Journal of Korea Trade Vol. 27, No. 1, February 2023, 139-158
https://doi.org/10.35611/jkt.2023.27.1.139
ISSN 1229-828X

Changes in Stock Market Co-movements between Contracting Parties after the Trade Agreement and Their Implications*

JKT 27(1)

Received 24 November 2022
Revised 9 January 2023
Accepted 10 February 2023

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Abstract

Purpose – The study of co-movements between stock markets is a crucial area of finance and has recently received much interest in a variety of studies, especially in international finance. Stock market co-movements are a major phenomenon in financial markets, but they are not necessarily independent of the real market. Several studies support the idea that bilateral trade linkages significantly impact stock market correlations. Motivated by this perspective, this study investigates whether real market integration due to trade agreements brings about financial market integration in terms of stock market co-movement.

Design/methodology – Over the 10 free trade agreements (FTAs) signed by the United States, using a dynamic conditional correlations (DCC) multivariate GARCH (MGRACH) model, we empirically measure the degree of integration by finding DCCs between the US market and the partner country's market. We then track how these correlations evolve over time and compare the results before and after trade agreements.

Findings – According to the empirical results, there are positive return spillover effects from the US market to eight counterpart equity markets, except Jordan, Morocco, and Singapore. Especially Mexico, Canada, and Chile have large return spillover effects at the 1% significance level. All partner countries of FTAs generally have positive correlations with the US over the entire period, but the size and variance are somewhat different by country. Meanwhile, not all countries that signed trade agreements with the United States showed the same pattern of stock market co-movement after the agreement. Korea, Mexico, Chile, Colombia, Peru, and Singapore show increasing DCC patterns after trade agreements with the US. However, Canada, Australia, Bahrain, Jordan, and Morocco do not show different patterns before and after trade agreements in DCCs. These countries generally have the characteristic of relatively lower or higher co-movements in stock markets with the US before the signing of the FTAs.

Originality/value – To our knowledge, few studies have directly examined the linkages between trade agreements and stock markets. Our approach is novel as it considers the problem of conditional heteroscedasticity and visualizes the change of correlations with time variations. Moreover, analyzing several trade agreements based on the United States enables the results of cross-country pairs to be compared. Hence, this study provides information on the degree of stock market integration with countries with which the United States has trade agreements, while simultaneously allowing us to track whether there have been changes in stock market integration patterns before and after trade agreements.

Keywords: DCC-GARCH Model, Stock Market Co-movements, Trade Agreements, Trade Intensity, United States
JEL Classifications: F14, F15, F36

* This work was supported by the Daegu University Research Grant 2020.
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1. Introduction

The study of co-movements between stock markets is a crucial area of finance and has recently received much interest in a variety of studies, especially in international finance. How do correlations between stock markets change over time and are they persistent? Is there a difference between the synchronization patterns in developed and developing countries? Does the global financial crisis strengthen the co-movement of the world stock markets? What are the determinants of cross-country financial interdependence? These are the main topics frequently mentioned. Various causal relationships have been discussed as the cause of this financial market synchronization. The extent of financial market synchronization is important to many economic agents. Cross-country correlations between returns in international equity markets are crucial for appropriate portfolio selection.

Stock market co-movements are major phenomena in financial markets, but they are not necessarily independent of the real market. Understanding the role of increasing economic integration among countries and their impact on their stock markets has been very interesting to academia, policymakers, and practitioners for many years. Several studies support the idea that bilateral trade linkages significantly impact stock market correlations. Bracker, Docking, and Koch (1999) investigated how and why each pair of national equity markets displayed varying degrees of co-movement over time and reported that trade had a significant impact on the degree of stock market integration. Pretorius (2002) examined the determinants of interdependence for emerging stock markets in Africa, Asia, Latin America, and Europe using cross-sectional and time-series datasets. This study argues that bilateral trade relations and industrial growth differentials are major determinants of stock market interdependence. Likewise, Johnson and Soenen (2003) provide evidence to support the view that economic integration between countries has a significant influence on their stock market correlations in the Americas. They found that a high share of trade with the United States had a strong positive effect on stock market co-movements. Forbes and Chinn (2004) and Hornbeck (2004) showed that trade intensity was a significant factor in explaining the correlations between stock markets. Chambet and Gibson (2008) also find that financial markets are more integrated among countries with a uniform trade structure. The authors argue that increasing openness to international trade might positively contribute to the integration of financial markets among nations. They also suggest that financial markets were more segmented among countries that had not fully allowed international trade. Using a sample of developed and emerging markets, Tavares (2009) found that increasing bilateral trade intensity increases the correlation of stock market returns. These empirical results support the claim that an increase in trade volume in the real market also affects the capital market. Beine and Candelon (2011) investigated the impact of trade and financial liberalization on the degree of stock market co-movement among emerging economies. Their results strongly support the positive impact of trade and financial liberalization on the degree of cross-country stock market linkages. The results in most of the literature indicate that bilateral trade linkages between countries have a significant impact on stock market interdependence. However, some studies report that trade linkages have no impact on stock market relations. For example, Paramati, Gupta, and Roca (2015) failed to confirm the impact of bilateral trade linkage on stock market correlations for the Australasian region. However, these studies also attempt to prove that changes in the real market can affect the stock market.

Motivated by this perspective, we investigate whether real market integration due to trade agreements brings about financial market integration in terms of stock market co-movements. According to various previous studies, it can be assumed that changes in the real market due to a certain cause affect the capital market. However, few studies focus on free trade agreements (FTAs) as a cause of changes in the real market. To our knowledge, only one study has directly examined the linkages between trade agreements and the stock market. Ewing et al. (1999) tested the co-movements of North American stock markets, in the long run, using a co-integration methodology. They found no co-integration in these markets, even when the North American Free Trade Agreement (NAFTA) was taken into account. However, the conditional heteroscedasticity of the error term tends to influence the cointegration test. Lee and Tse (1996) and Tse (2000) stated that in the case of the presence of GARCH errors, this method might not be able to achieve significant results, even though a co-integration relationship exists.

Therefore, we attempted to conduct an analysis utilizing a new methodology to address these problems. Over the 10 FTAs signed by the United States, using a DCC multivariate GARCH (MGRACH) model, we empirically measure the degree of integration by finding the DCCs between the US market and the partner country's market. We then track how these correlations evolve over time and compare the results before and after trade agreements. Our approach is new as it considers the problem of conditional heteroscedasticity and visualizes the change in correlation with time variation. Moreover, analyzing several trade agreements based in the United States enables us to compare the findings of cross-country pairs. Thus, this study provides information on the degree of integration of stock markets with countries that have trade agreements with the United States while simultaneously allowing us to track whether there have been changes in stock market integration patterns before and after trade agreements.

The remainder of this paper is organized as follows. Section 2 introduces several papers measuring stock market co-movements between countries, and presents the methodology and data of this paper. In Section 3, we discuss the empirical results of the DCC-GARCH model and estimate dynamic conditional correlations (DCCs). Finally, Section 4 summarizes the main results and suggests future research topics.

2. Methodology and Data

2.1. Literature on the Measurement of stock market co-movement

Numerous studies investigate the transmission mechanisms of stock price movements across international equity markets. King and Wadhwani (1990) and Baig and Goldfajn (1999), an early group of studies on stock market co-movements, focused on finding evidence of a significant increase in unconditional correlations of stock returns among countries. However, Forbes and Rigobon (2002) and Bordo and Murshid (2001) claimed that previous studies have shown biased results because they failed to account for heteroscedasticity. To resolve the heteroscedasticity issue in co-movement analysis, some studies have utilized the GARCH model and attempted to show the existence of a variance spillover effect. Hamao et al. (1990) utilized ARCH models and reported a price volatility spillover effect among three major international stock markets: Tokyo, London, and New York. Kanas (1998) employs the EGARCH model and shows spillover effects in European equity markets. Ng (2000) adopted the multivariate GARCH model and revealed that the Pacific Basin stock markets were driven by a regional shock from Japan and a global shock from the US. Furthermore, following Engle's (2002) method, many studies employ the DCC-MGARCH model to show the contagion effects of a crisis. Our study also focuses on the literature that employs the DCC-MGARCH model.

Regarding the Asian crisis, Yang (2005) examined the international stock market correlations between Japan and the Four Asian Tigers with a DCC estimation using daily data from 1990 to 2003. The results show that stock market correlations fluctuate widely over time and volatilities appear to be contagious across markets. Additionally, correlations increased during the period of high market volatilities when risk diversification was needed the most, which was bad news for international diversification. By analyzing the correlation coefficient series, Chiang et al. (2007) identified two different phases of the Asian crisis. The first showed an increase in correlation (contagion), whereas the second showed a continued high correlation (herding). Statistical analysis of the correlation coefficients also revealed a shift in variance during the crisis period, casting doubt on the benefits of international portfolio diversification. Huyghebaert and Wang (2010) investigate the integration and causality of interdependencies among seven major East Asian stock exchanges before, during, and after the 1997-1998 Asian financial crisis. Their dataset showed that the relationships among East Asian stock markets varied over time. They discovered that stock market interactions were limited before the Asian financial crisis, but Hong Kong and Singapore responded significantly to shocks in most East Asian markets during this crisis. After the crisis, shocks in Hong Kong and Singapore largely impacted other East Asian stock markets, except for those in Mainland China. The USA strongly influenced stock returns in East Asia, except for Mainland China, in all periods, while the reverse did not hold.

Another group of studies analyzes the spillover effects of the global financial crisis. Savva et al. (2009) investigated the spillover effect from the US to major European stock markets and identified the role of the euro. Statistical break tests confirmed that the introduction of the euro significantly affected cross-market correlations. Although dynamic correlations of shocks between all market pairs increased during the crisis, the correlation between Frankfurt and Paris in the post-euro period was the highest, indicating increased integration of these markets. Other findings have shown that negative shocks have larger effects than positive shocks. Notably, Horvath and Poldauf (2012) investigated stock market co-movements in Australia, Brazil, Canada, China, Germany, Hong Kong, Japan, Russia, South Africa, the UK, and the US, both at the market and sectoral level in 2000-2010. Using multivariate GARCH models, their results suggest that the correlations among equity returns during the financial crisis somewhat increased. The US stock market was found to be the most correlated with the stock markets in Brazil, Canada, and the UK. The correlation between the US and Chinese stock markets was essentially zero before the crisis but became slightly positive during the crisis. The sectoral indices were less correlated than the market indices over the entire period, although the correlations increased during the crisis. Hwang, Min, and Kim (2013) analyzed the DCCs of daily stock returns between 10 emerging economies and the US during the crisis period of 2006-2010. They find different patterns of crisis spillover among these emerging markets and discover three distinctive phases of crisis spillover: contagion, herding, and post-crisis adjustment. They also showed that increases in credit default swap (CDS) and treasury-eurodollar rate (TED) spreads decreased conditional correlations, while increases in foreign institutional investment, exchange market volatility, and the CBOE Volatility Index (VIX) of the S&P 500 increased conditional correlations.

2.2. DCC-GARCH Model

Measuring methods of co-movement between stock markets include vector autoregression (VAR), Grander causality, co-integration, vector error-correction model (VECM), Markov-switching models, ARCH, GARCH, CCC-GARCH, and so on. Among these methods, we employed the DCC estimator proposed by Engle (2002). The DCC-GARCH model is more flexible than the constant conditional correlation (CCC) model, yet more parsimonious than the widely employed parametric model. In particular, we chose this model among several models because we have to track changes in stock market co-movements between countries over time. For example, in the case of the CCC model, since co-movements between countries have a fixed value, it is difficult to confirm dynamic movements. For ease of exposition, we present a model for N = 2, that is, two stock markets.

Let $R_t = [R_{1t}, R_{2t}]'$ be a 2×1 vector containing the equity market returns in the conditional mean equation. A VAR representation of the conditional mean equation can be expressed as in Eq. (1):

$$A(L)\, y_t = e_t \qquad \text{where } e_t | \Omega_{t-1} \sim N(0, H_t) \quad \forall t = 1, \ldots, T \tag{1}$$

A(L) is a polynomial matrix in the lag operator L, and $H_t \equiv \{h_{it}\}$ for $\forall_i = 1,2$ is the conditional variance-covariance matrix of the equity returns vector $R_t = [R_{1t}, R_{2t}]'$. Ω_{t-1} is the information set that includes all information up to time t-1. The first DCC-GARCH component of the framework can be rewritten as the conditional variance-covariance matrix in Eq. (2):

$$H_t = D_t R_t D_t \tag{2}$$

where $D_t = \text{diag}(\sqrt{h_{ii,t}})$ is a 2×2 diagonal matrix of time-varying conditional standard deviations from univariate GARCH models and $R_t = \{\rho_{ij}\}_t$ is the time-varying conditional quasi-correlation matrix containing conditional correlation coefficients. The conditional variance h_{it} follows univariate GARCH processes in the following manner. In Eq. (3), α_{ip} is the ARCH parameter and β_{iq} is the GARCH parameter.

$$h_{i.t} = \omega_i + \sum_{p=1}^{P_i} \alpha_{ip} \varepsilon^2{}_{i.t-p} + \sum_{q=1}^{Q_i} \beta_{iq} h_{i.t-q} \qquad \forall i = 1,2 \tag{3}$$

The second component of the framework consists of a specific DCC structure that can be expressed by Eq. (4):

$$R_t = Q_t^{*-1} Q_t Q_t^{*-1} \quad \text{where} \quad Q_t = (1 - \lambda_1 - \lambda_2)\bar{Q} + \lambda_1 \varepsilon_{t-1} \varepsilon'{}_{t-1} + \lambda_2 Q_{t-1} \tag{4}$$

$\bar{Q}$ is the unconditional correlation matrix of the ε's, and $Q^*_t = \text{diag}(\sqrt{q_{ii,t}})$ is a 2×2 diagonal matrix containing the square root of the diagonal elements of $Q_t = \{q_{ij}\}_t$. Scalar parameters λ_1 and λ_2 capture the effects of previous shocks and previous dynamic correlations. In other words, λ_1 and λ_2 are parameters that govern the dynamics of the conditional quasi-correlations. In Eq. (4), λ_1 and λ_2 are non-negative and satisfy $0 < \lambda_1 + \lambda_2 < 1$.

In this study, our key element of interest in R_t is $\rho_{12,t} = q_{12,t}/\sqrt{q_{11,t} q_{22,t}}$, which represents the conditional correlation between US stock returns and those of other countries. Finally, the maximum likelihood method is used to estimate the parameters. Assuming conditional normality, the log-likelihood function has the following form:

$$L = [-\frac{1}{2}\sum_{t=1}^{T}(n\log(2\pi) + \log \mid D_t \mid^2 + \varepsilon'_t D_t^{-2}\varepsilon_t)]$$

$$+ [-\frac{1}{2}\sum_{t=1}^{T}(log \mid R_t \mid + \varepsilon'_t R_t^{-1}\varepsilon_t + \varepsilon'_t\varepsilon_t)] \tag{5}$$

Engle (2002) proposed a two-step approach to estimate the DCC model.

2.3. Data and Summary

We collected daily stock prices of national indices from Datastream, considering the period of each of the 10 FTAs. Table 1 lists the stock indices utilized in this study.

Table 1. Stock Index

Country	Index Name	Code
Korea	KOREA SE COMPOSITE INDEX (KOSPI)	KORCOMP(PI)
Mexico	MEXICO IPC (BOLSA)	MXIPC35(PI)
Canada	S&P/TSX COMPOSITE INDEX	TTOCOMP(PI)
Australia	S&P/ASX 200 INDEX	ASX200I(PI)
Bahrain	BAHRAIN ALL SHARE	BHRALSH(PI)
Chile	CHILE SANTIAGO SE GENERAL (IGPA)	IGPAGEN(PI)
Colombia	COLOMBIA IGBC INDEX	COLIGBC(PI)
Jordan	AMMAN SE FINANCIAL MARKET	AMMANFM(PI)
Morocco	MOROCCO ALL SHARE (MASI)	MASIIDX(PI)
Peru	S&P/BVL GENERAL(IGBVL)	PEGENRL(PI)
Singapore	STRAITS TIMES INDEX L	SNGPORI(PI)
US	S&P 500 COMPOSITE INDEX	S&PCOMP(PI)

Source: Datastream.

Currently, the United States has FTAs with 19 countries: Israel, Korea, Mexico, Canada, Australia, Bahrain, Chile, Colombia, Jordan, Morocco, Oman, Peru, Panama, Singapore, the Dominican Republic, El Salvador, Guatemala, Honduras, and Nicaragua. However, in this paper, we examine only 11 countries: not including Israel, Oman, Panama, the Dominican Republic, El Salvador, Guatemala, Honduras, and Nicaragua. The US-Israel FTA was signed on April 22, 1985, when the stock market was not developed in earnest. The stock markets of Panama, the Dominican Republic, El Salvador, Guatemala, Honduras, and Nicaragua are still immature, so the data are limited. In the case of Oman, the DCC-GARCH method is inappropriate for these analyses.

Table 2 shows RTA_names and the period of each analysis. Basically, the analysis period is divided into three parts: the five years before signature, the transition period, and the five years after entry into force. In the case of Mexico, Bahrain, Morocco, and Singapore, the period before the signature is shorter than five years because of limited data coverage.

Table 2. RTA_Names and the Period of Analysis

RTA_name	Counterpart Country	Before Signature (1)*	Transition Period (2)	After Entry into Force (3)*
KOREA-US	Korea	02-06-30~07-06-29	07-06-30~12-03-15	12-03-16~17-03-15
AFTA	Mexico	88-01-04~92-12-16	92-12-17~94-01-01	94-01-02~99-01-01
NAFTA	Canada	87-12-17~92-12-16	92-12-17~94-01-01	94-01-02~99-01-01
US-Australia	Australia	99-05-18~04-05-17	04-05-18~05-01-01	05-01-02~10-01-01
US-Bahrain	Bahrain	03-01-02~05-09-13	05-09-14~06-08-01	06-08-02~11-08-01
US-Chile	Chile	98-06-06~03-06-05	03-06-06~04-01-01	04-01-02~09-01-01
US-Colombia	Colombia	01-11-22~06-11-21	06-11-22~12-05-15	12-05-16~17-05-15
US-Jordan	Jordan	95-10-24~00-10-23	00-10-24~01-12-17	01-12-18~06-12-17
US-Morocco	Morocco	02-01-02~04-06-14	04-06-15~06-01-01	06-01-02~11-01-01
US-Peru	Peru	01-04-12~06-04-11	06-04-12~09-02-01	09-02-02~14-02-01
US-Singapore	Singapore	99-08-31~03-05-05	03-05-06~04-01-01	04-01-02~09-01-01

Note: The transition period is from the signature date to the entry into force date.
Source: Authors' summary using World Trade Organization (WTO) regional trade agreement (RTA) database.

Most of the level variables of macroeconomic and financial time-series data are non-stationary. Accordingly, there is a possibility of spurious regression. Therefore, the analysis begins with Augmented Dickey-Fuller (ADF, 1981) and Phillips–Perron (PP, 1988) unit root tests for each stock market in the full period. The null hypothesis is that the variable contains a unit root and the alternative is that the variable is generated by a stationary process. Table 3 presents the test results. From Table 3, we can see that the original series in the levels are not stationary. In contrast, all daily returns, R_{it}, are stationary at the 1% significance level.

R_{it} is calculated as follows. Let Y_t denote the closing price at time t. To achieve stationarity, we transform the nominal stock price data by taking the first difference of the logarithm for each stock price series and multiplying it by 100.

$$R_t = 100 \times \log(Y_t/Y_{t-1}) = 100 \times [\log(Y_t) - \log(Y_{t-1})] \tag{6}$$

Plots of daily indices and returns for each market series are illustrated in Fig. 1. These figures are the trend charts of the daily stock indices and returns of each country in the sample period of the FTAs. Gray shading indicates the transition period for trade agreements. The figures below show the presence of the volatility clustering phenomenon during the selected sample period. This second-order dependence of squared returns can be captured by a GARCH process. Following a rough estimate, Bahrain, Colombia, and Jordan have different patterns of stock indices and returns from those of the US. However, they are not easily distinguishable from the eye.

Table 3. Unit Root Tests: Full Period

	Levels		Differences	
	ADF Test	PP Test	ADF Test	PP Test
US	-1.883	-1.984	-52.181***	-90.606***
Korea	-1.981	-1.959	-28.134***	-58.284***
Mexico	-2.772	-2.258	-21.924***	-43.698***
Canada	-1.985	-1.813	-24.542***	-45.436***
Australia	-1.476	-1.535	-27.349***	-54.764***
Bahrain	-1.054	-1.074	-30.539***	-40.020***
Chile	-2.097	-1.866	-19.838***	-41.915***
Colombia	-0.920	-0.846	-40.138***	-52.264***
Jordan	-1.215	-1.220	-31.274***	-51.499***
Morocco	-1.195	-1.141	-25.518***	-35.047***
Peru	-0.458	-0.239	-23.023***	-49.391***
Singapore	-1.198	-1.184	-48.490***	-48.490***

Note: 1) Significance at ***1, **5, and *10 percent levels. 2) The intercept was included in the regression to test all variables.
Source: Authors' analysis using daily stock prices.

Fig. 1. Daily Stock Indices and Returns

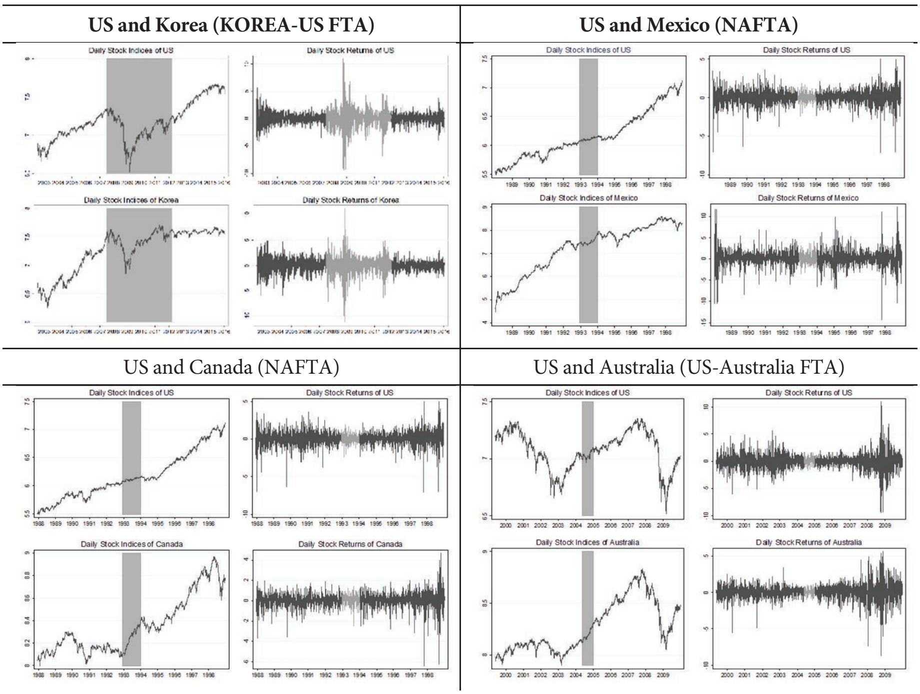
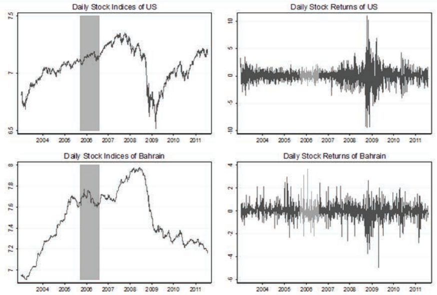
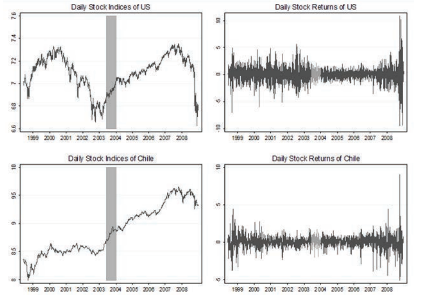


Fig. 1. (Continued)

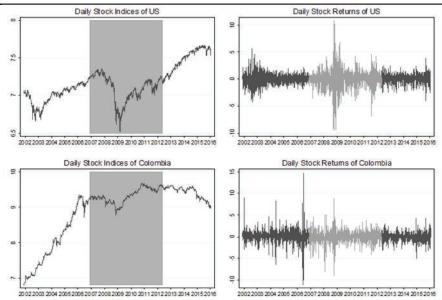
US and Bahrain (US-Bahrain FTA)



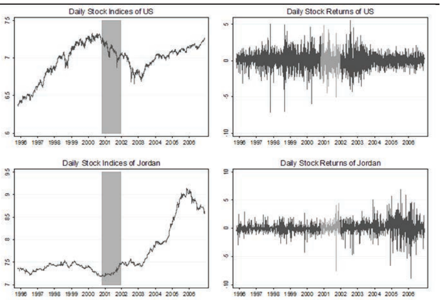
US and Chile (US-Chile FTA)



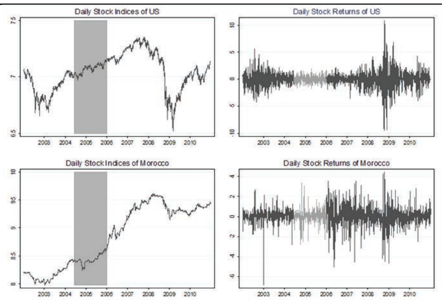
US and Colombia (US-Colombia FTA)



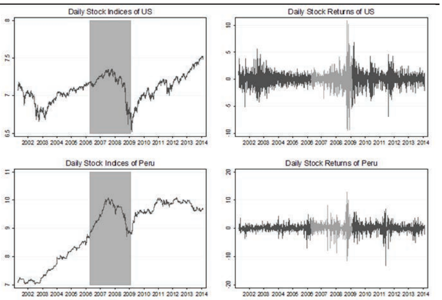
US and Jordan (US-Jordan FTA)



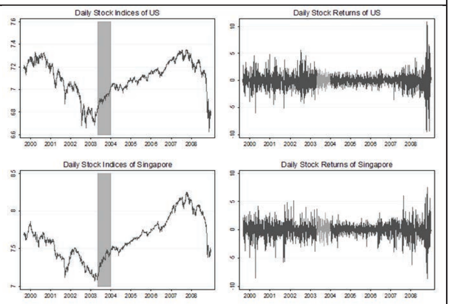
US and Morocco (US-Morocco FTA)



US and Peru (US-Peru FTA)



US and Singapore (US-Singapore FTA)



Source: Authors' analysis.

Table 4 presents the summary statistics of the data. Based on the full sample period, the average returns of all countries, except Singapore, are positive, and Mexico has the largest average return of 0.1276. However, comparing the absolute values of returns among countries does not make sense because the analysis period differs from country to country. Mexico also

Table 4. Summary Statistics of the Stock Returns

	Korea	Mexico	Canada	Australia	Bahrain	Chile
			Full Period			
Mean	0.0264	0.1276	0.0251	0.0184	0.0096	0.0352
Median	0.0182	0.0285	0.0305	0.0190	0.0000	0.0220
Maximum	11.2843	12.1537	4.6835	5.6282	3.6132	9.0578
Minimum	-11.1720	-14.3139	-6.3728	-8.7043	-4.9200	-5.0168
Std.Dev.	1.3580	1.7530	0.6673	1.0303	0.6150	0.7842
Skewness	-0.4798	0.0023	-1.0311	-0.5735	-0.4484	-0.0041
Kurtosis	9.4758	10.9202	12.9213	10.3552	9.2775	14.5151
Observation	3537	2869	2882	2774	2237	2759
			The Period Before Signature			
Mean	0.0654	0.2185	0.0036	0.0104	0.0996	0.0261
Median	0.0837	0.1066	0.0000	0.0035	0.0499	0.0000
Maximum	4.8772	11.7086	1.9288	3.4447	2.9435	4.4666
Minimum	-5.9654	-10.5259	-3.6757	-5.5498	-2.3129	-3.7735
Std.Dev.	1.3634	1.7141	0.5545	0.7414	0.4903	0.7177
Skewness	-0.3395	0.0347	-0.5025	-0.5850	0.7552	0.0878
Kurtosis	4.6238	11.4918	6.6447	7.7451	8.2374	7.5605
Observation	1305	1292	1305	1305	703	1304
			Transition Period			
Mean	0.0129	0.1536	0.0996	0.1166	-0.0082	0.1321
Median	0.0314	0.0867	0.1199	0.1146	-0.0175	0.1627
Maximum	11.2843	4.0960	1.4180	1.0865	3.6132	1.7009
Minimum	-11.1720	-3.4994	-2.5006	-1.0904	-2.1976	-1.9497
Std.Dev.	1.6856	1.2128	0.4859	0.4167	0.7156	0.6502
Skewness	-0.5429	0.1774	-0.8462	-0.1934	0.8176	-0.5262
Kurtosis	9.2236	3.4140	6.3833	3.1744	7.4951	3.7322
Observation	1229	272	272	164	230	150
			The Period After Entry Into Force			
Mean	-0.0078	0.0322	0.0311	0.0141	-0.0358	0.0333
Median	0.0000	0.0000	0.0653	0.0119	0.0000	0.0553
Maximum	2.9124	12.1537	4.6835	5.6282	2.6217	9.0578
Minimum	-3.4615	-14.3139	-6.3728	-8.7043	-4.9200	-5.0168
Std.Dev.	0.7770	1.8779	0.7909	1.2980	0.6504	0.8581
Skewness	-0.0331	-0.0028	-1.1594	-0.4872	-0.9171	-0.0249
Kurtosis	4.7180	10.1900	12.7005	7.9079	8.9772	17.5862
Observation	1003	1305	1305	1305	1304	1305

Table 4. (Continued)

	Colombia	Jordan	Morocco	Peru	Singapore	US
			Full Period			
Mean	0.0587	0.0417	0.0525	0.0761	-0.0088	0.0276
Median	0.0218	0.0000	0.0374	0.0243	0.0000	0.0264
Maximum	14.6879	6.8164	4.4635	12.8156	7.5306	10.9571
Minimum	-11.0519	-8.8549	-6.8172	-13.2908	-8.6960	-9.4695
Std.Dev.	1.2844	0.9666	0.8408	1.4736	1.2994	1.1065
Skewness	-0.1936	-0.3098	-0.6244	-0.5139	-0.4055	-0.2930
Kurtosis	16.0348	13.8187	10.0112	14.2726	7.8127	12.0978
Observation	3694	2909	2347	3342	2437	7329
			The Period Before Signature			
Mean	0.1866	-0.0132	0.0334	0.1254	-0.0546	
Median	0.1458	0.0000	0.0365	0.0501	-0.0314	
Maximum	14.6879	2.9449	2.7317	4.8898	5.1524	
Minimum	-11.0519	-4.2573	-6.8172	-6.8836	-8.5488	
Std.Dev.	1.4860	0.6004	0.6002	0.9464	1.3502	
Skewness	-0.0756	0.0667	-2.2931	-0.2501	-0.2966	
Kurtosis	18.9517	8.2521	31.1985	9.1247	5.8520	
Observation	1304	1305	638	1304	959	
			Transition Period			
Mean	0.0233	0.0859	0.0467	0.0143	0.1678	
Median	0.0069	0.0000	0.0542	0.0000	0.1979	
Maximum	8.7952	4.3071	3.3118	12.8156	3.0084	
Minimum	-9.0849	-7.5835	-2.8235	-11.4408	-2.8430	
Std.Dev.	1.2612	0.8949	0.6382	2.1189	1.1084	
Skewness	-0.5634	-1.1478	-0.1328	-0.3932	-0.0765	
Kurtosis	9.8546	24.3638	8.8703	9.9250	3.1676	
Observation	1430	300	405	733	173	
			The Period After Entry Into Force			
Mean	-0.0622	0.0864	0.0636	0.0617	0.0014	
Median	0.0000	0.0000	0.0352	0.0000	0.0263	
Maximum	4.2654	6.8164	4.4635	6.9163	7.5306	
Minimum	-5.0146	-8.8549	-5.0167	-13.2908	-8.6960	
Std.Dev.	0.9717	1.2391	0.9850	1.4640	1.2834	
Skewness	-0.1267	-0.3268	-0.4558	-0.4700	-0.5040	
Kurtosis	5.5315	9.5057	6.9894	11.3855	9.8122	
Observation	960	1304	1304	1305	1305	

Source: Authors' analysis.

had the highest standard deviation for risk measures, whereas Bahrain showed the lowest variation. As with most financial time series data, we find that all countries except Mexico are positively skewed; in other words, they indicate a long right-fat tail. The kurtosis of each series is higher than that of the normal distribution, which has a kurtosis of three. Hence, the empirical distribution has more weight in the tails and is leptokurtic. These series have asymmetric distributions. If the normality assumption does not hold for the standardized residuals, we must estimate the parameters of the GARCH model using Quasi-Maximum Likelihood (QML) instead of Maximum Likelihood (ML).

3. Empirical Results

3.1. Estimation of the DCC-GARCH model

In this section, we estimate the DCC-GARCH model using Eqs. (7)–(11) as follows:

Return equations:

$$R_{i,t} = \gamma_0 + \gamma_1 R_{i,t-1} + \gamma_2 R_{US,t-1} + \varepsilon_{1,t} \quad (7)$$

$$R_{US,t} = \delta_0 + \delta_1 R_{i,t-1} + \delta_2 R_{US,t-1} + \varepsilon_{2,t} \quad (8)$$

Variance equations:

$$h_{11,t} = a_0 + a_1 \varepsilon^2_{1,t-1} + a_2 h_{11,t-1} \quad (9)$$

$$h_{22,t} = b_0 + b_1 \varepsilon^2_{2,t-1} + b_2 h_{22,t-1} \quad (10)$$

$$h_{12,t} = h_{21,t} = (1-\lambda_1-\lambda_2)h + \lambda_1 \varepsilon_{t-1} \varepsilon'_{t-1} + \lambda_2 h_{12,t-1} \quad (11)$$

Theodossiou et al. (1997) and Martens and Poon (2001) mentioned the need for additional re-adjustment of the stock market dates to not underestimate the true correlations between these stock markets because the international financial markets had different trading hours for each country.

From this perspective, we matched the "t-1" date of the US with the "t" date of Korea, Australia, Bahrain, Jordan, Oman, Morocco, and Singapore to obtain dynamic conditional correlations. We looked at unconditional correlations between these countries and the US to determine which cross-county(i) pairs have the probability of underestimating the true correlations. Furthermore, to ensure the homogeneity of the data, we used only the raw data of the days when the two markets were both open. In Jordan, there are too many holidays to ignore. Table 5 presents the estimation results from Eqs. (7) and (11), respectively.

From Table 5, we can see that lagged US stock returns (coefficient γ_2) in the mean equation are positive and significant for all countries except Jordan, Morocco, and Singapore. This implies that there are positive return spillover effects from the US market to the eight counterpart equity markets. Mexico (0.2172), Canada (0.2130), and Chile (0.2538) had large return spillover effects at the 1% significance level. The magnitude of the spillover ranged from 0.0280 (Bahrain) to 0.2538 (Chile). No country has a negative return spillover effect from the US. In the case of the US, there are significant return spillover effects from the lagged stock returns (coefficient δ_1) of Korea, Mexico, Australia, Chile, Colombia, Peru, and Singapore. Among these countries, Chile, Colombia, and Peru, which are in the Americas, have negative return signals to the US. The others have a positive sign. There is also no significant return spillover from Canada, Bahrain, Jordan, or Morocco to the US.

Most countries except Korea and Singapore are influenced by their own lagged returns (coefficient γ_1), and the direction of the sign is positive in countries other than Australia. However, the US is influenced by its own lagged returns (coefficient δ_2) in the negative direction, except in the case of the US-Colombia FTA.

Table 5. Estimation Results of the DCC-GARCH Model

	Korea	Mexico	Canada	Australia	Bahrain
Return equation	$R_{i,t} = \gamma_0 + \gamma_1 R_{i,t-1} + \gamma_2 R_{US,t-1} + \varepsilon_{1,t}$, $R_{US,t} = \delta_0 + \delta_1 R_{i,t-1} + \delta_2 R_{US,t-1} + \varepsilon_{2,t}$				
Variance equation	$h_{11,t} = a_0 + a_1 \varepsilon^2_{1,t-1} + a_2 h_{11,t-1}$, $h_{22,t} = b_0 + b_1 \varepsilon^2_{2,t-1} + b_2 h_{22,t-1}$ $h_{12,t} = h_{21,t} = (1-\lambda_1-\lambda_2)h + \lambda_1 \varepsilon_{t-1}\varepsilon'_{t-1} + \lambda_2 h_{12,t-1}$				
Variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
γ_0	0.0542***	0.1193***	0.0269***	0.0588***	0.0181*
	(0.0178)	(0.0262)	(0.0103)	(0.0140)	(0.0109)
γ_1	-0.0262	0.1418***	0.0317*	-0.0853***	0.1837***
	(0.0195)	(0.0338)	(0.0169)	(0.0228)	(0.0251)
γ_2	0.0427**	0.2172***	0.2130***	0.0301**	0.0280***
	(0.0213)	(0.0207)	(0.0240)	(0.0152)	(0.0107)
δ_0	0.0589***	0.0605***	0.0572***	0.0377**	0.0492***
	(0.0140)	(0.0142)	(0.0140)	(0.0174)	(0.0185)
δ_1	0.1475***	0.0499**	0.0206	0.1705***	0.0137
	(0.0140)	(0.0207)	(0.0245)	(0.0255)	(0.0316)
δ_2	-0.1436***	0.0081	0.0209	-0.1416***	-0.0802***
	(0.0193)	(0.0086)	(0.0292)	(0.0227)	(0.0232)
a_0	0.0171***	0.1485***	0.0148***	0.0091***	0.0122***
	(0.0042)	(0.0236)	(0.0029)	(0.0024)	(0.0031)
a_1	0.0771***	0.1317***	0.0864***	0.0743***	0.1647***
	(0.0082)	(0.0148)	(0.0112)	(0.0102)	(0.0225)
a_2	0.9135***	0.8165***	0.8774***	0.9170***	0.8228***
	(0.0090)	(0.0192)	(0.0159)	(0.0112)	(0.0216)
b_0	0.0209***	0.0048***	0.0114***	0.0103***	0.0121***
	(0.0036)	(0.0017)	(0.0032)	(0.0026)	(0.0033)
b_1	0.0996***	0.0345***	0.0543***	0.0653***	0.0694***
	(0.0100)	(0.0056)	(0.0080)	(0.0079)	(0.0096)
b_2	0.8816***	0.9599***	0.9311***	0.9276***	0.9194***
	(0.0111)	(0.0069)	(0.0108)	(0.0084)	(0.0107)
λ_1	0.0126**	0.0356***	0.0309***	0.0548***	0.0168
	(0.0050)	(0.0072)	(0.0056)	(0.0167)	(0.0110)
λ_2	0.9714***	0.9518***	0.9381***	0.5845***	0.8997***
	(0.0128)	(0.0107)	(0.0103)	(0.1768)	(0.0755)
$\lambda_1 + \lambda_2$	0.9840	0.9874	0.9690	0.6393	0.9165
Test for $\lambda_1=\lambda_2=0$	12445.16***	50661.52***	21011.2***	39.54***	325.69***

Source: Authors' analysis.

Table 5. (Continued).

Chile	Colombia	Jordan	Morocco	Peru	Singapore
(6)	(7)	(8)	(9)	(10)	(11)
0.0536***	0.0712***	-0.0002	0.0462***	0.0960***	0.0516**
(0.0107)	(0.0171)	(0.0136)	(0.0125)	(0.0166)	(0.0203)
0.0360***	0.0673***	0.1322***	0.2446***	0.0690***	-0.0034
(0.0098)	(0.0158)	(0.0200)	(0.0246)	(0.0158)	(0.0235)
0.2538***	0.1409***	0.0100	0.0093	0.1736***	0.0304
(0.0207)	(0.0190)	(0.0120)	(0.0114)	(0.0192)	(0.0227)
0.0330*	0.0639***	0.0564***	0.0414**	0.0655***	0.0189
(0.0178)	(0.0142)	(0.0142)	(0.0188)	(0.0152)	(0.0178)
-0.0590***	-0.0677***	0.0179	0.0009	-0.0349*	0.1921***
(0.0217)	(0.0185)	(0.0111)	(0.0228)	(0.0191)	(0.0191)
-0.0052	0.0305***	-0.0377**	-0.0846***	-0.0353***	-0.1503***
(0.0309)	(0.0114)	(0.0180)	(0.0225)	(0.0122)	(0.0228)
0.0141***	0.1595***	0.0466***	0.0390***	0.0539***	0.0178***
(0.0029)	(0.0214)	(0.0090)	(0.0077)	(0.0097)	(0.0054)
0.1427***	0.2065***	0.2451***	0.2686***	0.1824***	0.1035***
(0.0155)	(0.0191)	(0.0219)	(0.0310)	(0.0184)	(0.0118)
0.8331***	0.6884***	0.7710***	0.7023***	0.7955***	0.8916***
(0.0168)	(0.0276)	(0.0193)	(0.0317)	(0.0195)	(0.0116)
0.0125***	0.0207***	0.0118***	0.0111***	0.0181***	0.0099***
(0.0037)	(0.0038)	(0.0026)	(0.0030)	(0.0034)	(0.0033)
0.0812***	0.0974***	0.0807***	0.0733***	0.0825***	0.0791***
(0.0105)	(0.0097)	(0.0088)	(0.0096)	(0.0086)	(0.0107)
0.9133***	0.8857***	0.9124***	0.9182***	0.9022***	0.9165***
(0.0114)	(0.0108)	(0.0091)	(0.0101)	(0.0097)	(0.0114)
0.0233***	0.0281***	0.0079	0.0064	0.0197***	0.0082***
(0.0051)	(0.0074)	(0.0084)	(0.0049)	(0.0040)	(0.0030)
0.9595***	0.9582***	0.9015***	0.9806***	0.9762***	0.9869***
(0.0079)	(0.0134)	(0.1050)	(0.0162)	(0.0053)	(0.0036)
0.9828	0.9863	0.9094	0.9870	0.9959	0.9951
25032.28***	44279.59***	130.46***	5492.13***	240000***	160000***

Source: Authors' analysis.

The coefficients for the lagged variance (coefficients a_2 and b_2) and shock-squared terms (coefficients a_1 and b_1) in the variance equation are significant for all countries, which is consistent with the time-varying volatility and confirms the adequacy of the GARCH (1,1) specification. In other words, the DCC-GARCH (1,1) model we use fits the data. An advantage of using this model is that 11 possible pairwise correlation coefficients for the 12 index returns in the sample can be estimated using a single system equation.

Importantly, Table 5 shows the estimates for the dynamics of conditional correlations (coefficients λ_1 and λ_2) between the returns of the US and other partner countries. The coefficients λ_1 and λ_2 of all US county pairs are nonnegative, and the sum of λ_1 and λ_2 is very close to 1, indicating high persistence in the conditional variances. Furthermore, all of them are less than 1, which means that the conditional variances are finite, and their series is strictly stationary. Moreover, the coefficient estimates across countries are not that dissimilar.

3.2. Estimating DCCs

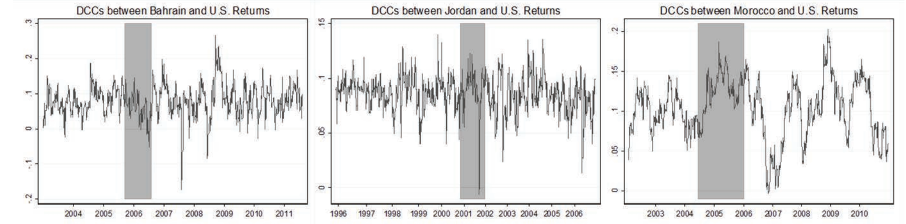
This section empirically presents the dynamics of conditional correlation. We estimate the DCCs between the daily stock returns of the S&P 500 index and those of the 11 counterpart countries' stock indices. Fig. 2 shows the estimated DCCs between the stock returns of the US and those of Korea, Mexico, Canada, Australia, Bahrain, Chile, Colombia, Jordan, Morocco, Peru, and Singapore for each period. Fig. 2 illustrates the dynamic conditional correlations between the US and each partner country. From this figure, it is clear that time-varying conditional correlations exist, even though the size of variation is slightly different by country and time.

Table 6 provides the conditional means of DCCs before, during, and after signing trade agreements. This table is crucial for this study. Each country has a different period of analysis, so it is more important to compare the value between columns (2) and (4) by country than the absolute value. By comparing the DCC changes before and after the FTA between the US and the partner countries, we can infer whether the integration of the real market due to trade agreements contributed to the integration of the stock market between the parties.

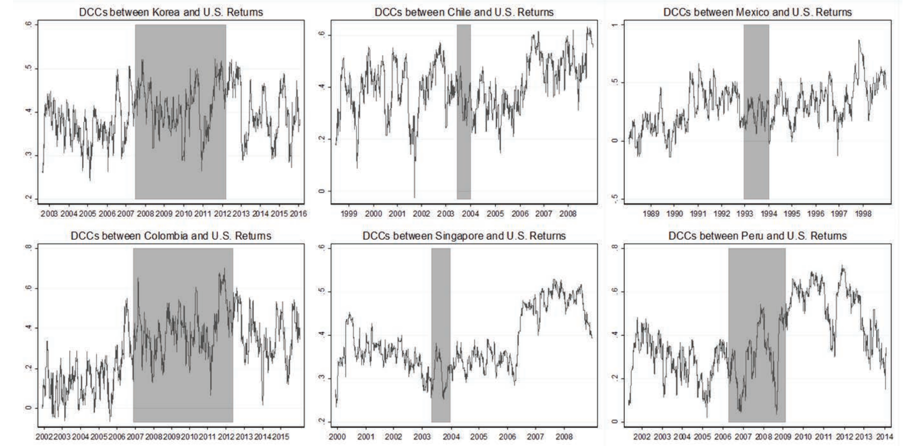
In Fig. 2, we divide the 11 country pairs into three groups according to the pattern of DCC changes between the US and each of its partner countries. The countries included in the first group (Group 1) are Bahrain, Jordan, and Morocco, where the DCC has not undergone significant changes before and after the agreement, and the degree of stock market integration with the US continues to be low. Among the countries that have signed an FTA with the US, the Bahrain stock market has the lowest conditional correlation with the US stock market. In Table 6, the mean value of DCC between the US and Bahrain increases only slightly from 0.0796 to 0.0831. As the US-Bahrain FTA was concluded for political rather than economic reasons, the effect of the agreement on real market integration is low, and it might not be linked to corporate performance. Similarly, Jordan has the second lowest DCC value at 0.0873 before the US-Jordan FTA and 0.0844 after. Consequently, the trade agreement between the US and Jordan does not lead to consolidation of the stock market. Jordan adapts a fixed exchange rate system, and its stock market has more holidays than other countries. These factors may have affected our results. In the case of the US-Morocco FTA, Morocco's DCC value is 0.0965 before the trade agreement and 0.0990 after the trade agreement. Thus, the overall degree of integration between the two stock markets was low. However, Figure 2 shows that the width of the DCC variation between the US and Morocco was larger than that before entry into force.

Fig. 2. DCCs between US and Partner Countries.

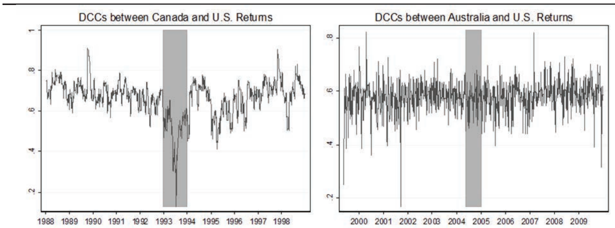
Group 1



Group 2



Group 3



Source: Authors' analysis.

The countries included in the second group (Group 2) are Korea, Chile, Mexico, Colombia, Singapore, and Peru. These countries show a pattern of increasing DCC with the United States after the agreement, which means that the degree of integration in the stock market between the two countries increased after the agreement. The DCC value of Mexico was 0.2439 before NAFTA, but the DCC value increased by approximately 50% in the decade after NAFTA. Of course, serious financial or economic crises can affect the stock market's co-movement, so we should consider the collapse of the Mexican peso and the switch to the free-floating exchange rate system in December 1994. The stock market integration between the United States and Mexico is not very high in absolute value, but considering that Mexico's stock market itself was not mature from 1988 to 1999, the increase in DCC after NAFTA is noteworthy. Korea had an increasing DCC value of 0.3655 before the KORUS FTA and 0.4011 after the FTA. Fig. 2 outlines that the variation width of DCCs increases after the signing of the KORUS FTA containing the transition period. Chile experiences a further increase in DCCs from 0.3881 to 0.4268 after the US-Chile trade agreement. In Fig. 2, after the entry into force of the FTA, the DCCs between the two countries show an upward trend and low variation. Accordingly, we find that the relationship between the US and Chile stock markets becomes closer after the FTA. Colombia and Peru, which belong to South America, show the most striking changes in conditional correlations with the US. In Table 6, Colombia has DCC values of 0.1593 before the US-Colombia FTA and 0.3618 after the FTA. In Peru, the DCC changed from 0.2845 to 0.5245 after the trade agreement. From these results, we find that the degree of stock market integration of Colombia and Peru with the US is not very high before the trade agreements, but after the trade agreements, the degree of integration jumps significantly owing to the increase in economic dependence. Besides, we assume that the close distance between these countries and the US may have a crucial influence on the results. Singapore has quite increasing DCC values, from 0.3394 to 0.4111, before and after the US-Singapore trade agreement. It is noteworthy that the conditional correlation between the US and Singapore jumped between 2006 and 2007, about two years after entry into force.

Table 6. Mean of the Estimated DCCs by Period

	Full Period	Before Signature*	Transition period	After Entry Into Force*
	(1)	(2)	(3)	(4)
KOREA-US	0.3921	0.3655	0.4128	0.4011
US-Mexico	0.3009	0.2439	0.2467	0.3679
US-Canada	0.6626	0.6895	0.5083	0.6677
US-Australia	0.5812	0.5787	0.5701	0.5852
US-Bahrain	0.0798	0.0796	0.0613	0.0831
US-Chile	0.4050	0.3881	0.3635	0.4268
US-Colombia	0.3000	0.1593	0.3875	0.3618
US-Jordan	0.0862	0.0873	0.0887	0.0844
US-Morocco	0.1029	0.0965	0.1253	0.0990
US-Peru	0.3828	0.2845	0.3007	0.5254
US-Singapore	0.3761	0.3394	0.3150	0.4111

Source: Authors' analysis.

The countries included in the third group (Group 3) are Canada and Australia. These countries do not show different patterns in DCCs before and after the trade agreements. However, unlike the countries included in Group 1, these countries maintain a high level of stock market integration with the United States. Furthermore, they seem to have a relatively stationary dynamic conditional correlation and a low variance. In the case of the US-Australia FTA, Australia has a similar DCC value of 0.5787 before the trade agreement and 0.5852 after it. This outcome signifies that the linkage between the US and Australian stock markets was quite high and stable in terms of mean and variance, even before the US-Australia FTA.

Canada has a DCC value of 0.6895 before NAFTA and 0.6677 after the agreement. This notion implies that Canada and the United States were already highly integrated with their stock markets before NAFTA. Meanwhile, it is noteworthy that the difference between the DCCs before and after NAFTA is negligible for the US and Canada. We think that this is because the US-Canada FTA had already been conducted since 1987, and the signing of additional agreements did not have a meaningful impact on the correlations between the two stock markets.

NAFTA is multilateral FTAs between the United States, Canada and Mexico. So, we attempted to further analyze the co-movement between the Canadian and Mexican stock markets to clarify the relationship between NAFTA contracting parties. Figure 3 and Table 7 show the DCCs between Canadian and Mexican stock markets. Figure 3 highlights the tendency of the DCCs to increase after entry into force. More specifically, in Table 7, Canada-Mexico has a DCC value of 0.2243 before NAFTA and 0.3217 after NAFTA. This means that the stock markets of Canada and Mexico are more integrated after NAFTA. In summary, in the case of NAFTA, the newly signed country-pair experiences additional stock market integration after the trade agreement.

Fig. 3. DCCs between Canada and Mexico

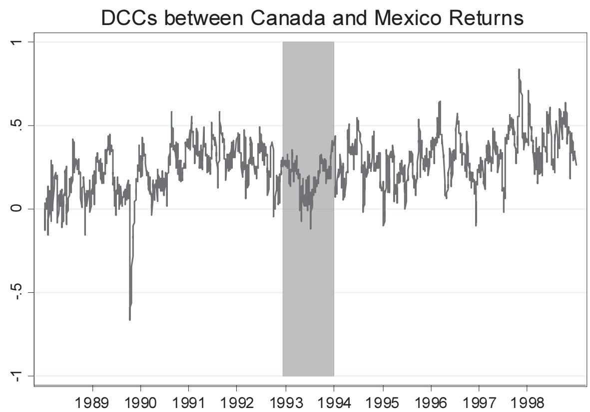


Table 7. Mean of the Estimated DCCs by Period (Canada and Mexico)

	Full Period	Before Signature*	Transition Period	After Entry Into Force*
	(1)	(2)	(3)	(4)
Canada-Mexico	0.2661	0.2243	0.1952	0.3217

4. Conclusions and Suggestions

This study examines whether real market integration resulting from trade agreements brings stock market integration. Using return and variance equations, we analyze how market integration caused by the FTA affects the co-movements of the stock market between the two countries that signed the FTA. To examine the changes in the process of concluding an FTA agreement, the before-FTA, transition period, and after-FTA periods were analyzed separately. Over the 10 FTAs signed by the United States, we empirically measure the co-movements of stock markets between the US and the 11 partner countries using a DCC multivariate GARCH model. According to the empirical results, there are positive return spillover effects from the US market to its eight counterpart equity markets, except Jordan, Morocco, and Singapore. Especially Mexico, Canada, and Chile have large return spillover effects at the 1% significance level. We also find the DCCs, track how these correlations evolve over time, and compare the results before and after trade agreements. All partner countries of FTAs generally have positive correlations with the US over the entire period, but the size and variance are somewhat different by country. Korea, Mexico, Chile, Colombia, Peru, and Singapore show increasing DCC patterns after trade agreements with the US. However, Canada, Australia, Bahrain, Jordan, and Morocco do not show different patterns before and after trade agreements in DCCs. These countries generally have the characteristic of relatively lower or higher co-movements in stock markets with the US before signing FTAs. These relative differences may be the cause of the increasing DCC pattern in countries.

In our analysis, not all countries that signed trade agreements with the United States showed the same pattern of stock market co-movement after the agreement. Therefore, this finding needs to be analyzed more closely. Several previous studies have mentioned trade as a key linkage variable for the economic integration of the real market, leading to an increase in the correlation between stock markets. This argument is reasonable because increased trade volume after trade agreements can increase firms' output and improve growth prospects. Therefore, we can interpret the analysis results in connection with changes in trade flows. If the assumption is true that an increase in trade intensity between two countries leads to an increase in stock market correlation, an agreement signed by the US that did not have a substantial impact on the size of trade intensity between contracting parties may not lead to an increase in stock market co-movements. In our results, these likely agreements are the US-Canada, US-Australia, US-Bahrain, US-Jordan, and US-Morocco. Hence, in future studies, it is imperative to examine which trade agreements signed by the United States have changed the degree of trade intensity between signatories and to strictly reconfirm whether the trade agreement has increased the correlation of the stock market only if it affects the degree of trade intensity between countries. Our study empirically analyzed the impact of FTAs on stock market integration and real market integration and found significant empirical implications. It is necessary to develop research by expanding FTA agreements and countries and attempting to generalize the research results through future research.

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