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Analysis of REITs and REIT ETFs Cointegration during the Flash Crash.

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In this study I revisit the "disintegration hypothesis" of financial assets around a major crisis event. I examine whether the Vanguard Real Estate Investment Trust and iShares Dow Jones US Real Estate Index Fund exchange traded funds disintegrate from the ten largest Real Estate Investment Trusts during the 14:45 Flash Crash on May 6, 2010. I find that six of the ten largest REITs are not cointegrated with the Vanguard Real Estate Investment Trust prior to the Flash Crash and that five of the ten largest REITs are not cointegrated with iShares Dow Jones US Real Estate Index Fund prior to the Flash Crash. After the Flash Crash all REITs are cointegrated with the two REIT ETFs. This clearly refutes the "disintegration hypothesis" of REITs and REIT ETFs.

INTRODUCTION

In this study I test the "disintegration hypothesis" on Real Estate Investment Trusts (REITs) and REIT Exchange Traded Funds (ETFs) during the Flash Crash of May 6, 2010 which started at 14:45. On this day all financial markets experienced extreme market fluctuations within the trading day that had never been observed before. I examine whether the Vanguard REIT ETF (VNQ) and iShares Dow Jones US Real Estate Index Fund (IYR) REIT ETFs disintegrate from the ten most popular REITs. A study by Hoesli and Oikarinen (2012) examines the cointegration between REITs and the stock market, which in my opinion has no theoretical basis. The cointegration between REITs and REIT ETFs on the other hand has a strong theoretical basis. REITs and REIT ETFs both track the real estate market. During the Flash Crash the S&P 500 index and its affiliated ETFs experienced the most severe corrections. That is why most studies of the Flash Crash, such as Ivanov (2011), Easley, Lopez and O'Hara (2011) and Madhaven (2012) among many, focus on S&P 500 index products since the overall consensus is that the crash has been prompted in the S&P 500 futures market. This is the first study to the best of my knowledge to examine the behavior of assets other than S&P 500 index products on the day of the Flash Crash.

REIT ETFs are designed to track a REIT index. The REIT ETFs that I study are VNQ and IYR. VNQ has as an underlying index the MSCI US REITs index (symbol RMZ). IYR has as an underlying index the Dow Jones U.S. Real Estate Index (symbol DJUSRE). To qualify as a REIT a trust is required to invest at least 75% of all of their assets in real estate and derive at least 75% of all revenue from real estate or mortgages. Like other investment companies REITs are also required to distribute at least 90% of all income to their investors and to have at least 100 investors (http:\\www.reit.com). REITs trade on an exchange just like stocks, closed-end funds and ETFs.

This study contributes to our knowledge of the relation of assets during extreme market events. The understanding of how assets behave in times of crisis further our understanding of the diversification benefits of REITs and REIT ETFs. The overall consensus among investors is that in times of crises:

"Cash is king". Because all investors liquidate financial assets to obtain cash simultaneously in time of crisis all financial asset prices move in one direction – down. Therefore, overall correlations among assets increase and gravitate toward one. However, the "disintegration hypothesis" suggests the contrary. There is evidence indicating that some financial assets diverge from other assets which causes them to behave differently. These are the assets that would contribute most to diversification and only studies like this one can help us identify assets with these appealing characteristics.

LITERATURE REVIEW

Harris (1989) examines the S&P 500 spot-futures basis during the October 1987 crash. He documents an increase in the spot-futures basis around this event and suggests that nonsynchronous trading might be the cause. This evidence he interprets as being in support of the proposed by him "disintegration hypothesis" of spot and futures markets. Blume, Mackinlay and Terker (1989) do not specifically state that they test the "disintegration hypothesis." However, they find a linkage-breakdown between S&P 500 and non-S&P 500 stocks and futures and cash markets on both October 19, 1987 and October 20, 1987 which can be interpreted as being in support of the "disintegration hypothesis" between S&P 500 and non-S&P 500 stocks. Additionally, Jones, Nachtmann and Phillips-Patrick (1993) also study the linkage breakdown between S&P 500 and non-S&P 500 index stocks during the October 1987 and October 1989 crises. Jones, Nachtmann and Phillips-Patrick (1993) for the first time use cointegration analysis and document that the linkage between S&P 500 and non-S&P 500 NYSE listed stocks does not breakdown, which is contrary to the "disintegration hypothesis."

Ivanov (2011) examines the cointegration between the S&P 100 and the S&P 500 indexes around the crises of Black Monday of October 19, 1987, the Friday the 13th mini-crash of October 13, 1989, the 1997 mini-crash of October 27, 1997, the Flash Crash of May 6, 2010 and the Japanese Earthquake of March 11, 2011. He provides evidence in support of the "disintegration hypothesis" in the relation between the S&P 100 and the S&P 500.

Ivanov (2012) examines if the Vanguard Real Estate Investment Trust ETF and the iShares Dow Jones US Real Estate Index Fund ETF disintegrate from their underlying indexes during the recent financial crisis. He fails to find support for the "disintegration hypothesis" of these ETFs and their underlying indexes. He finds that the financial crisis instead has improved the relation between REIT ETFs and their underlying indexes.

DATA AND METHODOLOGY

The two REIT ETFs that are used in this study are the Vanguard REIT ETF (VNQ) and the iShares Dow Jones US Real Estate Index Fund (IYR). VNQ's underlying index is the MSCI US REITs index and IYR's underlying index is the Dow Jones U.S. Real Estate Index. There are other REIT ETFs traded in the financial markets today. However, I focus on VNQ and IYR because they represent 71% of all assets under management and 84% of all trading activity in terms of volume as of 01/23/2012. The REIT and REIT ETFs data are from pitrading.com. Table 1 provides summary information on the two REIT ETFs and the ten REITs used in this study. Table 1 Panel A provides information on REIT ETFs whereas Panel B provides basic information on REITs.

TABLE 1
SUMMARY INFORMATION

Panel A. REIT ETFs

Ticker	ETF Name	Underlying Index	Exp	Net Assets	Avg. Vol
VNQ	Vanguard REIT ETF	MSCI US REIT Index	0.12	29.71B	2,486,890
IYR	iShares Dow Jones US Real Estate Index Fund	Dow Jones U.S. Real Estate Index	0.47	4.59B	9,656,920

TABLE 1 (CONTINUED)
SUMMARY INFORMATION

Panel B. REITs

Symbol	Name	Type	Market Cap	Avg. Vol.
SPG	Simon Property Group	Retail	49.46B	1,171,160
PSA	Public Storage	Diversified	25.79B	703,862
HCP	HCP Inc.	Healthcare Facilities	21.01B	2,469,360
VTR	Ventas Inc.	Healthcare Facilities	19.43B	1,360,040
EQR	Equity Residential	Residential	18.79B	2,047,390
BXP	Boston Properties Inc.	Office	16.27B	847,992
PLD	ProLogis Inc.	Industrial	18.17B	2,644,970
VNO	Vornado Realty Trust	Diversified	15.75B	902,000
AVB	AvalonBay Communities Inc.	Residential	15.75B	877,000
HCN	Health Care REIT Inc.	Healthcare Facilities	16.11B	1,788,440

Note: Data as of January 21, 2013, retrieved from finance.yahoo.com

The REITs that are examined are the largest in the industry. They represent a range of industries within the REIT segment, such as retail, Healthcare Facilities, Industrial, Office, Residential and Diversified REITs. The ten REITs are the largest components of these two REIT ETFs. For example, the ten REITs represent approximately 30% of IYR's net assets (information retrieved from http://www.djindexes.com/mdsidx/downloads/fact_info/Dow_Jones_US_Real_Estate_Index_Fact_Sheet.pdf on January 23, 2013).

The question that this study addresses is: "Are REIT ETFs disintegrating from REITs during the Flash Crash?" The Flash Crash starts at 14:45 and I examine the cointegration of REITs and REIT ETFs before and after this time of the trading day.

The theoretical association between REITs and REIT ETFs and the Granger Representation Theorem suggest that cointegration might exist between these two assets. The Granger Representation Theorem (Engle and Granger, 1987) states that if two series are both integrated of order one there might exist a joint long-term error correction representation of their relation. I use the Augmented Dickey Fuller and Phillips Perron Unit Root tests to establish whether the price series are integrated of order one. The most widely used method to test for cointegration is the Johansen Test using Trace Statistic (Johansen, 1991) naturally before first establishing that the price series are integrated of order one. I use this method because it allows for the identification of multiple cointegrating vectors. The alternative to this method is the Engle-Granger two-step cointegration methodology (Engle and Granger, 1987) but it is limited to testing only for one cointegrating vector.

ANALYSIS

Table 2 reports summary statistics for prices before and after the Flash Crash. Judging by the summary statistics on REITs and REIT ETFs it is difficult to discern the gravity of the Flash Crash. The average prices before and after 14:45 on the day of the Flash Crash are relatively close, even though after the Flash Crash the average prices are lower. Volatility has not changed as much either before versus after the event. This indicates that based on the univariate analysis and at first glance both periods before and after 14:45 are not much different.

TABLE 2
REIT AND REIT ETFs PRICES BEFORE AND DURING THE FLASH CRASH

	Before					After				
	N	Mean	Std Dev	Min	Max	N	Mean	Std Dev	Min	Max
VNQ	4666	50.77	0.93	48.12	52.08	1971	49.56	0.95	45.00	50.97
IYR	10509	51.26	0.86	48.59	52.59	3770	50.04	0.97	44.84	51.42
AVB	1721	101.50	1.91	97.25	105.14	1227	99.44	1.59	93.41	101.73
BXP	1984	78.71	1.32	75.51	80.76	1489	78.06	1.24	73.81	79.87
EQR	2551	45.03	0.96	42.82	46.56	1695	44.13	0.77	41.56	47.33
HCN	1936	41.85	0.82	40.02	43.06	1414	40.56	0.59	38.47	41.62
HCP	2515	31.05	0.56	29.49	31.89	1705	30.65	0.59	28.53	31.61
PLD	2484	12.03	0.36	11.19	12.62	1744	11.75	0.31	10.65	12.17
PSA	1725	95.24	1.54	91.38	97.48	1306	93.68	1.38	89.04	96.07
SPG	2281	85.57	1.78	81.28	88.80	1491	83.95	1.42	78.91	86.44
VNO	1855	78.74	1.77	74.86	82.04	1403	77.43	1.40	72.73	79.61
VTR	1774	45.92	0.62	44.20	46.94	1345	45.50	0.67	43.14	46.58

To further examine the basic characteristics of REITs and REIT ETFs I also examine the behavior of the intradaily rates of return of these assets. Table 3 reports summary statistics for REITs and REIT ETFs returns before and after the Flash Crash at 14:45. The rates of return exhibit different pattern – the average returns prior to the event are negative whereas they are positive after the event. The REIT ETFs volatility has increased significantly after the event but the same cannot be said for REITs. Some REITs such as AVB, HCN, SPG and VNQ experience an increase in volatility, whereas the rest experience decrease in the returns volatility after the Flash Crash. These differences indicate that further analysis rather than simple univariate analysis is needed to understand what happens to the relation of REITs and REIT ETFs in an extreme event.

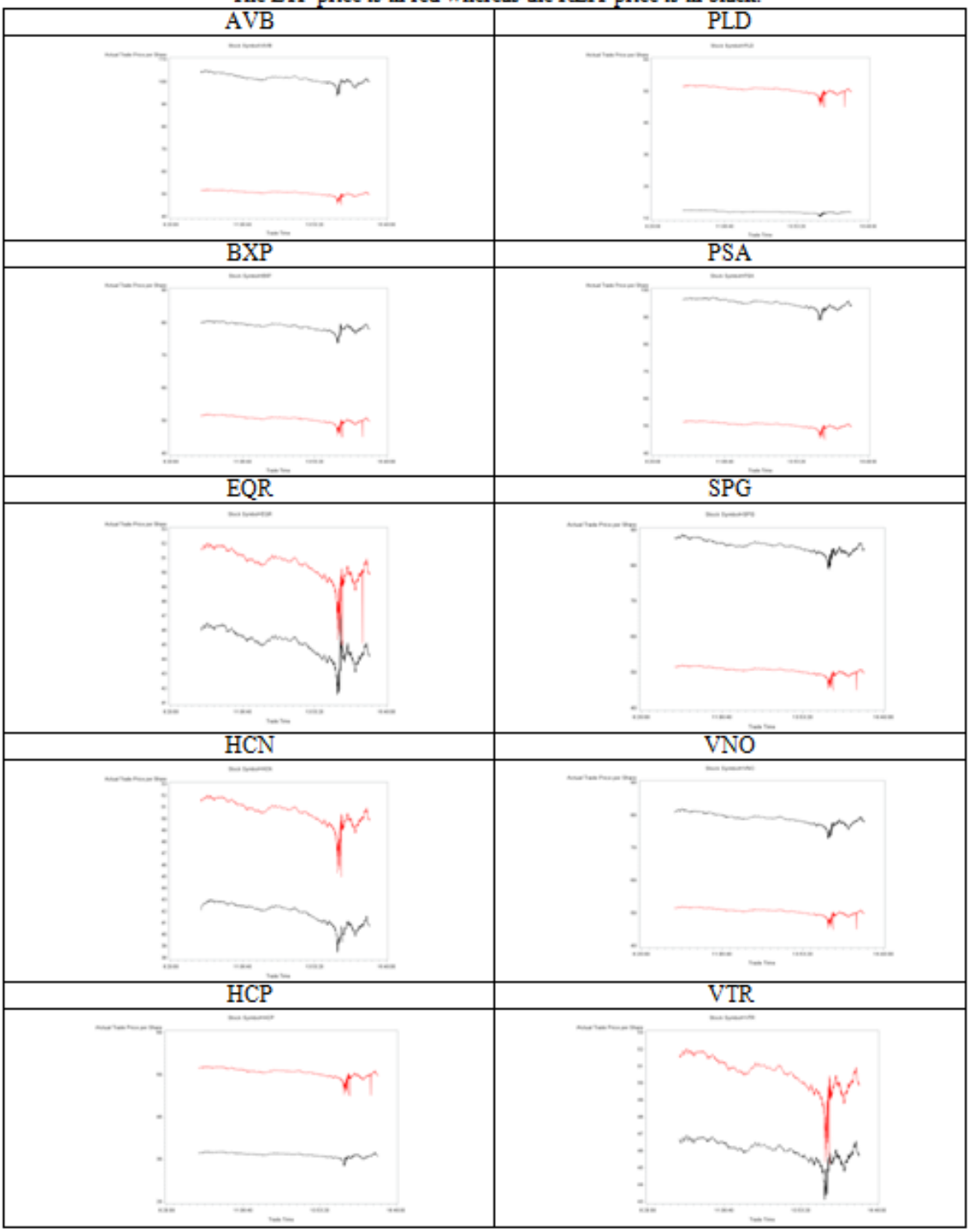
TABLE 3
RATES OF RETURN BEFORE AND DURING THE FLASH CRASH

	Before				After			
	Mean	Std Dev	Min	Max	Mean	Std Dev	Min	Max
VNQ	-0.00001	0.0005	-0.0094	0.0094	0.00004	0.0068	-0.1001	0.1126
IYR	-0.00001	0.0005	-0.0309	0.0321	0.00003	0.0057	-0.0767	0.0831
AVB	-0.00004	0.0006	-0.0033	0.0046	0.00003	0.0034	-0.0367	0.0470
BXP	-0.0001	0.0046	-0.2039	0.0061	0.00003	0.0034	-0.0392	0.0436
EQR	-0.0002	0.0082	-0.4115	0.0084	0.00003	0.0043	-0.0461	0.0482
HCN	-0.0001	0.0012	-0.0485	0.0028	0.00002	0.0021	-0.0255	0.0275
HCP	-0.0001	0.0045	-0.2246	0.0044	0.00003	0.0033	-0.0584	0.0636
PLD	-0.0003	0.0119	-0.5936	0.0082	0.00005	0.0058	-0.0474	0.0536
PSA	0.0041	0.1707	-0.0046	7.0905	0.00003	0.0024	-0.0209	0.0259
SPG	-0.0001	0.0015	-0.0666	0.0035	0.00004	0.0039	-0.0497	0.0395
VNO	-0.0001	0.0013	-0.0449	0.0065	0.00003	0.0030	-0.0353	0.0350
VTR	-0.0003	0.0096	-0.4024	0.0044	0.00003	0.0029	-0.0325	0.0299

The first step in the cointegration analysis is to visually inspect the behavior of the REIT and REIT ETFs prices on the day of the Flash Crash. Figure 1 provides the plot of the REIT and REIT ETFs prices. Clearly, both the REIT and the REIT ETF experience downward trends prior to the Flash Crash at 14:45 and upward trends after 14:45. The trends indicate that unit roots might be present.

FIGURE 1
REIT AND REIT ETF PRICES DURING THE DAY OF THE FLASH CRASH, MAY 6, 2010

The ETF price is in red whereas the REIT price is in black.



To formally test for the presence of unit roots I employ standard Augmented Dickey Fuller and Phillips-Perron Unit Root tests. Table 4 reports results of the Augmented Dickey Fuller and Phillips-Perron Unit Root tests. Both tests have null hypothesis of unit roots. Both tests fail to reject the null hypothesis of unit roots in each REIT and REIT ETF log price for the zero mean model specification. For the single mean and trend models the results before and after the Flash Crash are mixed. The presence of unit roots in the log price series indicates that I can use the Granger representation theorem (Engle and Granger, 1987) to formally test for cointegration between REITs and REIT ETFs.

TABLE 4
AUGMENTED DICKEY FULLER AND PHILLIPS-PERRON UNIT ROOT TESTS RESULTS

		Augmented Dickey Fuller Test		Philips Perron Test	
		Before	After	Before	After
VNQ	Zero Mean	0.6791	0.6849	0.6791	0.6849
	Single Mean	0.9992	0.0019	0.9992	0.0019
	Trend	0.9378	0.0008	0.9241	0.0008
IYR	Zero Mean	0.6791	0.6849	0.6791	0.6852
	Single Mean	0.9985	0.0019	0.9997	0.0019
	Trend	0.4911	0.0001	0.9538	0.0008
AVB	Zero Mean	0.6794	0.6845	0.6796	0.6846
	Single Mean	0.9729	0.1347	0.9766	0.1827
	Trend	0.7065	0.3082	0.4503	0.3507
BXP	Zero Mean	0.6801	0.6847	0.6801	0.6848
	Single Mean	0.9956	0.0376	0.9951	0.0962
	Trend	0.3601	0.1161	0.2261	0.2448
EQR	Zero Mean	0.6789	0.6849	0.6790	0.6850
	Single Mean	0.9935	0.0081	0.9929	0.0091
	Trend	0.4761	0.0271	0.2659	0.0226
HCN	Zero Mean	0.6800	0.6842	0.6799	0.6842
	Single Mean	0.9982	0.2107	0.9979	0.3198
	Trend	0.1626	0.2090	0.1431	0.3278
HCP	Zero Mean	0.6788	0.6859	0.6787	0.6860
	Single Mean	0.9992	0.0885	0.9986	0.2054
	Trend	0.7819	0.1426	0.7067	0.3100
PLD	Zero Mean	0.6733	0.6883	0.6731	0.6885
	Single Mean	0.9904	0.0519	0.9881	0.0904
	Trend	0.6169	0.0380	0.6111	0.0279
PSA	Zero Mean	0.6803	0.6846	0.6804	0.6844
	Single Mean	0.9971	0.2229	0.9970	0.3303
	Trend	0.5545	0.1700	0.2781	0.2143
SPG	Zero Mean	0.6793	0.6851	0.6792	0.6851
	Single Mean	0.9929	0.0651	0.9896	0.0527
	Trend	0.4965	0.0526	0.4230	0.0118
VNO	Zero Mean	0.6791	0.6852	0.6791	0.6852
	Single Mean	0.9845	0.2776	0.9818	0.2929
	Trend	0.0816	0.3922	0.0318	0.3103
VTR	Zero Mean	0.6798	0.6850	0.6798	0.6850
	Single Mean	0.9950	0.1689	0.9933	0.1555
	Trend	0.5126	0.2329	0.3565	0.1263

Table 5 reports the Johansen Cointegration Test results on the logarithms of REIT and REIT ETF prices before and after the Flash Crash. AVB, BXP, PLD, PSA, VNO and VTR are not cointegrated with VNQ prior to the Flash Crash, which is surprising. It is surprising because the REIT ETFs consist of REITs and both reflect real estate market conditions. However, the ten largest REITs examined in the study represent about 30% of IYR and most likely a similar proportion in VNQ. This means that about 70% of their composition is smaller REITs and the behavior of smaller REITs might be different from the behavior of larger REITs.

Naturally, this is an empirical question, which unfortunately I cannot address in this study due to data limitation. Of course, if such data becomes available to me I would perform the analysis in a future study. At this point I can only infer, based on the Ivanov (2011) study, what these relations might be and this seems like a plausible explanation for the lack of cointegration. Ivanov (2011) documents evidence in support of the "disintegration hypothesis" of smaller firms members of the S&P 500 index and the larger firms members of the S&P 100 index. Similarly, AVB, BXP, PLD, PSA and VTR are not cointegrated with IYR prior to the Flash Crash. After the Flash Crash started all REITs and REIT ETFs are cointegrated. This supports the notion that in times of crisis "cash is king" and every investor is moving to safety. These facts clearly refute the "disintegration hypothesis" and as such suggest that REITs and REIT ETFs do not provide diversification benefits in "bad" times.

TABLE 5
JOHANSEN TRACE COINTEGRATION TEST RESULTS

		VNQ		IYR				
		Before	After	Before	After			
	H0: Rank=r	Trace	Trace	Trace	Trace	5% Critical Value	Drift in ECM	Drift in Process
AVB	0	11.61	48.47**	14.31	56.47**	15.34	Const	Linear
	1	0.61	2.56	1.54	3.08	3.84		
BXP	0	12.30	90.03**	11.07	62.00**	15.34	Const	Linear
	1	1.10	4.37	2.31	3.78	3.84		
EQR	0	23.10**	56.02**	25.39**	64.50**	15.34	Const	Linear
	1	1.61	5.56	2.88	4.64	3.84		
HCN	0	33.02**	75.00**	31.98**	66.52**	15.34	Const	Linear
	1	1.86	2.60	2.75	2.60	3.84		
HCP	0	19.09**	98.25**	25.79**	90.33**	15.34	Const	Linear
	1	2.25	3.80	4.94	4.05	3.84		
PLD	0	8.57	132.94**	12.94	119.27**	15.34	Const	Linear
	1	2.09	3.54	2.91	4.38	3.84		
PSA	0	9.92	116.91**	13.08	64.85**	15.34	Const	Linear
	1	0.78	2.42	2.05	3.24	3.84		
SPG	0	18.39**	94.31**	22.68**	91.66**	15.34	Const	Linear
	1	0.34	4.10	0.92	3.97	3.84		
VNO	0	12.57	115.30**	24.70**	128.79**	15.34	Const	Linear
	1	0.42	3.29	1.10	3.56	3.84		
VTR	0	10.53	87.07**	11.14	92.25**	15.34	Const	Linear
	1	0.41	3.67	1.16	3.49	3.84		

Note: ** represents statistical significance at the 5% level.

CONCLUSION

In this study the "disintegration hypothesis" of REITs and REIT ETFs is examined. This is the first study to examine assets other than S&P 500 index products during the day of the Flash Crash. This study contributes to our knowledge of the relation of assets during extreme events. The understanding of how assets behave in times of crisis further our understanding of the diversification benefits of these instruments.

I find evidence refuting the "disintegration hypothesis" in that all REITs and REIT ETFs are cointegrated during the Flash Crash but only a few prior to the crash. This indicates that the diversification benefits of REITs and REIT ETFs are minimal and as such REITs and REIT ETFs might be considered substitutes for investment purposes.

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