lodging Trust Inc	FCH	0.435%
First Industrial Realty Trust Inc	FR	0.704%
First Potomac Realty Trust	FPO	0.044%
Forest City Realty Trust Inc Class A	FCEA	1.452%
Four Corners Property Trust Inc	FCPT	3.307%
Franklin Street Properties Corp	FSP	-0.053%
Gaming and Leisure Properties Inc	GLPI	-0.263%
General Growth Properties Inc	GGP	2.212%
GEO Group Inc	GEO	1.390%
Getty Realty Corp	GTY	0.641%
Global Net Lease Inc	GNL	0.188%
Government Properties Income Trust	GOV	0.364%
Gramercy Property Trust	GPT	0.459%
HCP Inc	HCP	0.627%
Healthcare Realty Trust Inc	HR	0.419%
Healthcare Trust of America Inc Class A	HTA	1.261%
Hersha Hospitality Trust Class A	HT	0.421%
Highwoods Properties Inc	HIW	0.500%
Hospitality Properties Trust	HPT	0.444%
Host Hotels & Resorts Inc	HST	0.701%
Hudson Pacific Properties Inc	HPP	1.097%
Investors Real Estate Trust	IRET	0.113%
Iron Mountain Inc	IRM	1.183%
Kilroy Realty Corp	KRC	0.741%
Kimco Realty Corp	KIM	0.902%
Kite Realty Group Trust	KRG	0.192%
LaSalle Hotel Properties	LHO	0.923%
Lexington Realty Trust	LXP	0.433%
Liberty Property Trust	LPT	0.499%
Life Storage Inc	LSI	0.798%
LTC Properties Inc	LTC	0.799%
Macerich Co	MAC	1.503%
Mack-Cali Realty Corp	CLI	0.282%
Medical Properties Trust Inc	MPW	0.788%
Mid-America Apartment Communities Inc	MAA	0.795%
Monmouth Real Estate Investment Corp	MNR	0.488%
Monogram Residential Trust Inc	MORE	0.682%
National Health Investors Inc	NHI	0.664%
National Retail Properties Inc	NNN	0.748%
National Storage Affiliates Trust	NSA	3.682%
New Senior Investment Group Inc	SNR	-1.959%

contd. table 1

<i>Company Name</i>	<i>Ticker</i>	<i>Average Monthly Returns</i>
New York REIT Inc	NYRT	-0.288%
NorthStar Realty Europe Corp	NRE	-2.165%
NorthStar Realty Finance Corp	NRF	0.806%
Omega Healthcare Investors Inc	OHI	0.745%
One Liberty Properties Inc	OLP	0.786%
Paramount Group Inc	PGRE	-0.171%
Pebblebrook Hotel Trust	PEB	0.618%
Pennsylvania REIT	PEI	1.339%
Physicians Realty Trust	DOC	1.921%
Piedmont Office Realty Trust Inc Class A	PDM	0.482%
Post Properties Inc	PPS	0.474%
Prologis Inc	PLD	0.748%
PS Business Parks Inc	PSB	0.918%
Public Storage	PSA	1.162%
QTS Realty Trust Inc Class A	QTS	3.242%
RAIT Financial Trust	RAS	0.254%
Ramco-Gershenson Properties Trust	RPT	0.572%
Realty Income Corp	O	0.930%
Regency Centers Corp	REG	0.817%
Retail Opportunity Investments Corp	ROIC	0.944%
Retail Properties of America Inc	RPAI	1.456%
Rexford Industrial Realty Inc	REXR	1.484%
RLJ Lodging Trust	RLJ	0.661%
Rouse Properties Inc	RSE	0.986%
Ryman Hospitality Properties Inc	RHP	1.082%
Sabra Health Care REIT Inc	SBRA	0.895%
Saul Centers Inc	BFS	0.872%
Select Income REIT	SIR	0.577%
Senior Housing Properties Trust	SNH	0.659%
Seritage Growth Properties Class A	SRG	2.686%
Silver Bay Realty Trust Corp	SBY	-0.002%
Simon Property Group Inc	SPG	1.224%
SL Green Realty Corp	SLG	1.292%
Spirit Realty Capital Inc	SRC	1.321%
STAG Industrial Inc	STAG	1.331%
STORE Capital Corp	STOR	2.178%
Summit Hotel Properties Inc	INN	0.884%
Sun Communities Inc	SUI	0.672%
Sunstone Hotel Investors Inc	SHO	0.810%
Tanger Factory Outlet Centers Inc	SKT	1.008%
Taubman Centers Inc	TCO	1.146%
Terreno Realty Corp	TRNO	0.649%
Tier REIT Inc	TIER	2.022%
UDR Inc	UDR	0.639%
Universal Health Realty Income Trust	UHT	0.649%
Urban Edge Properties	UE	1.385%

contd. table 1

<i>Company Name</i>	<i>Ticker</i>	<i>Average Monthly Returns</i>
Urstadt Biddle Properties Inc Class A	UBA	0.677%
Ventas Inc	VTR	1.285%
VEREIT Inc	VER	0.151%
Vornado Realty Trust	VNO	1.021%
Washington REIT	WRE	0.490%
Weingarten Realty Investors	WRI	0.765%
Welltower Inc	HCN	0.695%
Whitestone REIT	WSR	0.600%
WP Carey Inc	WPC	0.723%
WP Glimcher Inc	WPG	-1.484%
Xenia Hotels & Resorts Inc	XHR	-0.789%
<i>Average of All US REITs</i>		0.848%
Max		3.911%
Min		-2.165%

Employing the approach of Jegadeesh and Titman (2001), we rank all the REITs based on their recent end-of-month past returns. We also check if a price momentum term structure exists, as Novy-Marx (2012) suggests. To alleviate concerns over data snooping, we adopt 1 month, 2 months, 3 months and 6 months as the past returns' lookback periods. Stocks with performance in the top 30% in each lookback period will be included in the winner portfolio, and the bottom 30% in the loser portfolio.

To study price momentum, we will long the winner portfolio and short the loser portfolio simultaneously at the end of every month. To study the trend of momentum profits over time, we examine the performance of the long-short price momentum portfolios with holding periods of 1 month, 2 months, 3 months and 6 months. The long-short portfolios are equally weighted and will not rebalance over the holding period. We summarize these strategies in Table 2a.

There is currently no research on time series momentum strategies for REITs in the established literature. This paper will investigate if time series momentum exists in the US REIT market. We will calculate the recent past returns of all REITs at the end of every month. The lookback periods of past returns will be 1 month, 2 months, 3 months and 6 months.

At the end of every month, we take long positions for all REITs with positive returns in each lookback period and simultaneously take short positions for all REITs with negative returns in each lookback period. We then evaluate the performances of long-short time series momentum portfolios with holding periods of 1 month, 2 months, 3 months and 6 months. The long-short portfolios are equally weighted and will not rebalance over the holding period. We summarize these strategies in Table 2b.

Table 2a: Definition of Price Momentum Strategies for US REITs

<i>Lookback Period</i>	<i>Holding Period</i>	<i>Long/Short</i>
1 month	1 month	Long Top 30% Ranked
	2 months	Short Bottom 30% Ranked
	3 months	
	6 months	
2 months	1 month	Long Top 30% Ranked
	2 months	Short Bottom 30% Ranked
	3 months	
	6 months	
3 months	1 month	Long Top 30% Ranked
	2 months	Short Bottom 30% Ranked
	3 months	
	6 months	
6 months	1 month	Long Top 30% Ranked
	2 months	Short Bottom 30% Ranked
	3 months	
	6 months	

Table 2b: Definition of Time Series Momentum Strategies for US REITs

<i>Lookback Period</i>	<i>Holding Period</i>	<i>Long/Short</i>
1 month	1 month	Long All Stocks With Positive Returns
	2 months	Short All Stocks With Negative Returns
	3 months	
	6 months	
2 months	1 month	Long All Stocks With Positive Returns
	2 months	Short All Stocks With Negative Returns
	3 months	
	6 months	
3 months	1 month	Long All Stocks With Positive Returns
	2 months	Short All Stocks With Negative Returns
	3 months	
	6 months	
6 months	1 month	Long All Stocks With Positive Returns
	2 months	Short All Stocks With Negative Returns
	3 months	
	6 months	

The performance of the long components, the short components and the long-short momentum portfolios will be reported. We also evaluate the profitability of both the price momentum and the time series momentum strategies for the US REIT market.

3. Performance of Price Momentum Strategies

Tables 3a to 3d summarize the performance of standard price momentum strategies from January 1997 to July 2016, with past returns' lookback periods being 1 month, 2 months, 3 months and 6 months.

Table 3a: Performance of Price Momentum Strategies for US REITs Lookback Period of 1 Month

	<i>Long Strategy</i>	<i>Short Strategy</i>	<i>Long and Short Strategy</i>
<i>Holding Period of 1 Month</i>			
Mean Return (%)	0.375%	-1.429%**	-1.054%**
Median Return (%)	0.685%	-1.535%	-0.859%
Standard Dev. (%)	5.787%	7.551%	4.190%
Information Ratio	0.065	-0.189	-0.252
<i>Holding Period of 2 Months</i>			
Mean Return (%)	0.992%	-2.518%**	-1.520%**
Median Return (%)	1.246%	-2.436%	-0.862%
Standard Dev. (%)	8.526%	10.686%	5.276%
Information Ratio	0.116	-0.236	-0.288
<i>Holding Period of 3 Months</i>			
Mean Return (%)	2.041%**	-3.043%**	-0.994%*
Median Return (%)	2.423%	-3.482%	-0.806%
Standard Dev. (%)	10.412%	12.622%	6.567%
Information Ratio	0.196	-0.241	-0.151
<i>Holding Period of 6 Months</i>			
Mean Return (%)	4.528%**	-5.746%**	-1.218%
Median Return (%)	4.916%	-5.090%	-0.240%
Standard Dev. (%)	16.079%	20.692%	10.523%
Information Ratio	0.282	-0.278	-0.116

The mean monthly returns are marked with an asterisk if they are different from zero significantly. ** and * indicate significance at the 1% and 5% levels, respectively. The information ratio is the mean return divided by the standard deviation.

Table 3b: Performance of Price Momentum Strategies for US REITs Lookback Period of 2 Months

	<i>Long Strategy</i>	<i>Short Strategy</i>	<i>Long and Short Strategy</i>
<i>Holding Period of 1 Month</i>			
Mean Return (%)	0.440%	-1.450%**	-1.010%**
Median Return (%)	0.859%	-1.491%	-0.547%
Standard Dev. (%)	5.439%	7.953%	4.933%
Information Ratio	0.081	-0.182	-0.205
<i>Holding Period of 2 Months</i>			
Mean Return (%)	1.338%*	-2.232%**	-0.894%*
Median Return (%)	1.628%	-2.025%	-0.203%

Standard Dev. (%)	8.278%	11.171%	6.056%
Information Ratio	0.162	-0.200	-0.148
Holding Period of 3 Months			
Mean Return (%)	2.317%*	-2.875%*	-0.558%
Median Return (%)	2.749%	-2.753%	-0.006%
Standard Dev. (%)	9.789%	13.223%	6.952%
Information Ratio	0.237	-0.217	-0.080
Holding Period of 6 Months			
Mean Return (%)	4.873%**	-5.673%**	-0.800%
Median Return (%)	5.572%	-5.230%	0.756%
Standard Dev. (%)	15.465%	21.339%	11.945%
Information Ratio	0.315	-0.266	-0.067

The mean monthly returns are marked with an asterisk if they are different from zero significantly. ** and * indicate significance at the 1% and 5% levels, respectively. The information ratio is the mean return divided by the standard deviation.

Table 3c: Performance of Price Momentum Strategies for US REITs Lookback Period of 3 Months

	<i>Long Strategy</i>	<i>Short Strategy</i>	<i>Long and Short Strategy</i>
Holding Period of 1 Month			
Mean Return (%)	0.653%	-1.227%*	-0.574%
Median Return (%)	1.082%	-1.221%	-0.199%
Standard Dev. (%)	5.293%	8.113%	5.256%
Information Ratio	0.123	-0.151	-0.109
Holding Period of 2 Months			
Mean Return (%)	1.631%**	-2.010%**	-0.379%
Median Return (%)	1.898%	-2.275%	-0.076%
Standard Dev. (%)	7.820%	11.519%	7.166%
Information Ratio	0.209	-0.174	-0.053
Holding Period of 3 Months			
Mean Return (%)	2.537%**	-2.717%**	-0.180%
Median Return (%)	3.168%	-3.069%	0.230%
Standard Dev. (%)	9.634%	13.793%	8.417%
Information Ratio	0.263	-0.197	-0.021
Holding Period of 6 Months			
Mean Return (%)	5.312%**	-5.376%**	-0.064%
Median Return (%)	5.597%	-4.755%	1.172%
Standard Dev. (%)	15.505%	22.223%	14.553%
Information Ratio	0.343	-0.242	-0.004

The mean monthly returns are marked with an asterisk if they are different from zero significantly. ** and * indicate significance at the 1% and 5% levels, respectively. The information ratio is the mean return divided by the standard deviation.

Table 3d: Performance of Price Momentum Strategies for US REITs Lookback Period of 6 Months

	<i>Long Strategy</i>	<i>Short Strategy</i>	<i>Long and Short Strategy</i>
<i>Holding Period of 1 Month</i>			
Mean Return (%)	0.776%*	-0.926%	-0.150%
Median Return (%)	1.077%	-1.419%	0.065%
Standard Dev. (%)	5.334%	8.466%	5.952%
Information Ratio	0.145	-0.109	-0.025
<i>Holding Period of 2 Months</i>			
Mean Return (%)	1.688%**	-1.766%*	-0.077%
Median Return (%)	1.848%	-1.950%	0.327%
Standard Dev. (%)	7.686%	12.161%	8.146%
Information Ratio	0.220	-0.145	-0.010
<i>Holding Period of 3 Months</i>			
Mean Return (%)	2.643%**	-2.284%*	0.359%
Median Return (%)	3.644%	-2.544%	0.732%
Standard Dev. (%)	9.458%	13.944%	8.801%
Information Ratio	0.279	-0.164	0.041
<i>Holding Period of 6 Months</i>			
Mean Return (%)	5.275%**	-4.822%**	0.453%
Median Return (%)	6.047%	-3.592%	1.502%
Standard Dev. (%)	14.645%	22.779%	15.611%
Information Ratio	0.360	-0.212	0.029

*The mean monthly returns are marked with an asterisk if they are different from zero significantly. ** and * indicate significance at the 1% and 5% levels, respectively. The information ratio is the mean return divided by the standard deviation.*

Our results show that regardless of the lookback period, the monthly mean returns of the long-short strategy are generally negative. For the relatively short-term 1-month and 2-month lookback periods, the monthly mean returns range from -1.520% to -0.558%. The monthly mean returns for the 3-month lookback period slightly improve to between -0.574% and -0.064%. For the 6-month lookback period, the results range from -0.077% to 0.453%. Compared with the average monthly returns of 0.848% on all REITs, all long-short strategies underperform.

Breaking down the long and the short components of the portfolio reveals more details about the price momentum strategy. We find that for nearly all lookback and holding periods, the long component of past relative winners yields good positive returns, while shorting past relative losers generates deeply negative returns. These results are quite surprising. Consequently, this explains why long-short portfolios perform poorly.

It is found that the average monthly return of all REITs is 0.848%. Meanwhile, we find that 136 of 148 REITs, or 92% of the REITs in the sample

period, on average experienced positive monthly returns. These imply that investors taking short positions for REITs will in general barely generate profits.

Focusing on the long component, we find that longing the relative winners is a fruitful tactic. For a holding period of 2 months, monthly returns of the long strategy range from 0.992% to 1.688%. Monthly returns of a 3-month holding period range between 2.041% and 2.643%. For a 6-month holding period, the results range from 4.528% to 5.312%. Regardless of the choice of lookback periods, these price momentum strategies outperform the average REIT monthly return of 0.848%, with profits increasing with longer holding periods.

The information ratio is the mean return divided by the standard deviation. A higher information ratio represents a better risk-adjusted performance. For the long component, when the holding period increases, the information ratio increases, with the highest found in the 6-month holding period. The information ratio of the 3-month holding period ranges from 0.196 to 0.279, while that of the 6-month holding period ranges from 0.282 to 0.360.

In conclusion, during the sample period from January 1997 to July 2016, investing in REITs with the strategy of longing the relative winner's portfolio can generate an average return from 0.375% to 5.312% per month. The return is higher when adopting a longer holding period.

To investigate whether the market has corrected its inefficiency over time, we examine the stability of long-short profits by conducting subsample analyses. The subsample analyses of 1-month, 2-month, 3-month and 6-month lookback periods are illustrated in Tables 4a, b, c and d, respectively.

Table 4a: Subsample Analysis of Price Momentum Strategies for US REITs Lookback Period of 1 Month

	<i>Long Strategy</i>	<i>Short Strategy</i>	<i>Long and Short Strategy</i>
<i>Holding Period of 1 Month</i>			
1997 – 2001	-0.580%	-1.568%	-2.148%
2002 – 2006	1.141%	-2.197%	-1.056%
2007 – 2011	0.076%	-0.690%	-0.614%
2012 – 2016	1.026%	-1.329%	-0.303%
<i>Holding Period of 2 Months</i>			
1997 – 2001	-0.502%	-2.174%	-2.676%
2002 – 2006	2.749%	-4.185%	-1.436%
2007 – 2011	-0.245%	-1.361%	-1.606%
2012 – 2016	2.247%	-2.531%	-0.284%
<i>Holding Period of 3 Months</i>			
1997 – 2001	-0.031%	-2.345%	-2.376%
2002 – 2006	4.896%	-5.726%	-0.830%
2007 – 2011	0.201%	-1.240%	-1.039%
2012 – 2016	3.404%	-3.093%	0.311%

Table 4b: Subsample Analysis of Price Momentum Strategies for US REITs Lookback

Period	Long Strategy	Short Strategy	Long and Short Strategy
1997 – 2001	1.297%	-3.322%	-2.025%
2002 – 2006	9.428%	-11.003%	-1.575%
2007 – 2011	1.539%	-3.844%	-2.305%
2012 – 2016	6.706%	-5.278%	1.428%

Table 4b: Subsample Analysis of Price Momentum Strategies for US REITs Lookback Period of 2 Months

	Long Strategy	Short Strategy	Long and Short Strategy
Period of 2 Months			
Period of 1 Month			
1997 – 2001	-0.472%	-1.426%	-1.898%
2002 – 2006	1.278%	-2.281%	-1.003%
2007 – 2011	-0.024%	-0.945%	-0.969%
2012 – 2016	1.179%	-1.266%	-0.087%
Period of 2 Months			
1997 – 2001	-0.173%	-1.944%	-2.117%
2002 – 2006	3.124%	-3.850%	-0.726%
2007 – 2011	0.208%	-1.322%	-1.114%
2012 – 2016	2.505%	-2.059%	0.446%
Period of 3 Months			
1997 – 2001	0.202%	-2.220%	-2.018%
2002 – 2006	4.829%	-5.984%	-1.155%
2007 – 2011	0.812%	-1.045%	-0.233%
2012 – 2016	3.805%	-2.566%	1.239%
Period of 6 Months			
1997 – 2001	1.738%	-3.381%	-1.643%
2002 – 2006	9.705%	-10.837%	-1.132%
2007 – 2011	2.173%	-4.241%	-2.068%
2012 – 2016	6.996%	-4.855%	2.141%

Table 4c: Subsample Analysis of Price Momentum Strategies for US REITs Lookback Period of 3 Months

	Long Strategy	Short Strategy	Long and Short Strategy
Period of 3 Months			
Period of 1 Month			
1997 – 2001	-0.179%	-1.098%	-1.277%
2002 – 2006	1.433%	-1.932%	-0.499%
2007 – 2011	0.244%	-0.873%	-0.629%
2012 – 2016	1.327%	-1.183%	0.144%
Period of 2 Months			
1997 – 2001	0.251%	-1.669%	-1.418%
2002 – 2006	3.227%	-3.620%	-0.393%
2007 – 2011	0.560%	-1.025%	-0.465%
2012 – 2016	2.838%	-2.056%	0.782%

<i>Holding Period of 3 Months</i>			
1997 – 2001	0.719%	-2.110%	-1.391%
2002 – 2006	4.990%	-5.520%	-0.530%
2007 – 2011	0.788%	-1.088%	-0.300%
2012 – 2016	4.199%	-2.566%	1.633%
<i>Holding Period of 6 Months</i>			
1997 – 2001	2.481%	-3.339%	-0.858%
2002 – 2006	10.067%	-10.056%	0.011%
2007 – 2011	2.488%	-3.993%	-1.505%
2012 – 2016	7.611%	-5.094%	2.517%

Table 4d: Subsample Analysis of Price Momentum Strategies for US REITs Lookback Period of 6 Months

	<i>Long Strategy</i>	<i>Short Strategy</i>	<i>Long and Short Strategy</i>
<i>Holding Period of 1 Month</i>			
1997 – 2001	0.173%	-0.521%	-0.348%
2002 – 2006	1.551%	-1.641%	-0.090%
2007 – 2011	0.210%	-0.719%	-0.509%
2012 – 2016	1.487%	-0.983%	0.504%
<i>Holding Period of 2 Months</i>			
1997 – 2001	0.657%	-0.825%	-0.168%
2002 – 2006	3.315%	-3.310%	0.005%
2007 – 2011	0.468%	-1.321%	-0.853%
2012 – 2016	2.890%	-1.842%	1.048%
<i>Holding Period of 3 Months</i>			
1997 – 2001	0.935%	-0.834%	0.101%
2002 – 2006	5.241%	-4.921%	0.320%
2007 – 2011	1.004%	-1.259%	-0.255%
2012 – 2016	4.106%	-2.437%	1.669%
<i>Holding Period of 6 Months</i>			
1997 – 2001	2.690%	-2.021%	0.669%
2002 – 2006	10.318%	-9.073%	1.245%
2007 – 2011	2.464%	-4.342%	-1.878%
2012 – 2016	7.355%	-4.845%	2.510%

We divide the 20-year sample period from January 1997 to June 2016 into four five-year subsamples. The four subsample periods range from 1997 to 2001, 2002 to 2006, 2007 to 2011 and 2012 to 2016.

We observe that in general, the strategies perform best in the 2002 to 2006 subsample. For long strategies with 3-month holding periods in the 2002 to 2006 subsample, average monthly returns are from 4.829% to 5.241%, which are much better than returns of 2.041% to 2.643% in the whole sample. For 6-month holding periods, the monthly mean returns of the long component in this subsample range from 9.428% to 10.318%, which surpass the whole sample returns of 4.528% to 5.312%.

In sum, in the 2002 to 2006 subsample, monthly momentum returns from taking long positions are the greatest. Moreover, we recognize that the performance of the long portfolio between 2012 and 2016 is better than that in the 2007 to 2011 subsample.

Among the four subsamples, the results from 1997 to 2001 are generally the worst. For long strategies with a 6-month holding period, average monthly returns are from 1.297% to 2.690%, which are much worse than the whole sample returns of 4.528% to 5.312%. We observe that the price momentum profits from long portfolios do fluctuate throughout the entire sample period. Nevertheless, our results do not exhibit diminishing price momentum profits over time. We may therefore conclude that the market for US REITs does not correct its inefficiency over our 20-year sample.

4. Performance of Time Series Momentum Strategies

We examine the performance of time series momentum strategies from January 1997 to July 2016 for US REIT markets. Tables 5a to 5d summarize the performance of these strategies with past returns lookback periods of 1 month, 2 months, 3 months and 6 months.

Table 5a: Performance of Time Series Momentum Strategies for US REITs Lookback Period of 1 Month

	<i>Long Strategy</i>	<i>Short Strategy</i>	<i>Long and Short Strategy</i>
Holding Period of 1 Month			
Mean Return (%)	0.496%	-1.715%**	-1.222%**
Median Return (%)	1.046%	-1.747%	-0.920%
Standard Dev. (%)	5.447%	7.860%	5.048%
Information Ratio	0.091	-0.218	-0.242
Holding Period of 2 Months			
Mean Return (%)	1.133%*	-2.522%**	-1.394%**
Median Return (%)	1.290%	-2.117%	-1.024%
Standard Dev. (%)	8.345%	10.220%	5.024%
Information Ratio	0.136	-0.247	-0.277
Holding Period of 3 Months			
Mean Return (%)	2.099%**	-2.845%**	-0.755%
Median Return (%)	2.309%	-3.379%	-0.540%
Standard Dev. (%)	10.153%	11.815%	6.368%
Information Ratio	0.207	-0.241	-0.119
Holding Period of 6 Months			
Mean Return (%)	4.651%**	-5.578%**	-0.947%
Median Return (%)	4.910%	-4.610%	-0.186%
Standard Dev. (%)	15.264%	19.840%	10.606%
Information Ratio	0.305	-0.281	-0.089

The mean monthly returns are marked with an asterisk if they are different from zero significantly. ** and * indicate significance at the 1% and 5% levels, respectively. The information ratio is the mean return divided by the standard deviation.

Table 5b: Performance of Time Series Momentum Strategies for US REITs Lookback Period of 2 Months

	<i>Long Strategy</i>	<i>Short Strategy</i>	<i>Long and Short Strategy</i>
<i>Holding Period of 1 Month</i>			
Mean Return (%)	0.370%	-1.402%**	-1.032%**
Median Return (%)	0.826%	-1.559%	-0.536%
Standard Dev. (%)	5.128%	7.081%	4.183%
Information Ratio	0.072	-0.198	-0.247
<i>Holding Period of 2 Months</i>			
Mean Return (%)	1.158%*	-2.007%**	-0.849%**
Median Return (%)	1.677%	-1.926%	-0.563%
Standard Dev. (%)	7.971%	10.037%	4.862%
Information Ratio	0.145	-0.200	-0.175
<i>Holding Period of 3 Months</i>			
Mean Return (%)	1.966%**	-2.748%**	-0.782%
Median Return (%)	2.480%	-2.447%	-0.526%
Standard Dev. (%)	9.388%	12.255%	6.553%
Information Ratio	0.209	-0.224	-0.119
<i>Holding Period of 6 Months</i>			
Mean Return (%)	4.232%**	-5.138%**	-0.906%
Median Return (%)	4.893%	-4.974%	-0.354%
Standard Dev. (%)	15.169%	18.344%	8.255%
Information Ratio	0.279	-0.280	-0.110

The mean monthly returns are marked with an asterisk if they are different from zero significantly. ** and * indicate significance at the 1% and 5% levels, respectively. The information ratio is the mean return divided by the standard deviation.

Table 5c: Performance of Time Series Momentum Strategies for US REITs Lookback Period of 3 Months

	<i>Long Strategy</i>	<i>Short Strategy</i>	<i>Long and Short Strategy</i>
<i>Holding Period of 1 Month</i>			
Mean Return (%)	0.569%	-1.176%**	-0.609%*
Median Return (%)	1.050%	-1.706%	-0.371%
Standard Dev. (%)	5.391%	6.866%	3.667%
Information Ratio	0.106	-0.171	-0.166
<i>Holding Period of 2 Months</i>			
Mean Return (%)	1.506%**	-1.913%**	-0.413%
Median Return (%)	1.610%	-2.346%	-0.484%
Standard Dev. (%)	8.014%	9.861%	4.874%
Information Ratio	0.188	-0.194	-0.085
<i>Holding Period of 3 Months</i>			
Mean Return (%)	2.267%**	-2.834%**	-0.576%
Median Return (%)	2.988%	-3.738%	-0.455%
Standard Dev. (%)	9.085%	12.035%	6.657%
Information Ratio	0.250	-0.235	-0.087

Holding Period of 6 Months			
Mean Return (%)	4.328%**	-4.935%**	-0.625%
Median Return (%)	5.064%	-5.098%	-0.115%
Standard Dev. (%)	14.446%	17.715%	7.954%
Information Ratio	0.300	-0.279	-0.079

The mean monthly returns are marked with an asterisk if they are different from zero significantly. ** and * indicate significance at the 1% and 5% levels, respectively. The information ratio is the mean return divided by the standard deviation.

Table 5d: Performance of Time Series Momentum Strategies for US REITs Lookback Period of 6 Months

	<i>Long Strategy</i>	<i>Short Strategy</i>	<i>Long and Short Strategy</i>
Holding Period of 1 Month			
Mean Return (%)	0.631%	-1.110%*	-0.470%
Median Return (%)	1.255%	-1.000%	-0.375%
Standard Dev. (%)	4.999%	6.968%	4.397%
Information Ratio	0.126	-0.159	-0.107
Holding Period of 2 Months			
Mean Return (%)	1.304%**	-1.856%**	-0.536%
Median Return (%)	1.780%	-2.277%	-0.221%
Standard Dev. (%)	7.146%	10.159%	6.314%
Information Ratio	0.183	-0.183	-0.085
Holding Period of 3 Months			
Mean Return (%)	2.061%**	-2.325%**	-0.243%
Median Return (%)	3.250%	-2.677%	-0.098%
Standard Dev. (%)	8.696%	11.830%	7.162%
Information Ratio	0.237	-0.197	-0.034
Holding Period of 6 Months			
Mean Return (%)	4.039%**	-4.280%**	-0.203%
Median Return (%)	5.381%	-2.976%	0.659%
Standard Dev. (%)	13.159%	17.698%	10.598%
Information Ratio	0.307	-0.242	-0.019

The mean monthly returns are marked with an asterisk if they are different from zero significantly. ** and * indicate significance at the 1% and 5% levels, respectively. The information ratio is the mean return divided by the standard deviation.

It is interesting to note that for all lookback periods and all holding periods, all long-short portfolios generate negative returns, ranging from -1.394% to -0.203%, far underperforming the benchmark of 0.848%, the average monthly return of all REITs. Investigating the long and short components of the portfolios in detail, we can identify more characteristics of the time series momentum strategies.

We find that for the US REIT market, when considering all lookback periods and holding periods, the long component will generate positive returns. Meanwhile, the short component will experience negative returns. This

explains why a simultaneous long-short strategy is not a profitable one. Similar findings are also observed when adopting price momentum long-short strategies for REITs. As the average monthly return of all REITs is 0.848%, and 92% of the REITs in the sample period experience positive average monthly returns, taking short positions for REITs will be a painful lesson.

Consider the long component, for a 1-month holding period, monthly returns of long strategies range from 0.370% to 0.631%. Monthly returns of a 2-month holding period range between 1.133% and 1.506%. For the 3-month holding period, the results range from 1.966% to 2.267%. The average monthly returns for a 6-month holding period are between 4.039% and 4.651%. Regardless of the choice of lookback periods, the time series momentum strategies outperform 0.848%, the average monthly return of all REITs. Nevertheless, the time series momentum long strategies slightly underperform the price momentum long strategies.

For long portfolios, we find that the information ratio increases as the holding period increases, with the 6-month holding period being the highest, ranging from 0.279 to 0.307.

In conclusion, during the whole sample period from January 1997 to July 2016, investing in REITs by taking long positions in stocks with positive past returns can generate a return of 0.370% to 4.651% per month on average. The return is higher when adopting a longer holding period and underperforms the return of the price momentum strategies that long the relative winners.

To investigate whether the market has corrected its inefficiency over time, we examine the stability of the time series momentum long-short profits by conducting subsample analyses. The subsample analysis of lookback periods of 1 month, 2 months, 3 months and 6 months are illustrated in Tables 6a, b, c and d, respectively.

Table 6a: Subsample Analysis of Time Series Momentum Strategies for US REITs Lookback Period of 1 Month

	<i>Long Strategy</i>	<i>Short Strategy</i>	<i>Long and Short Strategy</i>
<i>Holding Period of 1 Month</i>			
1997 – 2001	-0.446%	-1.497%	-1.943%
2002 – 2006	1.030%	-2.485%	-1.455%
2007 – 2011	0.548%	-1.458%	-0.910%
2012 – 2016	0.973%	-1.509%	-0.536%
<i>Holding Period of 2 Months</i>			
1997 – 2001	-0.420%	-1.804%	-2.224%
2002 – 2006	2.621%	-4.519%	-1.898%
2007 – 2011	0.480%	-1.582%	-1.102%
2012 – 2016	1.930%	-2.327%	-0.397%

<i> Holding Period of 3 Months</i>			
1997 – 2001	0.080%	-1.793%	-1.713%
2002 – 2006	4.280%	-5.812%	-1.532%
2007 – 2011	1.446%	-1.100%	0.346%
2012 – 2016	3.062%	-2.900%	0.162%
<i> Holding Period of 6 Months</i>			
1997 – 2001	1.401%	-3.094%	-1.693%
2002 – 2006	8.652%	-10.766%	-2.114%
2007 – 2011	2.761%	-3.661%	-0.900%
2012 – 2016	6.762%	-5.137%	1.625%

Table 6b: Subsample Analysis of Time Series Momentum Strategies for US REITs Lookback Period of 2 Months

	<i> Long Strategy</i>	<i> Short Strategy</i>	<i> Long and Short Strategy</i>
<i> Holding Period of 1 Month</i>			
1997 – 2001	-0.384%	-1.177%	-1.561%
2002 – 2006	1.280%	-2.423%	-1.143%
2007 – 2011	-0.294%	-0.776%	-1.070%
2012 – 2016	1.082%	-1.377%	-0.295%
<i> Holding Period of 2 Months</i>			
1997 – 2001	-0.222%	-1.623%	-1.845%
2002 – 2006	2.832%	-4.201%	-1.369%
2007 – 2011	-0.040%	-0.425%	-0.465%
2012 – 2016	2.361%	-1.935%	0.426%
<i> Holding Period of 3 Months</i>			
1997 – 2001	0.162%	-1.995%	-1.833%
2002 – 2006	4.354%	-6.694%	-2.340%
2007 – 2011	0.327%	-0.098%	0.229%
2012 – 2016	3.473%	-2.454%	1.019%
<i> Holding Period of 6 Months</i>			
1997 – 2001	1.293%	-3.295%	-2.002%
2002 – 2006	8.801%	-11.069%	-2.268%
2007 – 2011	1.604%	-1.615%	-0.011%
2012 – 2016	6.373%	-5.150%	1.223%

Table 6c: Subsample Analysis of Time Series Momentum Strategies for US REITs Lookback Period of 3 Months

	<i> Long Strategy</i>	<i> Short Strategy</i>	<i> Long and Short Strategy</i>
<i> Holding Period of 1 Month</i>			
1997 – 2001	-0.327%	-1.010%	-1.337%
2002 – 2006	1.234%	-2.322%	-1.088%
2007 – 2011	0.254%	-0.412%	-0.158%
2012 – 2016	1.232%	-1.094%	0.138%

<i>Holding Period of 2 Months</i>			
1997 – 2001	-0.027%	-1.360%	-1.387%
2002 – 2006	2.861%	-4.219%	-1.358%
2007 – 2011	1.074%	-0.410%	0.664%
2012 – 2016	2.561%	-1.898%	0.663%
<i>Holding Period of 3 Months</i>			
1997 – 2001	0.268%	-1.569%	-1.301%
2002 – 2006	4.381%	-7.101%	-2.720%
2007 – 2011	1.362%	-0.339%	1.023%
2012 – 2016	3.689%	-2.585%	1.104%
<i>Holding Period of 6 Months</i>			
1997 – 2001	1.669%	-2.915%	-1.246%
2002 – 2006	8.846%	-10.461%	-1.615%
2007 – 2011	1.541%	-1.887%	-0.346%
2012 – 2016	6.627%	-5.229%	1.398%

Table 6d: Subsample Analysis of Time Series Momentum Strategies for US REITs Lookback Period of 6 Months

	<i>Long Strategy</i>	<i>Short Strategy</i>	<i>Long and Short Strategy</i>
<i>Holding Period of 1 Month</i>			
1997 – 2001	0.292%	-0.575%	-0.283%
2002 – 2006	1.454%	-2.469%	-1.015%
2007 – 2011	-0.350%	-0.552%	-0.902%
2012 – 2016	1.438%	-1.098%	0.340%
<i>Holding Period of 2 Months</i>			
1997 – 2001	0.432%	-0.761%	-0.329%
2002 – 2006	3.028%	-4.277%	-1.249%
2007 – 2011	-0.383%	-0.872%	-1.255%
2012 – 2016	2.667%	-1.973%	0.694%
<i>Holding Period of 3 Months</i>			
1997 – 2001	0.490%	-0.720%	-0.230%
2002 – 2006	4.653%	-6.196%	-1.543%
2007 – 2011	-0.061%	-0.305%	-0.366%
2012 – 2016	3.818%	-2.651%	1.167%
<i>Holding Period of 6 Months</i>			
1997 – 2001	1.917%	-2.421%	-0.504%
2002 – 2006	9.080%	-9.687%	-0.607%
2007 – 2011	0.008%	-1.034%	-1.026%
2012 – 2016	6.944%	-5.401%	1.543%

The entire sample period is from January 1997 to June 2016. We divide the 20-year sample into four five-year subsamples. The four subsample periods are from 1997 to 2001, 2002 to 2006, 2007 to 2011, and 2012 to 2016.

We observe that in general, the strategies perform the best in the 2002 to 2006 subsample. In this subsample, for a holding period of 3 months, the long

monthly mean returns range from 4.280% to 4.653%, which outperform the whole sample's returns of 1.966% to 2.267%. For long strategies with a 6-month holding period in the 2002 to 2006 subsample, average monthly returns are from 8.652% to 9.080%, which are much better than the whole sample's returns of 4.039% to 4.651%.

Overall, the monthly momentum returns from longing all recent past winners are the greatest when compared with the whole sample period averages. Moreover, we recognize that the performance of the long portfolio between 2012 and 2016 is better than those of the remaining two subsamples of 1997 to 2001 and 2007 to 2011.

Concerning the time series momentum of US REITs, our results do not demonstrate a diminishing trend of momentum profits over time. We observe a similar fact in the case of price momentum. This provides further evidence that the REIT market does not correct its inefficiency as time passes.

5. Conclusion

Research on time series momentum for REITs is rare in the literature. This paper supplements the literature by examining whether time series momentum works for the US REIT market. Choosing the 148 constituents of MSCI US REIT Index (RMZ) as samples, for the period from January 1997 to July 2016, this paper demonstrates that investing in US REITs using price momentum based strategies or time series momentum based long-short strategies generates negative returns. This is because 92% of the REITs in the sample experience positive monthly returns on average. As such, the short components drag down momentum profits. Further analysis of the long component shows that both price and time series momentum generate fruitful profits. For time series momentum, with holding periods of 3 months and 6 months, average monthly returns range from 1.966% to 4.651%. For price momentum with the same holding period, the mean monthly returns are even higher, from 2.041% to 5.312%. Regardless of the choice of lookback periods, we find that both price and time series momentum strategies outperform the average monthly return of all US REITs of 0.848%. We also examine the term structure of momentum for the REIT markets. Our results show that the longer the holding period, the better the long portfolio returns. These findings contradict the efficient market hypothesis. To investigate whether the REIT market has corrected its inefficiency over time, we conduct subsample analyses. We observe that in general, for both time series and price momentum strategies, long portfolio profits do not decay over time. This provides evidence that the REIT market does not correct its inefficiency over time.

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