Co-movement between equity and bond markets

Co-movement between Equity and Bond Markets

Ryuta Sakemoto*

School of Social Sciences, Heriot-Watt University, Edinburgh, EH14 4AS, United Kingdom

September 27th 2017

Abstract

This study explores the co-movement between equity and bond markets and decomposes it into the equity-bond, equity, and bond co-movements. Moreover, the estimation method captures the heterogeneity between developed and emerging equity markets. It reveals that both equity-bond and equity co-movements are important for the developed equity markets. Although the idiosyncratic component plays a substantial role in the emerging equity and bond markets, the global financial crisis has impacted on the co-movement of the emerging equity markets, while does not have an effect on that of the emerging bond markets. The co-movements depend upon market uncertainty measured by VIX.

JEL classification: C38, F36, G15

Keywords: Equity-bond co-movement, Market Uncertainty, International market, Market integration, Flight-to-quality

* Corresponding author. Tel.: +44(0) 131 451 3486
E-mail address: rs7@hw.ac.uk

1.Introduction

Equity and bond markets are the most important financial markets, and the relationship between these two markets is of particular interest for financial researchers and market participants. There are many factors which impact upon the relationship and affect the integration of the economy and currencies, such as the European Union (EU) and Euro, as well as the development of emerging markets, all of which have been widely examined.

Equity markets have co-movements (see for example, Bekaert and Harvey 1995, de Jong and de Roon 2005, Bekaert, Hodrick, and Zhang 2009, Pukthuanthong and Roll 2009, Bekaert, Harvey, Lundblad, and Siegel (2011), Christoffersen, Errunza, Jacobs, and Langlois 2012, Donadelli and Paradiso 2014, Eiling and Gerard 2014). Equity markets of developed and emerging countries have different market structure and Bekaert et al. (2009) focus on developed markets, de Jong and de Roon (2005), Donadelli and Paradiso (2014), and Eiling and Gerard (2014) examine emerging markets, and Pukthuanthong and Roll (2009), Bekaert et al. (2011), and Christoffersen et al. (2012) explore both developed and emerging markets.

Bond market co-movement is also investigated and Barr and Priestley (2004) use the Capital Asset Pricing Model (CAPM) and assess five developed markets. Volosovych (2011) employs the Principal Component Analysis (PCA) and explores the long-run relation of developed markets. Abad, Chulia, and Gomez-Puig (2010) adopt the CAPM model to explore EU bond markets. Pozzi and Wolswijk (2012) and Christiansen (2014) have also focused on EU bond markets and investigate the effects of the recent financial crisis.[1]

Moreover, cross asset co-movement, in particular, equity-bond market co-movement is important research area. For instance, Scruggs and Glabadanidis (2003) use the

[1] Baele (2005) adopts the regime switching model and finds the sensitivity to EU equity market shocks for each EU equity market increases over time. Cappiello, Kadareja, and Manganelli (2010) and Bekaert, Harvey, Lundblad, and Siegel (2013) examine that Euro membership and Euro adoption for equity market integration.

asymmetric dynamic covariance model and find that both equity and bond market shocks impact on equity market variance, although only bond market shocks have an effect on bond market variance.[2] Panchenko and Wu (2009) focus on emerging markets and adopt a semi-parametric approach. They conclude that equity and bond market decoupling is due to increased demand for equities. Baele, Bekaert, and Inghelbrecht (2010) employ the dynamic factor model with state-dependent factor betas and report that macroeconomic fundamentals are not critical determinants for equity and bond correlation. The volatility spillovers of the cross-asset markets are also investigated by Christiansen (2010). She presents that both global and regional bond market shocks are substantial for bond markets in EU countries after the introduction of Euro, while the effects of the global and the regional equity market shocks are marginal for the bond markets. Garcia and Tsafack (2011) investigate a dependence structure by using the regime-switching copula model and provide evidence that the dependence between equity and bond markets is weak. The correlation between equity and bond markets vary over time. Aslanidis and Christiansen (2012) adopt the smooth transition regression (STR) model that captures both positive and negative correlations.

The first contribution of this study is to decompose co-movements across equity and bond market into (i) equity-bond co-movement, (ii) asset specific co-movement, and (iii) developed or emerging market specific co-movement. In contrast to the previous studies, which capture the asset and cross-asset co-movements separately, I estimate both co-movements simultaneously. Moreover the co-movement is linked to each other. To this end, this study employs the dynamic hierarchical factor model (DHFM) proposed by Moench, Ng, and Potter (2013). This model has the benefit of imposing a hierarchical structure on the dataset and allows us to interpret the meaning of factors more easily than the conventional PCA approach. A hierarchical structure model is widely used to capture common and reginal

[2]Cappiello, Engle, and Sheppard (2006) extend this study and adopt the asymmetric generalized dynamic conditional correlation model.

components in several contexts (see for instance, Kose, Otrok, and Whiteman 2003, Moench and Ng 2011, Kose Otrok, and Prasad 2012, and Förster, Jorra, and Tillmann 2014).This approach differs from those of Pukthuanthong and Roll (2009) and Volosovych (2011), since their PCA methods do not assume the structure of data and they do not focus on cross-asset co-movements.

The second contribution of this study is to extend Connolly, Stivers, and Sun (2005, 2007), who show that, when equity market uncertainty is high, the equity (bond) return is low (high). They estimate the equity-bond correlation conditional upon the market uncertainty computed by the Chicago Board Options Exchange Volatility Index (VIX). They consider higher equity market uncertainty is related to hedging demand for bonds. I examine the equity-bond, equity, and bond co-movements are associated with market uncertainty. Connoly et al. (2005, 2007) focus on the correlations, but this study examines the co-movement conditional upon the change in VIX. My approach is not limited by the relation of two variables. For instance, Connoly et al. (2007) explore the equity and bond market correlation in one country and the equity market correlation between two countries. Our approach, however, the co-movement contains information of more than 30 countries.

This study finds that the equity-bond and equity co-movements have a similar impact on developed equity markets. The developed bond markets present strong heterogeneity after the financial crisis in 2008. More importantly, I observe that the idiosyncratic component dominates the emerging bond market fluctuations and the financial crisis has small effects on the emerging bond markets. The previous literature has not investigated these points. Moreover, the equity-bond, equity, and bond co-movements are affected by the market uncertainty. The new approach in this study allows us to conclude that the equity-bond co-movement is mainly driven by the equity co-movement.

The remainder of this paper is structured as follows: Section 2 explains data; Section 3 discusses the methodology; Section 4 reports the empirical results; Section 5 presents the robustness; and Section 6 provides a conclusion.

2. Data and summary statistics

This section explains the data used; 18 advanced economies and 13 emerging market equity and bond market indices based on Cappiello et al. (2006) and Panchenko and Wu (2009) are obtained from Thomson Reuters Datastream. Morgan Stanley Capital International (MSCI) country index total returns are employed as equity market returns. Datastream-constructed five-year average maturity government bond index total returns are adopted as bond market returns. If these bond indices are not available, J.P. Morgan emerging bond market index total returns are used. All data series are weekly and denominated in local currencies, since weekly data can avoid the nonsynchronous problem as in Bekaert et al. (2009). The sample period extends from January 2001 to December 2014.

The summary statistics are reported in Table 1 and mean returns and standard deviations are annualized. The entire average return of developed equity markets can be seen to be smaller

Table 1 Summary statistics

Panel A: Developed countries								
	Equity				Bond			
	Mean	Std.dev	Skew	Kurt	Mean	Std.dev	Skew	Kurt
Austria	2.50	24.91	-1.03	8.16	5.13	3.23	0.35	9.38
Belgium	3.59	21.46	-1.92	17.13	5.17	3.75	0.36	19.52
Denmark	8.57	19.60	-0.75	6.67	4.85	3.24	-0.05	4.41
France	1.44	20.46	-0.43	5.55	5.01	3.29	0.42	6.36
Germany	3.37	22.46	-0.61	6.63	4.77	3.18	0.04	3.41
Ireland	-3.44	26.73	-1.10	9.26	7.47	8.09	2.00	27.81
Italy	-1.78	22.34	-0.67	6.00	5.65	4.86	0.25	13.27
Netherlands	2.03	20.62	-0.85	6.90	5.02	3.02	0.00	3.76
Norway	7.50	23.62	-0.94	7.86	5.58	3.43	0.07	5.23
Spain	4.84	22.72	-0.15	4.34	5.52	4.77	0.79	12.06
Sweden	5.50	23.42	-0.58	5.50	4.79	3.14	0.06	3.95
Switzerland	3.48	17.32	-0.71	7.32	2.91	2.47	0.05	5.16
United Kingdom	4.07	17.25	-0.68	6.48	5.10	3.20	0.05	4.04
Australia	7.98	15.49	-0.63	6.20	6.03	3.92	-0.19	4.18
Japan	1.94	21.19	-0.47	5.35	1.35	1.67	-0.26	5.93
New Zealand	7.17	14.75	-0.58	6.23	6.28	3.16	0.15	4.21
Canada	5.71	17.80	-1.25	12.59	4.96	3.47	-0.11	4.59
United States	5.23	18.40	-1.27	15.90	4.64	4.35	-0.01	4.18
Average	3.87	20.59	-0.81	8.00	5.01	3.68	0.22	7.86
Panel B: Emerging countries								
Czech Republic	13.26	22.10	-0.22	8.64	2.12	0.45	6.82	119.58
Poland	5.92	24.30	-0.26	4.87	5.57	0.75	3.28	71.47
China	10.19	28.08	-0.29	4.81	0.64	1.19	-0.58	22.50
India	14.03	24.02	-0.53	5.42	6.85	1.90	3.94	57.16
Philippines	12.40	23.03	-0.11	5.34	5.99	2.04	2.32	24.12
Thailand	14.71	25.26	-0.32	5.09	3.69	1.24	4.94	63.07
Argentina	16.92	38.58	-0.33	6.17	28.72	14.18	4.82	58.90
Brazil	13.54	25.36	-0.48	6.35	12.05	2.74	-2.43	106.55
Mexico	15.30	20.24	-0.73	6.13	6.75	0.84	1.42	42.81
Egypt	20.52	29.87	-0.65	6.52	11.68	3.12	-0.51	27.77
Israel	4.02	19.51	-0.44	4.99	3.34	0.86	1.41	24.01
South Africa	15.64	19.82	0.06	5.05	8.08	0.67	-2.92	33.71
Turkey	17.22	35.25	-0.06	6.28	21.26	8.40	-3.82	270.53
Average	13.36	25.80	-0.33	5.82	8.98	2.95	1.44	70.94

Notes: This table shows average return, standard deviation, skewness and kurtosis of weekly equity and bond returns. The average returns and the standard deviations are annualized.

than that of developed bond markets (3.9% and 5.0%). The average standard deviation of developed equity markets is much larger than that of developed bond markets (20.6 and 3.7).

The returns of emerging equity markets vary across countries. For instance, Egypt is the highest (20.5%), while Israel is the lowest (4.0%). The emerging equity markets are more volatile than the developed equity markets. The average standard deviation of the emerging equity markets is 25.8 but that of the developed equity markets is 20.6. The emerging bond markets are heterogeneous and high inflation countries such as Argentina and Turkey show higher returns (28.7% and 21.2%).

3. Methodology

This section describes a model to capture market co-movement. This study adopts a four-level DHFM based on Moench et al. (2013). This model has common, block, subblock and idiosyncratic variation. Let $X_{bsn,t}$ be the *n*-th series in subblock *s* of block *b* in period *t* , and the four-level model is denoted as follow:

$$X_{bsn,t} = \lambda_H(L)H_{bs,t} + e_{X,t} \quad (1)$$

$$H_{bs,t} = \lambda_G(L)G_{b,t} + e_{H,t} \quad (2)$$

$$G_{b,t} = \lambda_F(L)F_t + e_{G,t} \quad (3)$$

where λ_H , λ_G , and λ_F denote parameters and $e_{X,t}$, $e_{H,t}$, and $e_{G,t}$ denote idiosyncratic, subblock and block variations. The block common factor $G_{b,t}$ is driven by the common factor F_t, which is the common component across blocks and the block specific shock $e_{G,t}$. The subblock factor $H_{bs,t}$ is also decomposed into the block factor $G_{b,t}$, which is the common component across subblocks and the subblock specific shock $e_{H,t}$. Applying the same procedure, the data series $X_{bsn,t}$ can be denoted as the subblock factor $H_{bs,t}$ and the

idiosyncratic shock $e_{X,t}$. It is assumed that $e_{X,t}$, $e_{H,t}$, $e_{G,t}$, and F_t are stationary, normally distributed autoregressive processes of order one and evolve as follows:

$$e_{X,t} = \psi_X e_{X,t-1} + \varepsilon_{X,t} \tag{4}$$

$$e_{H,t} = \psi_H e_{H,t-1} + \varepsilon_{H,t} \tag{5}$$

$$e_{G,t} = \psi_G e_{G,t-1} + \varepsilon_{G,t} \tag{6}$$

$$F_t = \psi_F F_{t-1} + \varepsilon_{F,t} \tag{7}$$

where ψ_X, ψ_H, ψ_G, and ψ_F denote the coefficient of the AR(1) dynamics and $\varepsilon_{X,t}$, $\varepsilon_{H,t}$, $\varepsilon_{G,t}$, and $\varepsilon_{F,t}$ follow $N(0, {\sigma_j}^2), j = X, H, G$, and F, and they are uncorrelated across time and blocks. In the estimation, the Markov Chain Monte Carlo (MCMC) method is employed to estimate the model and 50,000 samples are obtained after the initial 20,000 samples are discarded and stored every 50th draw. All data are standardized as in Moench et al. (2013).

Data are arranged into two asset blocks: equity and bond. It means that F_t captures co-movement across equity and bond markets, while $G_{1,t}$ ($G_{2,t}$) represents co-movement of equity (bond) markets. As discussed by Connolly et al. (2005), equities and bonds have different components. For equities, expected cash flows and discount rates are dependent upon the economic and market condition and stochastic. In contrast, for bonds, only the discount rates are stochastic and bonds have hedging demand for equities, thus, meaning that the two blocks reflect the difference between equities and bonds.

The equity block has developed and emerging subblocks, since Bekaert et al. (2011) report the developed and emerging equity markets have different levels of integration. $H_{11,t}$ represents co-movement of the developed equity markets and $H_{12,t}$ captures the emerging markets.[3] Although I consider dividing the bond block into the developed and emerging

[3] Ng (2000) also shows that emerging Asian equity markets are affected by both global (U.S.) and regional (Japan) markets.

subblocks, this factor cannot capture co-movement in the subblocks, and hence I do not build subblocks in the bond blocks. Table 2 indicates that the model structure and equity data have the common, asset block, and market development subblocks. Bond data have only common and asset block.

Table 2 Data and Model Structure

Block	Subblock	N
Equity Market	Developed	18
Equity Market	Emerging	13
Bond Market		31

Note: The number of series N in the block are reported.

4. Empirical results

4.1. All period results

I begin with presenting the posterior means of equity-bond, F_t, equity, $G_{1,t}$, bond, $G_{2,t}$, developed equity market, $H_{11,t}$, and emerging equity market co-movements, $H_{12,t}$. Note that these co-movements are estimated simultaneously and have the hierarchical structure. Figure 1 shows the posterior mean of equity-bond co-movement. It falls during the global financial crisis in 2008 and the bond market turmoil of Euro area around 2010. The fluctuation becomes smaller after 2012. The other four co-movements are presented in Figure 2. The equity co-movement captures the market crash during the global financial crisis. The bond co-movement is more volatile than the equity factor, reflecting the fact that the bond co-movement includes both developed and emerging markets. The developed and emerging equity market co-movements show a similar pattern to the equity market. The emerging market co-movement is more volatile than the developed one.

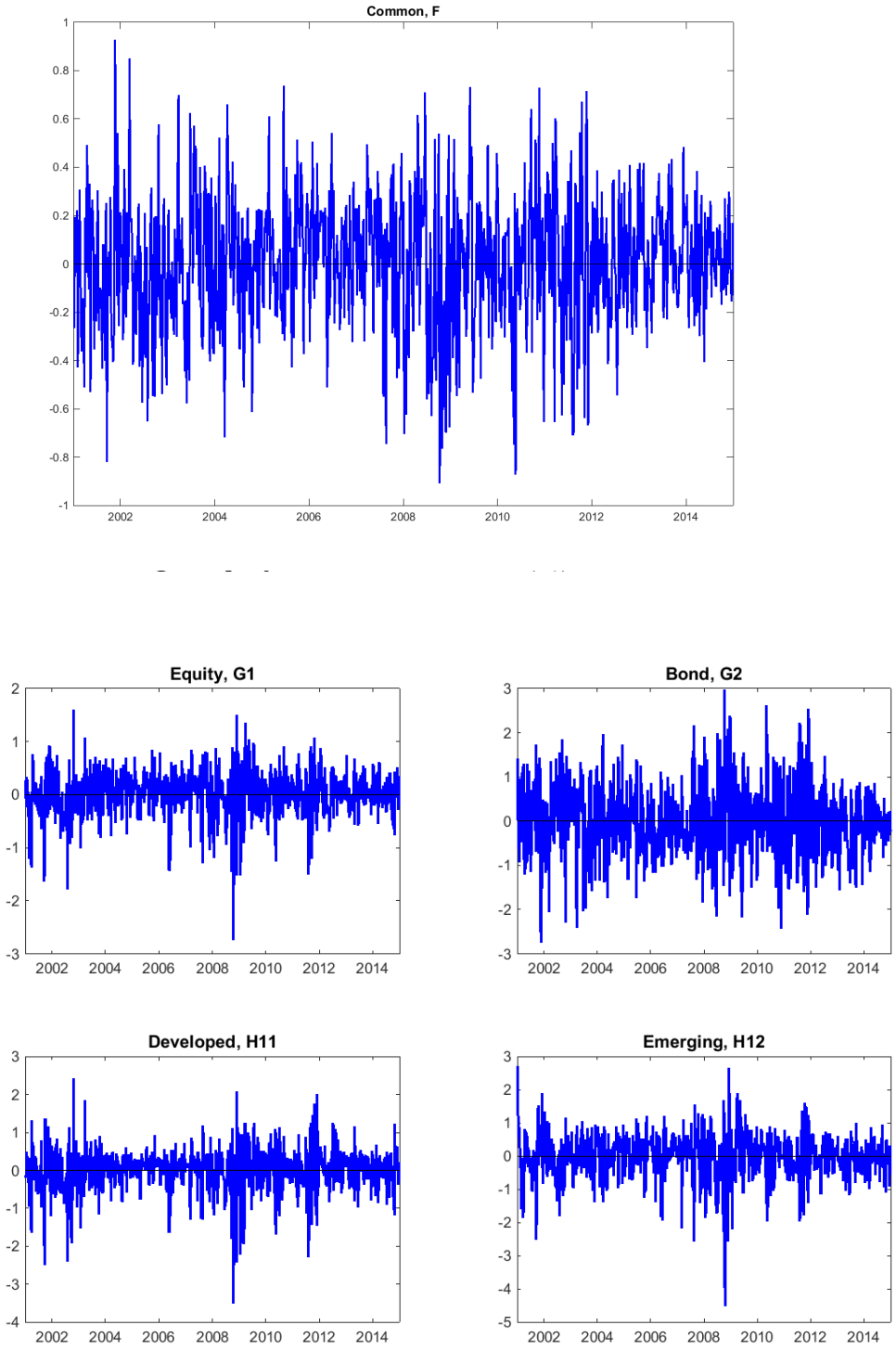

Fig. 2. Equity ($G_{1,t}$), bond ($G_{2,t}$), developed equity market ($H_{11,t}$), and emerging equity market ($H_{12,t}$) co-movements.

Next, I conduct variance decomposition and examine which variation is more important. This analysis investigates the impacts of equity-bond, equity, bond, developed equity, and emerging equity market co-movements for each market. This approach explores whether the equity-bond co-movement is substantial for both equity and bond markets. Following Moench et al. (2013), Table 3 demonstrates that the posterior means and standard deviations of estimated variance shares to the total variance. "Common" denotes the variance shares for the variance of the equity-bond common ($\varepsilon_{F,t}$) to the total variance. Similarly, "Asset" is $\varepsilon_{G,t}$, "Development" is $\varepsilon_{H,t}$, and "Idiosyncratic" is $\varepsilon_{X,t}$. Panel A in Table 3 shows the results of the equity block. The average row in the developed countries displays that the common, the equity, and the developed equity market co-movements have almost same contributions and each of them explains 20% of total variation. France has the highest share of common variation, 31% and New Zealand has the smallest, 5%. More than 80% of variation in New Zealand is explained by the idiosyncratic component. Panel B shows that the emerging country results and the common and the equity co-movement, on average, account for the 15% of variation, respectively. The idiosyncratic variation is more substantial in the emerging countries. More than 60% of the variation, on average, is accounted for by the idiosyncratic variation. These imply that the emerging equity markets are less integrated than developed equity markets, and these findings are consistent with those of Bekaert et al. (2011).

Table 3 Panel B reports the variance decomposition results in the bond markets. Here I have not included bond market development subblock, and hence the variance is decomposed into the common, bond, and idiosyncratic components. The equity-bond co-movement plays an important role and the average share is 44% in the developed countries. In particular, Euro adopting countries have higher shares. For instance, the values of Germany and Netherlands are more than 80%. The common currency plays an important role

in the co-movement of the European bond markets and this is similar to the findings of Abad et al. (2010). In contrast, the

Table 3 Decomposition of Variance

Posterior Mean (Standard Deviation)								
Panel A: Equity Markets								
Developed countries								
	Common		Asset		Development		Idiosyncratic	
Austria	0.127	(0.004)	0.132	(0.004)	0.129	(0.004)	0.612	(0.012)
Belgium	0.218	(0.006)	0.225	(0.007)	0.220	(0.006)	0.337	(0.018)
Denmark	0.182	(0.008)	0.188	(0.008)	0.184	(0.008)	0.447	(0.023)
France	0.307	(0.002)	0.317	(0.003)	0.310	(0.002)	0.065	(0.006)
Germany	0.281	(0.004)	0.290	(0.004)	0.284	(0.004)	0.144	(0.010)
Ireland	0.150	(0.008)	0.155	(0.008)	0.152	(0.008)	0.543	(0.024)
Italy	0.250	(0.005)	0.258	(0.005)	0.253	(0.005)	0.239	(0.015)
Netherlands	0.279	(0.004)	0.288	(0.004)	0.282	(0.004)	0.151	(0.010)
Norway	0.177	(0.007)	0.182	(0.008)	0.179	(0.008)	0.462	(0.022)
Spain	0.215	(0.006)	0.222	(0.007)	0.217	(0.006)	0.347	(0.019)
Sweden	0.233	(0.006)	0.240	(0.006)	0.235	(0.006)	0.292	(0.017)
Switzerland	0.248	(0.005)	0.256	(0.005)	0.251	(0.005)	0.245	(0.015)
United Kingdom	0.275	(0.004)	0.284	(0.004)	0.278	(0.004)	0.164	(0.011)
Australia	0.158	(0.008)	0.163	(0.008)	0.160	(0.008)	0.519	(0.025)
Japan	0.107	(0.008)	0.111	(0.009)	0.108	(0.008)	0.674	(0.026)
New Zealand	0.047	(0.012)	0.049	(0.013)	0.048	(0.005)	0.856	(0.023)
Canada	0.171	(0.008)	0.176	(0.008)	0.172	(0.008)	0.481	(0.023)
United States	0.212	(0.008)	0.219	(0.008)	0.214	(0.008)	0.355	(0.023)
Average	0.202	(0.006)	0.209	(0.006)	0.204	(0.006)	0.385	(0.018)
Emerging countries								
Czech Republic	0.175	(0.012)	0.180	(0.012)	0.100	(0.005)	0.545	(0.023)
Poland	0.188	(0.013)	0.194	(0.013)	0.107	(0.009)	0.511	(0.028)
China	0.206	(0.012)	0.213	(0.013)	0.118	(0.009)	0.463	(0.027)
India	0.155	(0.013)	0.160	(0.013)	0.089	(0.008)	0.597	(0.030)
Philippines	0.103	(0.011)	0.107	(0.012)	0.059	(0.007)	0.731	(0.028)
Thailand	0.129	(0.013)	0.133	(0.013)	0.074	(0.008)	0.665	(0.031)
Argentina	0.107	(0.012)	0.110	(0.013)	0.061	(0.007)	0.722	(0.030)
Brazil	0.199	(0.012)	0.205	(0.013)	0.114	(0.009)	0.483	(0.028)
Mexico	0.211	(0.012)	0.218	(0.013)	0.121	(0.009)	0.451	(0.027)
Egypt	0.060	(0.011)	0.062	(0.011)	0.034	(0.006)	0.844	(0.027)
Israel	0.099	(0.012)	0.103	(0.012)	0.057	(0.007)	0.741	(0.029)
South Africa	0.174	(0.013)	0.180	(0.013)	0.100	(0.008)	0.546	(0.029)
Turkey	0.124	(0.012)	0.128	(0.013)	0.071	(0.008)	0.678	(0.030)
Average	0.148	(0.012)	0.153	(0.013)	0.085	(0.008)	0.614	(0.028)

Table 3 (continue)

Posterior Mean (Standard Deviation)						
Panel B: Bond Markets						
Developed countries						
	Common		Asset		Idiosyncratic	
Austria	0.684	(0.021)	0.100	(0.006)	0.216	(0.017)
Belgium	0.507	(0.025)	0.074	(0.005)	0.419	(0.025)
Denmark	0.568	(0.023)	0.083	(0.006)	0.349	(0.022)
France	0.730	(0.016)	0.107	(0.007)	0.163	(0.012)
Germany	0.802	(0.013)	0.118	(0.008)	0.080	(0.007)
Ireland	0.025	(0.011)	0.004	(0.002)	0.972	(0.012)
Italy	0.151	(0.023)	0.022	(0.003)	0.827	(0.026)
Netherlands	0.817	(0.012)	0.120	(0.008)	0.063	(0.006)
Norway	0.352	(0.028)	0.051	(0.004)	0.596	(0.030)
Spain	0.178	(0.025)	0.026	(0.004)	0.796	(0.028)
Sweden	0.582	(0.022)	0.085	(0.006)	0.333	(0.021)
Switzerland	0.379	(0.026)	0.055	(0.004)	0.565	(0.028)
United Kingdom	0.529	(0.023)	0.077	(0.005)	0.393	(0.023)
Australia	0.301	(0.027)	0.044	(0.004)	0.655	(0.029)
Japan	0.133	(0.022)	0.019	(0.003)	0.848	(0.024)
New Zealand	0.183	(0.025)	0.027	(0.004)	0.790	(0.028)
Canada	0.449	(0.027)	0.066	(0.005)	0.485	(0.028)
United States	0.469	(0.025)	0.069	(0.005)	0.463	(0.026)
Average	0.435	(0.022)	0.064	(0.005)	0.501	(0.022)
Emerging countries						
Czech Republic	0.002	(0.003)	0.000	(0.000)	0.998	(0.003)
Poland	0.003	(0.003)	0.000	(0.000)	0.997	(0.004)
China	0.002	(0.003)	0.000	(0.000)	0.997	(0.003)
India	0.005	(0.005)	0.001	(0.001)	0.994	(0.006)
Philippines	0.003	(0.004)	0.000	(0.001)	0.996	(0.004)
Thailand	0.003	(0.004)	0.000	(0.001)	0.997	(0.004)
Argentina	0.005	(0.005)	0.001	(0.000)	0.994	(0.006)
Brazil	0.002	(0.002)	0.000	(0.000)	0.998	(0.003)
Mexico	0.003	(0.003)	0.000	(0.000)	0.997	(0.004)
Egypt	0.002	(0.002)	0.000	(0.000)	0.998	(0.002)
Israel	0.001	(0.002)	0.000	(0.000)	0.999	(0.002)
South Africa	0.002	(0.003)	0.000	(0.000)	0.997	(0.003)
Turkey	0.002	(0.003)	0.000	(0.000)	0.997	(0.003)
Average	0.003	(0.003)	0.000	(0.000)	0.997	(0.004)

Notes: Table 3 reports the posterior mean of variance share to common, asset (block), market development (subblock), and idiosyncratic shocks. The standard deviation is reported in parentheses. The sample period is January 2001 to December 2014.

bond factor has a smaller contribution. The average share is only 6% in the developed countries. Surprisingly, neither equity-bond nor bond co-movements have explain the fluctuation of the emerging bond markets being that almost all variations are dependent upon the idiosyncratic components[4].

4.2. Sub-period results

Given the heterogeneous results of the developed and equity markets, I will conduct sub-sample analysis. As shown by Christoffersen et al. (2012) and Pozzi and Wolswijk (2012), the financial crisis impacts on equity and bond markets. I divide the full sample into three sub-periods to explore the effect of the recent financial crisis. Following Bekaert, Ehrmann, Fratzscher, and Mehl (2014), the financial crisis period is defined from August 2007 to March 2009. The first sub-period (Period I) covers the time before the crisis which runs from January 2001 to July 2007. The second sub-period (Period II) is the crisis period, which spans August 2007 to March 2009. The third sub-period (Period III) is after the crisis, and covers April 2009 to December 2014.

Tables 4, 5 and 6 show that the variance decompositions for the sub periods. Table 5 Panel A presents that the share of the equity-bond co-movement in the emerging equity markets rises. Roughly 20% of the variation, on average, is accounted for by the common. The share of the equity co-movement also increases in Period II and the average share is 22%. These suggest that the co-movement between the developed and emerging equity markets becomes stronger during the financial crisis. The average share of the idiosyncratic variation in the emerging equity market is 48% and is still higher than that in the developed equity markets. This is consistent with the findings of Christoffersen et al. (2012), who report that the emerging equity markets still have diversification benefits during crises.

[4] Tsukuda et al. (2017) find that low integration of bond markets in the emerging Asian markets.

Interestingly, the share of the equity-bond co-movement does not change in both developed and emerging bond markets during the

Table 4 Decomposition of Variance for Period I

Posterior Mean (Standard Deviation)								
Panel A: Equity Markets								
Developed countries								
	Common		Asset		Development		Idiosyncratic	
Austria	0.096	(0.005)	0.100	(0.006)	0.098	(0.005)	0.706	(0.016)
Belgium	0.254	(0.007)	0.263	(0.008)	0.257	(0.007)	0.226	(0.021)
Denmark	0.182	(0.012)	0.189	(0.012)	0.185	(0.012)	0.444	(0.035)
France	0.309	(0.004)	0.320	(0.005)	0.314	(0.004)	0.057	(0.007)
Germany	0.299	(0.004)	0.310	(0.006)	0.303	(0.004)	0.087	(0.009)
Ireland	0.151	(0.014)	0.157	(0.014)	0.153	(0.014)	0.539	(0.041)
Italy	0.259	(0.007)	0.268	(0.008)	0.262	(0.007)	0.210	(0.020)
Netherlands	0.289	(0.005)	0.300	(0.006)	0.293	(0.005)	0.118	(0.012)
Norway	0.165	(0.012)	0.171	(0.013)	0.167	(0.012)	0.497	(0.036)
Spain	0.233	(0.008)	0.241	(0.009)	0.236	(0.009)	0.290	(0.025)
Sweden	0.246	(0.008)	0.255	(0.009)	0.250	(0.008)	0.249	(0.023)
Switzerland	0.260	(0.007)	0.269	(0.008)	0.263	(0.007)	0.209	(0.020)
United Kingdom	0.278	(0.006)	0.288	(0.007)	0.281	(0.006)	0.153	(0.015)
Australia	0.141	(0.013)	0.146	(0.013)	0.143	(0.013)	0.570	(0.038)
Japan	0.079	(0.013)	0.082	(0.014)	0.080	(0.013)	0.758	(0.040)
New Zealand	0.022	(0.008)	0.023	(0.009)	0.023	(0.008)	0.932	(0.025)
Canada	0.174	(0.012)	0.180	(0.013)	0.176	(0.012)	0.469	(0.036)
United States	0.227	(0.009)	0.235	(0.010)	0.230	(0.009)	0.308	(0.026)
Average	0.204	(0.009)	0.211	(0.009)	0.206	(0.009)	0.379	(0.025)
Emerging countries								
Czech Republic	0.149	(0.017)	0.154	(0.018)	0.105	(0.007)	0.591	(0.034)
Poland	0.158	(0.018)	0.164	(0.019)	0.113	(0.015)	0.565	(0.044)
China	0.141	(0.018)	0.146	(0.019)	0.100	(0.014)	0.614	(0.045)
India	0.103	(0.018)	0.106	(0.018)	0.073	(0.013)	0.718	(0.045)
Philippines	0.053	(0.014)	0.055	(0.014)	0.038	(0.010)	0.854	(0.037)
Thailand	0.102	(0.018)	0.106	(0.018)	0.073	(0.013)	0.719	(0.046)
Argentina	0.060	(0.015)	0.062	(0.015)	0.043	(0.011)	0.834	(0.040)
Brazil	0.144	(0.018)	0.149	(0.019)	0.102	(0.014)	0.605	(0.044)
Mexico	0.203	(0.019)	0.210	(0.019)	0.144	(0.017)	0.442	(0.041)
Egypt	0.025	(0.011)	0.026	(0.011)	0.018	(0.008)	0.931	(0.029)
Israel	0.118	(0.019)	0.122	(0.020)	0.083	(0.014)	0.677	(0.048)
South Africa	0.144	(0.019)	0.149	(0.019)	0.102	(0.014)	0.606	(0.045)
Turkey	0.091	(0.017)	0.094	(0.018)	0.065	(0.012)	0.750	(0.044)
Average	0.115	(0.017)	0.119	(0.018)	0.081	(0.012)	0.685	(0.042)

Table 4 (continue)

Posterior Mean (Standard Deviation)						
Panel B: Bond Markets						
Developed countries						
	Common		Asset		Idiosyncratic	
Austria	0.746	(0.023)	0.108	(0.008)	0.146	(0.016)
Belgium	0.865	(0.012)	0.126	(0.011)	0.009	(0.001)
Denmark	0.715	(0.021)	0.104	(0.009)	0.181	(0.017)
France	0.864	(0.012)	0.126	(0.011)	0.011	(0.001)
Germany	0.862	(0.012)	0.125	(0.011)	0.012	(0.001)
Ireland	0.774	(0.018)	0.112	(0.009)	0.113	(0.011)
Italy	0.820	(0.015)	0.119	(0.010)	0.061	(0.006)
Netherlands	0.865	(0.012)	0.126	(0.011)	0.010	(0.001)
Norway	0.401	(0.038)	0.058	(0.006)	0.540	(0.041)
Spain	0.860	(0.012)	0.125	(0.011)	0.015	(0.002)
Sweden	0.655	(0.026)	0.095	(0.008)	0.250	(0.024)
Switzerland	0.444	(0.034)	0.064	(0.006)	0.492	(0.036)
United Kingdom	0.636	(0.027)	0.092	(0.008)	0.272	(0.026)
Australia	0.392	(0.037)	0.057	(0.006)	0.551	(0.040)
Japan	0.110	(0.032)	0.016	(0.004)	0.875	(0.036)
New Zealand	0.349	(0.036)	0.050	(0.005)	0.601	(0.039)
Canada	0.503	(0.034)	0.073	(0.006)	0.424	(0.035)
United States	0.534	(0.031)	0.077	(0.006)	0.388	(0.032)
Average	0.633	(0.024)	0.092	(0.008)	0.275	(0.020)
Emerging countries						
Czech Republic	0.003	(0.004)	0.000	(0.000)	0.997	(0.003)
Poland	0.004	(0.005)	0.001	(0.000)	0.995	(0.004)
China	0.003	(0.004)	0.000	(0.000)	0.996	(0.003)
India	0.006	(0.007)	0.001	(0.001)	0.993	(0.006)
Philippines	0.004	(0.005)	0.001	(0.001)	0.996	(0.004)
Thailand	0.003	(0.005)	0.000	(0.001)	0.996	(0.004)
Argentina	0.004	(0.005)	0.001	(0.000)	0.996	(0.006)
Brazil	0.003	(0.004)	0.000	(0.000)	0.997	(0.003)
Mexico	0.006	(0.007)	0.001	(0.000)	0.993	(0.004)
Egypt	0.004	(0.005)	0.001	(0.000)	0.996	(0.002)
Israel	0.003	(0.004)	0.000	(0.000)	0.997	(0.002)
South Africa	0.006	(0.007)	0.001	(0.000)	0.993	(0.003)
Turkey	0.007	(0.007)	0.001	(0.000)	0.992	(0.003)
Average	0.004	(0.005)	0.001	(0.001)	0.995	(0.006)

Notes: Table 4 reports the posterior mean of variance share to common, asset (block), market development (subblock), and idiosyncratic shocks. The standard deviation is reported in parentheses. The sample period is January 2001 to July 2007.

Table 5 Decomposition of Variance for Period II

Posterior Mean (Standard Deviation)								
Panel A: Equity Markets								
Developed countries								
	Common		Asset		Development		Idiosyncratic	
Austria	0.167	(0.013)	0.177	(0.015)	0.168	(0.013)	0.488	(0.041)
Belgium	0.171	(0.021)	0.181	(0.023)	0.172	(0.021)	0.476	(0.064)
Denmark	0.203	(0.018)	0.215	(0.020)	0.203	(0.019)	0.379	(0.056)
France	0.305	(0.007)	0.323	(0.010)	0.305	(0.007)	0.067	(0.016)
Germany	0.270	(0.011)	0.286	(0.013)	0.271	(0.011)	0.173	(0.030)
Ireland	0.141	(0.021)	0.149	(0.023)	0.141	(0.022)	0.569	(0.065)
Italy	0.250	(0.013)	0.265	(0.015)	0.251	(0.013)	0.234	(0.039)
Netherlands	0.261	(0.012)	0.277	(0.014)	0.262	(0.012)	0.200	(0.034)
Norway	0.167	(0.020)	0.177	(0.022)	0.167	(0.020)	0.489	(0.061)
Spain	0.221	(0.016)	0.234	(0.018)	0.221	(0.017)	0.324	(0.049)
Sweden	0.225	(0.016)	0.239	(0.018)	0.226	(0.016)	0.310	(0.048)
Switzerland	0.239	(0.015)	0.253	(0.016)	0.240	(0.015)	0.269	(0.044)
United Kingdom	0.274	(0.010)	0.290	(0.012)	0.275	(0.011)	0.161	(0.029)
Australia	0.180	(0.019)	0.191	(0.020)	0.181	(0.019)	0.448	(0.057)
Japan	0.171	(0.019)	0.181	(0.020)	0.171	(0.019)	0.477	(0.058)
New Zealand	0.098	(0.020)	0.104	(0.022)	0.099	(0.020)	0.699	(0.062)
Canada	0.174	(0.021)	0.184	(0.023)	0.174	(0.021)	0.467	(0.064)
United States	0.169	(0.019)	0.179	(0.021)	0.169	(0.019)	0.484	(0.059)
Average	0.205	(0.016)	0.217	(0.018)	0.205	(0.016)	0.373	(0.049)
Emerging countries								
Czech Republic	0.235	(0.031)	0.249	(0.032)	0.113	(0.014)	0.403	(0.058)
Poland	0.222	(0.032)	0.235	(0.034)	0.108	(0.020)	0.435	(0.071)
China	0.255	(0.029)	0.270	(0.030)	0.124	(0.022)	0.351	(0.061)
India	0.186	(0.032)	0.196	(0.033)	0.090	(0.018)	0.528	(0.073)
Philippines	0.162	(0.033)	0.172	(0.035)	0.078	(0.018)	0.587	(0.079)
Thailand	0.157	(0.031)	0.166	(0.032)	0.076	(0.016)	0.601	(0.071)
Argentina	0.218	(0.031)	0.231	(0.032)	0.106	(0.020)	0.446	(0.068)
Brazil	0.265	(0.028)	0.280	(0.030)	0.129	(0.023)	0.326	(0.058)
Mexico	0.227	(0.030)	0.240	(0.031)	0.110	(0.021)	0.423	(0.066)
Egypt	0.141	(0.032)	0.149	(0.034)	0.068	(0.017)	0.643	(0.076)
Israel	0.129	(0.033)	0.137	(0.035)	0.062	(0.018)	0.672	(0.080)
South Africa	0.223	(0.031)	0.236	(0.033)	0.108	(0.020)	0.434	(0.068)
Turkey	0.252	(0.030)	0.267	(0.030)	0.122	(0.022)	0.358	(0.062)
Average	0.206	(0.031)	0.218	(0.032)	0.099	(0.019)	0.477	(0.069)

Table 5 (Continue)

Posterior Mean (Standard Deviation)						
Panel B: Bond Markets						
Developed countries						
	Common		Asset		Idiosyncratic	
Austria	0.811	(0.033)	0.107	(0.017)	0.082	(0.019)
Belgium	0.815	(0.029)	0.108	(0.018)	0.077	(0.017)
Denmark	0.220	(0.072)	0.029	(0.009)	0.751	(0.080)
France	0.863	(0.023)	0.115	(0.019)	0.022	(0.007)
Germany	0.823	(0.028)	0.109	(0.018)	0.068	(0.015)
Ireland	0.427	(0.071)	0.056	(0.010)	0.517	(0.076)
Italy	0.622	(0.056)	0.082	(0.012)	0.296	(0.054)
Netherlands	0.838	(0.026)	0.111	(0.009)	0.051	(0.012)
Norway	0.317	(0.069)	0.041	(0.016)	0.641	(0.075)
Spain	0.779	(0.036)	0.103	(0.011)	0.117	(0.025)
Sweden	0.522	(0.067)	0.069	(0.010)	0.409	(0.068)
Switzerland	0.311	(0.076)	0.041	(0.011)	0.649	(0.083)
United Kingdom	0.553	(0.064)	0.073	(0.009)	0.374	(0.064)
Australia	0.293	(0.075)	0.038	(0.009)	0.669	(0.081)
Japan	0.254	(0.075)	0.033	(0.005)	0.713	(0.082)
New Zealand	0.056	(0.042)	0.007	(0.009)	0.936	(0.047)
Canada	0.341	(0.074)	0.045	(0.010)	0.614	(0.080)
United States	0.335	(0.078)	0.044	(0.012)	0.621	(0.085)
Average	0.510	(0.055)	0.067	(0.012)	0.423	(0.054)
Emerging countries						
Czech Republic	0.046	(0.037)	0.006	(0.005)	0.948	(0.041)
Poland	0.020	(0.022)	0.003	(0.003)	0.978	(0.024)
China	0.025	(0.028)	0.003	(0.004)	0.972	(0.031)
India	0.019	(0.022)	0.002	(0.003)	0.979	(0.025)
Philippines	0.028	(0.030)	0.004	(0.004)	0.969	(0.033)
Thailand	0.019	(0.023)	0.002	(0.003)	0.978	(0.026)
Argentina	0.058	(0.041)	0.007	(0.005)	0.934	(0.046)
Brazil	0.013	(0.018)	0.002	(0.002)	0.985	(0.020)
Mexico	0.013	(0.018)	0.002	(0.002)	0.985	(0.020)
Egypt	0.013	(0.017)	0.002	(0.002)	0.986	(0.020)
Israel	0.011	(0.015)	0.001	(0.002)	0.987	(0.017)
South Africa	0.014	(0.018)	0.002	(0.002)	0.984	(0.020)
Turkey	0.007	(0.010)	0.001	(0.001)	0.992	(0.012)
Average	0.022	(0.023)	0.003	(0.003)	0.975	(0.026)

Notes: Table 5 reports the posterior mean of variance share to common, asset (block), market development (subblock), and idiosyncratic shocks. The standard deviation is reported in parentheses. The sample period is August 2007 to March 2009.

Table 6 Decomposition of Variance for Period III

Posterior Mean (Standard Deviation)								
Panel A: Equity Markets								
Developed countries								
	Common		Asset		Development		Idiosyncratic	
Austria	0.160	(0.008)	0.159	(0.007)	0.159	(0.013)	0.522	(0.022)
Belgium	0.210	(0.011)	0.208	(0.011)	0.208	(0.021)	0.374	(0.031)
Denmark	0.145	(0.013)	0.144	(0.013)	0.144	(0.019)	0.566	(0.037)
France	0.314	(0.005)	0.311	(0.005)	0.311	(0.007)	0.063	(0.008)
Germany	0.277	(0.007)	0.275	(0.007)	0.275	(0.011)	0.173	(0.017)
Ireland	0.135	(0.013)	0.134	(0.013)	0.134	(0.022)	0.597	(0.038)
Italy	0.252	(0.008)	0.250	(0.008)	0.250	(0.013)	0.249	(0.023)
Netherlands	0.279	(0.007)	0.277	(0.006)	0.277	(0.012)	0.167	(0.016)
Norway	0.188	(0.012)	0.187	(0.012)	0.187	(0.020)	0.438	(0.034)
Spain	0.198	(0.011)	0.197	(0.011)	0.197	(0.017)	0.408	(0.033)
Sweden	0.219	(0.010)	0.217	(0.010)	0.217	(0.016)	0.346	(0.030)
Switzerland	0.229	(0.010)	0.228	(0.009)	0.227	(0.015)	0.316	(0.027)
United Kingdom	0.266	(0.007)	0.265	(0.007)	0.265	(0.011)	0.204	(0.019)
Australia	0.151	(0.012)	0.150	(0.012)	0.150	(0.019)	0.549	(0.036)
Japan	0.081	(0.012)	0.081	(0.012)	0.081	(0.019)	0.758	(0.037)
New Zealand	0.034	(0.009)	0.033	(0.009)	0.033	(0.020)	0.899	(0.027)
Canada	0.151	(0.013)	0.150	(0.013)	0.150	(0.021)	0.550	(0.037)
United States	0.229	(0.009)	0.227	(0.009)	0.227	(0.019)	0.316	(0.026)
Average	0.195	(0.010)	0.194	(0.010)	0.194	(0.010)	0.416	(0.028)
Emerging countries								
Czech Republic	0.115	(0.016)	0.114	(0.015)	0.098	(0.007)	0.674	(0.030)
Poland	0.158	(0.019)	0.157	(0.019)	0.136	(0.018)	0.548	(0.044)
China	0.215	(0.020)	0.214	(0.020)	0.185	(0.022)	0.385	(0.041)
India	0.166	(0.019)	0.165	(0.019)	0.143	(0.019)	0.526	(0.044)
Philippines	0.099	(0.017)	0.099	(0.017)	0.085	(0.015)	0.716	(0.044)
Thailand	0.107	(0.017)	0.106	(0.017)	0.092	(0.015)	0.696	(0.044)
Argentina	0.086	(0.016)	0.086	(0.016)	0.074	(0.014)	0.754	(0.042)
Brazil	0.189	(0.019)	0.187	(0.019)	0.162	(0.020)	0.461	(0.042)
Mexico	0.166	(0.019)	0.165	(0.019)	0.143	(0.018)	0.526	(0.044)
Egypt	0.037	(0.012)	0.037	(0.012)	0.032	(0.010)	0.894	(0.033)
Israel	0.072	(0.015)	0.072	(0.015)	0.062	(0.013)	0.794	(0.040)
South Africa	0.162	(0.019)	0.160	(0.019)	0.139	(0.019)	0.539	(0.044)
Turkey	0.088	(0.017)	0.087	(0.017)	0.075	(0.015)	0.749	(0.045)
Average	0.128	(0.017)	0.127	(0.017)	0.110	(0.019)	0.636	(0.041)

Table 6 (Continue)

Posterior Mean (Standard Deviation)						
Panel B: Bond Markets						
Developed countries						
	Common		Asset		Idiosyncratic	
Austria	0.170	(0.072)	0.138	(0.010)	0.692	(0.068)
Belgium	0.115	(0.038)	0.100	(0.027)	0.785	(0.043)
Denmark	0.409	(0.091)	0.362	(0.085)	0.229	(0.026)
France	0.281	(0.070)	0.246	(0.056)	0.473	(0.042)
Germany	0.482	(0.104)	0.427	(0.101)	0.091	(0.014)
Ireland	0.013	(0.009)	0.012	(0.008)	0.975	(0.015)
Italy	0.002	(0.003)	0.002	(0.002)	0.997	(0.005)
Netherlands	0.451	(0.099)	0.399	(0.094)	0.150	(0.019)
Norway	0.181	(0.050)	0.159	(0.040)	0.661	(0.045)
Spain	0.003	(0.004)	0.003	(0.004)	0.994	(0.008)
Sweden	0.312	(0.075)	0.275	(0.063)	0.413	(0.039)
Switzerland	0.198	(0.053)	0.173	(0.043)	0.629	(0.044)
United Kingdom	0.257	(0.064)	0.226	(0.053)	0.518	(0.042)
Australia	0.125	(0.039)	0.109	(0.031)	0.766	(0.043)
Japan	0.064	(0.024)	0.056	(0.020)	0.881	(0.034)
New Zealand	0.073	(0.027)	0.064	(0.022)	0.863	(0.037)
Canada	0.248	(0.062)	0.218	(0.051)	0.535	(0.042)
United States	0.252	(0.062)	0.222	(0.053)	0.527	(0.043)
Average	0.202	(0.053)	0.177	(0.042)	0.621	(0.034)
Emerging countries						
Czech Republic	0.004	(0.004)	0.003	(0.003)	0.993	(0.007)
Poland	0.002	(0.003)	0.001	(0.002)	0.997	(0.005)
China	0.002	(0.003)	0.001	(0.002)	0.997	(0.005)
India	0.008	(0.007)	0.007	(0.006)	0.985	(0.012)
Philippines	0.002	(0.003)	0.002	(0.003)	0.996	(0.005)
Thailand	0.003	(0.004)	0.002	(0.003)	0.995	(0.006)
Argentina	0.011	(0.008)	0.009	(0.007)	0.980	(0.014)
Brazil	0.002	(0.003)	0.002	(0.002)	0.996	(0.005)
Mexico	0.002	(0.003)	0.002	(0.003)	0.996	(0.005)
Egypt	0.002	(0.002)	0.001	(0.002)	0.997	(0.004)
Israel	0.002	(0.002)	0.001	(0.002)	0.997	(0.004)
South Africa	0.005	(0.005)	0.004	(0.004)	0.991	(0.008)
Turkey	0.002	(0.003)	0.002	(0.003)	0.996	(0.006)
Average	0.003	(0.004)	0.003	(0.003)	0.994	(0.007)

Notes: Table 6 reports the posterior mean of variance share to common, asset (block), market development (subblock), and idiosyncratic shocks. The standard deviation is reported in parentheses. The sample period is April 2009 to December 2014.

financial crisis. In contrast to the previous literature, this paper's approach allows us to examine both equity and bond markets in the same context and the empirical results present that the global financial crisis has different impacts on equity and bond markets.

Table 6 Panel B presents that the equity-bond co-movement plays a small role for the developed bond markets with the average share of 20% in Period III. This is much smaller than those of Period I (63%) and Period II (51%). The idiosyncratic component is crucial, as Pozzi and Wolswijk (2012), Donadelli, Prosperi, Romei, and Silvestri (2013), and Christiansen (2014) have recognized. In particular, for Ireland, Spain, and Italy, almost all fluctuations can be traced back to the idiosyncratic components. However, the financial crisis does not play a substantial role for the emerging bond markets. This point has not been investigated by the previous studies. The share of the equity-bond co-movement is always marginal and the country specific reasons are main drivers to determine the fluctuations.

4.3. Common factors and market condition

This subsection investigates the relation between the co-movement and market condition. Following Connolly et al. (2005, 2007), the change in the Chicago Board Options Exchange Volatility Index (VIX) is adopted to capture the market condition.[5] The relation is motivated by a cross-market hedging decision. In other words, this test investigates the fight-to-quality. If market uncertainty increases, the bond return becomes higher, relative to the equity return for the hedge demand. If this relation holds, the change in VIX has a positive (negative) impact on the bond (equity) co-movement.

[5] Whaley (2000) shows that VIX capture investor sentiment and Ang, Hodrick, Xing, and Zhang (2006) provide evidence that the change in VIX prices equity market returns.

Table 7 displays that the conditional means of the co-movements. Observations are sorted by the change in VIX as in Connolly et al. (2005), and the averages of the co-movements are computed. The equity, developed equity, and emerging equity co-movements are become positive (negative) during VIX decreases (increases). Following Connolly et al. (2007), the bootstrap standard errors are reported in the parentheses and the mean values are above the two

Table 7 Conditional means of the co-movements and VIX

	Common	Equity	Bond	Developed	Emerging
0-25th Pctl	**0.086**	**0.277**	**-0.219**	**0.417**	**0.410**
	(0.020)	(0.028)	(0.063)	(0.039)	(0.042)
25-50th Pctl	**0.050**	**0.118**	-0.101	**0.143**	**0.116**
	(0.019)	(0.023)	(0.053)	(0.023)	(0.039)
50-75th Pctl	-0.005	0.017	0.027	0.007	0.040
	(0.019)	(0.025)	(0.054)	(0.027)	(0.038)
75-100th Pctl	**-0.118**	**-0.380**	**0.262**	**-0.559**	**-0.603**
	(0.025)	(0.037)	(0.072)	(0.052)	(0.058)

Notes: Table 7 reports on the relation between average of the co-movements and change in VIX. The bootstrap standard errors are reported in parentheses. Bold fonts indicate that the absolute mean value is above the two standard errors.

standard errors in the 0-25th and the 25-50th percentiles. In contrast, they are below the two standard errors in the 75-100th percentile. The magnitudes of the absolute mean values during VIX increases are greater than those during VIX decreases. For instance, the average equity co-movement is 0.28 in the 0-25th percentile, while it is -0.38 in the 75-100th percentile. In contrast, the bond co-movement shows the opposite relation to the equity co-movement. The mean value is positive when VIX increases. These implies that there is the cross-market hedging, as shown by Connolly et al. (2005, 2007). Moreover, the equity-bond co-movement shows the same pattern in terms of the equity factors and the mean value is positive during VIX decreases. This suggests that the relation is mainly driven by the equity markets.

5. Robustness

Table 8 Conditional means of the co-movements and other volatility indices

	Common	Equity	Bond	Developed	Emerging
Panel A: VDAX					
0-25th Pctl	**0.082**	**0.269**	**-0.214**	**0.378**	**0.350**
	(0.021)	(0.029)	(0.064)	(0.039)	(0.045)
25-50th Pctl	**0.035**	**0.112**	-0.076	**0.158**	**0.180**
	(0.017)	(0.025)	(0.051)	(0.027)	(0.037)
50-75th Pctl	-0.016	-0.026	0.056	**-0.074**	-0.052
	(0.021)	(0.026)	(0.061)	(0.029)	(0.043)
75-100th Pctl	**-0.087**	**-0.322**	**0.200**	**-0.452**	**-0.510**
	(0.024)	(0.038)	(0.069)	(0.055)	(0.058)
Panel B: NSVI					
0-25th Pctl	**0.043**	**0.140**	-0.095	**0.213**	**0.220**
	(0.021)	(0.031)	(0.063)	(0.042)	(0.049)
25-50th Pctl	0.007	0.048	-0.001	0.013	0.056
	(0.020)	(0.028)	(0.057)	(0.035)	(0.037)
50-75th Pctl	0.025	0.045	-0.103	0.011	0.053
	(0.021)	(0.028)	(0.058)	(0.036)	(0.043)
75-100th Pctl	**-0.061**	**-0.200**	**0.166**	**-0.226**	**-0.363**
	(0.024)	(0.041)	(0.068)	(0.057)	(0.066)
Panel C: World					
0-25th Pctl	0.004	**0.097**	-0.004	**0.124**	**0.122**
	(0.024)	(0.032)	(0.068)	(0.041)	(0.050)
25-50th Pctl	**0.034**	0.081	-0.073	**0.108**	**0.074**
	(0.017)	(0.048)	(0.048)	(0.032)	(0.037)
50-75th Pctl	**0.046**	0.069	**-0.118**	**0.069**	**0.098**
	(0.019)	(0.024)	(0.054)	(0.029)	(0.038)
75-100th Pctl	**-0.068**	**-0.215**	**0.161**	**-0.291**	**-0.353**
	(0.026)	(0.045)	(0.076)	(0.064)	(0.068)

Notes: Table 8 reports on the relation between average of the co-movements and change in volatility indices. Panel A uses the volatility index in the German equity market, Panel B uses that in the Japanese equity market, and Panel C uses the conditional volatility of the world equity market estimated by the GARCH model. The bootstrap standard errors are reported in parentheses. Bold fonts indicate that the absolute mean value is above the two standard errors.

The results in the previous section show that the equity-bond co-movement is related to market states estimated by the change in VIX[6]. I check the robustness of these results using other market indices. Volatility indices in the German stock market (VDAX) and the Japanese stock market (NSVI), and estimated conditional volatility of the world stock market index (World) are used in Table 8[7]. I can observe similar patterns. For instance, the equity-bond and equity co-movements are high in the 75-100th percentile, whereas the bond co-movement is low.

Finally, to see the benefits of adopting DHFM, I repeat the same estimations using co-movement factors obtained by the conventional Principal Component Analysis (PCA). Table 9 presents that the relation between the PCA factors and the change in VIX. Although the first and the second factors are strongly related to the change in VIX, it is difficult to interpret other three factors. Moreover, I cannot distinguish equity-bond and bond co-movements.

Table 9 Conditional means of the PCA and VIX

	PCA1	PCA2	PCA3	PCA4	PCA5
0-25th Pctl	**0.658**	**0.195**	-0.029	0.027	-0.005
	(0.062)	(0.078)	(0.087)	(0.079)	(0.079)
25-50th Pctl	**0.239**	0.050	-0.017	-0.059	-0.023
	(0.041)	(0.064)	(0.059)	(0.052)	(0.061)
50-75th Pctl	-0.002	-0.068	0.058	-0.116	0.028
	(0.045)	(0.065)	(0.054)	(0.063)	(0.061)
75-100th Pctl	**-0.903**	**-0.315**	-0.012	0.148	0.001
	(0.084)	(0.081)	(0.089)	(0.096)	(0.088)

Notes: Table 9 reports on the relation between average of the PCA and change in VIX. PCA*i* is obtained as the *i*-th principal component. The bootstrap standard errors are reported in parentheses. Bold fonts indicate that the absolute mean value is above the two standard errors.

[6] Gomes and Taamouti (2016) use a search index as the proxy of market states.
[7] I use the MSCI world index and estimate the conditional volatility by the GARCH model.

6. Conclusion

This study examines co-movements across equity and bond markets. To this end, the research employs the new principal component based method proposed by Moench et al. (2013), in order to specify heterogeneity of the asset class and market development. The empirical results reveal that both equity-bond and equity market co-movements are important for the developed equity markets. Although the idiosyncratic reason is more critical for the emerging equity markets, the importance of the equity-bond co-movement increases during the global financial crisis in 2008.

For the bond markets, the equity-bond co-movement dominates the fluctuations of the developed bond markets before the global financial crisis. However, the impact of the equity-bond co-movement does not increase during the crisis. This result implies that the crisis has heterogeneous impacts on the equity and bond markets. After the crisis, some bond markets do not co-move with the other countries. These findings are consistent with bond studies such as Pozzi and Wolswijk (2012) and Christiansen (2014). Moreover, this study shows that the idiosyncratic part explains almost all fluctuations of the emerging bond markets. This finding is not affected by the global financial crisis. This result suggests that the emerging bond markets are segmented from the world financial markets.

Finally, this study investigates the relation between the co-movements and market uncertainty as in Connolly et al. (2005, 2007). When market uncertainty is high, the equity market co-movements decrease, while the bond market co-movement increases. These suggest the cross-market hedging demand. The equity-bond co-movement also demonstrate the same pattern to the equity co-movement and this reflects that the equity co-movement is

the main driver for the relation between the equity-bond co-movement and market uncertainty.

References

Abad, P., Chulia, & Gomez-Puig, M. (2010). EMU and European government bond market integration. *Journal of Banking and Finance*, 34, 2851-2860.

Ang, A., Hodrick, R. J., Xing, Y., & Zhang, X. (2006). The cross-section of volatility and expected returns. *Journal of Finance*, 61, 259-299.

Aslanidis, N., & Christiansen, C. (2012). Smooth transition patterns in the realized stock-bond correlation. *Journal of Empirical Finance*, 19, 454-464.

Baele, L. (2005). Volatility spillover effects in European equity markets.*Journal of Financial and Quantitative Analysis*, 40, 373-401.

Baele, L., Bekaert, G., & Inghelbrecht, K. (2010). The determinants of stock and bond return comovements. *Review of Financial Studies*, 23, 2374-2428.

Barr, D. G., & Priestley, R. (2004). Expected returns, risk and the integration of international bond markets. *Journal of International Money and Finance*, 23, 71-97.

Bekaert, G., & Harvey, C. R. (1995). Time-varying world market integration. *Journal of Finance*, 50, 403-444.

Bekaert, G., Ehrmann, M., Fratzscher, M., & Mehl, A. (2014). Global crises and equity market contagion. *Journal of Finance*, 69, 2597-2649.

Bekaert, G., Harvey, C. R., Lundblad, C. T., & Siegel, S. (2011). What segments equity markets? *Review of Financial Studies*, 24, 3841-3890.

Bekaert, G., Harvey, C. R., Lundblad, C. T., & Siegel, S. (2013). The European union, the Euro, and equity market integration. *Journal of Financial Economics*, 109, 583-603.

Bekaert, G., Hodrick, R. J., & Zhang, X. (2009). International stock return comovements. *Journal of Finance*, 64, 2591-2626.

Cappiello, L., Engle, R. F., & Sheppard, K. (2006). Asymmetric dynamics in the correlations of global equity and bond returns. *Journal of Financial Econometrics*, 4, 537-572.

Cappiello, L., Kadareja, A., & Manganelli, S. (2010). The impact of the Euro on equity markets. *Journal of Financial and Quantitative Analysis*, 45(2), 473-502.

Christiansen, C. (2010). Decomposing European bond and equity volatility. *International Journal of Finance and Economics*, 15, 105-122.

Christiansen, C. (2014). Integration of European bond markets. *Journal of Banking and Finance*, 42, 191-198.

Christoffersen, P., Errunza, V., Jacobs, K., & Langlois, H. (2012). Is the potential for international diversification disappearing? A dynamic copula approach. *Review of Financial Studies*, 25, 3711-3751.

Connolly, R., Stivers, C., & Sun, L. (2005). Stock market uncertainty and the stock-bond return relation. *Journal of Financial and Quantitative Analysis*, 40, 161-194.

Connolly, R., Stivers, C., & Sun, L. (2007). Commonality in the time-variation of stock-stock and stock-bond return comovements. *Journal of Financial Markets*, 10, 192-218.

De Jong, F., & De Roon, F. (2005). Time-varying market integration and expected returns in emerging markets. *Journal of Financial Economics*, 78, 583-613.

Donadelli, M., & Paradiso, A. (2014). Is there heterogeneity in financial integration dynamics? Evidence from country and industry emerging market equity indexes. *Journal of International Financial Markets, Institutions and Money*, 32, 184-218.

Donadelli, M.,Prosperi, L., Romei, F,& Silvestri, F. (2013). Movements and co-movements among European Asset Classes: Portfolio allocation and policy implications. *Rivista Bancaria-Minerva Bancaria*, 1-2, 7-42.

Eiling, E., & Gerard, B. (2014). Emerging equity market comovements: trends and macroeconomic fundamentals. *Review of Finance*, 19, 1543-1585.

Förster, M., Jorra, M., & Tillmann, P. (2014). The dynamics of international capital flows: Results from a dynamic hierarchical factor model. *Journal of International Money and Finance*, 48, 101-124.

Garcia, R., & Tsafack, G. (2011). Dependence structure and extreme comovements in international equity and bond markets. *Journal of Banking and Finance*, 35, 1954–1970.

Gomes, P. & Taamouti, A. (2016). In search of the determinants of European asset market comovements. *International Review of Economics and Finance*, 44, 103-117.

Kose, M. A., Otrok, C., & Prasad, E. (2012). Global business cycles: convergence or decoupling? *International Economic Review*, 53, 511-538.

Kose, M. A., Otrok, C., & Whiteman, C. H. (2003). International business cycles: world, region, and country-specific factors. *American Economic Review*, 93, 1216-1239.

Moench, E., & Ng, S. (2011). A hierarchical factor analysis of U.S. housing market dynamics. *Econometrics Journal*, 14, C1-C24.

Moench, E., Ng, S., & Potter, S. (2013). Dynamic hierarchical factor models. *Review of Economics and Statistics*, 95, 1811-1817.

Ng, A. (2000). Volatility spillover effects from Japan and the US to the Pacific-Basin. *Journal of International Money and Finance*, 19, 207-233.

Panchenko, V., & Wu, E. (2009). Time-varying market integration and stock and bond return concordance in emerging markets. *Journal of Banking and Finance*, 33(6), 1014-1021.

Pozzi, L., & Wolswijk, G. (2012). The time-varying integration of Euro area government bond markets. *European Economic Review*, 56(1), 36-53.

Pukthuanthong, K., & Roll, R. (2009). Global market integration: an alternative measure and its application. *Journal of Financial Economics*, 94, 214-232.

Scruggs, J. T., & Glabadanidis, P. (2003). Risk Premia and the dynamic covariance between stock and bond returns. *Journal of Financial and Quantitative Analysis*, 38, 295-316.

Tsukuda, Y., Shimada, J., & Miyakoshi, T. (2017). Bond market integration in East Asia: Multivariate GARCH with dynamic conditional correlations approach. *International Review of Economics and Finance*, 51, 193-213.

Volosovych, V. (2011). Measuring financial market integration over the long run: Is there a U-shape? *Journal of International Money and Finance*, 30, 1535-1561.

Whaley, R. E. (2000). The investor fear gauge. *Journal of Portfolio Management*, Spring, 12-17.