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Spillovers of Non-Fundamental Risks: The Tale of Two Securitized Real Estate Markets

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Ambrose *et al.* (2007) find significant evidence of information spillover effects between index real estate investment trusts (REITs) and non-index REITs in the US markets using the inclusion of REITs into the S&P general market indices in an event study. This study, however, examines the effects of REIT index inclusion events by using non-index real estate operating company (REOC) returns in the US and Singapore. The study finds that REOC returns are more correlated with the general market index returns after REIT index inclusion events, but the spillover effects are smaller for REOCs in Singapore. The spillover effects of the REIT inclusion events are larger on non-index REITs than non-index REOCs in the US. When examining REIT inclusion events in Singapore, we find evidence of increases in betas only in the REIT market, but the changes in REOC betas are insignificant. However, we find that the REIT index inclusions significantly reduce the systematic risks of REOCs that sponsor the index REITs.

Keywords

Effects, Asset Comovement, Fundamental Factors, Sentiments and Market Friction, REITs and REOCs

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1. Introduction

The "fundamental" theory and the "sentiment-based" (also known "friction-based") theory are the two main explanations for the comovement of asset returns in the finance literature. The "fundamental" view hypothesizes that comovement of two asset returns in a frictionless market is correlated with changes in the fundamental values of the two assets. However, the "sentiment-based" view delinks the comovement of asset returns from fundamental comovement. Barberis *et al.* (2005) propose three sentiment views for the comovement of asset returns: (1) the "category view" which suggests that investors allocate funds by preferred categories (stocks, bonds and real estate) rather than individual assets. Return comovements are observed for assets in the same category, (2) the "habitat view", which suggests that investors trade only a subset of securities, and adjust their exposure in the investment "habitat" in response to fundamental shocks, and (3) the "information diffusion view", which indicates that common risk is incorporated into returns of different assets at different rates.

The empirical evidence that supports the "sentiment-based" hypothesis is mixed in the literature. Vijh (1994) finds that the betas of indexed stocks increase after their inclusion into the Standard and Poor's (S&P) 500 index. Using data extended over a longer time period from 1976 to 2000, Barberis *et al.* (2005) find significantly stronger beta effects for stock inclusion events. However, the events of index inclusion reduce comovements between stock market returns and other stocks in the non-index category. Ambrose *et al.* (2007) (hereafter referred to as ALP) find that the addition of real estate investment trusts (REITs) into the S&P indices generate positive spillovers of non-fundamental risks into non-index REITs. They argue that both index and non-index REITs are stocks that belong to the same ("overlapping") category; therefore, the excess comovements of non-index REITs in the overlapping category are not contradictory to the early results of Barberis et al. (2005) which show negative sentiment spillovers into the non-index category of stocks.

In the theoretical model of Barberis *et al.* (2005), how different assets in investor portfolios are classified into either a "category" or a "habitat" is not explicitly explained. Barberis and Shleifer (2003), however, argue that investors could group assets by "style", where assets in a particular "style" type share common characteristics and fundamentals, such as "real estate style". In ALP, investors view returns of the two overlapping categories of non-index REITs and index REITs to be correlated with a common "style" or sentiment. Therefore, the REIT index inclusions generate common sentiment spillovers that cause non-index REIT betas to increase.

A large number of studies in the real estate literature have found empirical evidence on the existence of common risk factors in REITs and direct real estate markets (Hoesli and Oikarinen 2012; Cotter and Roll 2015; Ling and Naranjo

2015). Risk spillovers create a long run equilibrium relationship between REITs and the underlying real estate (Boudry *et al.* 2012; Zhou 2013; Adams *et al.* 2015). There are also other studies which show that REITs share common risk factors with other stocks in the equity markets (Chiang *et al.* 2017).

Extending the tests in ALP on the overlapping category view of the US REIT market, this study empirically tests the spillovers of sentiment-induced shocks between REITs and real estate operating companies (REOCs) – the two assets are seemingly correlated but not in the same "category". Based on the event of the inclusion of the first set of six REITs into the S&P market indices on October 9, 2001, our results show significant increases in REOC betas afterwards. We find that inclusion of the REITs into the S&P index causes the daily and weekly betas of the REOCs to significantly increase by between 0.045 and 0.126 and 0.106 and 0.126, respectively. The REOC beta increases are, however, relatively smaller compared to the daily and weekly beta increases of non-index REITs which range between 0.148 and 0.215 and 0.236 and 0.336, respectively. Our robust results show significant evidence of spillover effects that occur not only across the same overlapping category (non-index REITs), but also across an uncorrelated category of assets (REOCs), and thus the "sentiment" view cannot be rejected.

Next, we replicate the tests by using REIT index inclusion events in Singapore, which is a rapidly growing REIT market in Asia. There were only two other REITs listed on the Singapore Exchange (SGX) when the first REIT was included into the general market index in Singapore. However, REOCs existed long before REITs, and 4 REOCs had already been included in the market index before the inclusion of REITs. We carry out cross-category asset return spillover tests by using the two "non-overlapping" securitized real estate samples (REITs and REOCs) in Singapore. In contrary to the US results, we find fewer spillover effects of the REIT index inclusion event on both index and non-index REOC betas in the Singapore tests with the use of daily returns. The results for the weekly return series are insignificant. There are two reasons for the less than robust results for Singapore. First, the REIT sector is relatively small in terms of market capitalization compared to the REOC sector, which existed long before REITs were introduced to Singapore. Second, the inclusion of 4 REOCs into the Strait Times Index (STI) even before the REIT index inclusion could have reduced the spillover effects of the REIT inclusion event.

In addition to replicating the robustness tests conducted in ALP, we conduct two more robust tests to rule out potential competing explanations. First, we control for housing price return, market interest rate and stock market volatility in the baseline regression and find that the spillover effects barely change. Second, we show that REIT betas are more positively correlated with market returns in the post REIT addition periods compared to REOC betas. Third, we find significant captive relationships whereby the betas of REOCs that sponsor the index REIT show stronger responses to the REIT index inclusion event.

The results imply that investors could harness the captive relationship between index REITs and the (sponsors) affiliated REOCs in Singapore to reduce systematic risks by holding the two stocks in portfolios.

This study finds evidence that supports the "sentiment-based" view in explaining the comovement between assets and that the spillover effects take place not only within categories but also across related categories. This study is related to the three strands of the real estate finance literature. First, the spillovers of sentiment risks from the REIT index inclusion events to REOC stocks are consistent with the results in the literature that find common risk factors in securitized real estate markets (Carmichael and Coën 2018; Lee *et al.* 2018; Liow and Ye 2018; Al-Abduljader 2019; Boudry *et al.* 2019). Second, the results on the differential responses by REITs with different portfolio compositions by property sector, region and size imply that diversification strategies and systematic risks matter for REITs (Carstens *et al.* 2019; Talukdar *et al.* 2021). Finally, like the literature on corporate real estate holdings (Ambrose *et al.* 2017; Freybote and Qian 2017; Mauck and Price 2018), we find significant increases in the betas from companies in the standard industry classification codes (SICC) categories that are unrelated to real estate and REITs following the REIT index inclusion events. The effects could be transmitted through the corporate real estate channel, especially for companies with high holdings of corporate real estate.

The paper is organized as follows: Section 1 discusses the motivations for the study. Section 2 discusses the data and empirical methodologies for testing the spillover effects of the REIT index inclusion events on REOC returns. Section 4 presents the empirical results that cover the REITs and REOCs in the US and Singapore markets. Section 5 concludes the paper.

2. REIT Markets in the US and Singapore

US REITs have a relatively long history with their inception dating back to 1960. The US Congress passed the REIT Act to give small retail investors an avenue to invest in income-generating commercial real estate. Singapore REITs (SREITs) only emerged in 2002 following the listing of the first retail mall REIT, Capitaland Mall Trust (CMT)[1] on the SGX. Prior to the emergence of REITs, REOCs were the only publicly listed securitized real estate vehicle that included firms involved in a wide range of real estate businesses which ranged from land development, residential real estate sales to commercial real estate investments.

[1] CapitaMall Trust (CMT) was the first REIT listed on the SGX in July 2002. In, 2015, the REIT was renamed as CapitaLand Mall Trust (CMT).

Like the US REITs, SREITs are a tax-transparent vehicle set up to invest (more than 75% of total assets) in income-generating real estate. High dividend payouts (more than 90% of earnings) and leverage restrictions[2] are two features of REITs that set them apart from REOCs in Singapore.

In 2005, there were only 7 SREITs with a total market capitalization of US$8.17 billion, which represented 2.5% of the total market capitalization of the SGX. The strong recovery in real estate prices in 2006 saw the rapid expansion of REITs in Singapore. More new REITs were listed during this period; at the same time, the incumbent REITs also aggressively grew their portfolios through accretive acquisitions. Some of the REITs also started to expand regionally by acquiring foreign real estate. In a short span of two years in 2007, the number of listed REITs increased to 20 and the total market capitalization grew to US$20.79 billion, which constituted 3.9% of the total SGX market capitalization. As of April 2013, 34 SREITs (inclusive of 8 business trusts) are listed on the SGX with total estimated S-REIT market capitalisation of approximately US$55.86 billion.

2.1 The US Experiment

Based on the treatment date of "October 9, 2001", which marks the first US REIT inclusion into the S&P general market indices (i.e. S&P 500, S&P 400, and S&P 600), we repeat the tests in ALP (the category view on the comovements between index and non-index REITs, and extend the tests on the comovements between index REITs and REOCs). Like ALP, the fundamental view is not rejected, if the inclusion of one REIT into a broader-based market index should have no significant spillover effects onto the other non-index REITs. During the study period from January 1, 2000 to December 31, 2003, none of the US REOCs were part of the constituents of the S&P general market indices. Using the same treatment event, we test the "sentiment-based" or "friction-based" view across related categories, which, if not rejected, should imply that the inclusion of the first REIT into the S&P index has significant spillover effects on REOC betas.

2.2 The Singapore Experiment

In the experiment with Singapore, we identify "March 18, 2005" as the treatment date on which the two pioneering REITs –CMT and Ascendas REIT (A-REIT), were concurrently added for the first time into the general market index in Singapore – the STI.[3] Due to the lack of non-index REITs in the SGX

[2] The Monetary Authority of Singapore, the de-facto Central Bank, has raised the leverage limits from from 45% to 50% of the total asset value effective 16 April 2020.
[3] In the two other emerging REIT markets in Asia, which are Japan and Hong Kong, no REITs were included in the general market indices.

during the study period[4], we cannot replicate the within category tests as in the US. Instead, we use the treatment event to test the non-fundamental view of the cross-category related spillover effects of the REIT index inclusion event on REOC stock returns. In the US, there were no REOCs in the S&P indices during the research period of ALP. However, REOCs were present for some time before REITs were listed in Singapore, and four REOCs (Capitaland, City Developments, Hong Kong Land HDG, and the UOL Group) were included into the STI constituents before the inclusion of the two index REITs. Therefore, in the Singapore experiment, we could separately test for the spillover effects of the inclusion of REITs into STI event on both index and non-index REOCs. In the context of Singapore, the results can be considered to further support the spillover effects of the REIT inclusion event on the non-REIT category. In the Singapore markets, REOCs are larger through market capitalization and also existed long before REITs. Institutional investors should thus also take into account the strong presence of REOCS, and also the captive relationships of REOCs with REITs sponsored by them.

3. Data Sources

The data are mainly obtained from two sources: Bloomberg and Datastream. We collected daily and weekly stock returns for about 8300 stocks in the US stock market during the sample period between January 1, 2000 and December 31, 2003. We also collected the same data for the universe of the Singapore stock market, which contain a total of 720 stocks at the end of 2013.

For the US experiment, we use the same treatment date on "October 9, 2001", and also keep the same sample period as that of ALP from January 1, 2000 to December 31, 2003 to ensure consistency in the tests. For the Singapore study, we winsorize the samples at both tails to keep a more balance sample that covers the period of July 1, 2003 to December 29, 2006 based on the treatment date defined by the first inclusion of CMT and A-REIT into the STI on "March 18, 2005". The winsorization strategy also removes two exogenous shocks that might bias the test results: (a) the shock associated with the severe acute respiratory syndrome (SARS) outbreak, which was only fully eradicated in July 2003,[5] and (b) the second shock related to the US subprime financial crisis that broke out after several US conglomerates filed for bankruptcy protection, including the Lehman Brothers between January and February 2007.

[4] CapitaCommercial Trust and Suntec REIT were the only two non-index REITs listed only shortly after inclusion event.

[5] The World Health Organization (WHO) removed Singapore from the list of SARS infected areas on May 30, 2003, when no new cases were reported for 20 consecutive days.

Table 1 presents the summary statistics that describe the differences between the US and Singapore securitized real estate markets. The two markets are structurally and fundamentally diverse. REITs are the dominant securitized real estate vehicle in the US, where 176 REITs were listed on the public exchanges during the study period of 2000 to 2003, compared to only 60 REOCs. In Singapore, however, REITs were only first introduced to the SGX in 2002, which have a shorter history relative to the US REITs that first appeared in 1961. REOCs are more established, and have longer presence in Singapore. There were 25 REOCs and 10 REITs listed on the SGX during the study period. In terms of market value, US REITs valued at US$122.4 billion were nearly 20 times larger than US REOCs, whereas in Singapore, REOCs with an aggregate market value of US$33.5 billion were nearly 3 times larger than Singapore REITs (US$11 billion). Regarding the performance statistics, we find that both the US and Singapore REITs share the same defensive characteristics with higher book to market value ratio, and lower systematic risks. Another interesting distinguishing feature of the two markets is the large number of REOCs in Singapore, which is reflected by a high Herfindahl index of 0.108. The presence of large developers with large controlling shares in the property market could have important impacts on the dynamics of the Singapore real estate markets.

Table 1 Characteristics of the REIT and REOC Markets in the US and Singapore

	US		Singapore	
	REIT	REOC	REIT	REOC
Established	1961	N.A.	2002	N.A.
Sample period	January 1, 2000 to December 31, 2003		July 1, 2003 to December 29, 2006	
Number of listed REITs	176	60	10	25
Market Value (MV) (US$ million)	122,433.812	6,155.422	10,968.065	33,467.464
Total Return (TR) (%)	0.003	0.028	0.005	0.008
Book to Market Value Ratio (bmk)	2.48	2.22	1.898	1.681
Price to Book Ratio (PB)	0.982	0.944	0.992	0.985
Relative Price to Book Ratio (RPB)	-0.425	-0.529	-0.689	-0.696
Systematic Risk (beta)	0.362	0.766	0.201	0.985
Herfindahl Index	0.019	0.024	0.074	0.108

Notes: The table shows the summary statistics for the sample REITs and REOCs in the US and Singapore markets. We include various statistics, such as total return, book to market value ratio, price to book ratio, relative price to book ratio, systematic risk and Herfindahl index. The data are obtained from Datastream.

4. Empirical Designs and Results

4.1. Return Beta of Index REITs

We first repeat the tests in ALP of the category view through a treatment of the REIT index inclusion event on October 9, 2001 in the US market. If the fundamental view is not rejected, we should expect that this inclusion event will have no significant spillover effects on the non-index REITs. Based on the same treatment, we also test if the REIT inclusion event has the same spillover effects on non-index REOCs, which are deemed as the proxy for non-overlapping real estate assets in a different but related category. Before proceeding to examine the spillover effect, we first investigate the changes of the beta of index REITs with the general stock markets after the REIT inclusion event. The firm fixed-effect panel regression (see ALP) is defined as follows:

$$R_{i,t} = \alpha + \beta_1 AFTER + \beta_2 R_{MKT-RE,t} + \beta_3 (R_{MKT-RE,t} \times AFTER) + \varepsilon_t \quad (1)$$

where $R_{i,t}$ is the log return (either daily or weekly) of asset *i* in period *t*. As defined in ALP, asset *i* is one of the six REITs absorbed by the S&P market indices on October 9, 2001 in the US market and one of the two REITs absorbed by the market index of the STI on March 18, 2005 in the Singapore market. In the US context, $R_{MKT-RE,t}$ is the value-weighted stock market return represented by all of the corresponding S&P index constituent stocks excluding all the index REITs in period *t*. "$AFTER$" is a binary dummy variable that indicates the treatment date of "October 9, 2001", which has a value of 1, if the sample date is after the first REIT was first included to one of the S&P general market indices (i.e., S&P500, S&P400 or S&P600), and 0 otherwise. In the Singapore context, $R_{MKT-RE,t}$ is the value-weighted stock market return represented by all of the corresponding STI constituent stocks excluding all the index REITs (CMT and A-REIT) and index REOCs (Capitaland, City Developments, Hong Kong Land HDG, and UOL Group) in period *t*. "$AFTER$" is a binary dummy variable that indicates the treatment date of "March 18, 2005", which has a value of 1 if the sample date is after the first REIT was first included in the general market indices of the STI, and 0 otherwise. The definitions of $R_{MKT-RE,t}$ and "$AFTER$" in the US and Singapore contexts remain the same in the following equations. To mitigate the concerns that unobserved heterogeneity across REIT type could bias the estimation on β_3, we further control for REIT type fixed effects.

Table 2 reports the coefficient β_3, which captures the differential betas "before" and "after" the REIT index inclusion event, and the level of significance for the beta differences. They are denoted by ΔBeta and Diff(p), respectively, in Table 2 and all of the other tables in the subsequent sections. Based on the independently collected data, but over the same sample period of January 1, 2000 to December 31, 2003 (the extraordinary shocks associated with the US September 11 attacks in 2001 are excluded), our results verify the prediction of ALP which shows significant increases in the index REIT betas after the REIT

inclusion event in the S&P indices and the magnitude of the increase is larger for weekly returns than daily returns. Despite the different estimators used, where ALP use the generalized method of moments (GMM), and we use the ordinary least squares (OLS) estimator for Equation (1), the results in Table 2 show that the standard errors are negligible between the OLS and the GMM models. The independently collected data (but over the same sample periods) and the OLS estimator used in our models produce robust results that are also consistent with those found in ALP. We are assured that our subsequent analyses with the use of the US data source and OLS estimation method would not cause biases vis-à-vis the results in ALP.

In the Singapore context, we find that the index REIT beta also increases significantly for both daily and weekly returns, which are estimated to be 0.440 and 0.374, respectively. The magnitude of the increase of daily returns is slightly larger than that of weekly returns, which is different from the results in the US context. The empirical evidence from both the US and Singapore contexts support the results in ALP and Barberis *et al.* (2005) in that the beta of stocks increase after their inclusion into the general stock market.

Table 2 Changes in Index REIT Betas after REIT Index Inclusion Events

Study	**ALP**		**This Study**			
Country	US		US		Singapore	
Asset Category	Index REIT		Index REIT		Index REIT	
	ΔBeta	Diff (p)	ΔBeta	Diff (p)	ΔBeta	Diff (p)
Daily	0.203	0.000	0.203	0.000	0.440	0.000
Weekly	0.389	0.000	0.337	0.000	0.374	0.000

Notes: This table shows the results on the differences in the average beta of index REITs "before" and "after" their inclusion events (ΔBeta). Diff(p) shows the level of significance on the change in beta. For the US tests, the event date is set on "October 9, 2001", whereas the event date, which coincided with the inclusion of the REITs into the STI, is set on "March 18, 2005". Columns (2) and (3) report the results in Ambrose et al. (2007; ALP); and Columns (4) and (5) shows the results replicated from the ALP models, but using data collected independently from Datastream. The last two columns (6 and 7) show the results of the event study by using Singapore data. Both daily and weekly return series are used in the tests.

4.2. Return Betas of Other Real Estate Assets

We next examine how the returns of non-index REITs or non-index REOCs associate with the general stock market after the REIT inclusion event in both the US and Singapore. As in ALP, we exclude all REITs that are added to any of the S&P market indices during the sample period in the US context. In the Singapore context, we exclude not only all the index REITs, but also all the

index REOCs, which were added to the STI over the sample period from July 1, 2003 to December 29, 2006. Following the methodology of ALP, we estimate the following regression in both the US and Singapore contexts:

$$R_{portfolio,t} = \alpha + \beta_1 AFTER + \beta_2 R_{MKT-RE,t} + \beta_3 (R_{MKT-RE,t} \times AFTER) + \varepsilon_t \quad (2)$$

where $R_{portfolio,t}$ is the log return of a portfolio of non-index REITs or REOCs in period t (either daily or weekly). Specifically, we construct the value weighted portfolio returns for the three categories of assets, represented by non-index REITs, $R_{nonindex\_REITs,t}$, non-index REOCs , $R_{nonindex\_REOCs,t}$, and index REOCs, $R_{index\_REOCs,t}$, respectively.[6] $R_{mkt-RE,t}$ and "$AFTER$" are defined in Equation (1). The OLS estimator is used to estimate the models and the results are summarized in Table 3. We find that the results of the non-index REITs in the US market in our study are almost the same as the those in ALP in terms of statistical significance and economic magnitude. The betas of the non-index REITs with S&P indices increase significantly for both daily and weekly return series. The significant increase in the beta of non-index REITs with S&P indices corresponds to the spillover hypothesis that returns of non-index REITs would be affected by index-related investor sentiment or market friction due to the REIT index inclusion event.

We next use the REOC returns as a proxy for assets that are not in the same category as REITs to test the spillover effects across related categories. We re-run Equation (2) by using the log returns of REOC portfolios as the dependent variable. In the US context, we use three different market indices excluding all of the index REITs: S&P400 (mid-cap), S&P500 (large-cap), and S&P600 (small-cap), and as proxies for the general market return, $R_{S\&P-RE,t}$, in Equation (2) to test for market-wide shocks of different size-based market portfolios. The results are summarized in the middle panel of Table 3. We find significantly positive (except for the weekly returns of S&P 500 Index) spillover effects to non-index REOCs, and the magnitude of non-index REOC betas increases which range from 0.045 (daily S&P500-beta) to 0.164 (weekly S&P600-beta). Interestingly, the non-index REOC beta increases are smaller than those estimated for the non-index REITs, which are from the same category. The results also show differential rates of "information diffusion" into the non-index REIT and non-index REOC markets in the US.

[6] In this study, "non-index REITs" refer to all REITs that are not in any of the S&P general market indices throughout the entire study period. However, the ALP uses only the constituents of the S&P REIT index that are not included in the general market indices. The S&P REIT index consists of 100 REITs, which cover more than 80% of the securitized U.S. real estate market.

Table 3 Spillover Effects and Market-wide Risks in Different Size-Based Market Portfolios

Study	**ALP**		**This Study**							
Country	**US**		**US**				**Singapore**			
Asset Category	Non-index REIT		Non-index REIT		Non-index REOC		Non-index REOCs		Index REOCs	
Market Returns:	ΔBeta	Diff (p)	ΔBeta	Diff (p)	ΔBeta	Diff (p)	ΔBeta	Diff (p)	ΔBeta	Diff (p)
	(a) Small-Cap Market Portfolio / S&P 600 Index Return						Straits Times Index (STI) Return			
Daily	0.201	0.000	0.215	0.000	0.126	0.000	0.179	0.000	0.155	0.000
Weekly	0.354	0.004	0.336	0.000	0.164	0.000	0.110	0.202	0.046	0.331
	(b) Large-Cap Market Portfolio / S&P 500 Index Return									
Daily	0.145	0.000	0.148	0.000	0.045	0.000				
Weekly	0.275	0.046	0.236	0.000	0.106	0.127				
	(c) Mid-Cap Market Portfolio / S&P 400 Index Return									
Daily	0.205	0.000	0.209	0.000	0.108	0.000				
Weekly	0.355	0.007	0.312	0.000	0.159	0.000				

Notes: This table shows the results on the differences in the average beta "before" and "after" the REIT index inclusion events (ΔBeta). Diff(p) shows the level of significance on the change in beta. For the US tests, the event date is set on "October 9, 2001", whereas the event date, which coincided with the inclusion of the REITs into the STI, is set on "March 18, 2005". Columns (2) and (3) report the results in Ambrose et al. (2007; ALP); and Columns (4) and (5) shows the results replicated from the ALP models, but using data collected independently from Datastream. For the "Non-index REOCs" category (Columns 6 and 7), we replicate the event tests by using REOC samples. For the US tests, we use three different indices as proxies for market returns, which include small cap market portfolio (represented by S&P600 index), large cap market portfolio (S&P500) and mid-cap market portfolio (S&P 400 index).

We then replicate the tests of the effects of REIT inclusion into index by using Singapore non-index REITs (Columns 8 and 9) and index REOCs (Columns 10 and 11), and the market return proxy is based on the STI return. Both daily and weekly return series are used in the tests.

Unlike the US, the REOCs of Singapore are relatively larger by market size, and some of them were included in the STI even before the existence of REITs in Singapore. Thus, we sort the REOC samples of Singapore into index and non-index REOCs, when the tests are repeated in the setup for Singapore. The results in the right panel of Table 3 show that increases in the daily beta of non-index REOCs (0.179) and index REOCs (0.155) are significant, but increases in the weekly betas are insignificant for them. The increase of the beta of non-index REOCs (0.179) for daily returns in Singapore is larger than that (ranging from 0.045 to 0.126) in the US. This could be explained by the relative larger market capitalization of REOCs than that of REITs in Singapore, while the

market capitalization of REOCs is smaller than that of REITs in the US. The differential beta changes imply that the diffusion rate of news of REIT index inclusion in the two non-overlapping markets is different, although both REIT and REOC markets react to the inclusion event.

4.3. Robustness Tests

The earlier results, however, cannot rule out the possibility that increases in non-index REIT and REOC betas might be driven by factors unrelated to the REIT index inclusion news, such as general increases in market-wide shocks, market friction and others. We also need to address possible endogeneity issues associated with changing compositions of the market indices. The following sections elaborate on further robustness checks on the empirical results.

4.4. Removing Non-Real Estate Related Shocks

Like ALP, we purge possible market-wide shocks in the US context that are unrelated to real estate markets in a two-stage process by first estimating the S&P index model (excluding index REITs), $R_{S\&P-RE,t}$, as follows:

$$R_{S\&P-RE,t} = \emptyset_0 + \emptyset_1 R_{non\_RE,non\_S\&P,t} + \eta_t \quad (3)$$

where $R_{non\_RE,non\_S\&P,t}$ represents the log value-weighted return of the non-index stock portfolios excluding all the REIT and REOC stocks.[7] The residual, η_t, which represents the market-wide (S&P index) shock that is orthogonal to non-real estate market shocks, is included in the following stage-two regressions:

$$R_{non\_index\_REOCs,t} = \alpha + \beta_1 AFTER + \beta_2 \eta_t + \beta_3 (\eta_t \times AFTER) + \varepsilon_t \quad (4a)$$

and

$$R_{non\_index\_REITs,t} = \alpha + \beta_1 AFTER + \beta_2 \eta_t + \beta_3 (\eta_t \times AFTER) + \varepsilon_t \quad (4b)$$

The results are summarized in the left and the centre panels of Table 4. The results show that the non-index REIT beta increases are positive and highly significant. The results are consistent with those found in ALP (the far left panel). We also find that the magnitude of the beta increases that range from 0.280 (daily with S&P600 residual) to 0.657 (weekly with S&P500 residual) is significantly larger than those reported in the earlier results that use "unpurged" market indexes (Table 3), which have the corresponding estimates ranging between 0.148 and 0.336. For the US REOC samples (the centre panel), the spillover effects of REIT index inclusion events are still significant, despite the

[7] The ALP study uses the return of the value-weighted portfolio of all non-index REIT stocks, $R_{non\_REITS,non\_S\&P,t}$.

fact that the market wide shocks have been from η_t. The non-index REOC betas increase by a larger magnitude of between 0.224 (daily with S&P400 residual) and 0.648 (weekly with S&P500 residual). The results indicate that the returns of the real estate related industry (not only the REIT category, but also real estate stocks outside of the REIT category) would be affected by the REIT index inclusion event. The relatively larger magnitude of beta increases of REITs over REOCs for both daily and weekly returns can be explained by the closer relationship between non-index REITs and index REITs compared with that of non-index REOCs and index REITs. Therefore, we conclude differential rates of the shock "diffusion" on REOC and REIT betas.

In the Singapore context, we change $R_{S\&P-RE,t}$ to $R_{STI-RE,t}$, and $R_{non\_RE,non\_S\&P,t}$ to $R_{non\_RE,non\_STI,t}$ in Equation (3). It can be observed in the right panel of Table 4 that the daily returns of non-index and index REOC betas increase significantly, and the magnitude is larger than that shown in Table 3. However, the beta increases for weekly returns are still insignificant.

We use a variation of the market model by switching the value-weighted market return, $R_{non\_RE,non\_S\&P,t}$, to the left side of the model, and use the three S&P indices to jointly purge the non-real estate shocks from market wide shocks:

$$R_{non\_RE,non\_S\&P,t} = \emptyset_0 + \emptyset_1 R_{S\&P500-RE,t} + \emptyset_2 R_{S\&P400-RE,t} + \emptyset_3 R_{S\&P600-RE,t} + \zeta_t \quad (5)$$

The residual, ζ_t, extracted from Equation 5 is then used to replace the earlier residual, η_t, in Equations (4a) and (4b) in the second stage regression. The results are summarized in the two bottom rows (Section d) of Table 4. We find that after purging the non-real estate market shocks, the spillover effects of the REIT index inclusion shocks on non-index REITs are negative, and the effects are even larger than those found in ALP. The beta decreases associated with the "purged" market-wide shocks are larger for REOCs, which are -1.205 (daily) and -1.242 (weekly). For the Singapore test, we exchange the non-index market portfolio return variable (right side variable) with the index-portfolio return (excluding real estate, left side variable) variable as in Equation (3), and include the residual, ζ_t, into Equation (4a), and the results are mixed. For weekly returns, the non-index REOC beta with residual portfolio returns is insignificant. The index REOC betas with residual portfolio returns are negative, although insignificant. In summary, we conclude that non-index and index REOCs tend to be less or not correlated with the overall market once the index-related contents are ruled out, which are consistent with the conclusions drawn from the US context.

Table 4 Spillover Effects and Real Estate Related Market Risks

Study	**ALP**		**This Study**							
Country	**US**		**US**				**Singapore**			
Asset Category	Non-index REITs		Non-index REITs		Non-index REOCs		Non-index REOC		Index REOC	
Market Returns:	ΔBeta	Diff(p)	ΔBeta	Diff(p)	ΔBeta	Diff(p)	ΔBeta	Diff(p)	ΔBeta	Diff(p)
	(a) Residual of S&P 600 Return						Residual of Straits Times Index (STI) Return			
Daily	0.501	0.000	0.280	0.000	0.253	0.000	0.286	0.000	0.173	0.053
Weekly	0.697	0.010	0.581	0.000	0.289	0.000	0.113	0.664	-0.229	0.365
	(b) Residual of S&P 500 Return									
Daily	0.352	0.000	0.641	0.000	0.624	0.000				
Weekly	0.523	0.054	0.657	0.000	0.648	0.000				
	(c) Residual of S&P 400 Return									
Daily	0.518	0.000	0.283	0.000	0.224	0.000				
Weekly	0.846	0.011	0.514	0.000	0.358	0.000				
	(d) Residual of Non-Real Estate and Non-index Stock Portfolio Returns						Residual of Non-Real Estate and Non-index Stock Portfolio Returns			
Daily	-0.561	0.000	-0.893	0.000	-1.205	0.000	-0.204	0.014	-0.130	0.143
Weekly	-0.754	0.054	-1.480	0.000	-1.242	0.000	0.237	0.262	-0.126	0.339

Notes: This table shows the results on the differences in the average beta "before" and "after" the REIT index inclusion events (ΔBeta). Diff(p) shows the level of significance on the change in beta. For the US tests, the event date is set on "October 9, 2001", whereas the event date, which coincided with the inclusion of the REITs into the STI, is set on "March 18, 2005". Columns (2) and (3) report the results in Ambrose et al. (2007; ALP); and Columns (4) and (5) shows the results replicated from the ALP models, but using data collected independently from Datastream. For the "Non-index REOCs" category (Columns 6 and 7), we replicate the event tests by using REOC samples. For the US tests, we use three different proxies for orthogonalized market returns, which include residuals of small cap market portfolio (S&P600 index), residual of large cap market portfolio (S&P500), residual mid-cap market portfolio (S&P 400 index), and residual of non-real estate and non-index stock portfolio returns.

We then replicate the tests of the effects of REIT inclusion into the index by using Singapore non-index REITs (Columns 8 and 9) and index REOCs (Columns 10 and 11), and the market return proxy is based on the residual of STI return. Both daily and weekly return series are used in the tests.

4.5. Changing Composition of Index Constituent Stocks

To minimize possible survival bias caused by contemporaneous changes to the constituent stocks in the general market index, we reconstruct the general market indices by using only stocks that stay (survive) in the index for the entire study period. While ALP hold the weight of the index constituents "constant" based on the initial values, we adjust for the weight of the index constitutes that "survived" based on their capitalization values. The results are summarized in Table 5. The results remain largely positive and significant. Similar to the test results in ALP, most of the spillover effects for non-index REITs are smaller with the use of the "survived" index relative to the results in Table 3. The differences in the spillover effects between our test results and those of ALP could be related to the different weighting schemes used for the index constituents. The spillover effects for REOCs in both the US and Singapore contexts remain positive and most of the spillover effects remain significant. Consistent with the results in Table 3, the beta changes of REOCs with S&P indices are smaller than those of non-index REITs with S&P indices. Therefore, the survival of the constituent stocks in the market indices has no significant impact on the spillover effects in both the US and Singapore tests. The results suggest that increases in non-index REITs and REOCs are not likely to be correlated with the dynamics of general market-wide shocks.

4.6. Gradual Increases in the Betas

If non-index REITs and REOCs share more commonalities with other stocks in the S&P indices after the REIT index inclusion event, increases in the betas of the two asset categories could be gradual, and not correlated to the inclusion into the index. We separate the two possible correlated effects by testing the rate of changes of non-REIT and REOC betas, and test if the beta changes occurred prior to the inclusion of the REITs into the index. We run the same regressions as ALP, but using daily data instead of the weekly data in ALP to increase the degree of freedom in our estimation:

$$R_{i,t} = \alpha + \Sigma_{d=1}^{5}\delta_d D_d + \beta R_{S\&P-RE,t} + \Sigma_{d=1}^{5}\phi_d (D_d \times R_{S\&P-RE,t}) + \varepsilon_t \qquad (6)$$

where D_d is a set of dummy variables (0,1), where each represents an approximately 6-month interval before and after the inclusion event: D_1 = [March 1st, 2001 to October 9th, 2001]; D_2 = [October 10th, 2001 to April 30th, 2002]; D_3 = [May 1st, 2002 to October 31st, 2002]; D_4 = [November 1st, 2002 to April 30th, 2003]; and D_5 = [May 1st, 2003 to December 31st, 2003].

Based on the treatment date on "October 9, 2001", the results in ALP show that the pre-treatment effects are all insignificant. Table 6 shows that the ϕ_1 coefficients for the non-index REITs and non-index REOCs in our models are insignificant, which validate the results in ALP that there is no significant effect

Table 5 Controlling for the Effects of Composition Changes in Market Indices

Study	**ALP**		**This Study**							
Country	**US**		**US**				**Singapore**			
Asset Category	Non-index REITs		Non-index REITs		Non-index REOCs		Non-index REOC		Index REOC	
Market Returns:	ΔBeta	Diff(p)	ΔBeta	Diff(p)	ΔBeta	Diff(p)	ΔBeta	Diff(p)	ΔBeta	Diff(p)
	(a) "Fixed" S&P 600 Index Return						"Fixed" Straits Times Index (STI) Return			
Daily	0.149	0.000	0.263	0.000	0.234	0.000	0.160	0.000	0.142	0.002
Weekly	0.260	0.022	0.311	0.002	0.221	0.000	0.085	0.664	0.010	0.365
	(b) "Fixed" S&P 500 Index Return									
Daily	0.113	0.001	0.118	0.000	0.107	0.000				
Weekly	0.192	0.103	0.117	0.060	0.276	0.119				
	(c) "Fixed" S&P 400 Index Return									
Daily	0.131	0.000	0.218	0.000	0.180	0.000				
Weekly	0.228	0.051	0.249	0.004	0.108	0.000				

Notes: This table shows the results on the differences in the average beta "before" and "after" the REIT index inclusion events (ΔBeta). Diff(p) shows the level of significance on the change in beta. For the US tests, the event date is set on "October 9, 2001", whereas the event date, which coincided with the inclusion of the REITs into the STI, is set on "March 18, 2005". Columns (2) and (3) report the results in Ambrose et al. (2007; ALP); and Columns (4) and (5) shows the results replicated from the ALP models, but using data collected independently from Datastream. For the "Non-index REOCs" category (Columns 6 and 7), we replicate the event tests by using REOC samples. For the US tests, we control for potential endogeneity by fixing the market returns using "Fixed" small cap market portfolio (S&P600 index), "Fixed" large cap market portfolio (S&P500) and "Fixed" mid-cap market portfolio (S&P 400 index). We then replicate the tests of the effects of REIT inclusion into the index by using Singapore non-index REOCs (Columns 8 and 9), and the market return proxy is based on "Fixed" STI return. Both daily and weekly return series are used in the tests.

Table 6 Changes in Betas "Before" and "After" the REIT Index Inclusion Events

Study	**ALP**		**This Study**							
Country	**US**		**US**				**Singapore**			
Asset Category	Non-index REITs		Non-index REITs		Non-index REOCs		Non-index REOC		Index REOC	
Market Returns:	ΔBeta	Diff(p)	ΔBeta	Diff(p)	ΔBeta	Diff(p)	ΔBeta	Diff(p)	ΔBeta	Diff(p)
	S&P 600 Index Return						STI return			
Initial Beta	0.171	0.000	0.173	0.000	0.158	0.000	0.552	0.000	1.038	0.000
$\phi_1 = \Delta\beta_1$	0.028	0.534	0.038	0.292	0.051	0.345	-0.306	0.127	-0.215	0.219
$\phi_2 = \Delta\beta_2$	0.114	0.022	0.132	0.018	0.062	0.011	-0.085	0.647	-0.212	0.180
$\phi_3 = \Delta\beta_3$	0.227	0.000	0.244	0.004	0.217	0.036	0.040	0.016	0.028	0.026
$\phi_4 = \Delta\beta_4$	0.240	0.000	0.250	0.006	0.189	0.009	0.430	0.028	0.445	0.001
$\phi_5 = \Delta\beta_5$	0.203	0.000	0.230	0.025	0.309	0.018	0.200	0.064	0.068	0.002
	S&P 500 Index Return									
Initial Beta	0.195	0.000	0.202	0.000	0.184	0.007				
$\phi_1 = \Delta\beta_1$	-0.005	0.898	0.001	0.446	0.013	0.249				
$\phi_2 = \Delta\beta_2$	0.064	0.238	0.064	0.094	0.006	0.158				
$\phi_3 = \Delta\beta_3$	0.127	0.040	0.135	0.000	0.109	0.000				
$\phi_4 = \Delta\beta_4$	0.165	0.001	0.162	0.001	0.100	0.009				
$\phi_5 = \Delta\beta_5$	0.252	0.000	0.264	0.019	0.228	0.004				
	S&P 400 Index Return									
Initial Beta	0.168	0.000	0.178	0.002	0.151	0.021				
$\phi_1 = \Delta\beta_1$	0.023	0.586	0.021	0.141	0.044	0.324				
$\phi_2 = \Delta\beta_2$	0.094	0.063	0.108	0.048	0.046	0.151				
$\phi_3 = \Delta\beta_3$	0.210	0.000	0.213	0.033	0.193	0.036				
$\phi_4 = \Delta\beta_4$	0.234	0.000	0.232	0.001	0.179	0.048				
$\phi_5 = \Delta\beta_5$	0.297	0.000	0.310	0.013	0.283	0.016				

(*Continued*…)

(Table 6 Continued)

Notes: This table shows the results on differences in average beta "before" and "after" the REIT index inclusion events (ΔBeta). Diff(p) shows the level of significance on the change in beta. For the US tests, the event date is set on "October 9, 2001", whereas the event date, which coincided with the inclusion of the REITs into the STI, is set on "March 18, 2005". The table captures the gradual changes in betas, by setting D_d, a set of dummy variables (0,1), to represent a 6-month interval before and after the inclusion event: D_1 = [March 1st, 2001 to October 9th, 2001]; D_2 = [October 10th, 2001 to April 30th, 2002]; D_3 = [May 1st, 2002 to October 31st, 2002]; D_4 = [November 1st, 2002 to April 30th, 2003]; and D_5 = [May 1st, 2003 to December 31st, 2003]. For the Singapore tests, the periods with changing beta are defined as: D_1= [October 1, 2004 to March 18, 2005]; and other post-event time dummy: D_2= [March 19, 2005 to September 30, 2005], D_3= [Oct 1, 2005 to February 28, 2006], D_4= [March 1, 2006 to July 31, 2006], and D_5= [August 1, 2006 to December 31, 2006].

prior to the inclusion of both the non-index REITs and REOCs in the US context. Like ALP, we also find evidence of large spillover effects as reflected by the positive and significant increases in betas in both the non-index REIT and REOC markets in the periods after treatment. Our results reject the fundamental view based on the evidence of the beta increases after the inclusion of REITs into the index from the overlapping assets (non-index REITs) in the same category, and the non-overlapping assets (REOCs) from the REITs related category. For the Singapore results (the far right panel of Table 6), we set a time dummy variable, D_d (0,1), around the treatment event date of "March 18, 2005", which includes the time dummy prior to the event, D_1= [October 1, 2004 to March 18, 2005], and another time dummy after the event: D_2= [March 19, 2005 to September 30, 2005], D_3= [Oct 1, 2005 to February 28, 2006], D_4= [March 1, 2006 to July 31, 2006], and D_5= [August 1, 2006 to December 31, 2006]. The betas prior to the inclusion and during the inclusion event of both the non-index and index REOCs are negative and insignificant, and the spillover effects become highly significant and positive, but delayed by one period. We only observe the positive increases in beta after D_2 periods. This could be explained by the relatively large market capitalization of the REOC industry.

4.7. Market Friction

Like Barberis *et al.* (2005) and ALP, we use the betas in Dimson (1979) to measure the contribution of market friction to the observed beta increase in non-index REIT and REOCs. The Dimson betas associated with the returns of the S&P general index (excluding all index REITs) five days prior to the inclusion and five days after the inclusion are estimated by using the following model:

$$R_{i,t} = \alpha + \beta AFTER + \Sigma_{d=-5}^{5} \beta_d R_{S\&P-RE,t-d} + \Sigma_{d=-5}^{5} \gamma_d (R_{S\&P-RE,t-d} \times AFTER) + \varepsilon_t \quad (7)$$

The Dimson beta prior to the REIT index inclusion event, "After =0", is calculated as the sum of $(\beta_{-5},\ldots,\beta_5)$, while the Dimson beta for the period after the inclusion of the REITs into the index, "After =1", is calculated as the sum of $(\beta_{-5},\ldots,\beta_5,\gamma_{-5},\ldots,\gamma_5)$. The market friction or information diffusion is in part driving the beta increase if the Dimson beta does not show significant increases in the periods after the inclusion relative to those prior to the inclusion, i.e., the beta changes should be insignificantly different from zero.

The results in ALP in Columns 2 and 3 of Table 7 show that the Dimson betas of the non-index REITs with a large-cap S&P500 index are insignificant, while those of the non-index REITs that are associated with small-cap (S&P600) and mid-cap (S&P400) stock returns increase significantly. ALP argue that the relative rate of incorporating the index inclusion information of non-index

REITs with reference to S&P500 is slower than that to the small-cap (S&P600) or mid-cap (S&P400) stocks prior to the inclusion event. Our results also show that increases in betas in both the non-index REIT and REOCs are significantly positive, thus market friction does not fully account for the beta changes. However, in Singapore, we show that market friction dominates the beta changes for the REOCs. In summary, we observe consistent patterns in our findings, which indicate that the inclusion of CMT and A-REIT into the STI, in contrary to the US evidence, has no significant spillover effects on the non-index REOCs.

Table 7 Dimson Betas on Market Friction

Study	**ALP**		**This Study**							
Country	**US**		**US**				**Singapore**			
Asset Category	Non-index REITs		Non-index REITs		Non-index REOCs		Non-index REOCs		Index REOCs	
Market Returns/ Dimson Beta	Δ Beta	Diff (p)	Δ Beta	Diff (p)	Δ Beta	Diff (p)	Δ Beta	Diff (p)	Δ Beta	Diff (p)
Market Index	S&P 600 Index Return						STI Return			
Daily	0.232	0.063	0.265	0.005	0.246	0.016	0.127	0.586	0.241	0.198
	S&P 500 Index Return									
	0.111	0.372	0.177	0.098	0.208	0.077				
	S&P 400 Index Return									
Daily	0.229	0.061	0.297	0.003	0.260	0.017				

Notes: This table shows the results on the differences in the average "Dimson" Beta "before" and "after" the REIT index inclusion events (ΔBeta). Diff(p) shows the level of significance on the change in beta. For the US tests, the event date is set on "October 9, 2001", whereas the event date, which coincided with the inclusion of the REITs into the STI, is set on "March 18, 2005". Columns (2) and (3) report the results in Ambrose et al. (2007; ALP); and Columns (4) and (5) shows the results replicated from the ALP models, but using data collected independently from Datastream. For the "Non-index REOCs" category (Columns 6 and 7), we replicate the event tests by using REOC samples. For the US tests, we use three different market returns proxies by using small cap market portfolio (S&P600 index), large cap market portfolio (S&P500) and mid-cap market portfolio (S&P 400 index).

We then replicate the tests of the effects of REIT inclusion into the index by using Singapore non-index REOCs (Columns 8 and 9) and index REOCs (Columns 10 and 11), and the market return proxy is based on STI return. Both daily and weekly return series are used in the tests.

4.8. Possible Misclassification of REIT and REOC Categories

If both the non-index REIT and REOC betas show similar patterns after the inclusion event of REITs into the index, we cannot rule out the possibility that REOCs and REITs could have been classified into the same category, instead of two non-overlapping categories. We test for possible misclassification errors

by cross-examining return comovements between index and non-index REITs and REOCs by running the following regression:

$$R_{i,t} = \alpha + \beta_1 AFTER + \beta_2 R_{j,t} + \beta_3 (R_{j,t} * AFTER) + \varepsilon_t \quad (8)$$

where ($i \neq j$) denotes either of the two non-overlapping categories of stocks. ALP run the cross-asset regression with index REIT as asset *i* and non-index REIT as asset *j*. We add two more tests with index REITs against non-index REOCs, and non-index REITs against non-index REOCs.

The results in Table 8 show that both the correlation between the value-weighted portfolio returns of the index and non-index REITs does not increase significantly after the REIT index inclusion event. The daily and weekly coefficients for β_3 in our study are estimated to be -0.032 and 0.046, respectively, but both are statistically insignificant. Insignificant changes between the index and non-index REIT betas are also reported in ALP. The results affirm that index REITs and non-index REITs are homogeneous assets from the same category, with a relation of around 1. When we cross-analyse the correlations between the REITs (both index and non-index) and REOCs, we find the beta of REOCs associated with index and non-index REITs ranges from 0.370 (daily return before inclusion event) to 0.625 (daily return after inclusion event) during the sample period, which is significantly smaller than the beta (around 1.000) of non-index REITs associated with index REITs. Moreover, the betas of REOCs associated with index and non-index REITs increase significantly after the inclusion event for daily returns. The US results in Table 8 suggest that REOCs are somewhat similar to REITs, because both are related to the real estate industry. However, they are placed in different categories, since the beta REOCs associated with REITs are far less than 1. Similar results are found in the Singapore context, where the betas of REOCs associated with REITs are positive but less than 0.5. Therefore, the spillover effects found in this study are not likely to be caused by misclassification between REITs and REOCs. The weaker correlation of REOCs with non-index REITs as opposed to the correlation of index REITs with non-index REITs, could explain for the smaller beta changes of REOCs in Tables 3, 4 and 5. We thus argue that spillovers of the inclusion shocks of REITs into REOCs are not restricted to investor sentiment in the same category. The results add incremental value to the tests of the "sentiment-based" or "friction-based" view, and the differences in beta changes between the two non-overlapping assets also offer evidence to the "information diffusion" view.

Table 8 Misclassification Tests on REIT and REOC Categories

Study	**ALP**			**This Study**					
Country	**US**			**US**			**Singapore**		
Market Return:	Before	After	Diff (p)	Before	After	Diff(p)	Before	After	Diff(p)
				Index REITs vs Non-index REITs			Index REITs vs Non-index REOCs		
Daily	1.054	1.063	0.923	1.120	1.088	0.466	0.115	0.390	0.000
Weekly	0.974	1.113	0.124	0.910	0.956	0.593	0.088	0.199	0.124
				Index REITs vs Non-index REOCs			Index REITs vs Index REOCs		
Daily				0.439	0.625	0.000	0.101	0.309	0.000
Weekly				0.593	0.601	0.231	0.089	0.221	0.005
				Non-index REITs vs Non-index REOCs					
Daily				0.370	0.575	0.000			
Weekly				0.518	0.576	0.881			

Notes: This table shows the results on the differences in the average "Dimson" Beta "before" and "after" the REIT index inclusion events (ΔBeta). Diff(p) shows the level of significance on the change in beta. For the US tests, the event date is set on "October 9, 2001". We conduct the misclassification tests and compare our results with those of ALP by using index and non-index REITs (Columns 2 and 3). Our misclassification test results are summarized in Columns (4) and (5), where the top panel show the pair-wise samples of index and non-index REITs; and index-REITs and non-index REOCs (the center panel of Columns 4 and 5), and the non-index REITs and non-index REOCs (the bottom panel of Columns 4 and 5). Both daily and weekly return series are used in the tests.

4.9. Betas of Non-Real Estate Stocks

In Tables 3 to 5, we observe that the beta changes of REOCs with S&P indices are smaller than those of non-index REITs after the REIT index inclusion event. We assume that the closer relationship between index REITs and non-index REITs, compared to the relationship between non-index REOCs, could explain for the smaller beta changes. If this assumption is true, then the beta of non-real estate industry stocks with S&P indices should show no changes after the REIT index inclusion event. To test if the comovement of the non-real estate industry stocks with S&P indices would be affected by the REIT index inclusion event, we construct a portfolio that includes all "non-index & non-real estate" stocks. This portfolio should eliminate the industries captured in the S&P indices to rule out other inclusion events that might contaminate our results. For data availability, here we only conduct the test by using S&P 500. The regression is the same as in Equation (3) where $R_{portfolio,t}$ is the log value weighted portfolio return of all "non-index & non-real estate" stocks excluding stocks of industries captured by S&P 500. Specifically, S&P 500 comprises 285 industries and the universe of the US stock market comprises 1089 industries. Therefore $R_{portfolio,t}$ represents the log return of all "non-index & non-real estate" stocks which comprise 804 industries. In addition to the REIT inclusion event during the sample period, there are also other industry stocks that are entering S&P 500 during this period of time. If the S&P 500 industries are not purged, when a non-real estate industry stock enters the S&P 500, it would be difficult to identify whether the beta changes of the non-real estate industry stocks with S&P 500 are caused by the inclusion event of the REITs or the non-real estate industry stocks. Before examining the spillover effect of the REIT inclusion effect on non-real estate industry stock, we first replicate the regression of Equation (1) to see how non-real estate industry stocks are associated with index REITs. Panel A of Table 9 shows that prior to the inclusion event, the betas of the non-real estate industry stocks with index REITs are 0.208 (daily returns) and 0.093 (weekly returns). Although the betas of the daily and weekly returns increase after the event, the magnitude (0.434 for daily returns and 0.317 for weekly returns) is still less than that of the betas of non-index REITs with index REITs or REOCs with index REITs reported in Table 9. This result suggests that real estate related stocks (both non-index REITs and REOCs) are more correlated with index REITs than the non-real estate industry stocks, thus resulting in higher comovement with S&P indices after the REIT inclusion event. Panel B of Table 9 presents the spillover effects of the REIT inclusion event on non-real estate industry stocks. We find that the changes of the betas of non-real estate industry stock are negative and insignificant, thus implying that a REIT inclusion event does not have positive effects on the comovement of non-real estate industry stock with S&P 500 returns. The results in Table 9 provide further evidence that the "friction- or sentiment-based" spillover effect would be effective only in related categories.

Table 9 Betas of Non-real Estate Industry Stocks with S&P 500

Panel A. Index REITS with Non-real Estate Industry Stocks

Country	**US**		
Market Return:	Before	After	Diff (p)
	S&P 500 Index Return		
Daily	0.208	0.434	0.000
Weekly	0.093	0.317	0.000

Panel B. Spillover Effects on Non-real Estate Industry Stocks

Country	**US**	
Asset Category	Non-real Estate Industry Stocks	
Market Returns:	ΔBeta	Diff (p)
	S&P 500 Index Return	
Daily	-0.098	0.000
Weekly	-0.077	0.214

Notes: Panel A shows the results on the differences in the average beta of non-real estate industry stocks with S&P 500 "before" and "after" the REIT index inclusion events (ΔBeta). Diff(p) shows the level of significance on the change in beta. For the US tests, the event date is set on "October 9, 2001". Panel B shows the spillover effects of REIT inclusion event on non-real estate industry stocks.

5. Conclusion

Building on the study by ALP, we empirically test the comovement of returns of assets in the same category and/or in a different but overlapping category. We found significant increases in non-index REIT betas after a REIT index inclusion event, and the results are consistent with those in ALP for the US REIT market. We expand the study by ALP by using REOCs as the proxy of non-overlapping assets in a different, but related category in the Singapore and US markets.

The three main findings of this study are: first, the first REIT inclusion into US S&P market index on October 9, 2011 causes the betas of other non-index REITs to increase. The event also has significant spillovers to betas of REOCs that share some overlapping features in the real estate market. However, the spillover effects to the betas of REOC returns are smaller than to those of the REIT returns. We conduct various tests that control for market-wide risks, changing index composition (endogeneity), market friction, misclassification problems, and other possible driving forces, and the results remain robust and consistent. The results find evidence that is consistent with the sentiment-based view. Second, we replicated the tests of the REIT index inclusion event with REIT and REOCs in Singapore. In contrary to the results of the US REOCs, we find relatively smaller spillover effects of the REIT index inclusion event

on REOC betas in the Singapore tests. The different outcomes between the US and Singapore experiments imply that the categorization of assets (the category or habitat view) is not the only condition, but market friction might also explain for the spillover effects.

Third, in the Singapore experiment, we find that REIT returns are more positively correlated with market returns in the periods after the inclusion of REITs into the index compared to the REOC returns. The relative changes in the REIT and REOC betas increase more after the REIT inclusion event. We use the index inclusion events of the three sponsored REITs, and find significant evidence that shows larger spillovers to the betas of the REOCs that are also the sponsors of the index REITs in Singapore.

For institutional investors that include US and Singapore REITs and REOCs in their investment "habitat", they ought to understand that there are potential intra- and inter spillover effects within the same category and across the overlapping categories of asset markets. Asset comovements are different between the US and Singapore. Singapore based investors should not indiscriminately replicate the strategies that work in the US to portfolios in Singapore. Another implication for investors with exposure to the REITs and REOCs of Singapore is that they could harness the captive relationships of index REITs and their REOC sponsors to reduce systematic risks.

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Appendices

Table A-1 Characteristics of the REIT and REOC Markets in the US and Singapore

	US		Singapore	
	REIT	REOC	REIT	REOC
Established	1961	N.A.	2002	N.A.
Sample period	January 1, 2000 to December 31, 2003		July 1, 2003 to December 29, 2006	
Number of listed REITs	176	60	10	25
Market Value (MV) (US$ million)	122,433.812	6,155.422	10,968.065	33,467.464
Total Return (TR) (%)	0.003	0.028	0.005	0.008
Book to Market Value Ratio (bmk)	2.48	2.22	1.898	1.681
Price to Book Ratio (PB)	0.982	0.944	0.992	0.985
Relative Price to Book Ratio (RPB)	-0.425	-0.529	-0.689	-0.696
Systematic Risk (beta)	0.362	0.766	0.201	0.985
Herfindahl Index	0.019	0.024	0.074	0.108

Notes: The table shows the summary statistics for the sample REITs and REOCs in the US and Singapore markets. We include various statistics, such as total return, book to market value ratio, price to book ratio, relative price to book ratio, systematic risk and Herfindahl index. The data are obtained from Datastream.

Table A-2 Changes in Index REIT Betas After REIT Index Inclusion Events

Study	**ALP**		**This Study**			
Country	US		US		Singapore	
Asset Category	Index REIT		Index REIT		Index REIT	
	ΔBeta	Diff (p)	ΔBeta	Diff (p)	ΔBeta	Diff (p)
Daily	0.203	0.000	0.203	0.000	0.440	0.000
Weekly	0.389	0.000	0.337	0.000	0.374	0.000

Notes: This table shows the results on the differences in the average beta of index REITs "before" and "after" their inclusion events (ΔBeta). Diff(p) shows the level of significance on the change in beta. For the US tests, the event date is set on "October 9, 2001", whereas the event date, which coincided with the inclusion of the REITs into the STI, is set on "March 18, 2005". Columns (2) and (3) report the results in Ambrose et al. (2007; ALP); and Columns (4) and (5) shows the results replicated from the ALP models, but using data collected independently from Datastream. The last two columns (6 and 7) show the results of the event study by using Singapore data. Both daily and weekly return series are used in the tests.

Table A-3 Spillover Effects and Market-wide Risks in Different Size-Based Market Portfolios

Study	**ALP**		**This Study**							
Country	**US**		**US**				**Singapore**			
Asset Category	Non-index REIT		Non-index REIT		Non-index REOC		Non-index REOCs		Index REOCs	
Market Returns:	ΔBeta	Diff (p)	ΔBeta	Diff (p)	ΔBeta	Diff (p)	ΔBeta	Diff (p)	ΔBeta	Diff (p)
	(a) Small-Cap Market Portfolio / S&P 600 Index Return						Straits Times Index (STI) Return			
Daily	0.201	0.000	0.215	0.000	0.126	0.000	0.179	0.000	0.155	0.000
Weekly	0.354	0.004	0.336	0.000	0.164	0.000	0.110	0.202	0.046	0.331
	(b) Large-Cap Market Portfolio / S&P 500 Index Return									
Daily	0.145	0.000	0.148	0.000	0.045	0.000				
Weekly	0.275	0.046	0.236	0.000	0.106	0.127				
	(c) Mid-Cap Market Portfolio / S&P 400 Index Return									
Daily	0.205	0.000	0.209	0.000	0.108	0.000				
Weekly	0.355	0.007	0.312	0.000	0.159	0.000				

Notes: This table shows the results on the differences in the average beta "before" and "after" the REIT index inclusion events (ΔBeta). Diff(p) shows the level of significance on the change in beta. For the US tests, the event date is set on "October 9, 2001", whereas the event date, which coincided with the inclusion of the REITs into the STI, is set on "March 18, 2005". Columns (2) and (3) report the results in Ambrose et al. (2007; ALP); and Columns (4) and (5) shows the results replicated from the ALP models, but using data collected independently from Datastream. For the "Non-index REOCs" category (Columns 6 and 7), we replicate the event tests by using REOC samples. For the US tests, we use three different indices as proxies for market returns, which include small cap market portfolio (represented by S&P600 index), large cap market portfolio (S&P500) and mid-cap market portfolio (S&P 400 index).

We then replicate the tests of the effects of REIT inclusion into index by using Singapore non-index REITs (Columns 8 and 9) and index REOCs (Columns 10 and 11), and the market return proxy is based on the STI return. Both daily and weekly return series are used in the tests.

Table A-4 Spillover Effects and Real Estate Related Market Risks

Study	**ALP**		**This Study**							
Country	**US**		**US**				**Singapore**			
Asset Category	Non-index REITs		Non-index REITs		Non-index REOCs		Non-index REOC		Index REOC	
Market Returns:	ΔBeta	Diff(p)	ΔBeta	Diff(p)	ΔBeta	Diff(p)	ΔBeta	Diff(p)	ΔBeta	Diff(p)
	(a) Residual of S&P 600 Return						Residual of Straits Times Index (STI) Return			
Daily	0.501	0.000	0.280	0.000	0.253	0.000	0.286	0.000	0.173	0.053
Weekly	0.697	0.010	0.581	0.000	0.289	0.000	0.113	0.664	-0.229	0.365
	(b) Residual of S&P 500 Return									
Daily	0.352	0.000	0.641	0.000	0.624	0.000				
Weekly	0.523	0.054	0.657	0.000	0.648	0.000				
	(c) Residual of S&P 400 Return									
Daily	0.518	0.000	0.283	0.000	0.224	0.000				
Weekly	0.846	0.011	0.514	0.000	0.358	0.000				
	(d) Residual of Non-Real Estate and Non-index Stock Portfolio Returns						Residual of Non-Real Estate and Non-index Stock Portfolio Returns			
Daily	-0.561	0.000	-0.893	0.000	-1.205	0.000	-0.204	0.014	-0.130	0.143
Weekly	-0.754	0.054	-1.480	0.000	-1.242	0.000	0.237	0.262	-0.126	0.339

Notes: This table shows the results on the differences in the average beta "before" and "after" the REIT index inclusion events (ΔBeta). Diff(p) shows the level of significance on the change in beta. For the US tests, the event date is set on "October 9, 2001", whereas the event date, which coincided with the inclusion of the REITs into the STI, is set on "March 18, 2005". Columns (2) and (3) report the results in Ambrose et al. (2007; ALP); and Columns (4) and (5) shows the results replicated from the ALP models, but using data collected independently from Datastream. For the "Non-index REOCs" category (Columns 6 and 7), we replicate the event tests by using REOC samples. For the US tests, we use three different proxies for orthogonalized market returns, which include residuals of small cap market portfolio (S&P600 index), residual of large cap market portfolio (S&P500), residual mid-cap market portfolio (S&P 400 index), and residual of non-real estate and non-index stock portfolio returns.

We then replicate the tests of the effects of REIT inclusion into the index by using Singapore non-index REITs (Columns 8 and 9) and index REOCs (Columns 10 and 11), and the market return proxy is based on the residual of STI return. Both daily and weekly return series are used in the tests.

Table A-5 Controlling for the Effects of Composition Changes in Market Indices

Study	**ALP**		**This Study**							
Country	**US**		**US**				**Singapore**			
Asset Category	Non-index REITs		Non-index REITs		Non-index REOCs		Non-index REOC		Index REOC	
Market Returns:	ΔBeta	Diff(p)	ΔBeta	Diff(p)	ΔBeta	Diff(p)	ΔBeta	Diff(p)	ΔBeta	Diff(p)
	(a) "Fixed" S&P 600 Index Return						"Fixed" Straits Times Index (STI) Return			
Daily	0.149	0.000	0.263	0.000	0.234	0.000	0.160	0.000	0.142	0.002
Weekly	0.260	0.022	0.311	0.002	0.221	0.000	0.085	0.664	0.010	0.365
	(b) "Fixed" S&P 500 Index Return									
Daily	0.113	0.001	0.118	0.000	0.107	0.000				
Weekly	0.192	0.103	0.117	0.060	0.276	0.119				
	(c) "Fixed" S&P 400 Index Return									
Daily	0.131	0.000	0.218	0.000	0.180	0.000				
Weekly	0.228	0.051	0.249	0.004	0.108	0.000				

Notes: This table shows the results on the differences in the average beta "before" and "after" the REIT index inclusion events (ΔBeta). Diff(p) shows the level of significance on the change in beta. For the US tests, the event date is set on "October 9, 2001", whereas the event date, which coincided with the inclusion of the REITs into the STI, is set on "March 18, 2005". Columns (2) and (3) report the results in Ambrose et al. (2007; ALP); and Columns (4) and (5) shows the results replicated from the ALP models, but using data collected independently from Datastream. For the "Non-index REOCs" category (Columns 6 and 7), we replicate the event tests by using REOC samples. For the US tests, we control for potential endogeneity by fixing the market returns using "Fixed" small cap market portfolio (S&P600 index), "Fixed" large cap market portfolio (S&P500) and "Fixed" mid-cap market portfolio (S&P 400 index).

We then replicate the tests of the effects of REIT inclusion into the index by using Singapore non-index REOCs (Columns 8 and 9), and the market return proxy is based on "Fixed" STI return. Both daily and weekly return series are used in the tests.

Table A-6 Changes in Betas "Before" and "After" the REIT Index Inclusion Events

Study	**ALP**		**This Study**							
Country	**US**		**US**				**Singapore**			
Asset Category	Non-index REITs		Non-index REITs		Non-index REOCs		Non-index REOC		Index REOC	
Market Returns:	ΔBeta	Diff(p)	ΔBeta	Diff(p)	ΔBeta	Diff(p)	ΔBeta	Diff(p)	ΔBeta	Diff(p)
	S&P 600 Index Return						STI return			
Initial Beta	0.171	0.000	0.173	0.000	0.158	0.000	0.552	0.000	1.038	0.000
$\phi_1 = \Delta\beta_1$	0.028	0.534	0.038	0.292	0.051	0.345	-0.306	0.127	-0.215	0.219
$\phi_2 = \Delta\beta_2$	0.114	0.022	0.132	0.018	0.062	0.011	-0.085	0.647	-0.212	0.180
$\phi_3 = \Delta\beta_3$	0.227	0.000	0.244	0.004	0.217	0.036	0.040	0.016	0.028	0.026
$\phi_4 = \Delta\beta_4$	0.240	0.000	0.250	0.006	0.189	0.009	0.430	0.028	0.445	0.001
$\phi_5 = \Delta\beta_5$	0.203	0.000	0.230	0.025	0.309	0.018	0.200	0.064	0.068	0.002
	S&P 500 Index Return									
Initial Beta	0.195	0.000	0.202	0.000	0.184	0.007				
$\phi_1 = \Delta\beta_1$	-0.005	0.898	0.001	0.446	0.013	0.249				
$\phi_2 = \Delta\beta_2$	0.064	0.238	0.064	0.094	0.006	0.158				
$\phi_3 = \Delta\beta_3$	0.127	0.040	0.135	0.000	0.109	0.000				
$\phi_4 = \Delta\beta_4$	0.165	0.001	0.162	0.001	0.100	0.009				
$\phi_5 = \Delta\beta_5$	0.252	0.000	0.264	0.019	0.228	0.004				
	S&P 400 Index Return									
Initial Beta	0.168	0.000	0.178	0.002	0.151	0.021				
$\phi_1 = \Delta\beta_1$	0.023	0.586	0.021	0.141	0.044	0.324				
$\phi_2 = \Delta\beta_2$	0.094	0.063	0.108	0.048	0.046	0.151				
$\phi_3 = \Delta\beta_3$	0.210	0.000	0.213	0.033	0.193	0.036				
$\phi_4 = \Delta\beta_4$	0.234	0.000	0.232	0.001	0.179	0.048				
$\phi_5 = \Delta\beta_5$	0.297	0.000	0.310	0.013	0.283	0.016				

(*Continued…*)

(Table A-6 Continued)

Notes: This table shows the results on differences in average beta "before" and "after" the REIT index inclusion events (ΔBeta). Diff(p) shows the level of significance on the change in beta. For the US tests, the event date is set on "October 9, 2001", whereas the event date, which coincided with the inclusion of the REITs into the STI, is set on "March 18, 2005". The table captures the gradual changes in betas, by setting D_d, a set of dummy variables (0,1), to represent a 6-month interval before and after the inclusion event: D_1 = [March 1st, 2001 to October 9th, 2001]; D_2 = [October 10th, 2001 to April 30th, 2002]; D_3 = [May 1st, 2002 to October 31st, 2002]; D_4 = [November 1st, 2002 to April 30th, 2003]; and D_5 = [May 1st, 2003 to December 31st, 2003]. For the Singapore tests, the periods with changing beta are defined as: D_1= [October 1, 2004 to March 18, 2005]; and other post-event time dummy: D_2= [March 19, 2005 to September 30, 2005], D_3= [Oct 1, 2005 to February 28, 2006], D_4= [March 1, 2006 to July 31, 2006], and D_5= [August 1, 2006 to December 31, 2006].

Table A-7 Dimson Betas on Market Friction

Study	**ALP**		**This Study**							
Country	**US**		**US**				**Singapore**			
Asset Category	Non-index REITs		Non-index REITs		Non-index REOCs		Non-index REOCs		Index REOCs	
Market Returns/ Dimson Beta:	ΔBeta	Diff(p)	ΔBeta	Diff(p)	ΔBeta	Diff(p)	ΔBeta	Diff(p)	ΔBeta	Diff(p)
Market Index	S&P 600 Index Return						STI Return			
Daily	0.232	0.063	0.265	0.005	0.246	0.016	0.127	0.586	0.241	0.198
	S&P 500 Index Return									
	0.111	0.372	0.177	0.098	0.208	0.077				
	S&P 400 Index Return									
Daily	0.229	0.061	0.297	0.003	0.260	0.017				

Notes: This table shows the results on the differences in the average "Dimson" Beta "before" and "after" the REIT index inclusion events (ΔBeta). Diff(p) shows the level of significance on the change in beta. For the US tests, the event date is set on "October 9, 2001", whereas the event date, which coincided with the inclusion of the REITs into the STI, is set on "March 18, 2005". Columns (2) and (3) report the results in Ambrose et al. (2007; ALP); and Columns (4) and (5) shows the results replicated from the ALP models, but using data collected independently from Datastream. For the "Non-index REOCs" category (Columns 6 and 7), we replicate the event tests by using REOC samples. For the US tests, we use three different market returns proxies by using small cap market portfolio (S&P600 index), large cap market portfolio (S&P500) and mid-cap market portfolio (S&P 400 index).
We then replicate the tests of the effects of REIT inclusion into the index by using Singapore non-index REOCs (Columns 8 and 9) and index REOCs (Columns 10 and 11), and the market return proxy is based on STI return. Both daily and weekly return series are used in the tests.

Table A-8 Misclassification Tests on REIT and REOC Categories

Study	ALP			This Study					
Country	US			US			Singapore		
Market Return:	Before	After	Diff (p)	Before	After	Diff (p)	Before	After	Diff (p)
	Index REITs vs Non-index REITs						Index REITs vs Non-index REOCs		
Daily	1.054	1.063	0.923	1.120	1.088	0.466	0.115	0.390	0.000
Weekly	0.974	1.113	0.124	0.910	0.956	0.593	0.088	0.199	0.124
				Index REITs vs Non-index REOCs			Index REITs vs Index REOCs		
Daily				0.439	0.625	0.000	0.101	0.309	0.000
Weekly				0.593	0.601	0.231	0.089	0.221	0.005
				Non-index REITs vs Non-index REOCs					
Daily				0.370	0.575	0.000			
Weekly				0.518	0.576	0.881			

Notes: This table shows the results on the differences in the average "Dimson" Beta "before" and "after" the REIT index inclusion events (ΔBeta). Diff(p) shows the level of significance on the change in beta. For the US tests, the event date is set on "October 9, 2001". We conduct the misclassification tests and compare our results with those of ALP by using index and non-index REITs (Columns 2 and 3). Our misclassification test results are summarized in Columns (4) and (5), where the top panel show the pair-wise samples of index and non-index REITs; and index-REITs and non-index REOCs (the center panel of Columns 4 and 5), and the non-index REITs and non-index REOCs (the bottom panel of Columns 4 and 5). Both daily and weekly return series are used in the tests.

Table A-9 Betas of Non-real Estate Industry Stocks with S&P 500

Panel A. Index REITS with Non-real Estate Industry Stocks

Country	**US**		
Market Return:	Before	After	Diff (p)
	S&P 500 Index Return		
Daily	0.208	0.434	0.000
Weekly	0.093	0.317	0.000

Panel B. Spillover Effects on Non-real Estate Industry Stocks

Country	**US**	
Asset Category	Non-real Estate Industry Stocks	
Market Returns:	ΔBeta	Diff (p)
	S&P 500 Index Return	
Daily	-0.098	0.000
Weekly	-0.077	0.214

Notes: Panel A shows the results on the differences in the average beta of non-real estate industry stocks with S&P 500 "before" and "after" the REIT index inclusion events (ΔBeta). Diff(p) shows the level of significance on the change in beta. For the US tests, the event date is set on "October 9, 2001". Panel B shows the spillover effects of REIT inclusion event on non-real estate industry stocks.