CHAPTER 13

Equity Markets Integration and Active Portfolio Management

Gabriel Petre, Olga Sulla, and Daniel Vela Barón

13.1 Introduction

This chapter analyzes portfolio diversification and active management strategies that could enhance risk-return properties of equity portfolios versus benchmarks despite the effect of international financial integration. The chapter's hypothesis is that despite the high degree of global stock market integration, local equity indices and specific industries can be

Comments from the participants of the Sixth Public Investors Conference Bank of International Settlements—World Bank—Bank of Canada are highly appreciated. The opinions and statements are the sole responsibility of the authors and do not necessarily represent those of the World Bank.

G. Petre (✉)
Pension & Endowments Department (PEN), World Bank Treasury, Washington, DC, USA
e-mail: gpetre@worldbank.org

O. Sulla • D. Vela Barón
Quantitative Solutions, Strategic Asset Allocation, and Analytics Department (QSA), World Bank Treasury, Washington, DC, USA
e-mail: osulla@worldbank.org; dvelabaron@worldbank.org

N. Bulusu et al. (eds.), *Advances in the Practice of Public Investment Management*, https://doi.org/10.1007/978-3-319-90245-6_13

identified by portfolio managers to take active positions that improve their performance versus benchmarks.

Global diversification opportunities are identified by selecting the least co-integrated equity indices in various regions and industries. The analysis indicates that there might be opportunities for improving risk-return profiles of global equity index portfolios, but further work is warranted to better understand the liquidity implications on transaction costs as well as the scalability of such strategies.

Although relevant for any active portfolio manager, the chapter seeks to provide strategies for institutional investors, particularly pension funds and sovereign wealth funds that have large exposures to global equity markets. Eighty percent of sovereign wealth funds invest in public equity, some of them exceeding 50% of the allocation of their entire portfolio, as illustrated in Figs. 13.1 and 13.2. Most of these institutions implement active portfolio management strategies, either internally or through external managers, seeking to generate returns in excess of market benchmarks. The recent surge in their total assets under management makes them major players in global equity markets (Fig. 13.3). Therefore, an analysis of equity market integration and potential returns from diversification into less integrated markets and industries is beneficial for the active strategies of these institutions.

Some of the factors behind equity market integration include (1) larger global interdependence due to increased trade and greater policy coordination across countries (Fig. 13.4); (2) increasing diversification of firms' sales and financing sources, (3) convergence in industrial composition due to emergence of large global conglomerates, (4) adjustment of institutional investors' regulations to global markets allowing to invest across border; (5) cross-listing regulations permitting companies to directly raise funds or borrow abroad (Fig. 13.5); and (6) emergence of regional stock exchanges like Euronext; Eastern Caribbean ECSE, BRVM, and BVMAC in Africa; ASEAN in East Asia; and MILA in Latin America, harmonizing corporate governance and listing procedures and supporting the trend of integration.

This chapter emphasizes integration at both country level and industry level and studies its implications for portfolio diversification strategies. Research on global integration at the industry level is important due to increasing economic integration as well as industrial developments. Some of the industries may be driven more by local factors, while others by global ones. The latter affects the behavior of the industry indices in terms of their co-movements globally.

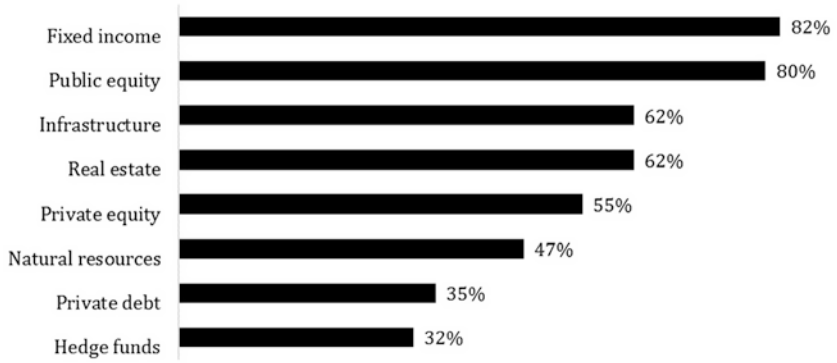

Fig. 13.1 Portion of sovereign wealth funds investing in each asset class

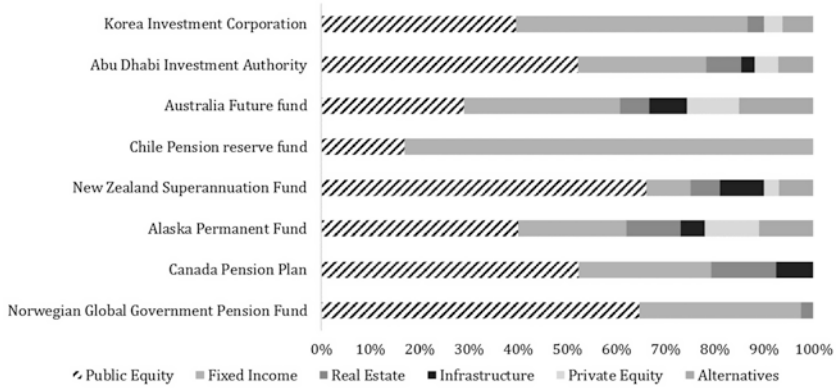

Fig. 13.2 Asset allocation of selected institutional investors, percentage of total portfolio

Co-integration tests are the tool used to identify potential diversification opportunities, in order to select the least co-integrated stock markets within various geographical regions and the least co-integrated industries within the global industries. The stock market indices identified as the

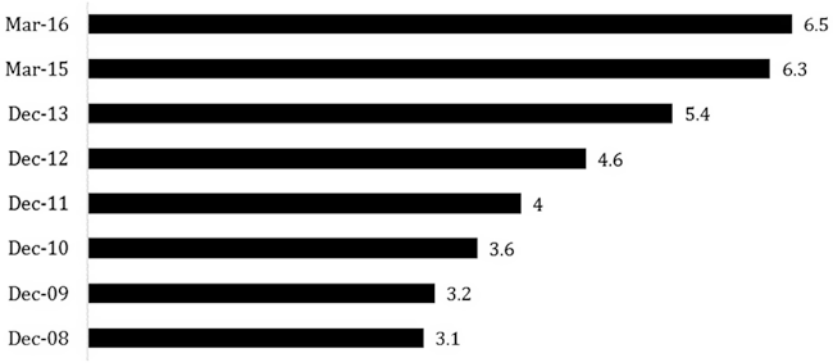

Fig. 13.3 Sovereign wealth funds' assets under management, USD trillion

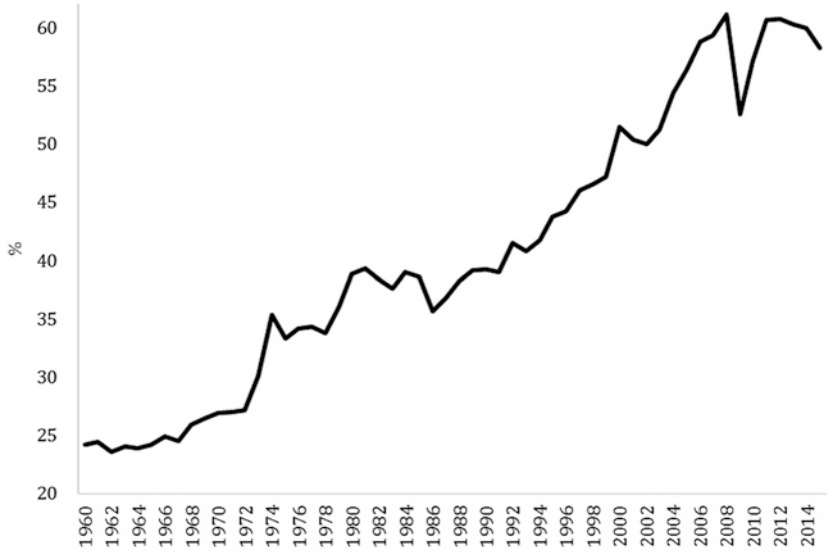

Fig. 13.4 World trade as a percentage of GDP

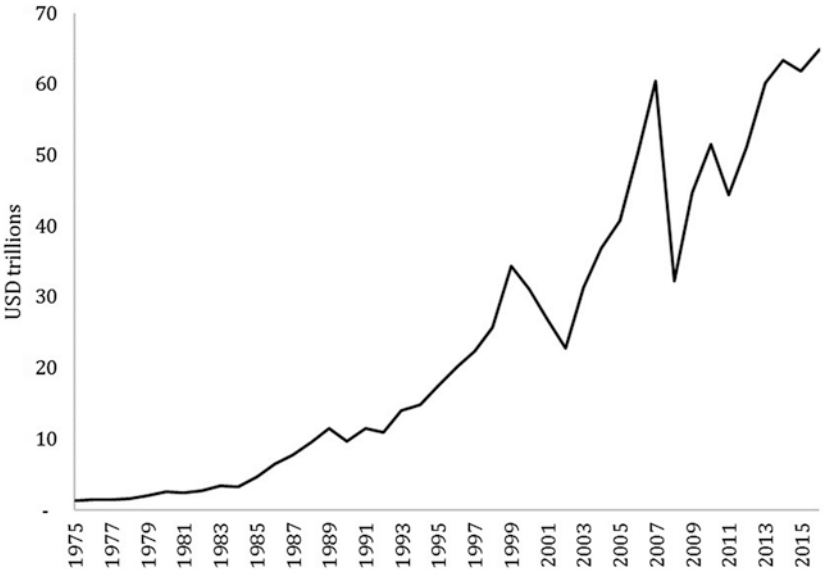

Fig. 13.5 Market capitalization of globally listed companies

least co-integrated are then analyzed under an active management strategy, where their weight in an original benchmark MSCI (developed, emerging, or industry) is increased with various scenarios, and a risk-return analysis is conducted.

Seven sections are included in this chapter. Following this introduction, the next section reviews the literature that analyzes stock market integration both at country and industry levels. The third section provides an overview of the hypothesis and the methodology used to identify the diversification opportunities by selecting stock market indices by country and industry. The fourth section reviews the data used for the analysis. The fifth section describes the results of the co-integration analysis for the examined regions and shows the back-test performance of portfolios applying active strategies that consider the diversification opportunities. The subsequent section expands the analysis to industry data. Finally, the seventh section concludes with the results of the analysis and suggests further research.

13.2 Literature Review

This section reviews papers focused on examining stock market integration in developed and emerging countries, using either bivariate or multivariate co-integration techniques.

Financial and econometric literature encompasses various co-integration analyses of equity markets among different regions. Neaime (2015) examines the co-integration among the stock markets of countries in the Middle East and North Africa (MENA) region with some of the biggest stock markets in the world. The author finds that Turkey, Egypt, and Morocco are highly linked to the US, UK, and French markets. Jordan is found to be linked in a smaller degree and the countries of the Gulf Cooperation Council (GCC, composed of Bahrain, Oman, Qatar, Kuwait, Saudi Arabia, and the United Arab Emirates) are shown to be segmented from the main stock markets in the world, mainly because of their traditional restrictions on participation of non-GCC investors.

Likewise, Paramati et al. (2013) test the co-integration between Australia and 18 frontier markets in 5 different regions and find that Australian investors have diversification opportunities in these 18 markets as the co-integration test indicates no long-term relationship. These two papers perform a Johansen co-integration test, which is a linear test that does not consider structural breaks. In other papers, described below, both assumptions are shown to produce biased results in favor of the null hypothesis of no co-integration.

Lim et al. (2003) study the Association of Southeast Asian Nations (ASEAN) countries' stock markets (Indonesia, Malaysia, Philippines, Singapore, and Thailand) from 1998 to 2002. Their analysis concludes that there is a collective factor which drives the five markets together in the long run, mainly as a result of their trade and investment agreements. In this paper, the authors conduct Bierens's test, which, in contrast to other co-integration tests (Johansen, Engle-Granger, and Gregory-Hansen) is non-linear.

Syriopoulos (2011) tests the co-integration between the stock markets of Balkan countries (Romania, Bulgaria, Croatia, Turkey, Cyprus, and Greece) and the stock markets of the United States and Germany. The author finds co-integration among them by performing an eight-dimensional vector error correction model. The most significant

relationship he finds is between Germany and Greece, while Romania and Turkey are found to be integrated to a lesser extent with the US and German stock markets.

Beyer et al. (2009) studied the co-integration among inflation and nominal interest rates in 15 markets. This paper shows the importance of considering structural breaks, as nine economies are found to lack a long-term relationship when testing for co-integration without considering the breaks, but the conclusion changes once the structural breaks are considered with a Carrion-i-Silvestre and Sansó test.

Furthermore, Aggarwal, Lucey, and Muckley (2010) studied the dynamic integration between European stock markets by performing three different tests: (1) dynamic robust eigenvalue analyses, (2) a Kalman filter approach, and (3) a recursive co-integration technique proposed by Hansen and Johansen. The authors find that the co-integration in the stock markets of the continent has increased throughout the tested sample.

Some of these papers also perform a Granger causality test to further explain the dynamics of the long-term relationships among the stock markets in the regions. Such is the case of Neaime (2015) with the MENA region, Syriopoulos (2011) in the Balkan region, and Paramati et al. (2013) with Australia and 18 frontier markets.

Brooks and Del Negro (2004) find that industry effects have gone from less than half as important as country effects in the mid-1990s to almost twice as important in early 2000s, in the technology, media, and telecom (TMT) industries.

Finally, Bekaert, Hodrick, and Zhang (2009) examine if the degree of stock market integration varies across industries by comparing the variance explained by global factors relative to the total explained variance. They find that the least integrated industry is mining, followed by oil and gas. Although these are industries affected by global commodity prices, they are also more likely to be regulated by local authorities. Furthermore, they find that the most integrated industries were machinery and construction. Overall, the differences in the degree of integration among different industries are less marked than the differences between countries, reflecting the fact that industry portfolios represent well-diversified portfolios across countries.

13.3 Hypothesis and Methodology

Depending on their level of co-integration, the equity market indices that are not co-integrated with the rest can offer profitable opportunities to international investors, both at the country and industry levels. This chapter aims to identify if idiosyncratic factors which provide diversification opportunities for investors remain despite the current high levels of stock market integration. The presence of common trends between developing and mature equity markets or among the developing markets themselves may indicate limited portfolio gains from diversification. This is because common factors limit the amount of independent variation.

While simple correlation measures the linear synchronicity of the changes between two time series, co-integration measures the long-term convergence of the levels of the time series and whether the residual between them is stationary (absent a trend). Although the co-integrated time series levels can show some unstable periods, they should exhibit a mean-reverting spread. Thus, co-integration measures the long-run equilibrium relationship among two-time series, where each of them exhibits a non-stationary trend. Two non-stationary ($I(1)$) time series are co-integrated if the residual of some linear combination between them is stationary.

To test for co-integration, usually the Engle-Granger two-step test is performed. As introduced in Engle and Granger (1987), one-time series (y_t) is regressed with a series of independent variables ($x_{1,t}$, $x_{2,t}$, …, $x_{n,t}$). The residuals of the linear combination ($u_t = y_t - \beta X_t$), estimated with ordinary least squares, are then tested for a unit root, with either the Augmented Dickey Fuller (ADF) test (see Fuller 1976) or the Phillips-Perron test. If the residuals are stationary, there is co-integration among the time series and hence a long-run equilibrium relationship between them. The linear combination of the time series is usually called the co-integrated relation, with the coefficients of the regression (β_1, β_2, …, β_n) representing the co-integration vector. In the Engle-Granger co-integration test, the residual of a linear combination of two non-stationary and co-integrated time series must be stationary.

In this chapter, the Gregory-Hansen (GH) test was used (see Gregory and Hansen 1996) to test for co-integration (instead of the Engle-Granger test or the Johansen[1] test), given that equity indices could possibly exhibit structural breaks, for example, during the global financial crisis. Gregory and Hansen include three alternative models: (1) level, (2) level shift with trend, and (3) regime shift, by providing additional statistics with their corresponding critical values and allow controlling for those structural breaks.

Therefore, the analysis to identify the least co-integrated indices both by country and industry consists of two main econometric tests: the ADF unit-root test to establish non-stationary of the stock market indices and the Gregory-Hansen co-integration test with structural breaks to identify the least co-integrated indices by country and industry. If the ADF unit-root tests show that the time series imply an $I(1)$ process, then a GH test can be performed. In the GH test, the null hypothesis of no co-integration with structural breaks is tested against the alternative of co-integration with structural breaks.

Following the co-integration analysis conducted per the methodology described above, the stock market indices exhibiting the least co-integrated characteristics are given greater weights in portfolios than they have in the benchmark MSCI index portfolios. Three portfolio analysis scenarios are conducted: (1) invest an additional 2% in each one of the least co-integrated country stock market index, (2) invest an additional 3% in each of the least co-integrated country stock market index, and (3) invest a total of the maximum between 5% of the index in the least co-integrated stock market country index and the amount allowed by its market capitalization. The last scenario considers possible liquidity constraints that can be found in the market, as the investment is subject to the availability of the asset in the market. If its market capitalization relative to the total market capitalization of all the other countries in the index is below 5%, then the investment is limit to that cap.

13.4 Data

Two separate data sets were created—one for the country analysis and the second for the industry analysis.

For the country analysis, 68 countries were selected and divided into 11 different regions: (1) Eastern Asia—Emerging, (2) Southern Asia, (3) Eastern Asia—Developed, (4) Latin America and the Caribbean, (5) North America, (6) Middle East, (7) Africa, (8) Eastern Europe, (9) Western Europe, (10) Southern Europe, and (11) Northern Europe. The MSCI data in dollar terms was used for each country. Monthly data were collected from 1969; however, the analysis was conducted from the date of the most recent available information of all the countries within the regions with data for no less than ten years.

For the industry analysis, the data was divided between developed and emerging markets, and MSCI monthly data was used from June of 2008. The analysis was conducted in US dollar terms rather than on local

currency indices in order to allow co-integration tests on a series of the same properties and neutralize the exchange rate effect. The industries considered were (1) consumer discretionary, (2) consumer staples, (3) energy, (4) financial, (5) health care, (6) industrials, (7) information technology, (8) materials, (9) telecommunication services, and (10) utilities.

13.5 Results by Country

13.5.1 Co-integration Tests

The results of co-integration test on stock market indices globally are demonstrated in Table 13.2 preceded by ADF test on each one of the indices to establish their lack of stationarity (Table 13.1). The Gregory-Hansen co-integration tests with structural breaks show that stock market indices globally exhibit high co-integration overall; however, some countries are less co-integrated within their own regions. Countries were identified as the least co-integrated if the test indicates that the co-integration with most of the other countries within its region is not significant. Given that the null hypothesis of the GH test is no co-integration, if the country has high p-values with some of its peers, then it is identified as belonging to the set of the least co-integrated countries in the region. This chapter identifies the following as the least co-integrated stock market indices: Philippines, New Zealand, Jordan, Nigeria, Austria, Denmark, and the Netherlands.

More specifically, within the stock market indices of the emerging countries of Eastern Asia, the one of the Philippines is the least co-integrated, as it seems not to be co-integrated with either Malaysia or Indonesia's stock market indices. New Zealand's stock market index is the least co-integrated country in the developed countries of Eastern Asia and Oceania. Narayan and Smyth (2005) arrive at a similar conclusion; they suggest that New Zealand is only co-integrated with the United States, but is not co-integrated with other G7 economies. The stock market indices of the three countries clustered as Southern Asia are highly co-integrated. Jordan seems to have the least co-integrated stock market index in the Middle East, as it does not have a significant statistical relationship with some of the biggest stock markets in the region, including Morocco, Egypt, and Israel. This reinforces the conclusion in Neaime (2015), since he describes Jordan as a country linked to a smaller degree with other countries in the Middle East. Nigeria's stock market is the least

Table 13.1 Augmented Dickey Fuller test

Country	*p-value*	*Country*	*p-value*	*Country*	*p-value*	*Country*	*p-value*
China	0.15	Trinidad and Tobago	0.92	Czech Republic	0.57	Belgium	0.84
India	0.97	United Arab Emirates	0.21	Hungary	0.69	Denmark	1.00
Malaysia	0.83	South Africa	1.00	Croatia	0.47	Norway	0.71
Thailand	0.61	Israel	0.68	Romania	0.64	Portugal	0.48
Indonesia	0.98	Qatar	0.45	Ukraine	0.16	Finland	0.43
Philippines	0.93	Kuwait	0.32	Lithuania	0.57	Austria	0.47
Pakistan	0.84	Morocco	0.71	Bosnia and Herzegovina	0.29	Ireland	0.50
Vietnam	0.40	Nigeria	0.59	Estonia	0.61	Greece	0.23
Sri Lanka	0.83	Egypt	0.82	Serbia	0.19	Japan	0.51
Kazakhstan	0.37	Kenya	0.97	United Kingdom	0.86	Hong Kong	0.80
Brazil	0.44	Jordan	0.43	France	0.77	Korea	0.88
Mexico	0.74	Bahrain	0.09*	Germany	0.79	Australia	0.90
Chile	0.60	Tunisia	0.85	Switzerland	0.87	Taiwan	0.62
Colombia	0.57	Mauritius	0.90	Sweden	0.87	Singapore	0.63
Argentina	0.49	Lebanon	0.46	Netherlands	0.84	New Zealand	0.81
Peru	0.68	Russia	0.41	Spain	0.63	United States	0.98
Jamaica	0.97	Poland	0.52	Italy	0.48	Canada	0.93

The test is conducted with all the available data for each country. *Indicates significance at the 10% level.
Source: Authors' calculations

co-integrated in Africa. In Western Europe, Austria and the Netherlands' stock market indices are the least co-integrated, while Denmark seems to have the least co-integrated stock market index in Northern Europe. These results follow Worthington and Higgs (2007), as they identify the Netherlands as the least influential market in Europe through a Granger causality test, and together with Denmark are described as two of the less integrated markets in Europe. In Eastern Europe, all the indices are highly co-integrated, only the ones of Hungary and the Czech Republic do not have a strong co-integration relationship between them, but co-integration is significant with other countries' indices of the region. Finally, the countries of Latin America and the Caribbean and the countries of North

Table 13.2 Gregory-Hansen co-integration test with structural breaks (p-value) among different regions

Latin America and the Caribbean

		Independent variables							
		Brazil	Mexico	Chile	Colombia	Argentina	Peru	Jamaica	Trinidad and Tobago
Dependent variables	Brazil	–	0.00**	0.00**	0.00**	0.03**	0.00**	0.00**	0.00**
	Mexico	0.00**	–	0.07*	0.12	0.03**	0.00**	0.00**	0.01**
	Chile	0.00**	0.02**	–	0.00**	0.02**	0.00**	0.00**	0.01**
	Colombia	0.00**	0.01**	0.00**	–	0.00**	0.00**	0.02**	0.01**
	Argentina	0.06*	0.01**	0.03**	0.03**	–	0.00**	0.01**	0.01**
	Peru	0.00**	0.01**	0.00**	0.03**	0.02**	–	0.00**	0.01**
	Jamaica	0.01**	0.00**	0.00**	0.00**	0.08*	0.00**	–	0.00**
	Trinidad and Tobago	0.00**	0.00**	0.02**	0.01**	0.01**	0.01**	0.00**	–

Eastern Asia—Emerging

		Independent variables					
		China	Malaysia	Thailand	Indonesia	Philippines	Vietnam
Dependent variables	China	–	0.00**	0.02**	0.01**	0.00**	0.00**
	Malaysia	0.00**	–	0.00**	0.01**	0.09*	0.00**
	Thailand	0.01**	0.00**	–	0.02**	0.02**	0.00**
	Indonesia	0.00**	0.00**	0.01**	–	0.10	0.00**
	Philippines	0.00**	0.01**	0.00**	0.01**	–	0.00**
	Vietnam	0.01**	0.01**	0.01**	0.02**	0.04**	–

Eastern Asia—Developed and Oceania

		Independent variables						
		Japan	Hong Kong	Korea	Australia	Taiwan	Singapore	New Zealand
Dependent variables	Japan	–	0.06*	0.00**	0.02**	0.00**	0.02**	0.02**
	Hong Kong	0.01**	–	0.00**	0.00**	0.00**	0.00**	0.10
	Korea	0.03**	0.00**	–	0.02**	0.00**	0.01**	0.02**
	Australia	0.01**	0.00**	0.00**	–	0.00**	0.00**	0.08*
	Taiwan	0.00**	0.04**	0.00**	0.01**	–	0.01**	0.00**
	Singapore	0.02**	0.01**	0.01**	0.00**	0.00**	–	0.03**
	New Zealand	0.06*	0.05*	0.00**	0.07*	0.00**	0.03**	–

Africa

		Independent variables			
		South Africa	Nigeria	Kenya	Mauritius
Dependent variables	South Africa	–	0.11	0.00**	0.00**
	Nigeria	0.16	–	0.01**	0.00**
	Kenya	0.00**	0.06*	–	0.00**
	Mauritius	0.03**	0.00**	0.00**	–

(*continued*)

Table 13.2 (continued)

Northern Europe

		Independent variables							
		Lithuania	Estonia	UK	Sweden	Denmark	Norway	Finland	Ireland
Dependent variables	Lithuania	–	0.04**	0.00**	0.00**	0.01**	0.00**	0.00**	0.00**
	Estonia	0.03**	–	0.00**	0.04**	0.05**	0.00**	0.08*	0.00**
	UK	0.00**	0.00**	–	0.01**	0.39	0.00**	0.02**	0.00**
	Sweden	0.00**	0.01**	0.00**	–	0.27	0.01**	0.01**	0.00**
	Denmark	0.00**	0.08*	0.03**	0.00**	–	0.12	0.04**	0.00**
	Norway	0.00**	0.00**	0.00**	0.06*	0.65	–	0.04**	0.00**
	Finland	0.00**	0.06*	0.01**	0.02**	0.08*	0.00**	–	0.01**
	Ireland	0.00**	0.00**	0.00**	0.00**	0.06*	0.00**	0.01**	–

Middle East

		Independent variables									
		UAE	Israel	Qatar	Kuwait	Morocco	Egypt	Jordan	Bahrain	Tunisia	Lebanon
Dependent variables	UAE	–	0.04**	0.00**	0.01**	0.00**	0.01**	0.01**	0.00**	0.00**	0.00**
	Israel	0.11	–	0.04**	0.00**	0.02**	0.01**	0.11	0.00**	0.00**	0.00**
	Qatar	0.01**	0.03**	–	0.01**	0.02**	0.07*	0.01**	0.00**	0.00**	0.00**
	Kuwait	0.06*	0.02**	0.02**	–	0.01**	0.00**	0.01**	0.00**	0.00**	0.00**
	Morocco	0.01**	0.01**	0.05*	0.00**	–	0.02**	0.25	0.00**	0.00**	0.01**
	Egypt	0.00**	0.01**	0.02**	0.02**	0.02**	–	0.11	0.00**	0.00**	0.00**
	Jordan	0.01**	0.01**	0.02**	0.01**	0.05*	0.01**	–	0.00**	0.00**	0.00**
	Bahrain	0.02**	0.01**	0.03**	0.00**	0.00**	0.01**	0.00**	–	0.00**	0.00**
	Tunisia	0.00**	0.00**	0.01**	0.00**	0.00**	0.00**	0.00**	0.00**	–	0.00**
	Lebanon	0.05*	0.00**	0.03**	0.01**	0.02**	0.00**	0.01**	0.00**	0.00**	–

North America

		Independent variables	
		United States	Canada
Dependent variables	United States	–	0.01**
	Canada	0.08*	–

Southern Europe

		Independent variables						
		Croatia	Bosnia and Herzegovina	Serbia	Spain	Italy	Portugal	Greece
Dependent variables	Croatia	–	0.12	0.00**	0.04**	0.02**	0.00**	0.01**
	Bosnia and Herzegovina	0.02**	–	0.01**	0.00**	0.00**	0.02**	0.02**
	Serbia	0.02**	0.01**	–	0.12	0.08*	0.01**	0.00**
	Spain	0.04**	0.00**	0.00**	–	0.00**	0.06*	0.04**
	Italy	0.01**	0.00**	0.00**	0.00**	–	0.02**	0.06*
	Portugal	0.00**	0.04**	0.00**	0.02**	0.02**	–	0.00**
	Greece	0.02**	0.03**	0.00**	0.01**	0.01**	0.00**	–

Eastern Europe

		Independent variables					
		Russia	Poland	Czech Rep.	Hungary	Romania	Ukraine
Dependent variables	Russia	–	0.00**	0.00**	0.02**	0.01**	0.02**
	Poland	0.00**	–	0.01**	0.05*	0.00**	0.00**
	Czech Rep.	0.00**	0.00**	–	0.10*	0.05*	0.00**

(*continued*)

Table 13.2 (continued)

Eastern Europe							
	Hungary	0.03**	0.03**	0.25	–	0.00**	0.02**
	Romania	0.00**	0.00**	0.02**	0.00**	–	0.00**
	Ukraine	0.00**	0.00**	0.00**	0.02**	0.00**	–

Western Europe							
		Independent variables					
		France	Germany	Switzerland	Netherlands	Belgium	Austria
Dependent variables	France	–	0.03**	0.02**	0.23	0.05*	0.49
	Germany	0.06*	–	0.00**	0.00**	0.00**	0.48
	Switzerland	0.05*	0.00**	–	0.00**	0.02**	0.22
	Netherlands	0.08*	0.00**	0.00**	–	0.13	0.45
	Belgium	0.01**	0.00**	0.00**	0.15	–	0.42
	Austria	0.13	0.07*	0.02**	0.13	0.30	–

Southern Asia				
		Independent variables		
		India	Pakistan	Sri Lanka
Dependent variables	India	–	0.00**	0.00**
	Pakistan	0.00**	–	0.00**
	Sri Lanka	0.01**	0.00**	–

The test is conducted with all the available data for each country

The null hypothesis for the Gregory-Hansen test is no co-integration

Source: Authors' calculations

*Indicate significance at the 10% level, **Indicate significance at the 5% level

Table 13.3 Correlation among selected regions

Eastern Asia-Emerging

	China	Malaysia	Thailand	Indonesia	Philippines	Vietnam
China	1	0.61	0.65	0.61	0.55	0.44
Malaysia	0.61	1	0.63	0.66	0.58	0.30
Thailand	0.65	0.63	1	0.74	0.66	0.41
Indonesia	0.61	0.66	0.74	1	0.68	0.42
Philippines	0.55	0.58	0.66	0.68	1	0.43
Vietnam	0.44	0.30	0.41	0.42	0.43	1

Middle East

	UAE	Israel	Qatar	Kuwait	Morocco	Egypt	Jordan	Bahrain	Tunisia
UAE	1	0.42	0.71	0.58	0.26	0.56	0.42	0.57	0.17
Israel	0.42	1	0.32	0.26	0.23	0.45	0.32	0.20	(0.00)
Qatar	0.71	0.32	1	0.54	0.10	0.56	0.48	0.48	0.16
Kuwait	0.58	0.26	0.54	1	0.21	0.38	0.18	0.55	0.12
Morocco	0.26	0.23	0.10	0.21	1	0.34	0.08	0.17	0.12
Egypt	0.56	0.45	0.56	0.38	0.34	1	0.31	0.37	0.18
Jordan	0.42	0.32	0.48	0.18	0.08	0.31	1	0.27	0.07
Bahrain	0.57	0.20	0.48	0.55	0.17	0.37	0.27	1	0.15
Tunisia	0.17	(0.00)	0.16	0.12	0.12	0.18	0.07	0.15	1

Africa

	South Africa	Nigeria	Kenya	Mauritius
South Africa	1	0.23	0.43	0.43
Nigeria	0.23	1	0.21	0.23
Kenya	0.43	0.21	1	0.55
Mauritius	0.43	0.23	0.55	1

Source: Authors' calculations

America are highly co-integrated when the statistical test is performed considering the structural breaks.

Under a short-term measure, such as the Pearson correlation[2] of the time series returns, results can differ as shown in Table 13.3. The least co-integrated countries are not necessarily the ones with the lowest correlation. In the case of the emerging countries in Eastern Asia, Vietnam has the lowest correlation. The same is the case for Tunisia in Africa. However, Nigeria is the country with the lowest correlations in Africa. Co-integration entails a mean reversion dynamic within a long-term horizon, in shorter horizons time series returns can be correlated or uncorrelated.

13.5.2 Portfolio Analysis

Following the identification of the least co-integrated stock market indices, a portfolio analysis is conducted by actively overweighting the least co-integrated stock market indices versus the benchmark. This analysis is done from 2006 to 2015 to review the impact of performing active management with the selected countries. Thus, the historical indices of MSCI-developed countries and MSCI-emerging countries are overweighed with the least co-integrated countries' equity indices. As shown in Fig. 13.6, the weights of the actual indices are reduced proportionally to add an additional percentage of the least co-integrated countries. The allocation for the Philippines in the actual MSCI index is around 1%, and for Jordan, the allocation is below 0.2%. In this chapter, Nigeria is also included in this index of the emerging markets, although this country is considered a frontier market by MSCI. For the developed countries, the Netherlands is the least integrated country with the highest allocation in the actual MSCI index, with an assigned percentage between 2% and 3%. Denmark has an allocation between 1% and 2%, while the actual allocation for New Zealand and Austria is below 1%. Three long-term overweighting strategies are analyzed, as mentioned in section three.

Notably, all three portfolio scenarios show better performance than the benchmark actual index for both emerging and developed market indices and in both an absolute and relative basis. Table 13.4 shows the absolute returns for the three scenarios when an additional portion is added for the

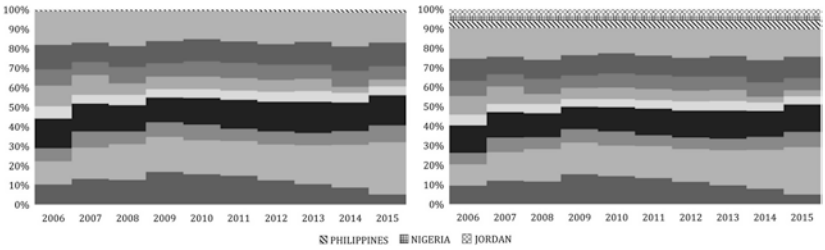

Fig. 13.6 Actual MSCI emerging market index versus overweighed MSCI emerging market with additional 3% in non-integrated countries

Table 13.4 Absolute return analysis for developed market index

	Actual	*Invest additional 2%*	*Invest additional 3%*	*Invest max (5% in total, market size cap)*
Annual returns	−1.51%	−1.35%	−1.28%	−1.10%
Annual standard deviation	18.72%	18.35%	18.18%	18.34%
Risk adjusted returns	−0.08	−0.07	−0.07	−0.06
Maximum drawdown	58.16%	58.12%	58.10%	57.78%
1st percentile	−14.24%	−14.36%	−14.42%	−14.28%
5th percentile	−9.60%	−9.45%	−9.51%	−9.43%

Source: Authors' calculations

least co-integrated stock market indices in the developed market index. The risk-adjusted returns increase for the three scenarios as the four countries that are added improve both the risk and return characteristics of the index.

The best improvement is shown by the alternative that allows a maximum investment of 5% or the amount allowed by its market capitalization, where the risk-adjusted returns increase from −8.09% to −6.00%. In the case of the emerging market index (see Table 13.5), the risk-adjusted returns improve for all the three scenarios, the last scenario being the one that shows the best results. The tables also show that the tail risk decreases in the emerging market index for all scenarios and the maximum drawdown is lower in both indices for all the scenarios.

Moreover, Table 13.6 presents the results on a relative basis (alternative scenario vs the actual index) for the developed market index. All the scenarios present a positive information ratio, the maximum is the option that caps the investment on the market capitalization as it limits the volatility of the liquidity premium from illiquid markets like the ones of New Zealand and Austria. This scenario also has a smaller tail than the scenario where an additional investment of 3% is included for all the least co-integrated economies.

Additionally, Table 13.7 presents the relative return analysis for the emerging market index. Again, all the scenarios show a positive information ratio, the highest being the option that caps the investment according to its market capitalization. Nonetheless this option has the highest volatility as a bigger portion of non-traditional investments is included.

Table 13.5 Absolute return analysis for emerging market index

	Actual	*Invest additional 2%*	*Invest additional 3%*	*Invest max (5% in total, market size cap)*
Annual returns	−0.08%	0.03%	0.09%	0.39%
Annual standard deviation	23.64%	22.83%	22.44%	22.60%
Risk-adjusted returns	−0.00	0.00	0.00	0.01
Maximum drawdown	62.67%	61.75%	61.30%	61.57%
1st percentile	−17.24%	−16.61%	−16.29%	−16.12%
5th percentile	−9.39%	−9.17%	−9.07%	−9.33%

Source: Authors' calculations

Table 13.6 Relative return analysis for developed market index

	Invest additional 2%	*Invest additional 3%*	*Invest max (5% in total, market size cap)*
Excess return	0.16%	0.24%	0.41%
Tracking error	0.81%	1.22%	0.89%
Information ratio	0.20	0.19	0.47
Maximum drawdown	2.11%	3.16%	1.64%
1st percentile	−0.57%	−0.85%	−0.59%
5th percentile	−0.32%	−0.49%	−0.33%

Source: Authors' calculations

Table 13.7 Relative return analysis for emerging market index

	Invest additional 2%	*Invest additional 3%*	*Invest max (5% in total, market size cap)*
Excess return	0.12%	0.17%	0.47%
Tracking error	1.17%	1.76%	2.00%
Information ratio	0.10	0.10	0.24
Maximum drawdown	4.14%	6.15%	4.87%
1st percentile	−0.70%	−1.05%	−1.35%
5th percentile	−0.52%	−0.78%	−0.90%

Source: Authors' calculations

Overall the results of the country analysis suggest that identifying and overweighting least co-integrated stock market indices can improve portfolio performance significantly both in relative and absolute terms under an active investment strategy. Both the returns and the risk measures showed an improvement; however, most of the improvement comes as a result of higher returns in the least co-integrated countries. It is important to consider that this can be a result of an embedded liquidity premium, which may also imply additional transaction costs.

13.6 Results by Industries

13.6.1 Co-integration Tests

Applying similar methodology, the chapter next analyzes the degree of integration among various global industrial stock market indices, identifies the least co-integrated ones, and performs portfolio analysis by applying active management strategies and overweighting those industries versus MSCI benchmark portfolios. As shown in Table 13.8, all the historical time series of the stock market indices by industry follow a $I(1)$ process; this allows the Gregory-Hansen co-integration test to be executed. Table 13.9 shows the results of the GH test with structural breaks for the stock market indices by industry in developed countries, with all of them being significantly co-integrated. Only the interaction between industrials

Table 13.8 Augmented Dickey Fuller test for industries

Industry in DM	*p-value*	*Industry in EM*	*p-value*
Energy	0.32	Energy	0.10
Materials	0.33	Materials	0.18
Industrials	0.81	Industrials	0.28
Cons Disc	0.88	Cons Disc	0.82
Cons Staples	0.96	Cons Staples	0.85
Health Care	0.95	Health Care	0.92
Financials	0.44	Financials	0.61
IT	0.70	IT	0.98
Telecom	0.81	Telecom	0.42
Utilities	0.24	Utilities	0.45

Source: Authors' calculations

Table 13.9 Gregory-Hansen co-integration test with structural breaks (*p*-value) among industries in developed countries

		Independent variables									
		Energy	*Materials*	*Industrials*	*Cons Disc*	*Cons Staples*	*Health Care*	*Financials*	*IT*	*Telecom*	*Utilities*
Dependent variables	Energy	–	0.03**	0.00**	0.00**	0.00**	0.00**	0.00**	0.00**	0.00**	0.00**
	Materials	0.03**	–	0.01**	0.00**	0.05**	0.01**	0.00**	0.01**	0.00**	0.00**
	Industrials	0.00**	0.00**	–	0.00**	0.00**	0.01**	0.00**	0.00**	0.01**	0.00**
	Cons Disc	0.00**	0.00**	0.00**	–	0.02**	0.00**	0.00**	0.00**	0.00**	0.00**
	Cons Staples	0.00**	0.00**	0.00**	0.01**	–	0.02**	0.00**	0.00**	0.00**	0.00**
	Health Care	0.00**	0.00**	0.01**	0.00**	0.03**	–	0.00**	0.00**	0.00**	0.00**
	Financials	0.01**	0.01**	0.01**	0.00**	0.00**	0.00**	–	0.01**	0.01**	0.00**
	IT	0.00**	0.00**	0.02**	0.00**	0.00**	0.00**	0.01**	–	0.02**	0.00**
	Telecom	0.00**	0.00**	0.02**	0.00**	0.12	0.00**	0.00**	0.00**	–	0.00**
	Utilities	0.10*	0.03**	0.10	0.02**	0.04**	0.01**	0.01**	0.09*	0.01**	–

The null hypothesis for the Gregory-Hansen test is no co-integration

Source: Authors' calculations

*Indicate significance at the 10% level, **Indicate significance at the 5% level

Table 13.10 Gregory-Hansen co-integration test with structural breaks (*p*-value) among industries in emerging countries

		Independent variables									
		Energy	*Materials*	*Industrials*	*Cons Disc*	*Cons Staples*	*Health Care*	*Financials*	*IT*	*Telecom*	*Utilities*
Dependent variables	Energy	–	0.00**	0.01**	0.00**	0.01**	0.02**	0.00**	0.13	0.02**	0.00**
	Materials	0.00**	–	0.04**	0.01**	0.00**	0.01**	0.00**	0.08*	0.02**	0.00**
	Industrials	0.00**	0.04**	–	0.00**	0.00**	0.00**	0.00**	0.17	0.00**	0.00**
	Cons Disc	0.00**	0.00**	0.00**	–	0.06*	0.01**	0.00**	0.30	0.00**	0.00**
	Cons Staples	0.00**	0.00**	0.00**	0.05*	–	0.00**	0.00**	0.31	0.00**	0.00**
	Health Care	0.00**	0.00**	0.00**	0.01**	0.03**	–	0.00**	0.20	0.00**	0.00**
	Financials	0.00**	0.00**	0.00**	0.00**	0.00**	0.00**	–	0.07*	0.05**	0.01**
	IT	0.00**	0.00**	0.00**	0.02**	0.08*	0.18	0.00**	–	0.00**	0.00**
	Telecom	0.00**	0.03**	0.00**	0.00**	0.00**	0.00**	0.03**	0.01**	–	0.00**
	Utilities	0.00**	0.00**	0.01**	0.01**	0.01**	0.01**	0.04**	0.19	0.00**	–

The null hypothesis for the Gregory-Hansen test is no co-integration

Source: Authors' calculations

*Indicate significance at the 10% level, **Indicate significance at the 5% level

Table 13.11 Absolute return analysis for emerging market index with industries

	Actual	*Invest additional 2%*	*Invest additional 3%*
Annual returns	0.17%	0.31%	0.38%
Annual standard deviation	23.32%	23.26%	23.24%
Risk-adjusted returns	0.71%	1.32%	1.62%
Maximum drawdown	57.75%	57.65%	57.59%
1st percentile	−17.28%	−17.25%	−17.23%
5th percentile	−8.99%	−9.00%	−9.00%

Source: Authors' calculation

Table 13.12 Relative return analysis for emerging market index with industries

	Invest additional 2%	*Invest additional 3%*
Excess return	0.14%	0.24%
Tracking error	0.23%	0.35%
Information ratio	0.61	0.69
Maximum drawdown	0.42%	0.28%
1st percentile	−0.13%	−0.20%
5th percentile	−0.09%	−0.13%

Source: Authors' calculations

and utilities, and consumer staples and telecommunications appear to be not co-integrated, when those are estimated as the independent variables respectively. Nevertheless, even these industries are co-integrated with all the others in the pool. Therefore, no diversification opportunities seem to be identified at the industry level for developed countries using the proposed methodology.

However, when the same analysis is performed for the stock market indices by industry in emerging countries, the information technology (IT) sector exhibits little co-integration with all other industries (except for telecom), signaling a possible diversification opportunity (Table 13.10).

13.6.2 Portfolio Analysis

The portfolio analysis overweighting the IT sector in emerging market is conducted next, and shows a portfolio performance improvement on the

risk-return frontier. As shown in the absolute basis analysis in Table 13.11, the risk-adjusted returns improve significantly and the tails remain invariant once the IT sector is overweight with an additional 2% and 3%.[3] Table 13.12 presents the results on a relative basis against the benchmark, both scenarios show a positive information ratio.

Overall, industry-level analysis shows that information technology sector in the emerging market category can present opportunities for diversification and additional portfolio gains in terms of risk return through active management versus a benchmark investment in the MSCI index.

13.7 Conclusion

The analysis in this chapter demonstrates potential opportunities for diversification and clear risk-adjusted return benefits in overweighting equity indices relative to the MSCI benchmarks in countries and industries found to be least co-integrated with the rest. Further in-depth research is needed to assess the factors behind the co-integration of global equity markets, including macro-economic, regulatory, and industry analysis. A deeper factor analysis would allow investors to forecast co-integration patterns and identify diversification opportunities going forward in a systematic way, given the overall financial integration trend.

In this chapter, the emerging countries' equity indices identified are the Philippines, Jordan, and Nigeria, which improved the portfolio risk-adjusted returns when included as an active portfolio strategy under three different scenarios. Among developed countries, New Zealand, Austria, the Netherlands, and Denmark stock market indices were identified as being least co-integrated. The returns of the historical MSCI benchmark were also enhanced when adding active strategies that consider these countries. Further research is needed to assess the likelihood of it being sustained going forward by identifying how the market and regulatory factors have shifted and impacted the observed idiosyncratic trend.

When the analysis is done by industry rather than by country, the diversification opportunities decrease, particularly in the developed markets, as the larger and the more co-integrated economies have a greater participation in each industry. For emerging markets, however, the analysis here indicates that the information technology sector can provide diversification opportunities. This industry enhances the MSCI benchmark risk-adjusted returns once its allocation in the index increases with active management strategies. This sector is mainly comprised of Asian compa-

nies in China, Taiwan, South Korea, Indonesia, and India. An individual GH test for these countries[4] in this sector shows that India is not co-integrated with South Korea nor with the United States. Additionally, a Granger causality test shows that the IT sector in South Korea and India has no effect on bigger industries like China's or Taiwan's. The sub-sectors that most of these companies belong to are internet software, semiconductors, technology hardware, electronic components, and IT consulting.

Finally, the fact that most of the regions or industries (except for the ones above) were found to be co-integrated does not mean that the potential of active management strategies is absent in the short run. Through strategies like pair trading, portfolio managers can identify if the short-term trend deviates from the long-term trend and consequently adjust their positions assessing the time when the two trends will converge again.

Notes

1. The Johansen co-integration test examines the co-integration relationship up to the rank of the time series. The test can be executed either with the trace or with eigenvalue. The test follows a sequence up to the first non-rejection of the null hypothesis, which will be the estimate of the number of co-integration relationships among the group of time series.
2. Correlations are estimated with monthly data from August 2008 to August 2016.
3. The scenario with the maximum between 5% and the total market capitalization is not considered in this case, since the emerging market index already invests more than 5% in the sector.
4. Data is not available for smaller industries, such as the one of the Philippines and Indonesia.

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