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Abstract

The BRICS market represents high growth economies. This paper empirically examines the long-run equilibrium as well as the short-run linkages between the BRICS REIT markets and the REIT markets in developed countries (United States, Australia and the United Kingdom). We employ fractional co-integration techniques between the BRICS REIT markets and 3 most developed REIT markets. This paper tests the hypothesis of fractional integration, our results showed no evidence of co-integration between BRICS REIT markets and the REIT markets of any of the developed economies in the long run, while the result only indicated that the BRICS REIT markets is influenced by the developed economies in the short run. The implications of this study shows that a portfolio of developed REIT markets are diversifiable when added into a portfolio of BRICS REIT markets. This is particularly significant for investors and fund analysts in other to reduce portfolio risks.

Keywords: BRICS; Fractional integration; Fractional cointegration; Real estate investment trust

JEL Classification: C22; C30; R00; R20.

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1. Introduction

The BRICS economies include Brazil, Russia, India, China and South-Africa (BRICS) and is significant in the global economy. BRIC acronym was established in 2006 consisting of Brazil, Russia, India and China; South Africa was included in the list in 2011 and therefore the acronym was changed to BRICS. BRICS was formed as an entity as a result of the expectations and prediction of future growth amongst these developing economies (Ntuli and Akinsomi, 2017). The GDP of the BRICS market in 2016 represented US$16.84 trillion collectively with China ranked as number 2 globally with US$11.20 trillion, India ranked as number 7 with US$2.26 trillion, Brazil ranked as number 9 with US$1.80 trillion, Russia ranked as number 12 with US1.28 trillion and South Africa ranked as number 39 with US$0.295 trillion[1].

As the five biggest and generally fast growing emerging economies, the BRICS economies have growing impacts on world economy from many perspectives. BRICS make up 40 percent of the world's population, 25 percent of the world's landmass, and about 20 percent of global GDP, and already control some 43 percent of global foreign exchange reserves (Agtmael, 2012). China and India are especially big contributors to the BRICS statistics. For example, in late 2010, China surpassed Japan's GDP for the first time, with China's GDP standing at $5.88 trillion compared to Japan's $5.47 trillion; China thus became the world's second-largest economy after the United States (Piper, 2015). Beside their regional/global economic/political influences, stock markets of BRICS also feature in the radar of global portfolio investments. Globally rising importance of real estate and Real Estate Investment Trusts (REITs) markets puts interesting dimensions on the global portfolio movements to BRICS REITs markets.

[1] http://databank.worldbank.org/data/download/GDP.pdf. Accessed January, 25th, 2018 at 14.30.

Previous literature have examined the BRICS markets albeit in other asset classes such as stocks and bonds. Authors such as Bianconi et al (2013) and Hammoudeh et al (2016) find that there exists diversification benefits when BRICS bonds and stocks are included in a portfolio with US and European stocks. However Zhang et al (2013) documents that in the long run the diversification benefits between BRICS and developed markets tend to reduce specifically after the financial crisis. However there is a dearth of research examining BRICS REITs markets as well as their correlation with international markets such as U.S, Australia and United Kingdom. Prior studies by authors such as Goetzmann and Ibbotson (1990) and Lui and Mei (1992) find that the expected returns of equity REITs move closely to small cap stocks and less with those of bonds, while Wang et al (1995) argue that REIT market do not enjoy the benefit of securitization that assets like general stocks enjoy. The disparity in results in understanding if general stock and REITs are correlated motivates this current study as past literature has shown that it is over-simplistic to assert that the results in previous literature of BRICS stock market can be applied to BRICS REITs market.

Two countries in the BRICS markets operate REITs- these include Brazil and South Africa; Russia, India and China do not currently operate REITs structure[2]. The REIT structure in Brazil is termed as Fundo de Investmento Imobiliaro (FII), and as at June 2016, there were 211 FIIs with 164 listed on the Sao Paulo Stock Exchange with a net asset value of BRL72 billion ($US22.44 billion)[3] (EPRA, 2017). According to SA REIT (2017) there are 28 listed REITs in South Africa with a combined value of R420

[2] Russia and China currently do not have a REIT regime structure whilst India has a REIT regime structure but no traded listed REITs. In our analysis we employ alternative property indexes for BRICS markets.
[3] As at 30, June 2016, closing exchange rates traded for 3.2082 Brazilian Reals for 1 US dollar. https://www.poundsterlinglive.com/best-exchange-rates/us-dollar-to-brazilian-real-exchange-rate-on-2016-06-30, accessed January 27th 2018 at 11.20am.

billion (US$35.43 billion)[4]. The BRICS REIT/Property markets are considered as developing REIT markets, the top 3 REITs markets as at 2016 include the United States with a value of US$747.75 billion, Australia with a value of US$79.78 billion and the United Kingdom valued at US$54.15 billion. (Ntuli and Akinsomi, 2017).

This paper examines and tests the linkages within the BRICS REITs market in Brazil, Russia, India, China and South Africa and developed top 3 REITs markets including United States, Australia and United Kingdom; specifically, our key research question examines if the BRICS REIT markets are segmented or co-integrated within and between the top international REIT markets. The motivation for this research work is relevant for several reasons including that, firstly, the three countries from BRICS including China, India and Brazil rank in the top 10 economies in the world with Russia ranking as 12th and South-Africa as 39th- they represent one of the fastest growing economies in the world. Secondly, an investigation into the BRICS REIT markets and other top REIT markets would assist analysts and investors to make better informed decision in terms of allocation of funds as well as an understanding of diversification benefits existing within BRICS markets and between top international REIT markets.

The rest of the paper is as follows: Section 2 reviews the literature, Section 3 reports on the data and the methodology employed. Section 4 analyses the data and the results, while Section 5 concludes the paper.

2. Literature Review

Costs and benefits of market integration are broadly discussed in the literature. For example Akdogan (1995, cited in Marashdeh, 2006) discussed that in case of integration

[4] As at January 27, 2017, exchange rates traded for 11.86 Rand for 1 US dollar.

among all stock markets, the systematic risk (market risk) becomes an unsystematic risk (firm-specific risk), and then diversified away by including the security. He also argues that in the case of integrated market, all firms can raise their capital with lower costs than firms do in a segmented market. Rangvid (2001) suggested that financial market integration lowers the cost of capital and smoothen the growth of investment, and also allows for better risk sharing among agents. Despite its benefits, financial integration has increased financial risks of local financial markets due to contagion risks as documented in various financial crisis. Therefore, the empirical literature reveals that integration and segmentation of financial markets have positive and negative sides. There is already a substantial body of evidence on the integration between stock markets and REITs, however focusing only on BRICS countries is generally rare for both stock markets and REITs integration perspective. According to the strategy adopted, the literature review focuses on integration (or segmentation) of BRICS stock and then REITs markets.

Using the correlation test and the Johansen's cointegration test from 1st January 2004 to 31st December 2013, Nashier (2015) found evidence for both short-term static and long-term dynamic integration between the BRICS stock markets. This suggests that there are limited benefits of any diversification or speculative activities between these markets. Bhar and Nikolova (2009) found that India showed the highest level of regional and global integration among the BRIC countries, followed by Brazil and Russia and lastly by China. Sheu and Liao (2011) demonstrated that the stock markets of Brazil, Russia and China have begun to exert significant influences on the Dow Jones, to some extent after 2006 and discussed that potential benefits from international risk diversification may have gradually diminished. By applying regression analysis, Granger's Causality Model, Vector Auto Regression (VAR) Model, and Variance Decomposition Analysis over the period from April 1, 2005 to March 31, 2010 Sharma et al. (2013) find that BRICS stock markets were influenced by each other, but not to a great extent. By employing the multivariate Fractionally Integrated Asymmetric Power ARCH (FIAPARCH) dynamic conditional correlation (DCC) framework during the period 1997–2012, Dimitriou et al. (2013) suggested that the empirical evidence does not confirm a contagion effect for most BRICS during the early stages of the crisis, indicating signs of isolation or decoupling. However, linkages reemerged (recoupled) after the Lehman Brothers collapse, suggesting a shift on investors' risk appetite. This evidence implies that there exists opportunities for diversification of the investors among the stock exchanges of BRICS. Zhang et al. (2013) provided evidence that 70% of BRICS stock markets conditional correlation series demonstrate an upward long-run trend with the developed stock markets. The authors argued that reducing diversification benefits are a long-run and world-wide phenomenon, especially after the 2008/2009 financial crisis. Bekiros (2014) showed that BRICS have become more internationally integrated after the US financial crisis and contagion is further substantiated, however, this study does not provide consistent evidence in support of the decoupling view. Naidu and Subbarayudu (2014) provide evidence that BRICS stock markets showed cointegration from 2009 to 2014 by using Johansen co-integration analysis. The authors also find that the correlation coefficient between the Sensex of India and SSE composite of China indicate negative correlation showing independent nature. As an extension of the existing literature, Chkili and Nguyen (2014) used a regime-switching model approach to investigate the dynamic linkages between the exchange rates and stock market returns for the BRICS countries and found that stock returns of the BRICS countries evolve according to low and high volatility regimes. Singh and Kaur (2016) found evidence that during a tranquil period, the BRIC markets do not cointegrate with each other, but during a crisis period, a co-movement emerges out among the countries except the Indian markets. Yarovaya and Lau (2016) explored the international portfolio diversification benefits available for UK investors holding a portfolio in the BRICS and MIST[5] emerging markets. The application of conventional and regime-switch cointegration techniques suggests an absence of diversification benefits. By utilizing Johansen cointegration tests, Ouattara (2017) finds that BRICS stock markets are not cointegrated in the long run, thus, being a favourable destination for the long-term investments.

Empirical literature focusing on integration of real estate markets in national/international level represents a recently evolving research interest. In this respect, the potential diversification benefits of real estate has attracted attentions from portfolio management perspective. For example, from a real estate securities perspective, Westerheide (2006) indicated that real estate securities seem to represent an asset class distinct from bonds and stocks in most countries. In the long run they seem to provide a potential for further diversification of asset portfolios. Yunus (2009) discussed that over a period between January 1990 and August 2007, the securitized property markets of Australia, Hong Kong, Japan, the United Kingdom and the United States are co-related, and from the perspective of the U.S. investor, the markets of the Netherlands and France provide greater diversification benefits.

A growing body of empirical analyses have also focused on the integration between stock market and REITs and also REITs markets themselves. Li and Wang (1995) suggested that in a general two-factor asset pricing framework, the REIT market is integrated with the general stock market. Eichholtz (1997)

[5] MIST is an acronym coined for the economies of Mexico, Indonesia, South Korea and Turkey.

found a high correlation between securitized real estate and stocks on an international basis. At the country-level analysis, He (1998) employed Dickey-Fuller and Johansen cointegration tests suggesting a stable long-run linear relationship between equity and mortgage REITs stock prices over the period from January 1972 through December 1995. This relationship reflects their common responses to changes in market returns and interest rates, as well as other additional fundamental factors. One of such factors is changes in real estate returns. Ling and Naranjo (1999) found evidence that REITs are integrated with the non-real-estate stocks and the degree of integration has significantly increased during the 1990s. By analyzing a panel of 16 countries over the 1990-2004 period, Hoesli and Serrano (2007) found a decline in correlation between securitized real estate and common stocks in France, Hong Kong, Italy, Japan, Spain, Sweden, and the U.K, which are inconsistent with the evidence provided by Ghosh et al. (1996) for only the U.S. and by Brounen and Eichholtz (2003) for both U.S. and U.K. On the other hand, Ambrose et al. (2007) argued that additions of several REITs stocks to Standard and Poor's (S&P) general market indices resulted in increasing correlation between non-index REITs and indexes. These authors further showed that market frictions play a greater role in the increased return correlation than does investor's sentiment.

In their analysis between January 1990 and June 2009 for 14 advanced national real estate stock markets, Schindler and Voronkova (2010) found several long-run relationships between international securitized real estate markets, and concluded that there still exist vast benefits from international diversification in the long run. They also noted that common long-run co-movements are time-varying and are much stronger when structural breaks are considered in the analysis. Gallo and Zhang (2010) showed global property markets are interregionally independent but found intraregional market cointegration. The study also suggested that cointegrated markets converge towards benchmark characteristics, reducing their attraction as portfolio candidates. Oikarinen et al (2011) presented evidence that REITs and direct real estate are likely to have similar long-term diversification benefits in a stock portfolio. By using a DCC-GARCH model and fixed-effects panel regression, Liu et al. (2012) studied correlations between the national real estate investment trusts (REIT) markets in the USA and the four Asia-Pacific countries of Australia, Hong Kong, Japan and Singapore. Panel regressions suggested that REIT correlations rise with increases in the interaction of national inflation rates and with higher global equity market uncertainty. It also found that REIT correlations fall with increases in the US default risk premium and global equity market volume. In a more recent paper, Liow and Schindler (2014) found that real estate and stock markets are both contemporaneously and causally linked in their returns and volatilities; however, the causality relationship appears weaker. In the long run, the real estate markets have slowly become more integrated with the global and regional stock markets, while less integrated with the local stock markets.

Overall, despite relatively increasing attention on the diversification benefits and cointegration of real estate markets, the empirical literature on international integrations of REIT markets is quite limited and no study is available for the integration of REITs in BRICS countries. Therefore, as the first in the literature, our study fills this literature gap by utilizing recent dataset and innovative modelling strategies.

3. Data and Methodology

The datasets used in this paper are time series of the FTSE EPRA/NAREIT Global Real Estate Index Series; the indices tickers obtained through Bloomberg terminals.

According to eligibility criteria defined in the ground rules of the index series[6] and the detailed email explanations of the Bloomberg officials, the series include only real estate securities involving real estate, heavy construction and home construction companies as the subsets. Real estate sub-sector involves the REIT shares. Ground rules of the index series suggest that these real estate companies must have derived, in the previous full financial year, at least 75 percent of their total EBITDA (Earnings Before Interest, Taxes, Depreciation and Amortization) from relevant real estate activities involving ownership, trading and development of income-producing real estate. In this respect, we employ the following FTSE EPRA/NAREIT indices: Emerging Brazil Index (ENEIBRU), Emerging Russia Index (ENEIRUU), Emerging India Index (ENEIINU), Emerging China Index (ENEICNU), Emerging South Africa Index (ENEIZAU), Australia Index (RUAU), United States Index (UNUS) and UK Index (ELUK). Each time series is sampled from 19 March 2012 to 08 November 2017 covering a total of 1473 data points. It is important to note from BRICS countries' perspective is that Russia[7] has its own type of REITs legislation since 2003, Indian[8] REIT was regulated in 2014, and China remains without a REIT regime amongst the BRICS countries.[9] Explanations of the Bloomberg officials also suggest that ENEIRUU (Russia), ENEIINU (India), and ENEICNU (China) are part of the FTSE EPRA/NAREIT Emerging Index that involves only REITs and real estate related shares. Therefore, in paralell to above data description, we assume that those emerging market indices essentially represent the shares of real estate firms involving REITs.

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[6] Available at: http://www.ftse.com/products/downloads/FTSE_EPRA_NAREIT_Global_Real_Estate_Index_Series.pdf?784 (accessed on 27 Feb, 2018).

[7] Available at: http://reitmind.com/russian-reits/ ; http://old.themoscowtimes.com/realestate/quarterly/article/384383.html (accessed on 27 Feb, 2018).

[8] Available at: https://www.pwc.com/gx/en/asset-management/assets/pdf/worldwide-reit-regimes-2017.pdf ; http://www.epra.com/application/files/9515/0366/6834/Global-REIT-Survey-complete.pdf (accessed on 27 Feb, 2018).

[9] Available at: https://assets.kpmg.com/content/dam/kpmg/pdf/2015/03/insights-on-real-estate-investment.pdf (accessed on 27 Feb, 2018).

The methodology used in this paper is based on the concept of fractional integration, which generalizes the standard nonstationary/stationary time process, which is constrained to integer degrees of differentiation, to the fractional case. An I(d) (or integrated of order d process) is defined as a process that requires d differences to render the series stationary I(0). In other words, x_t is I(d) if it can be represented as:

$$(1 - B)^d x_t = u_t, \quad t = 0, \pm 1, \ldots, \qquad (1)$$

where x_t is the time series to be fractionally differenced, B is the backward shift operator, that is $(Bx_t = x_{t-1})$; d can be any integer or fractional value and u_t is supposed to be I(0) as defined above.

In this context, the differencing parameter d is relevant from different perspectives. Thus, if d = 0, clearly $x_t = u_t$, and it is short memory or I(0) process, while d > 0 implies that x_t possesses long memory behaviour, so-called because of the strong degree of association between observations which are far away in time. Statistically, another relevant value is 0.5: if $d < 0.5$, x_t is covariance stationary, while $d \geq 0.5$ implies nonstationarity, in the sense that the variance of the partial sums increases in magnitude with d. Finally, $d < 1$ indicates mean reversion, with shocks disappearing in the long run, while $d \geq 1$ shows lack of mean reversion with shocks persisting forever.

We will employ both parametric (Dahlhaus, 1989; Robinson, 1994) along with semiparametric (Robinson, 1995, Abadir et al., 2007) methods for the estimation and testing of the differencing parameter d. Then, we will look at bivariate relationships between the REITS series and those corresponding to the three developed markets by testing the order of integration in the residuals from vis-à-vis relations among the variables, following the approach proposed in Cheung and Lai (1993) and Gil-Alana (2003).

4. Empirical results

This section is divided in two parts: in the first one, we look at REITS series for the BRICS countries, firstly from a univariate viewpoint, examining the statistical properties of the series from a fractional integration viewpoint. Then, we test for vis-à-vis relationships between each of the REITS and three international developed markets, in particular, one from Australia (RUAU index), one from US (UNSUS) and another one from the UK (ELUK).

We start by examining the following model,

$$y_t = \alpha + \beta t + x_t, \quad (1 - B)^d x_t = u_t, \quad t = 1, 2, ..., \qquad (2)$$

where y_t is the resulting transformed series, and the errors are assumed to follow in turn a white noise and an autocorrelated process. The first part of the model in (2) presents estimation of fractional integration parameters in three cases of no deterministic terms ($\alpha = \beta = 0$), that is as in (1); the case of intercept only ($\alpha \neq 0, \beta = 0$) and the case of time trend, that is both intercept and trend ($\alpha \neq 0, \beta \neq 0$). However, in the latter case, instead of imposing a parametric Autoregressive Moving Average (ARMA) structure on u_t, we employ a non-parametric method due to Bloomfield (1973) such that the error term is specified exclusively in terms of its spectral density function, which is given by

$$f_u(\lambda; \tau) = \frac{\sigma^2}{2\pi} \exp\left(2 \sum_{r=1}^{m} \tau_r \cos(\lambda r) \right), \qquad (3)$$

where σ^2 is the variance of the error term and m indicates the number of short-run dynamic terms for parameters τ_r with cosine function $\cos(\lambda r)$. This model approximates highly parameterized ARMA models with very few parameters, and produces autocorrelations decaying exponentially as in the Autoregressive (AR) case. Moreover, it is stationary for all range of parameters, unlike in the AR case.

Tables 1 and 2 display, respectively for the BRICS and the developed countries, the estimates of d, along with their corresponding 95% confidence bands, for the three cases of i) no deterministic terms, ii) a constant, and iii) a constant and a linear time trend, assuming in turn that u_t is a white noise (Tables 1i and 2i) and autocorrelated as in the model of Bloomfield (Tables 1ii and 2ii).

We observe from our results in Table 1 that only intercept is sufficient to describe the deterministic terms of the models for BRICS REITs in the context of fractional integration; the time trend being only required in case of China with autocorrelated errors. We also observe in this table that the estimated values of d are round 1 in all cases; however, looking at the confidence intervals associated to these values, we see that for Brazil, China and India, the unit root null hypothesis is rejected in favour of d > 1 with uncorrelated errors, while the contrary happens for South Africa with autocorrelation where the interval only includes values below unity, thus implying a small degree of mean reverting behaviour.

[Insert Tables 1 about here]

If we focus now on the developed countries, the estimated values of d also indicate nonstationarity (d > 0.5) in all cases and values close to 1, though mean reversion is detected in a number of cases, in particular for Australia and for the UK data under autocorrelation.

[Insert Tables 2 about here]

We also estimate the value of d using a semiparametric approach, where no functional form is imposed on the error term. In other words, we simply assume that u_t is

I(0) and focus mainly on the differencing parameter. We use here a "local" Whittle function estimated in the frequency domain, as initially proposed by Robinson (1995) and later extended and improved by Velasco (1999), Shimotsu and Phillips (2005), Abadir et al. (2007) and others.

[Insert Tables 3 and 4 about here]

Tables 3 and 4 display the estimated values of d for a selected group of bandwidth numbers from m = 30 to 40, respectively for BRICS and the developed markets. We see that for China, India, Russia and Australia, all the presented values are within the I(1) case. The same happens in some cases of the other countries (Brazil, South Africa and the U.S.), though this depends on the bandwidth number. The choice of m is quite important in this context since the estimates of d can be very sensitive to this number. It reflects the trade-off between bias and variance: the asymptotic variance is decreasing with m while the bias is growing with m.

The whole battery of the estimates of d for each country are displayed across Figures 1 (BRICS) and the three (Developed markets). In general, most values are closed to 1 and though in some cases, we detect some differences, generally speaking, we do not observe significant differences across the countries, which validates the analysis of cointegration.

Finally, we look at the vis-à-vis relationships among the five REIT series (BRICS) and the three ones of the developed countries. In particular, and based on the I(1) nature of the series, we follow Gil-Alana (2003); testing the null hypothesis of no cointegration, i.e.,

$$H_o : \; d \; = \; 1, \qquad (4)$$

against the alternative of fractional cointegration (i.e., d < 1) in the model given by

$$REIT_t \; = \; \alpha \; + \; \beta \, DEV_t \; + \; x_t \, , \qquad (1 - B)^d \, x_t \; = \; u_t \, , \qquad t \; = \; 1, 2, ..., \qquad (5)$$

using both the assumptions of white noise and autocorrelated (Bloomfield) errors earlier described.

[Insert Tables 5 and 6 about here]

The results are displayed across Tables 5 and 6. We observe that in the two cases, the estimated values of d are in the I(1) interval, rejecting the hypothesis of cointegration of any degree. Moreover, the β-coefficients are found to be statistically significant in all cases, though the estimates can be clearly spurious due to the nonstationary nature of the series. Because of this, in the following two tables (Tables 7 and 8), we conduct the same analysis as in (5) but based on the first differenced data. In otherwords, the estimated regression is now:

$$\left(1-B\right)REIT_t = \alpha \; + \; \beta\left(1-B\right)DEV_t \; + \; x_t, \qquad \left(1-B\right)^d x_t = u_t, \quad t = 1, 2, ..., \qquad (6)$$

where B is the usual backward shift operator. Thus, the estimation of the model in (6) is conducted for the two cases of uncorrelated and autocorrelated errors.

[Insert Tables 7 and 8 about here]

The first thing we observe is that most of the estimated values of d are around 0. The only evidence of I(d, d >0) (i.e., long memory) behaviour is found in the cases of ENEIBRU (Brazil) against the ELUK (UK); ENEICNU (China) against the three series, and in case of the ENEINU (India) against the US and UK series, with uncorrelated errors. In all the other cases, the I(0) hypothesis cannot be rejected. Focusing on the estimated values of β, they are significantly positive in all cases, ranging from 0.676 (ENEIBRU_Brazil) against the US) to 0.203 (ENEICNU_China against US).

5. Conclusions

This paper investigated BRICS (Brazil, Russia, India, China and South Africa) and international (Australia, US and the UK) REIT markets' integration and segregation by means of fractional integration framework from 2012:Q1 to 2017:Q4. This study contributed to the literature as the testing framework is a new approach, found to be robust to integration testing at both stationary and nonstationary ranges, since the classical unit root tests are not robust to fractional unit orders. Based on individual REIT index, we observed high degree of persistence in REIT indices for both BRICS and the three developed economies, with orders of integration around 1 implying nonstationarity of these series. Thus, this I(1) property informed the applicability of cointegration between BRICS REIT markets and the three international REIT markets. Fractional cointegration test showed no evidence of cointegration between BRICS REIT markets and REIT market of any of the developed economies, while the result only indicated that REIT markets in the developed economies caused those of the BRICS in the short run.

The implication of this result is that from an investment strategy point of view, this will assist investors and fund analysts in their decision making in the BRICS securitized property markets. The BRICS securitized property markets are not co-integrated with the United States, Australian and United Kingdom securitized property markets in the long-run. It therefore means that the inclusion of the BRICS securitized property markets in the portfolio of the developed securitized property markets can reduce portfolio risks and diversification benefits.

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Table 1: Estimates of d for each of the individual REITS series (logged data)

i) No autocorrelation				
Country	Series	No terms	Intercept	Time trend
BRAZIL	ENEIBRU	1.00 (0.97, 1.04)	**1.04 (1.01, 1.08)**	1.04 (1.01, 1.08)
CHINA	ENEIRUU	1.00 (0.96, 1.03)	**1.06 (1.02, 1.11)**	1.06 (1.02, 1.11)
INDIA	ENEIINU	1.00 (0.97, 1.04)	**1.05 (1.01, 1.09)**	1.05 (1.01, 1.09)
RUSSIA	ENEICNU	1.00 (0.96, 1.04)	**1.00 (0.97, 1.05)**	1.00 (0.97, 1.05)
S. AFRICA	ENEIZAU	1.00 (0.96, 1.04)	**1.00 (0.96, 1.05)**	1.00 (0.96, 1.05)
ii) With autocorrelation				
Country	Series	No terms	Intercept	Time trend
BRAZIL	ENEIBRU	0.99 (0.93, 1.04)	**1.02 (0.97, 1.07)**	1.02 (0.97, 1.07)
CHINA	ENEIRUU	0.99 (0.94, 1.05)	0.96 (0.90, 1.01)	**0.95 (0.90, 1.01)**
INDIA	ENEIINU	1.00 (0.95, 1.06)	**1.01 (0.95, 1.08)**	1.01 (0.95, 1.08)
RUSSIA	ENEICNU	0.99 (0.94, 1.05)	**0.97 (0.91, 1.02)**	0.97 (0.91, 1.02)
S. AFRICA	ENEIZAU	0.99 (0.94, 1.05)	**0.90 (0.83, 0.96)**	0.90 (0.83, 0.96)

In bold, significant estimates of fractional integration orders with confidence limits at 5% level in parenthesis.

Table 2: Estimates of d for each of the 3 developed countries (logged data)

i) No autocorrelation				
Country	Series	No terms	Intercept	Time trend
AUSTRALIA	RUAU	1.00 (0.96, 1.04)	**0.95 (0.91, 0.99)**	0.95 (0.91, 0.99)
U.S.	UNUS	1.00 (0.96, 1.04)	**1.00 (0.96, 1.05)**	1.00 (0.96, 1.05)
U.K.	ELUK	1.00 (0.96, 1.04)	**1.01 (0.96, 1.06)**	1.01 (0.96, 1.06)
ii) With autocorrelation				
Country	Series	No terms	Intercept	Time trend
AUSTRALIA	RUAU	0.99 (0.94, 1.06)	0.93 (0.86, 0.99)	**0.93 (0.86, 0.99)**
U.S.	UNUS	0.99 (0.94, 1.06)	**0.93 (0.87, 1.00)**	0.93 (0.87, 1.00)
U.K.	ELUK	0.99 (0.93, 1.05)	0.83 (0.79, 0.89)	**0.84 (0.80, 0.89)**

In bold, significant estimates of fractional integration orders with confidence limits at 5% level in parenthesis.

Table 3: Semiparametric estimates of d for the logged data

i) REIT					
	BRAZIL	CHINA	INDIA	RUSSIA	S. AFRICA
30	**1.051**	**0.997**	**0.942**	**0.869**	0.747
31	**1.062**	**0.990**	**0.957**	**0.860**	0.756
32	**1.084**	**0.981**	**0.955**	**0.880**	0.772
33	**1.107**	**1.000**	**0.950**	**0.894**	0.781
34	**1.131**	**1.005**	**0.959**	**0.888**	0.796
35	1.142	**1.020**	**0.973**	**0.876**	0.808
36	1.153	**1.027**	**0.984**	**0.861**	0.829
37	1.167	**1.047**	**0.990**	**0.873**	0.820
38	1.172	**1.049**	**0.977**	**0.890**	0.837
39	1.194	**1.053**	**0.990**	**0.904**	0.852
40	1.217	**1.025**	**1.002**	**0.906**	**0.872**

In bold, estimates of fractional orders with I(1) cases

Table 4: Semiparametric estimates of d for the logged data

	AUSTRALIA	U.K.	U.S.
30	**0.921**	0.838	0.685
31	**0.936**	0.850	0.684
32	**0.960**	0.860	0.704
33	**0.961**	0.833	0.700
34	**0.877**	0.844	0.712
35	**0.874**	**0.855**	0.730
36	**0.883**	**0.863**	0.747
37	**0.903**	**0.870**	0.757
38	**0.916**	**0.876**	0.754
39	**0.930**	**0.857**	0.753
40	**0.946**	**0,866**	0.762

In bold, estimates of fractional orders with I(1) cases

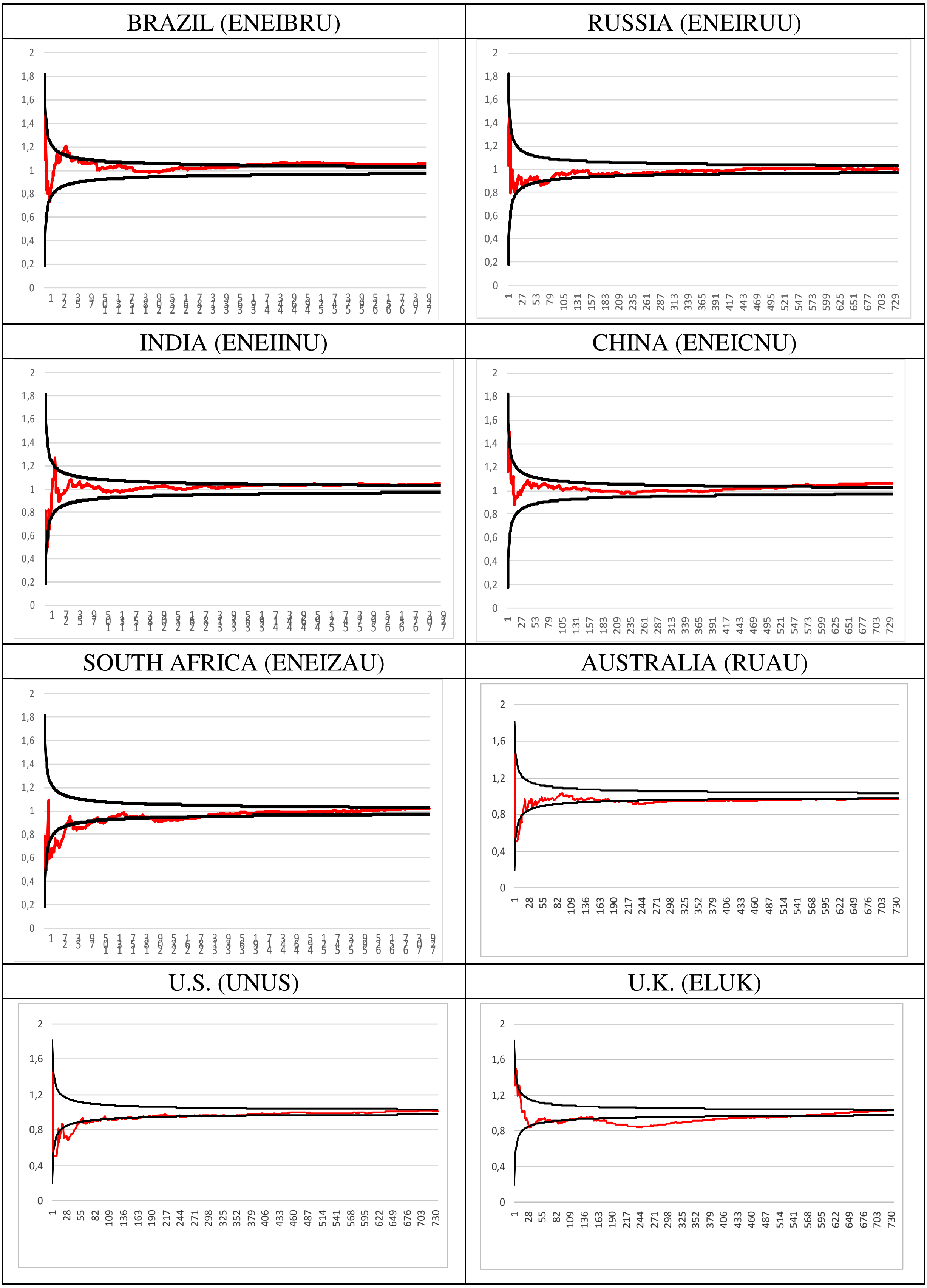

Figure 1: Stability of d across sample, approx. N/2

Table 5: Estimates in a long run equilibrium relationship with uncorrelated errors

Series	Dev. Markets	d	Intercept α	β-coefficient
ENEIBRU (Brazil)	RUAU (Australia)	1.01 (0.97, 1.05)	4.254 (11.82)	0.480 (10.26)
	UNUS (US)	1.02 (0.99, 1.06)	2.766 (11.62)	0.672 (11.62)
	ELUK (UK)	1.04 (1.01, 1.08)	4.521 (12.42)	0.485 (9.41)
ENEICNU (China)	RUAU (Australia)	1.05 (1.01, 1.10)	5.250 (15.48)	0.294 (8.39)
	UNUS (US)	1.05 (1.01, 1.10)	5.955 (17.32)	0.201 (4.52)
	ELUK (UK)	1.06 (1.02, 1.10)	5.435 (19.88)	0.294 (7.59)
ENEIINU (India)	RUAU (Australia)	1.03 (0.99, 1.07)	3.711 (9.06)	0.388 (7.93)
	UNUS (US)	1.04 (1.00, 1.09)	3.965 (8.32)	0.354 (5.73)
	ELUK (UK)	1.05 (1.01, 1.09)	2.811 (2.51)	0.550 (10.38)
ENEIRUU (Russia)	RUAU (Australia)	0.99 (0.94, 1.03)	4.840 (18.51)	0.353 (10.38)
	UNUS (US)	0.99 (0.95, 1.03)	4.844 (14.65)	0351 (8.19)
	ELUK (UK)	0.98 (0.95, 1.02)	3.087 (12.53)	0.633 (18.15)
ENEIZAU (South Africa)	RUAU (Australia)	0.95 (0.91, 1.00)	3.385 (12.06)	0.549 (15.03)
	UNUS (US)	0.96 (0.92, 1.01)	3.532 (19.81)	0.528 (11.28)
	ELUK (UK)	0.99 (0.95, 1.04)	3.408 (12.11)	0.594 (14.91)

Note, confidence interval of d in parenthesis in column 3; for intercept α and β estimates, values of t statistics are given in parentheses.

Table 6: Estimates in a long run equilibrium relationship with autocorrelated errors

Series	Dev. Markets	d	Intercept α	β-coefficient
ENEIBRU (Brazil)	RUAU (Australia)	1.01 (0.95, 1.06)	4.254 (11.83)	0.480 (10.27)
	UNUS (US)	1.01 (0.97, 1.08)	2.749 (6.17)	0.674 (11.66)
	ELUK (UK)	1.03 (0.99, 1.10)	4.524 (12.43)	0.485 (9.41)
ENEICNU (China)	RUAU (Australia)	0.95 (0.89, 1.10)	5.117 (18.96)	0.311 (8.87)
	UNUS (US)	0.95 (0.90, 0.99)	5.754 (16.81)	0.227 (5.12)
	ELUK (UK)	0.96 (0.91, 1.01)	5.381 (19.79)	0.301 (7.83)
ENEIINU (India)	RUAU (Australia)	0.99 (0.94, 1.07)	3.615 (9.58)	0.401 (8.17)
	UNUS (US)	0.99 (0.93, 1.07)	3.830 (8.05)	0.371 (6.02)
	ELUK (UK)	1.01 (0.96, 1.09)	2.813 (7.52)	0.550 (10.39)
ENEIRUU (Russia)	RUAU (Australia)	0.97 (0.92, 1.02)	4.829 (18.45)	0.354 (10.41)
	UNUS (US)	0.97 (0.91, 1.03)	4.830 (14.59)	0353 (8.22)
	ELUK (UK)	0.99 (0.94, 1.05)	3.094 (12.57)	0.632 (18.13)
ENEIZAU (South Africa)	RUAU (Australia)	0.84 (0.78, 0.91)	3.116 (11.34)	0.583 (16.31)
	UNUS (US)	0.85 (0.78, 0.92)	3.227 (9.18)	0.567 (12.43)
	ELUK (UK)	0.92 (0.87, 0.99)	3.407 (12.18)	0.594 (15.00)

Note, confidence interval of d in parenthesis in column 3; for intercept α and β estimates, values of t statistics are given in parentheses.

Table 7: Estimates in a first differenced relationship with uncorrelated errors

Series	Dev. Markets	d	Intercept α	β-coefficient
ENEIBRU (Brazil)	RUAU (Australia)	0.01 (-0.02, 0.05)	-0.00086 (-1.92)	0.482 (10.32)
	UNUS (US)	0.02 (-0.01, 0.06)	-0.00084 (-1.90)	0.674 (11.67)
	ELUK (UK)	0.04 (0.01, 0.08)	-0.00084 (-1.91)	0.487 (9.45)
ENEICNU (China)	RUAU (Australia)	0.05 (0.01, 0.10)	-0.00044 (-1.79)	0.294 (8.41)
	UNUS (US)	0.05 (0.01, 0.10)	-0.00050 (-0.87)	0.203 (4.55)
	ELUK (UK)	0.06 (0.02, 0.11)	-0.00046 (-1.56)	0.295 (7.62)
ENEIINU (India)	RUAU (Australia)	0.03 (-0.01, 0.07)	-0.00016 (-0.31)	0.389 (7.95)
	UNUS (US)	0.03 (0.00, 0.07)	-0.00021 (-1.23)	0.358 (5.80)
	ELUK (UK)	0.05 (0.00, 0.07)	-0.00023 (-0.30)	0.551 (10.39)
ENEIRUU (Russia)	RUAU (Australia)	-0.01 (-0.05, 0.03)	-0.00022 (-1.63)	0.354 (10.40)
	UNUS (US)	-0.01 (-0.04, 0.03)	-0.00018 (-1.50)	0351 (8.19)
	ELUK (UK)	-0.02 (-0.06, 0.02)	-0.00019 (-1.93)	0.634 (10.18)
ENEIZAU (South Africa)	RUAU (Australia)	-0.05 (-0.09, 0.01)	-0.00030 (-1.04)	0.551 (15.13)
	UNUS (US)	-0.04 (-0.08, 0.01)	-0.00023 (-0.73)	0.529 (11.35)
	ELUK (UK)	-0.01 (-0.04, 0.04)	-0.00030 (-0.78)	0.595 (14.93)

Note, confidence interval of d in parenthesis in column 3; for intercept α and β estimates, values of t statistics are given in parentheses.

Table 8: Estimates in a first differenced relationship with autocorrelated errors

Series	Dev. Markets	d	Intercept α	β-coefficient
ENEIBRU (Brazil)	RUAU (Australia)	0.01 (-0.04, 0.06)	-0.00086 (-1.52)	0.483 (10.32)
	UNUS (US)	0.01 (-0.04, 0.08)	-0.00084 (-1.50)	0.676 (11.71)
	ELUK (UK)	0.03 (-0.01, 0.10)	-0.00084 (-1.29)	0.487 (9.45)
ENEICNU (China)	RUAU (Australia)	-0.05 (-0.10, -0.01)	-0.00040 (-2.44)	0.311 (8.89)
	UNUS (US)	-0.05 (-0.10, 0.01)	-0.00045 (-1.60)	0.230 (5.19)
	ELUK (UK)	-0.04 (-0.09, 0.01)	-0.00042 (-1.39)	0.301 (7.03)
ENEIINU (India)	RUAU (Australia)	-0.01 (-0.06, 0.07)	-0.00023 (-0.44)	0.402 (8.18)
	UNUS (US)	0.01 (-0.07, 0.06)	-0.00017 (-0.33)	0.372 (6.03)
	ELUK (UK)	-0.01 (-0.07, 0.06)	-0.00025 (-0.50)	0.552 (10.41)
ENEIRUU (Russia)	RUAU (Australia)	-0.03 (-0.09, 0.02)	-0.00022 (-0.82)	0.356 (10.14)
	UNUS (US)	-0.03 (-0.09, 0.02)	-0.00018 (-1.58)	0355 (8.28)
	ELUK (UK)	-0.01 (-0.07, 0.04)	-0.00029 (-0.87)	0.633 (18.15)
ENEIZAU (South Africa)	RUAU (Australia)	-0.16 (-0.22, -0.09)	-0.00030 (-2.25)	0.590 (16.45)
	UNUS (US)	-0.15 (-0.20, -0.08)	-0.00024 (-1.60)	0.572 (12.54)
	ELUK (UK)	-0.08 (-0.13, -0.01)	-0.00030 (-1.28)	0.600 (15.15)

Note, confidence interval of d in parenthesis in column 3; for intercept α and β estimates, values of t statistics are given in parentheses.