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Integration in Futures Markets

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Abstract

This paper aims to examine integration in equity index futures markets around the globe, which has not been explored in prior literature. Overall, the integration in futures markets is obviously stronger than that in the associated equity markets, although a sudden decrease is observed from years 2012 to 2014 due to a reduction in the volatility of futures markets. Thus, a long memory behavior of the integration in futures markets is not present. Specifically, the degree of integration of developed futures markets is much higher than that of emerging futures markets and the integration among European futures markets are the strongest. In addition, the integration is associated with stock market crash but not with stock market jump. We conclude that benefits from cross-market diversification still exist even during a turbulent period.

Keywords: Market Integration, Futures Markets, Principal Components Analysis, Market Crash
JEL Classification: G12, G13, G15

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1. Introduction

Equity market integration has been of interest for a long time, but it is not true for futures markets. Although an underlying asset and its derivatives share common characteristics that lead to a high correlation, a strong cointegration, and a long term co-movement, the rules, regulations, trading methods, and players in the two markets are different. For example, Andersen (1996), investigating noise trading in equity and futures markets, shows that the equity market is dominated by noise traders, whereas the futures market is dominated by informed traders. In addition, several studies show that equity futures markets possess higher price discovery than their corresponding equity stock markets. Therefore, a dominant informational role in futures markets leads to a question whether the degree of integration in equity futures markets is the same as that of corresponding equity markets.

This study fills the gap in prior literature by focusing on the level of integration in equity index futures markets around the world. We follow Pukthuanthong and Roll's (2009) methodology for identifying a level of integration as well as for comparison purposes. The main findings are as follows. First, the degree of integration in the equity index futures markets is higher than that in their corresponding equity spot markets. Second, the level of integration in the futures markets is associated with changes in their return volatility. Last, developed futures markets are more integrated than emerging futures markets. The futures markets in European countries are more integrated with global factors than the other regions.

The contribution of this study provides not only a profound understanding of integration development in equity index futures markets but also an implication in cross-market portfolio diversification. Moreover, the findings in this study call for future research. For example, what factors cause a change in the level of integration in futures markets or whether a structural change exists in the development of integration process. A comprehensive study of the integration in futures markets facilitates and supports investors for their portfolio management and policymakers to design appropriate rules and regulations.

2. Literature review

Kearney and Lucey (2004) provide an excellent review of market integration in equity markets. Two measurements of market integration are widely proposed. First, a direct measurement is grounded on the law of one price. Assets in different markets with similar risk profiles should have the same prices. Thus, the markets are integrated. Second, an indirect measurement relates financial market integration to liberalization and deregulation policies. Errunza and Losq (1985) find the integration between nine emerging markets and the U.S., which is not consistent with the mild segmentation hypothesis. Moreover, Errunza, Losq, and Padmanabhan (1992) test the market integration of emerging markets with the international asset pricing model (IAPM) and do not find a perfect integration or a perfect segmentation. Thus, the market integration shows a long memory behavior.

Another approach of studies in financial market integration is the analysis of financial liberalization. If markets have higher degrees of liberalization, investors are able to invest in multiple markets, or the barriers of investment are less. Furthermore, borrowers benefit from a relatively low cost of capital. Khanthavit and Sungkaew (1993), measuring Thailand's barriers to investment for Hong Kong, Japan, Singapore, the U.K.,

and the U.S., report that Japan possesses the highest barrier of investment and cost of equity. Additionally, many studies examine a relationship between investment barriers and market integration; for example, Bekaert (1995) measures the market integration with the correlation of excess returns between individual 19 emerging markets and the U.S. market and finds that a change in indirect barriers (i.e., differences in information availability, accounting standards, and investor protection) affects the market integration more than a change in direct barriers (i.e., legal barriers, political risk, and economic policy risk). Nishiotis (2004) measures the market segmentation between the U.S. closed-end funds and individual domestic closed-end funds in nine emerging countries and finds that indirect barriers lead to market segmentation even in a nonexistence of capital flow restriction. In summary, most previous findings document that either a perfect market segmentation or a perfect market integration does not exist. Liberalization, especially a reduction in indirect barriers, plays a vital role in the growth of market integration.

One of the interesting topics in market integration is a study of the time-varying integration behaviors. Bekaert and Harvey (1995) apply a conditional regime-switching model to measure the degree of market integration. They conclude that the degree of market integration is time-varying but does not increase over time. De Jong and De Roon (2005), using the fraction of non-investable assets to world assets as a proxy of market segmentation and allowing time-varying market integration, document that a decrease in market segmentation leads to a reduction in returns, which is consistent with the findings of Khanthavit and Sungkaew (1993). Yu, Fung, and Tam (2010) show the low degree of integration from 2002 to 2006 and an increase in integration in 2007 and 2008 in Asian equity markets.

An existence of time-varying market integration guides the development of an integration index as follows. Carrieri, Errunza, and Hogan (2007) create an integration index with R-squared from the asset pricing model and find that financial liberalization is an important factor of market integration. Pukthuanthong and Roll (2009) employ the principal components analysis to find global factors for the analysis of market integration. R-squared values from the regression is employed as the degree of integration, which is similar to the use of Carrieri et al. (2007). An upward trend in market integration especially during the bear market is prevalent. Carrieri, Chaieb, and Errunza (2013) create an integration index with the R-squared from the IAPM suggested by Errunza and Losq (1985). Surprisingly, the integration index does not show an increasing trend. This reconfirms the time-varying behavior of financial market integration.

In conclusion, previous studies in financial market integration focus on stock markets, especially in emerging markets. Therefore, this study fills the gap in this area by focusing on the time-varying integration in equity index futures markets around the world.

3. Data

The sample period is from January 1, 2007 to December 31, 2015. We retrieve continuous series futures prices from DataStream. The continuous series used in this study is a perpetual series of futures prices. It starts at the nearest contract month, which forms the first price for the continuous series until either the contract reaches its expiration or until the first business day of the notional contract month, whenever is sooner. At this point prices from the next trading contract month are taken. No adjustment for price differentials is made. We use the continuous series because nearby contracts are the most liquid assets, which possess information on how investors view the future movement in the underlying asset (Daigler and Wiley, 1999; Pukthuanthong and Roll, 2009). This is supported by the Samuelson effect (1965), which affirms that futures prices

are highly volatile when futures contracts approach the expiration. The prices of futures contracts are in the United States dollar. The sample includes 28 active equity index futures markets.[1] As the data in Poland are not available from June 23, 2014 onwards, we exclude Poland in 2014 and 2015 for the analysis. Table 1 reports the list and the relevant information of equity index futures contracts in each country shown in our samples.

Table 1: List of equity index futures markets.

Country	Name	Exchange	Underlying Name	DataStream Start Date	Trading Cycle
U.S.	CME-S&P 500 INDEX CONTINUOUS	Chicago Mercantile Exchange	S&P 500 COMPOSITE	23-Apr-82	Mar, Jun, Sep, Dec
U.K.	LIFFE-FTSE 100 INDEX CONTINUOUS	NYSE Euronext Liffe	FTSE 100	3-May-84	Mar, Jun, Sep, Dec
Brazil	BMF-BOVESPA INDEX CONTINUOUS	BM&F Bovespa	BRAZIL BOVESPA	14-Feb-86	Feb, Apr, Jun, Aug, Oct, Dec
Hong Kong	HKFE-HANG SENG INDEX CONTINUOUS	Hong Kong Futures Exchange	HANG SENG	18-Jan-88	All
Japan	TSE-TOPIX INDEX CONTINUOUS	Osaka Securities Exchange	TOPIX	5-Sep-88	Mar, Jun, Sep, Dec
Netherlands	AEX-AEX INDEX CONTINUOUS	Euronext.liffe Amsterdam	AEX INDEX (AEX)	26-Oct-88	All
South Africa	SAFEX-ALL SHARE 40 INDEX CONT.	South African Futures Exchange	FTSE/JSE TOP 40	2-May-90	Mar, Jun, Sep, Dec
Germany	EUREX-DAX INDEX CONTINUOUS	EUREX	DAX 30 PERFORMANCE (XETRA)	23-Nov-90	Mar, Jun, Sep, Dec
Spain	MEFF-IBEX 35 PLUS INDEX CONT.	MEFF Renta Variable	IBEX 35	20-Apr-92	All
Norway	OSLO-OBX INDEX CONTINUOUS	Oslo Stock Exchange	OSLO SE OBX	4-Sep-92	All
Belgium	BELFOX-BEL20 INDEX CONTINUOUS	NYSE Euronext - Euronext Brussels - Derivatives	BEL 20	29-Oct-93	All
Hungary	BSE-BUX INDEX CONTINUOUS	Budapest Stock Exchange	BUDAPEST (BUX)	3-Apr-95	All
Malaysia	KLSE-KLCI CONTINUOUS	Kuala Lumpur	FTSE BURSA MALAYSIA KLCI	15-Dec-95	All
Portugal	BDP-PSI 20 INDEX CONTINUOUS	New York Stock Exchange (NYSE) Euronext	PORTUGAL PSI-20	20-Jun-96	Mar, Jun, Sep, Dec
Poland	WSE-WIG 20 CONTINUOUS	Warsaw	WARSAW GENERAL INDEX 20	16-Jan-98	Mar, Jun, Sep, Dec
Taiwan	TAIFEX-TAIEX WEIGHTD INDEX CONTINUOUS	Taiwan Futures Exchange	TAIWAN SE WEIGHED TAIEX	21-Jul-98	All
Singapore	SGX DT-MSCI SING. INDEX CONT.	Singapore Exchange - Derivatives Trading Division	MSCI SINGAPORE F	7-Sep-98	All
France	MONEP-CAC 40 INDEX CONTINUOUS	Euronext Paris MATIF	FRANCE CAC 40	8-Jan-99	All
Mexico	MEXDER-IPC INDEX CONTINUOUS	Mexican Derivatives Exchange	Mexican IPC	1-Jun-99	Mar, Jun, Sep, Dec
Greece	ADEX-FTSE/ASE-20 CONTINUOUS	Athens Derivatives Exchange	FTSE/ATHEX LARGE CAP	30-Aug-99	Mar, Jun, Sep, Dec
Canada	ME-S&P CANADA 60 INDEX CONT.	Montreal Exchange	S&P/TSX 60 INDEX	7-Sep-99	Mar, Jun, Sep, Dec
Australia	SFE-SPI 200 INDEX CONT. TRAD	ASX Trade24	S&P/ASX 200	2-May-00	All
India	NSE-S&P CNX NIFTY CONTINUOUS	National India		12-Jun-00	All
Italy	IDEM-FTSE MIB CONTINUOUS	Italian Derivatives Market	FTSE MIB INDEX	22-Mar-04	Mar, Jun, Sep, Dec
Turkey	TURKDEX-ISE 30 CONTINUOUS	Turkish Derivatives Exchange	BIST NATIONAL 30	4-Feb-05	Feb, Apr, Jun, Aug, Oct, Dec
Sweden	OMX-OMXS30 INDEX CONTINUOUS	OM Nordic Exchange	OMX STOCKHOLM 30 (OMXS30)	15-Feb-05	All
Russian	RTS-RTS INDEX CONTINUOUS	Russian Trading System	RUSSIA RTS INDEX	3-Aug-05	Mar, Jun, Sep, Dec
Thailand	TFEX-SET50 INDEX CONTINUOUS	Thailand Futures Exchange	BANGKOK S.E.T. 50	28-Apr-06	Mar, Jun, Sep, Dec

Note: 28 active futures markets are retrieved from DataStream. Continuous series data is a perpetual series of futures prices. It starts from the nearest contract month, which forms the first price for the continuous series until either the contract reaches its expiration or until the first business day of the notional contract month, whichever is sooner. At this point, prices from the next trading contract month are taken. No adjustment for price differentials is made. The prices of futures contracts are in the United States dollar.
Source: Thomson Reuter DataStream.

[1] Over the examined periods, there are a total of 33 equity index futures markets in DataStream.

Equity index futures prices are reported in the United States dollar for consistency and comparison purposes. Futures returns are calculated as a consecutive difference in logarithm of futures prices. Table 2 shows annual returns and standard deviations of futures markets in the percentage form. The classification of developed and emerging markets follows the criteria of the MSCI. In general, returns in equity futures markets around the globe are positive, except the periods of the financial turmoil. In a similar vein, the standard deviations of stock index futures during the periods of financial turmoil are relatively high. The shrink in world economic activity in 2015 also caused a decline in the growth of financial markets.

Table 2: Descriptive statistics of 28 active futures markets.

	2007	2008	2009	2010	2011	2012	2013	2014	2015
Developed markets:									
Australia	21.5657	-72.3375	51.4200	11.1319	-13.8045	15.4295	0.3351	-7.3735	-13.5846
	[24.9687]	[51.1683]	[31.6414]	[26.6291]	[29.4519]	[16.7830]	[17.0421]	[14.3663]	[22.9771]
Belgium	4.0618	-79.0400	31.5400	-2.4267	-21.2826	19.3606	20.9877	-1.2771	1.0538
	[17.6240]	[42.5156]	[30.3409]	[28.2383]	[33.8090]	[23.0389]	[16.5577]	[13.0405]	[17.6787]
Canada	24.2553	-61.1775	41.7450	16.4711	-12.6081	7.7222	3.5355	0.0394	-28.3051
	[18.6880]	[48.4317]	[35.6743]	[20.4234]	[25.3132]	[17.1018]	[13.2737]	[12.0666]	[18.0455]
France	11.0606	-57.9350	24.2941	-7.8739	-18.6890	16.4352	21.1364	-12.9292	-2.5688
	[18.1787]	[45.2244]	[33.4103]	[29.5706]	[36.2944]	[26.0837]	[18.3581]	[15.0667]	[20.1311]
Germany	29.7225	-55.2125	25.3200	9.4731	-16.4780	27.5300	27.6700	-10.1826	-1.7038
	[16.5865]	[44.7839]	[34.0013]	[24.0869]	[35.8111]	[23.9756]	[16.9852]	[15.8383]	[21.2284]
Hong-Kong	32.0650	-63.2275	42.6675	5.5547	-19.7073	21.1346	3.6772	1.3064	-7.3005
	[28.1697]	[48.9513]	[32.8597]	[18.6745]	[25.2111]	[17.5116]	[15.4958]	[14.7129]	[22.6467]
Italy	3.1561	-71.1450	22.6259	-18.061	-28.5425	10.7273	20.3034	-12.2273	0.9071
	[16.4906]	[42.5363]	[38.2677]	[31.1023]	[39.9685]	[33.2778]	[22.5746]	[20.5880]	[23.1542]
Japan	-6.8227	-31.1150	3.7047	13.572	-13.7184	5.8695	22.4661	-5.1815	8.7615
	[18.6165]	[43.0432]	[26.1489]	[18.6824]	[22.6656]	[15.0800]	[22.8595]	[18.1372]	[18.9579]
Nether-lands	13.7230	-75.5375	34.5950	0.4999	-13.2355	11.4513	20.3128	-7.2041	-6.6310
	[17.0159]	[48.2990]	[34.9285]	[26.0554]	[30.4376]	[21.2794]	[14.8782]	[13.1614]	[18.8851]
Norway	25.4100	-95.9200	72.1050	17.2376	-11.1448	21.2323	12.3699	-16.5480	-13.1920
	[26.3693]	[63.3532]	[48.8232]	[33.4291]	[36.5604]	[24.5029]	[17.9129]	[18.0139]	[23.5621]
Portugal	24.6173	-74.0900	32.0875	-14.4868	-32.7625	5.4663	19.9400	-42.5861	-0.6203
	[15.7747]	[38.6913]	[26.6727]	[33.2150]	[31.4405]	[23.1379]	[22.1608]	[21.8450]	[23.4167]
Singapore	20.1811	-63.5100	49.0825	17.5021	-21.8420	23.9539	-1.0325	-0.4215	-22.4066
	[25.0065]	[38.5588]	[31.8305]	[19.5033]	[24.1242]	[15.4123]	[13.0216]	[10.5805]	[16.7949]
Spain	16.7354	-53.6800	30.9475	-23.199	-14.8514	-1.1978	24.9565	-8.9459	-17.3576
	[17.8950]	[45.4834]	[31.8865]	[36.3330]	[36.7569]	[33.1698]	[20.9194]	[17.5712]	[21.6110]
Sweden	-0.5130	-67.4950	48.3075	26.3325	-14.6192	17.5417	20.4402	-10.0173	-8.3642
	[24.2457]	[51.2771]	[47.3135]	[30.2320]	[39.4292]	[26.3630]	[19.5389]	[15.0853]	[19.6962]
U.S.	3.3460	-48.9525	22.4096	13.0301	1.4389	13.3541	26.3475	10.5687	-0.7998
	[15.9972]	[41.6904]	[26.1555]	[17.8868]	[23.5286]	[13.5455]	[11.0616]	[11.4228]	[15.4358]
U.K.	5.2371	-67.8325	32.0775	7.3743	-5.1431	10.5786	15.5162	-8.3168	-10.3197
	[18.7134]	[44.9534]	[31.7682]	[21.6605]	[25.6233]	[17.5751]	[13.0368]	[12.3010]	[18.5515]

	2007	2008	2009	2010	2011	2012	2013	2014	2015
Emerging markets:									
Brazil	52.1075	-76.3850	87.8625	7.6562	-28.8300	-0.5296	-28.3875	-14.0216	-51.7112
	[36.5689]	[64.4127]	[40.6754]	[28.9099]	[33.4356]	[26.8185]	[25.3238]	[33.0205]	[35.4697]
Greece	23.7560	-108.3925	23.0064	-56.8800	-86.6575	21.9370	27.9225	-54.3347	-42.5187
	[20.5491]	[48.2097]	[45.1156]	[47.8944]	[55.5095]	[52.9334]	[36.7638]	[35.5804]	[53.8172]
Hungary	14.8055	-82.8100	57.1225	-6.3702	-34.4350	17.3887	5.5930	-29.1178	24.3674
	[21.8382]	[56.9495]	[49.4239]	[39.5614]	[40.9855]	[30.4561]	[20.9528]	[20.4141]	[21.0829]
India	54.7500	-94.7200	65.2300	21.8967	-44.3675	23.4635	-3.9543	24.6355	-10.0802
	[30.0265]	[51.5402]	[41.5175]	[21.9630]	[26.5997]	[21.8401]	[25.9245]	[15.2357]	[18.9310]
Malaysia	33.7250	-53.3150	38.7850	29.8450	-1.9463	14.4396	4.3127	-12.5907	-23.2395
	[26.0983]	[30.7932]	[21.0203]	[17.4366]	[18.7748]	[11.4348]	[15.5767]	[11.7701]	[21.5051]
Mexico	10.1542	-48.6850	41.6850	23.8373	-13.5663	23.7150	-1.9400	-10.8626	-15.3377
	[25.8115]	[47.0740]	[36.2890]	[22.0640]	[27.3839]	[17.9056]	[21.3694]	[15.5911]	[20.5880]
Poland	20.3705	-82.6950	36.3650	11.6882	-35.9500	30.0325	-3.5958	-N.A.-	-N.A.-
	[25.9640]	[52.2152]	[53.7046]	[33.2045]	[38.6041]	[27.9384]	[23.6328]	- N.A.-	- N.A.-
Russia	17.5541	-136.9900	94.0075	20.8439	-23.8279	12.9593	-4.4656	-61.5517	-1.8049
	[25.5495]	[77.8300]	[54.8326]	[29.6285]	[35.7660]	[27.8141]	[20.0869]	[38.9387]	[35.3653]
South Africa	17.9965	-57.3075	46.7150	24.8113	-17.7470	16.2682	-2.4159	-3.8216	-23.8214
	[29.9381]	[54.8753]	[39.5104]	[28.7410]	[33.9078]	[24.0259]	[20.3186]	[16.9182]	[25.8279]
Taiwan	7.6816	-62.7600	63.1750	19.4873	-26.5900	13.9139	10.1152	1.3566	-14.7442
	[25.2364]	[43.4129]	[30.0227]	[20.7143]	[25.5838]	[17.5590]	[13.5889]	[11.6618]	[18.6527]
Thailand	34.4125	-71.7800	55.1150	42.4650	-3.5599	31.7825	-13.4047	12.5417	-28.9963
	[30.8868]	[45.1433]	[34.8311]	[22.8440]	[30.1269]	[17.4827]	[25.7522]	[17.0289]	[19.2678]
Turkey	52.7775	-95.1450	68.4300	18.0689	-44.0250	50.4125	-32.2825	16.6651	-38.9314
	[41.2359]	[62.5222]	[41.2601]	[31.1889]	[35.8620]	[23.2521]	[37.4942]	[28.9680]	[31.4457]

Note: The table presents annual returns (shown in the first row) and their corresponding annual standard deviations of returns (shown in brackets in the second row) of futures contract in each year classifying into developed and emerging markets as suggested by the MSCI. The observed data is from January 1, 2007 to December 31, 2015. The data of Poland futures market is not available from 2014 onwards. Numbers shown in the table are in percentage.
Source: Authors' calculation.

4. Methodology

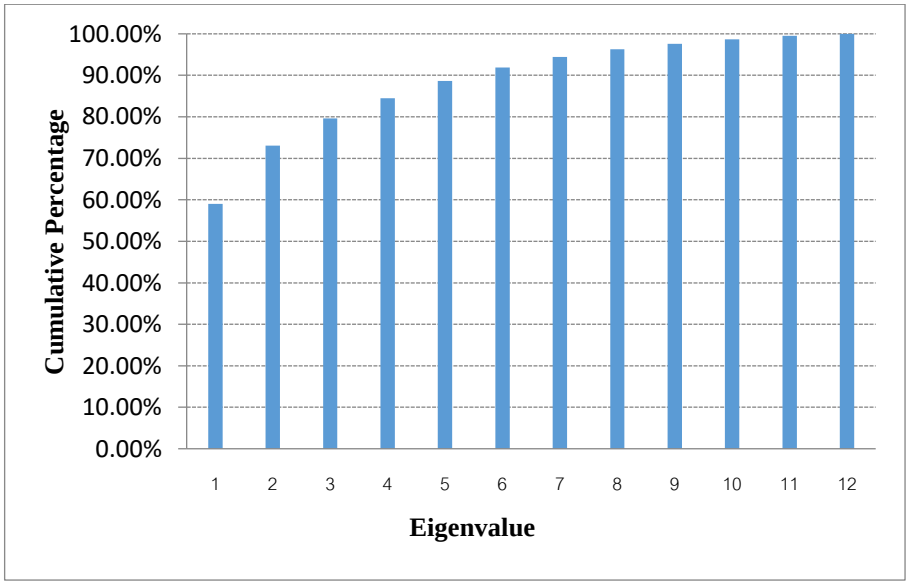
4.1 Estimation of global factors

Given 82 country samples over the period of 1973-2004, Pukthuanthong and Roll (2009) divide the data into three periodic cohorts and use 17 markets in the first cohort, which has the longest history, to estimate global factors. As futures markets do not have long data as stock markets do, we are not able to separate the data to multi-cohort. We select 11 countries with the longest chronological data to estimate global factors, comprising Belgium, Brazil, Germany, Hong Kong, Japan, Norway, Spain, South Africa, the Netherlands, the U.K., and the U.S. Principal components analysis from the information of these 11 countries and a lagged return of the U.S. is employed to estimate the common factors. This methodology alleviates a potential problem of model misspecification, which is superior to the approach of Carrieri et al. (2007; 2013). The largest six eigenvalues explain more than 90 percent of variance. Figure 1 depicts an average cumulative percentage of variance of 11 countries and a lagged return of the U.S.

for seven years. The first component alone explains about 60% and the others totally explain about 31% of the variance. This evidence of the explanation power of eigenvalues in the futures markets is consistent with the findings of Pukthuanthong and Roll (2009), which confirms the validity of multiple global factors.

Estimated eigenvalues are employed to calculate weights of returns in each market for the calculation of common factors. The weight from the previous year is used with returns in the following year. Therefore, the weights estimated from the years 2007 to 2014 are used with the returns from the years 2008 to 2015, respectively. The eigenvalues of each country are separately estimated and that country itself is excluded when the weights of factors are estimated in order to prevent the high principal component weightings in the particular country. Different time zones are of concern. We follow the practice of Pukthuanthong and Roll (2009) by including one-day lagged returns of the North American countries because it is the last trading region.

Figure 1: Average cumulative percentage of variance explained by sorted eigenvalues.



Note: This figure depicts an average cumulative percentage of variance explained by sorted 12 eigenvalues. 11 futures markets with the longest data history and one-day lagged of the U.S. return of from 2007 to 2014 are included in the estimation. The prices of futures contracts are in the United States dollar.
Source: Authors' calculation.

4.2 Measurement of market integration

Returns of futures markets are explained by common global factors as shown in equation (1). An advantage of this estimation is that it is not restricted to any specific asset pricing model.

$$R(i,t) = \alpha(i) + \sum_{n=1}^{N} \beta(i,n) f(n,t) + \varepsilon(i,t) \qquad (1)$$

where $R(i,t)$ is the return of futures market in country i at time t.
$f(n,t)$ is the global factor n at time t.
$\varepsilon(i,t)$ is the error term.

If the return is mostly explained by common global factors, the R-squared should be high, showing the market integration. Carrieri et al. (2007) and Pukthuanthong and Roll (2009) introduce the integration index based on this premise as:

$$Integration\ index = 1 - \frac{Var(\varepsilon)}{Var(R)} \quad (2)$$

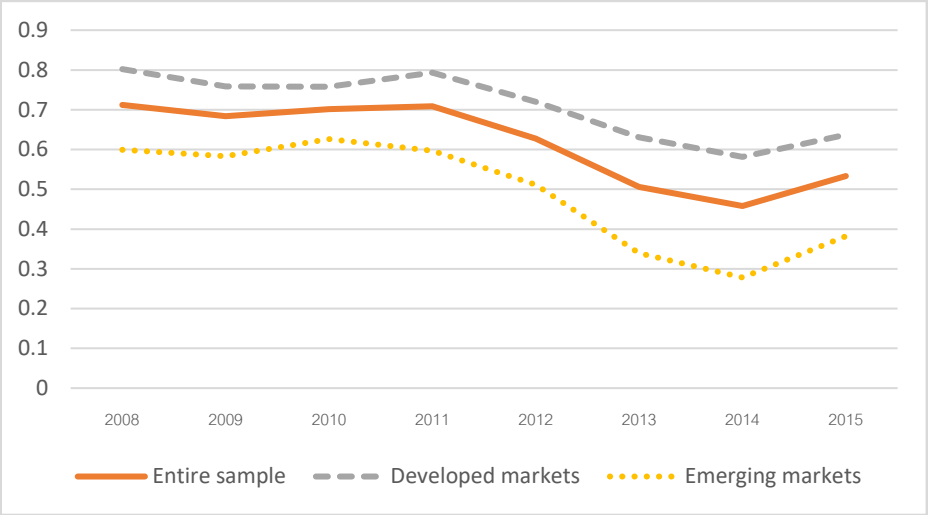
Futures markets are more integrated when the integration index in Equation (2) approaches one. We prefer employing the R-squared to the correlation for the construction of the integration index because the correlation is potentially biased. For example, when changes in futures prices in two markets are perfectly explained by global common factors (theoretically, it is the perfect integration), their correlation can be less than one when the weight of each global factor is different in explaining the market movement. Therefore, the correlation underestimates the market integration (Carrieri et al., 2007; Pukthuanthong and Roll, 2009). We follow the R-squared estimation model suggested by Pukthuanthong and Roll (2009) which is more reliable than the models developed by Errunza and Losq (1985) and Carrieri et al. (2007). Important drawbacks are that the models are grounded on a particular asset pricing model and occupy a misspecification. Although R-squared value is potentially biased because of heteroskedasticity (Forbes and Rigobon, 2002) and of sampling error in the global factors (Pukthuanthong and Roll, 2009), we mitigate the problems by using the multi-factor model and assigning various weights to the global factors to estimate R-squared values. This is supported and suggested by Pukthuanthong and Roll (2009), who state that "…*When comparing integration among countries, sampling error in the global factors is not likely to be serious. … the estimated R-squares will vary over time due to sampling error, but the variation will be strongly correlated across countries and inter-country rankings should be fairly reliable.*"

5. Empirical results

Figure 2 depicts the average of R-squared values from Equations (1) and (2), which represent the level of market integration.[2] We take an average of R-squared of the observed futures markets in each period. The level of market integration slightly changes over the period of study and it declines particularly from the years 2012 to 2014. Comparing to the equity market integration, our findings are different from the findings of Pukthuanthong and Roll (2009), which measure the level of integration among stock markets from 1974 to 2007. Their findings show the increasing trend in the degree of market integration, but we do not observe a trend in the equity index futures markets. However, the results demonstrate a similar pattern as shown in Lehkonen (2014), who applies the methodology suggested by Pukthuanthong and Roll (2009) to study market integration of stock markets from the years 1987 to 2011. During the overlapping period from the years of 2008 to 2011, the adjustment pattern in the integration level between Lehkonen (2014) and our study is similar, indicating that the degree of integration boosts at the early stage of the crisis but it slightly changes during the crisis. For example, a high degree of integration is noted in 2008, which is the burst of the subprime and it marginally declines in 2009.

[2] An availability of the individual country's R-square values is available upon request.

Figure 2: Global integration of equity index futures markets.



Note: The R-squared value from the regression of futures markets returns is a measurement of the level of integration. The regression is analyzed for each country, then R-squared values are averaged over a year. The figure depicts the degree of integration of the entire sample, developed countries, and emerging countries. The classification of developed and emerging markets follows the classification of the MSCI. The data of the Poland futures market is not available since 2014.
Source: Authors' calculation.

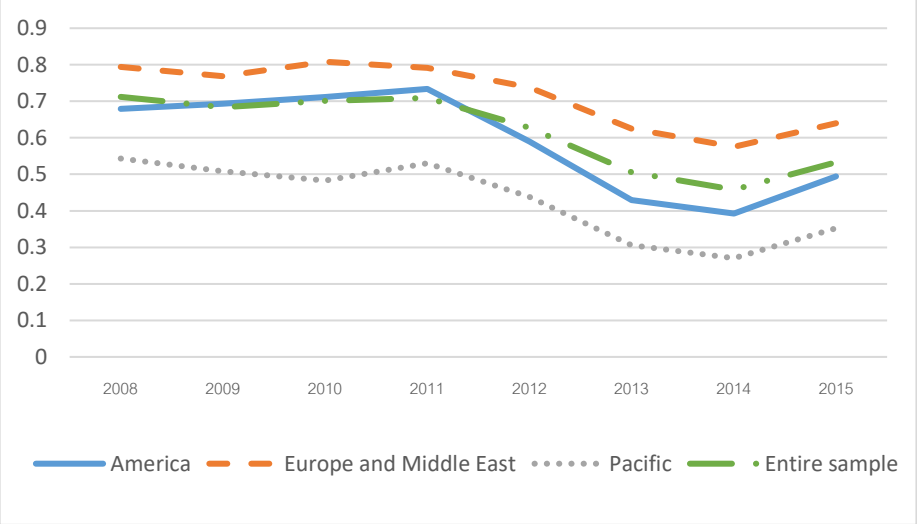
The integration index shows the time-varying integration degrees but does not always increase over time. The interesting finding is a sharp decline in the integration level from the years 2012 to 2014. The volatility during this period is decreasing from the previous years, and this is a potential reason for a reduction in the degree of the market integration. Although the findings of Solnik, Boucrelle, and Le Fur (1996) suggest that the correlation across markets increases in periods of high volatility, our study finds that the degree of market integration is associated with not only a level of volatility but also a change in volatility (see Table 2).

Figure 2 depicts that the degree of market integration of developed markets is much higher than that of emerging markets because developed markets are more responsive to global factors. Developed markets have larger market sizes, higher liquidity, and economic influences,[3] so they are more informationally efficient, which investors react immediately given an arrival of new information.

Next, we investigate the level of integration of futures markets categorized by the region, which is presented in Figure 3. European futures markets have the highest integration degree, and the Pacific futures markets have the lowest integration degree.

[3] The framework of the MSCI to classify market development includes economic development, market size and liquidity, and market accessibility. Please visit https://www.msci.com/market-classification for details.

Figure 3: Global integration of equity index futures markets by regions.



Note: The R-squared value from the regression of futures markets returns is a measurement of the level of integration. The regression is analyzed for each country, then R-squared values are averaged over a year. The figure depicts the degree of integration of the entire sample, developed countries, and emerging countries. The classification of developed and emerging markets follows the classification of the MSCI. The data of the Poland futures market is not available from 2014.
Source: Authors' calculation.

Furthermore, we analyze an association between jump and crash in stock markets and futures integration. The definitions of crash and jump suggested by Hutton et al. (2009) are employed, where jump (crash) of each country is equal to one when the daily return of the country's stock index increases (decreases) more than one standard deviation from its mean. Then, we count a number of jumps and crashes of each country in each year and run the regression of the level of integration of futures markets on jump and crash of their associated stock markets as reported in Table 3. Column 1 does not include a fixed effect, Columns 2 and 3 consider only the country effect and the year fixed effect, respectively, and Column 4 includes both the country and year fixed effects. The results present that crash in stock markets is positively associated with the integration in futures markets, while we do not find any significant relationship between jump in stock markets and integration in futures markets. However, the relationship between crash and integration disappears when year fixed effect is considered.

Table 3. The association between jump and crash in stock market and futures integration.

VARIABLES	(1) Integration	(2) Integration	(3) Integration	(4) Integration
Jump	-0.0029	0.0006	-0.0057	-0.0006
	(-1.0713)	(0.4184)	(-1.5460)	(-0.3356)
Crash	0.0067***	0.0056***	0.0038	-0.0010
	(2.6336)	(3.8762)	(0.9814)	(-0.6446)
Constant	0.5657***	0.5444***	0.7220***	0.7632***
	(25.9621)	(53.4233)	(9.3217)	(16.0214)
Country FE	No	Yes	No	Yes
Year FE	No	No	Yes	Yes
R-squared	0.055	0.238	0.188	0.612
Observations	222	222	222	222

Note: Values in the parentheses are *t*-statistic. *** show statistical significance at the 1% level.
Source: Authors' calculation.

6. Discussion

Our results report that the level of integration in equity index futures markets shows a time-varying pattern that has not been explored in prior literature, and it does not always illustrate an upward trend. This is supported by the finding of Bekaert and Harvey (1995). Moreover, the level of integration in futures markets is higher than that in their associated equity markets (Pukthuanthong and Roll 2009; Lehkonen, 2014), which can be explained by differences in investor types and information accessibility. Equity markets are dominated by noise traders whereas futures markets are dominated by informed traders (Andersen, 1996; Holmes and Tomsett, 2004; Lertweeranontharat et al., 2016). Morck, Yeung, and Yang (2000) suggest that investors trade more in developed markets than in emerging markets due to a better information environment. Therefore, futures prices can incorporate available global information faster than stock prices that subsequently leads to the higher integration in futures markets. However, the adjustment of the integration in emerging markets is more sensitive than that in developed markets. A reason is deduced from the findings of Solnik et al. (1996) that the return volatility of emerging markets is higher than that of developed markets, which implies higher vulnerability of both equity and futures markets in emerging countries. Moreover, futures markets are associated with their market turmoil and the shift of market volatility. For example, we observe the highest integration in 2008 due to the global financial crisis. Our empirical evidence supports this argument as crash in stock markets is associated with the integration in futures market but it is not true for the jump. This is consistent with an asymmetric effect of bad news over good news on information transmission (Booth, Martikainen, and Tse, 1995; Bhar, 2001; Lin et al., 2002).

We also find that futures markets in Europe and the Middle East have the highest levels of integration, and futures markets in the Pacific have the lowest. This can be explained as the volatility of futures market in Europe and the Middle East (the Pacific) is the highest (lowest), and integration is associated with volatility (Solnik et al., 1996). Another possible reason,[4] which has to be further explored, is that the European markets have strong political and economic relationships and the European Union (EU) is considered as the largest economy in the world, European markets are likely to be more aligned and responsive to global factors than markets in the other regions.

Based on our findings, integration does not always benefit investors, since the level is high, especially during a financial turbulent period. However, international investors are still benefited from the lower level of integration of emerging futures markets. Given the findings in the study, it is interesting to examine what new factors cause market integration, for example, technology development in financial markets may increase market integration since investors can access information and trade in various markets easier. Moreover, global and regional factors differently influence the level of market integration. We leave them for future research.

7. Conclusion

This paper studies the level of integration in equity index futures markets, which has not been examined in the previous literature. We follow Pukthuanthong and Roll (2009) integration methodology in equity stock markets. The index shows that the integration level changes over time, suggesting that the integration in futures markets is

[4] Please see https://ec.europa.eu/trade/policy/eu-position-in-world-trade/index_en.htm.

time-varying as in stock markets is. However, we do not observe an upward trend in futures market integration. A remarkable finding is a decline in the level of integration from the years 2012 to 2014, which is explained by a decrease in the futures market volatility. Moreover, the integration in futures markets is associated with stock market crash, and European futures markets have higher integration level than the other regions. This implies that investors can gain benefits from cross-market diversification.

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