An Empirical Investigation of Financial Integration in East Asia--Toward Regional or Global Integration?

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April 1, 2012

Preliminary Draft

Abstract

This paper explores the degree of financial integration in East Asia and whether the region is moving closer toward regional or global integration in terms of equity markets. Using a volatility spillover model as the basis for empirical investigation, the analysis shows that during a period when both global and regional financial conditions were favorable and relatively stable, the region as a whole achieved higher regional integration. On the other hand, during a turbulent period, equity returns were more susceptible to negative prolonged global shocks and regional integration was hampered to some degree. This finding suggests that broader regional financial stability mechanisms, such as an exchange rate coordination mechanism and a capital flows monitoring system, may be conducive to further regional financial integration. The study also shows that the degree of financial integration of the economies in the region is quite diversified. Efforts should be made to bridge the gaps among different economies.

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1. Introduction

Since the Asian financial crisis in 1997, East Asian economies have been working together closely to promote regional financial integration. Over the years, they have made significant achievements. Under the framework of ASEAN+3, they achieved the Chiang Mai Initiative (CMI), the Asian Bond Market Initiative (ABMI), and the Economic Review and Policy Dialogue (ERPD). The Executives' Meeting of East Asia-Pacific Central Banks (EMEAP) economies have also established two Asian Bond Funds (ABFs) to develop regional bond markets.

In more recent years, the global financial crisis and European debt crisis have further highlighted the importance of financial integration and cooperation in strengthening the financial safety net and promoting regional financial markets. Against this background, in March 2010, the Chiang Mai Initiative Multilateralization (CMIM) Agreement came into effect. In January 2012, the ASEAN+3 Macroeconomic Research Office (ARMO) was officially inaugurated as an independent macroeconomic surveillance unit of the CMIM Agreement.

It is believed that long-term commitments to financial cooperation among Asian economies, in addition to closer trade and economic ties and increasing financial openness, is a driving force behind financial integration in East Asia. As a consequence, financial rates of return appear to move more closely together, an indication of closer regional financial integration.

Meanwhile, the region is also moving toward global integration. As East Asian economies are more open to international capital markets, they become more susceptible to global shocks. It also causes co-movements of financial returns of local markets. In other words, regional and global integration may both result in closer linkages among financial markets in the region. It is therefore important to distinguish and identify the real sources behind global and regional integration.

The purpose of this paper is to study the degree of financial integration by looking at equity returns, and to determine whether the region is moving toward a global integration or a regional one. I choose equity returns as the key variable in this study since they are more sensitive to different sources of shocks than other financial variables. Equity market in East Asia is also a major source of funding in the region other than the banking sector. In addition, the dynamics of equity market integration is important for policy makers in the sense that increases in international risk sharing may cause cyclical movements in the region to be less divergent and thereby help promote regional integration.

The following sections are arranged as follows. In Section 2, I employ the correlation matrix and σ-convergence to give an initial look at the degree of regional financial integration among 10 East Asian economies: China (CN), Hong Kong (HK), Indonesia (ID), Japan (JP), Malaysia (MY), Singapore (SG), South Korea (KR), the Philippines (PH), Thailand (TH), and Taiwan (TW).

While correlation matrix and σ-convergence are simple to use and can give us some rough ideas about the degree of financial integration in the region without going through model estimation, their usage is limited in studies since local equity returns of each economy in the region are driven by movements of both regional and global equity returns, and the above measures are not able to distinguish between regional and global sources. Therefore, we need a model to separate global, regional, and local factors in order to deliver more precise results.

To address this issue, in Section 3, I set up a simple volatility spillover model based on Baele et al. (2004) and Baltzer et al. (2008) analyses. The model is then estimated by the threshold generalized autoregressive conditional heteroskedasticity (TGARCH) method, using the same data set as in Section 2, to quantify impacts of sources of shocks-global, regional, and idiosyncratic ones-on equity returns, and calculate their relative importance. This will enable us to evaluate the role of global and regional factors in regional equity markets. The last section discusses implications for regional financial integration based on the empirical findings.

2. Correlation Matrix and σ-Convergence

2.1 Correlation Matrix

The correlation matrix is a simple tool to look at the correlation coefficients of the columns of a matrix. That is, row *i* and column *j* of the correlation matrix is the correlation between column *i* and column *j* of the original matrix. It is a starting point to gives us a look at how, in a given period of time, equity returns of different markets are related.

The data used here is daily equity returns in each local market from 1993 to 2011 (see Appendix A for a description of equity market data sources). In order to make an international comparison (with US equity return) on the same basis, all equity returns of these East Asian economies are adjusted for daily changes in exchange rates.

Table 1 shows the correlation matrix of rate of returns of 10 economies in East Asia and US from 1993~2011. It shows that, except for the case of China, all economies appear to mirror the trends of one another, with correlation coefficients from 0.249 (Japan and Indonesia) to as high as 0.635 (Hong Kong and Singapore). On the other hand, the correlation coefficients of these economies associated with the US in comparison are quite low. Only Singapore reaches the level of more than 0.200. It appears that, as far as equity return is concerned, the degree of regional integration is much higher than that of global integration.

Table 1 Correlation Matrix of Daily Equity Returns (1993~2011)

	CN	HK	ID	JP	KR	MY	PH	SG	TH	TW	US
CN	1.000										
HK	0.162	1.000									
ID	0.070	0.379	1.000								
JP	0.086	0.419	0.249	1.000							
KR	0.095	0.430	0.292	0.360	1.000						
MY	0.071	0.404	0.441	0.237	0.281	1.000					
PH	0.064	0.359	0.374	0.269	0.279	0.331	1.000				
SG	0.119	0.635	0.461	0.388	0.414	0.476	0.381	1.000			
TH	0.076	0.404	0.406	0.251	0.339	0.404	0.322	0.491	1.000		
TW	0.103	0.380	0.255	0.312	0.379	0.255	0.257	0.398	0.269	1.000	
US	0.008	0.165	0.064	-0.003	0.145	0.041	0.040	0.228	0.109	0.089	1.000

Source: Author's calculation.

However, there is a problem in Table 1: it ignores the nonsynchronous US trading effect that might distort the real picture. The nonsynchronous trading effect arises when data is assumed to be recorded at certain times when in fact it is collected at other times for another region. Supposed the US equity market closes at time *t* and it East Asian economies open their markets at time *t*+1, the actual time difference is a lag of 5 to 6 hours, instead of one full day. In fact, it is the US equity return at time *t*-1 that may affect East Asian equity returns at time *t*.

Table 2 addresses this problem by treating the US rate of return at time *t*-1 as when the information reaches equity markets in East Asia at time *t*. In other words, the correlation matrix is calculated based on current returns in East Asian equity markets and one-period lag return in the US market.

Table 2 Correlation Matrix of Daily Equity Returns (1993~2011)
(nonsynchronous US trading effect adjusted)

	CN	HK	ID	JP	KR	MY	PH	SG	TH	TW	US
CN	1.000										
HK	0.162	1.000									
ID	0.070	0.379	1.000								
JP	0.086	0.419	0.249	1.000							
KR	0.095	0.430	0.292	0.360	1.000						
MY	0.071	0.404	0.441	0.237	0.281	1.000					
PH	0.064	0.359	0.374	0.269	0.279	0.331	1.000				
SG	0.119	0.635	0.461	0.388	0.414	0.476	0.381	1.000			
TH	0.076	0.404	0.406	0.251	0.339	0.404	0.322	0.491	1.000		
TW	0.103	0.380	0.255	0.312	0.379	0.255	0.257	0.398	0.269	1.000	
US	0.066	0.381	0.209	0.400	0.276	0.232	0.333	0.291	0.186	0.269	1.000

Source: Author's calculation.

After recalculation, correlation coefficients with the US, except China's, rise dramatically. This indicates that fluctuations in the US market have impacts on the East Asian markets. The highest one is Japan (0.400), followed by Hong Kong (0.381), the Philippines (0.333), and Singapore (0.291).

One can also put all 10 economies together and look at its correlation coefficient as a group relative to US. To this end, I use equity market capitalization in US dollar as weights to compile a hypothetical series of rates of return in the region. Table 3 reports equity market weights of the East Asian economies from 1993 to 2011.

Table 4 reports the relationship between regional and US rates of return. The left column is the correlation coefficient without adjusting nonsynchronous US trading effect. As the data in that column show, the correlation coefficient between regional and US return is quite low at the level of 0.088. However, once adjusted for the effect mentioned above, the coefficient jumps up to 0.422, an indication that both markets are closely correlated.

Table 3 Equity Market Weights of East Asian Economies

	CN	HK	ID	JP	KR	MY	PH	SG	TH	TW
1993	0.009	0.091	0.008	0.689	0.033	0.052	0.010	0.032	0.030	0.046
1994	0.006	0.055	0.010	0.734	0.039	0.039	0.012	0.028	0.026	0.051
1995	0.006	0.062	0.014	0.728	0.037	0.044	0.012	0.031	0.028	0.038
1996	0.014	0.096	0.019	0.645	0.030	0.066	0.017	0.033	0.021	0.059
1997	0.034	0.125	0.009	0.656	0.013	0.028	0.009	0.032	0.007	0.087
1998	0.036	0.096	0.006	0.683	0.032	0.027	0.010	0.027	0.010	0.073
1999	0.027	0.096	0.010	0.692	0.048	0.022	0.006	0.031	0.009	0.059
2000	0.067	0.128	0.006	0.651	0.031	0.023	0.005	0.032	0.006	0.051
2001	0.085	0.130	0.006	0.580	0.050	0.030	0.005	0.030	0.009	0.075
2002	0.084	0.127	0.008	0.571	0.059	0.034	0.005	0.028	0.012	0.072
2003	0.069	0.137	0.010	0.568	0.057	0.031	0.004	0.028	0.023	0.073
2004	0.051	0.139	0.012	0.576	0.063	0.029	0.005	0.035	0.019	0.071
2005	0.037	0.135	0.010	0.588	0.092	0.023	0.005	0.033	0.016	0.061
2006	0.095	0.178	0.014	0.478	0.087	0.024	0.007	0.040	0.015	0.062
2007	0.267	0.192	0.015	0.314	0.081	0.023	0.007	0.039	0.014	0.048
2008	0.192	0.179	0.013	0.421	0.064	0.026	0.007	0.036	0.014	0.048
2009	0.245	0.208	0.019	0.299	0.075	0.026	0.008	0.044	0.016	0.060
2010	0.209	0.208	0.028	0.294	0.084	0.031	0.012	0.050	0.021	0.063
2011	0.207	0.198	0.034	0.290	0.088	0.035	0.015	0.053	0.024	0.056

Source: Calculation based on equity market capitalization data from World Federation of Exchanges and Shanghai Stock Exchange.

Table 4 Correlation Matrix of Daily Equity Returns (1993~2011)

Nonsynchronous Trading Effects Not Adjusted		
	Region	US
Region	1.000	
US	0.088	1.000
Nonsynchronous Trading Effects Adjusted		
	Region	US
Region	1.000	
US	0.422	1.000

Source: Author's calculation

2.2 σ-Convergence

Another simple indicator independent of model estimation is the σ-convergence. Adam et al. (2002) proposed this indicator and it has since been used by many studies on financial integration. The terminology of σ-convergence is borrowed from endogenous growth theory. It is in fact the cross-sectional volatility or dispersion in the area of finance.

σ-convergence refers to a reduction in the dispersion of equity returns across economies and therefore serves as an indicator to measure the degree of integration[1]. The formula of σ-convergence is as follows:

$$\sigma_t = \sqrt{\sum_{i=1}^{n} w_{i,t} \left(r_{i,t} - r_t \right)^2} \qquad (1)$$

where σ_i : the degree of regional or global integration, $w_{i,t}$: weight of economy i (composed by equity market capitalization), $r_{i,t}$: equity returns of each economy at time t, r_i : weighted regional equity returns at time *t* or global equity returns at time $t-1$. Both $r_{i,t}$ and r_i are adjusted by exchange rate changes.

According to this formula, decreases in σ_t indicate increases in the degree of integration. A full integration is reached if $\sigma_t = 0$.

Table 5 and Figure 2 report the degree of regional and global financial integration using σ-convergence as the indicator. The table shows equity markets in East Asia are all moving toward regional and global integration. However, relatively speaking, they are moving toward more to regional integration, as regional σ_t has been consistently lower than global σ_t.

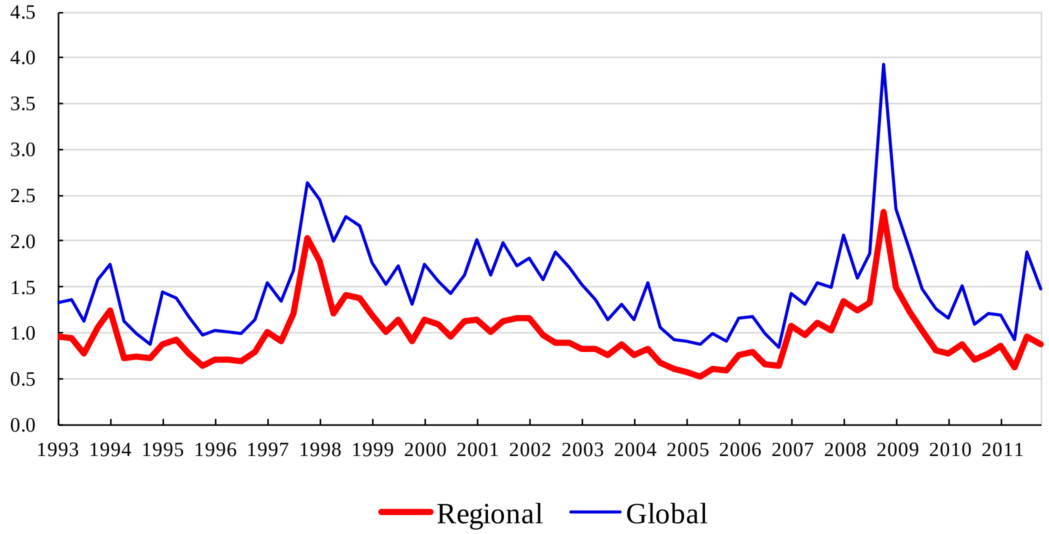
[1] Another related concept is the β-convergence, which is really an indicator for the *speed*, not the *degree* of integration. According to Adam et al. (2002), "β-convergence measures the speed of adjustment of deviations of countries to the long-run benchmark value, while σ-convergence measures if countries tend to become more similar over time in terms of deviations from the benchmark."

Table 5 Degree of Financial Integration (σ-Convergence)

	Regional	Global
1993	0.931	1.347
1994	0.858	1.182
1995	0.801	1.242
1996	0.723	1.043
1997	1.286	1.802
1998	1.444	1.215
1999	1.061	1.579
2000	1.081	1.589
2001	1.104	1.840
2002	0.977	1.743
2003	0.817	1.335
2004	0.715	1.166
2005	0.571	0.920
2006	0.711	1.047
2007	1.042	1.446
2008	1.554	2.361
2009	1.140	1.745
2010	0.783	1.241
2011	0.827	1.369
Average	0.970	1.485

Source: Author's calculation.

Figure 2 Degree of Financial Integration (σ-Convergence)



3. A Volatility Spillover Model

Market return and volatility in one market is often correlated with those in other markets. Engle et al. (1990) developed a prototype volatility spillover model to study how information revealed in one market has impacts on other markets. Lin et al. (1994) referred to this model as a signal-extraction model with GARCH process and used it to investigate the volatility spillover between Tokyo and New York markets.

In later years, this approach went on to be widely used as a tool for the analysis of cross-market transmission or financial contagion across borders. Bekaert and Harvey (1997), Ng (2000), and Bekaert et al. (2005) all considered volatility-spillover effects on international equity markets. Another line of study is to use this approach to conduct empirical research on regional and global financial integration, as explored by Baele et al. (2004), Baltzer et al. (2008), Christiansen (2007), World Bank (2006), etc. The approach has also been adopted by the European Central Bank in its annual report *Financial Integration in Europe* (e.g. European Central Bank 2011). Because it is about how information affects across markets, this model is categorized as a news-based measure in financial integration literature[2].

In general, the model assumes that each equity market of the individual economy is affected by three sources of orthogonal shocks: global, regional, and local shocks. If markets in the region become more integrated, we should expect that regional factor plays an increasing role in movements of equity returns relative to global or local shocks. It is therefore important to identify and separate these sources to evaluate their relative importance.

3.1 The Model

$$r_{us,t} = \alpha_{us} + \beta_{us} r_{us,t-1} + \varepsilon_{us,t} \tag{2}$$

[2] For surveys on various measures of financial integration, see Baele et al. (2004) and Cavoli et al. (2004). Based on Baele et al. (2004), there are three main categories of measures in the literature of financial integration: price-based measures, news-based measures, and quantity-based measures. Cavoli et al. (2004) adopted a somewhat different classification: price-based measures, quantity-based measures, and regulatory and institutional measures.

$$E_{t-1}\left(\varepsilon_{us,t}^2\right)=\sigma_{us,t}^2=\delta_{us,0}+\delta_{us,1}\varepsilon_{us,t-1}^2+\delta_{us,2}I\left(\varepsilon_{us,t-1}<0\right)\varepsilon_{us,t-1}^2+\delta_{us,3}\sigma_{us,t-1}^2 \quad (3)$$

where $r_{us,t}$ and $\sigma_{us,t}^2$ are US rate of return and its conditional variance, respectively. $E(\cdot)$ is the expectation operator conditional on the information at time t and $I(\cdot)$ is the indicator function which takes on value one if the error term in the preceding period is smaller than zero, and value zero if greater than zero.

(2) is the mean equation. It states that US equity return consists of the expected and unexpected rate of return. Investors forms their expected equity returns through an AR(1) process. The error term ($\varepsilon_{us,t}$) denotes the unexpected ones. The conditional variance ($\sigma_{us,t}^2$) follows a TGARCH process in (3) to reflect the leverage effect in the equity market. That is, negative news from the global or regional market may increase volatility more than positive news[3]. The model is therefore an AR(1)-TGARCH (1,1) model.

The second step is to set up equations for regional equity market. The mean equation is as follows:

$$r_{ea,t}=\alpha_{ea}+\beta_{ea}r_{ea,t-1}+\varepsilon_{ea,t} \quad (4)$$

where $r_{ea,t}$ and $\sigma_{ea,t}^2$ are regional rate of return and its conditional variance, respectively.

(4) is similar to (2). The regional equity rate of return ($r_{ea,t}$) consists of expected ($\alpha_{ea}+\beta_{ea}r_{ea,t-1}$) and unexpected return ($\varepsilon_{ea,t}$), and the unexpected one follows a simple AR(1) process[4]. As the unexpected regional rate of return would be affected by the US counterpart, the following equation is set up to remove this effect:

[3] Preliminary estimation using the ever-popular GARCH (1,1) model without this asymmetry effect shows that the sum of estimated coefficients in the variance equation failed to meet stationarity requirement for some economies.

[4] Global equity return may directly affect regional and local returns. For simplicity, this paper does not consider this mean spillover effect. For a model considering both the mean spillover and volatility spillover effects, see Christiansen (2007).

$$\varepsilon_{ea,t} = \delta_{ea}^{us} \varepsilon_{us,t-1} + e_{ea,t} \quad (5)$$

(5) orthogonalizes $\varepsilon_{ea,t}$ and $\varepsilon_{us,t-1}$. And the error term $e_{ea,t}$ is the unexpected components that is not explained by US unexpected rate of return. Here the one-period lag of $\varepsilon_{us,t}$ is used as the explanatory variable to remove nonsynchronous trading effect.

The variance equation for regional equity market is

$$E_{t-1}\left(e_{ea,t}^2\right) = \sigma_{ea,t}^2 = \delta_{ea,0} + \delta_{ea,1} e_{ea,t-1}^2 + \delta_{ea,2} I\left(e_{ea,t-1} < 0\right) e_{ea,t-1}^2 + \delta_{ea,3} \sigma_{ea,t-1}^2 \quad (6)$$

The third step is to set up individual economy's mean and variance equations. The mean equation for individual economy *i* is as follows:

$$r_{i,t} = \alpha_i + \beta_i r_{i,t-1} + \varepsilon_{i,t} \quad (7)$$

$$\varepsilon_{i,t} = \delta_i^{us} \varepsilon_{us,t-1} + \delta_i^{ea} e_{ea,t} + e_{i,t} \quad (8)$$

The unexpected rate of local return $\varepsilon_{i,t}$ is explained by unexpected rate of US return $\varepsilon_{us,t-1}$ and unexpected rate of regional return $e_{ea,t}$.

The variance equation also follows a TGARCH (1, 1) process:

$$E_{t-1}\left(e_{i,t}^2\right) = \sigma_{i,t}^2 = \delta_{i,0} + \delta_{i,1} e_{i,t-1}^2 + \delta_{i,2} I\left(e_{i,t-1} < 0\right) e_{i,t-1}^2 + \delta_{i,3} \sigma_{i,t-1}^2 \quad (9)$$

From (8), one can get the following equations,

$$E_{t-1}\left(\varepsilon_{i,t}^2\right) = \sigma_{i,\varepsilon,t}^2 = \left(\delta_i^{us}\right)^2 \sigma_{us,t-1}^2 + \left(\delta_i^{ea}\right)^2 \sigma_{ea,t}^2 + \sigma_{i,t}^2 \quad (10)$$

As in the volatility spillover literature, the entire model assumes that the shocks of the US ($\varepsilon_{us,t-1}$), regional market ($e_{ea,t}$), and economy *i* ($e_{i,t}$) are uncorrelated.

Based on (10), one can derive three variance ratios as the following:

$$\text{Global variance ratio: } \frac{\left(\delta_i^{us}\right)^2 \sigma_{us,t-1}^2}{\sigma_{i,\varepsilon,t}^2} \quad (11)$$

Regional variance ratio: $\dfrac{\left(\delta_i^{ea}\right)^2 \sigma_{ea,t}^2}{\sigma_{i,\varepsilon,t}^2}$ (12)

Local variance ratio: $\dfrac{\sigma_{i,t}^2}{\sigma_{i,\varepsilon,t}^2}$ (13)

These three ratios can be used to measure the degree of regional financial integration relative to that of global financial integration.

The model also implies the following conditional correlation expressions:

$$\rho_{i,us,t} = \frac{\delta_i^{us}\sigma_{us,t-1}}{\sigma_{i,\varepsilon,t}} \tag{14}$$

$$\rho_{i,ea,t} = \frac{\delta_{ea}^{us}\delta_i^{us}\sigma_{us,t-1}^2 + \delta_i^{ea}\sigma_{ea,t}^2}{\sigma_{i,\varepsilon,t}\sigma_{ea,t}} \tag{15}$$

$$\rho_{i,j,t} = \frac{\delta_i^{us}\delta_j^{us}\sigma_{us,t-1}^2 + \delta_i^{ea}\delta_j^{ea}\sigma_{ea,t}^2}{\sigma_{i,\varepsilon,t}\sigma_{j,\varepsilon,t}} \tag{16}$$

One can use these conditional correlations as a starting point to measure the effects of financial contagion on a global or regional scale on the individual equity market.

3.2 Estimation and Empirical Findings

3.2.1 Estimation

The model is estimated by the TGARCH method with the same data set of daily equity returns as in Section 2. However, in this Section, regional rate of return is computed as the weighted sum rates of return of the individual economies excluding that of the individual economy under analysis. For example, in analyzing Taiwan's integration with the regional market, the weighted regional rate of only come from rate of return of all the other 9 economies but Taiwan. This means that there are 10 sets of weight and regional rate of return for estimation.

To reflect major economic events, two time dummies, $D_{1,i}$ and $D_{2,i}$, are also added to (8). The first time dummy is from July 1997 to June 1998 to indicate the period of the Asian financial crisis. The second one is from September 2008 to December 2011 to reflect the period of global financial crisis and the subsequent European debt crisis. The time dummies are associated with δ_i^{ea} and δ_i^{us}, respectively, in the following ways[5,6]:

$$\delta_i^{us} = \delta_{0,i}^{us} + \delta_{1,i}^{us} D_{1,i} \tag{17}$$

$$\delta_i^{ea} = \delta_{0.i}^{ea} + \delta_{1.i}^{ea} D_{2,i} \tag{18}$$

Appendix B and C report the estimation of individual economies' equity returns and residual tests, respectively, for reference.

3.2.2 The Region (East Asia)

The empirical findings for the region as a whole are reported in Table 6 in Figure 3. The variance ratios in the table explain reasonably well the major events that affected equity returns in the region.

For example, the booms in East Asian equity markets in years 1993 and 1995 stemmed from massive inflows of Japanese savings into this region[7]. The Asian financial crisis in 1997~1998 and the outbreak of Severe Acute Respiratory Syndrome (SARS) in 2003 had all inflicted impacts to the region as a whole. These major regional events are all reflected in the higher regional variance ratios in Table 6.

As for global events, there was a major global equity market downturn in 2002 due to a series of accounting scandals. From year 2008 on, the region was hit

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5 This specification is different from that of Baele et al. (2004) and Baltzer et al. (2008). In addition to differences in the choice of subperiods, their time dummies appear in both equations, i.e. $\delta = \delta_{0.i} + \delta_{1,i} D_{1,i} + \delta_{2,i} D_{2,i}$, while in this paper only one dummy is assigned to the repective equation. The reason is that the first time dummy is a major regional event, while the second time dummy stands for global events that affect local markets.

6 However, the differences are minor with or without time dummies in the model. Estimated variance ratios from the model without time dummies are list in Appendix E for reference.

7 Equity markets in the region in 1993 were among the top-performing markets in the world. Although there was a dip in 1994, they soon regained momentum in 1995 until December.

first by the global financial crisis and then the European debt crisis. The high global variance ratios in Table 6 indicate those major global events. However, the findings fail to reflect the dot-com bubble burst in 2000 and the 911 attacks in 2001 that had caused global markets to stutter, probably because their duration was relatively short.

Table 6 Degree of Financial Integration (Variance Ratios)

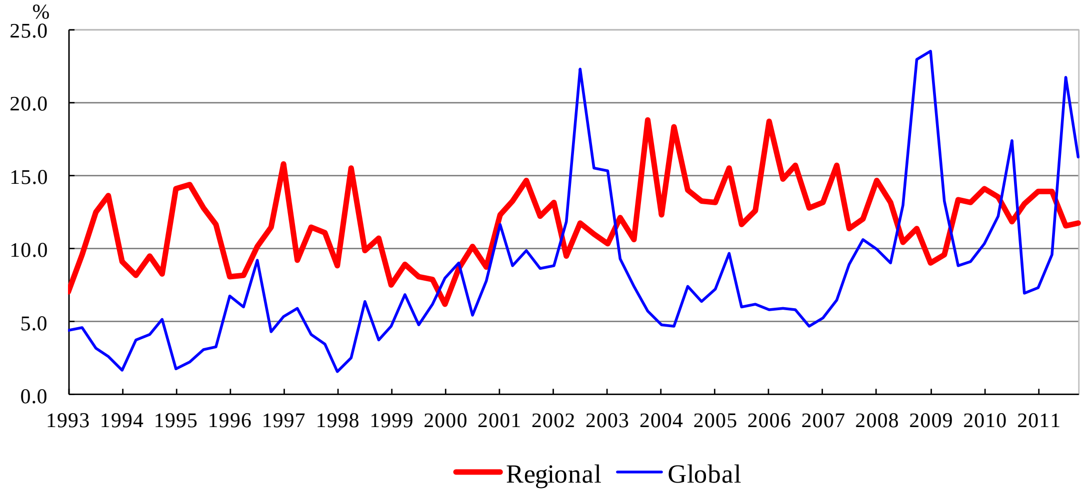
unit:%

Year	Global	Regional	Local
1993	3.72	10.70	85.57
1994	3.69	8.77	87.54
1995	2.61	13.27	84.12
1996	6.59	9.48	83.93
1997	4.70	11.89	83.41
1998	3.58	11.23	85.19
1999	5.64	8.13	86.22
2000	7.58	8.44	83.97
2001	9.78	13.15	77.07
2002	14.67	11.40	73.94
2003	9.46	13.00	77.54
2004	5.84	14.49	79.66
2005	7.30	13.26	79.44
2006	5.60	15.53	78.87
2007	7.85	13.11	79.05
2008	13.74	12.43	73.83
2009	13.68	11.29	75.04
2010	11.75	13.17	75.09
2011	13.75	12.83	74.42
1993~1995	3.34	10.91	85.74
1996~1999	5.13	10.18	84.69
2000~2003	10.37	11.50	78.13
2004~2007	6.65	14.10	79.25
2008~2011	13.23	12.43	74.34
1993~2011	7.98	11.87	80.15

Source: Author’s estimations.

Years 2004 to 2007 is an interesting period, when both global and regional financial conditions were favorable and relatively stable, and there was some steady progress in regional financial integration. On average, the regional variance ratio reached 14.10%, higher than the global variance ratio of the same period (6.65%). It was also higher than the regional ratio of 11.50% in 2000~2003.

Figure 3 Degree of Financial Integration (Variance Ratios)



In comparison, in the period of financial turbulence (2008~2011), equity returns were more susceptible to prolonged global shocks. During this period, the global variance ratio jumped to 13.23%, compared to 6.65% of the preceding period (2004~2007). On the other hand, the average regional variance ratio only dropped slightly from 14.10% of 2004~2007 to 12.43%. In short, there was a trend asymmetry between the global and regional ratios.

Overall, after year 2000, degrees of regional integration were quite stable (between 11.29% and 15.53%). However, East Asian economies were more susceptible to global shocks than to regional ones, making their global variance ratios subject to wilder fluctuations. Regional integration was hampered to some degree in the case of negative prolonged global shocks.

These results confirm Asian Development Bank's (2010) earlier observations, when they used cross-market dispersions in equity returns as the indicators to measure regional equity market integration, that "the crisis underscored the interconnectedness of, and spillovers between, global, regional, and national price movements. Asian equity markets have relatively high levels of foreign participation and remain vulnerable to sudden shifts in capital flows as well as developments in US markets."

The findings suggest that at least in the medium term, regional financial stability seems a prerequisite to maintain regional integration. Developing broader financial stability mechanisms, such as regional exchange rate cooperation and capital flows monitoring system, to shield against negative global shocks may be conducive to achieving this end. On the other hand, as the degree of regional integration was quite stable over time, it also indicates the region should implement measures to further enhance regional integration. In this regard, regional payment systems and credit rating agencies to facilitate trading are desirable.

The analysis also shows that idiosyncratic shocks from individual equity markets are still the driving force for the stock return volatility, as is indicated by high local variance ratios in Table 6. However, the ratio has been trending downward from 85.74% in the earlier period of 1993~1995 to 74.34% in the more recent period of 2008~2011. Both global development and regional efforts have fostered a closer link among economies in the region.

3.2.3 Individual Economies

Economies are not homogenous across the region and may exhibit different patterns. Some economies are more susceptible to regional shocks, while others global shocks, indicating different degrees of regional and global integration. To save space, the following focuses on the regional and global variance ratios for each economy in the period of 2004~2007 and of 2008~2011. Detailed results on the degree of regional and global integration of each economy over the years are list in Tables D.1 and D.2 in Appendix D for reference.

Figure 4 shows that during 2004~2007, 7 economies had regional variance ratios higher than their respective global variance ratios. In particular, Hong Kong, Korea, and Singapore were in a group whose regional variance ratio is higher than 20%. Malaysia and Taiwan came next with regional variance ratios more than 15%. As for global integration in the same period, Hong Kong had the highest variance ratio 15.01% and the others were all lower than 10%.

Figure 4 Regional and Global Variance Ratios (2004~2007)

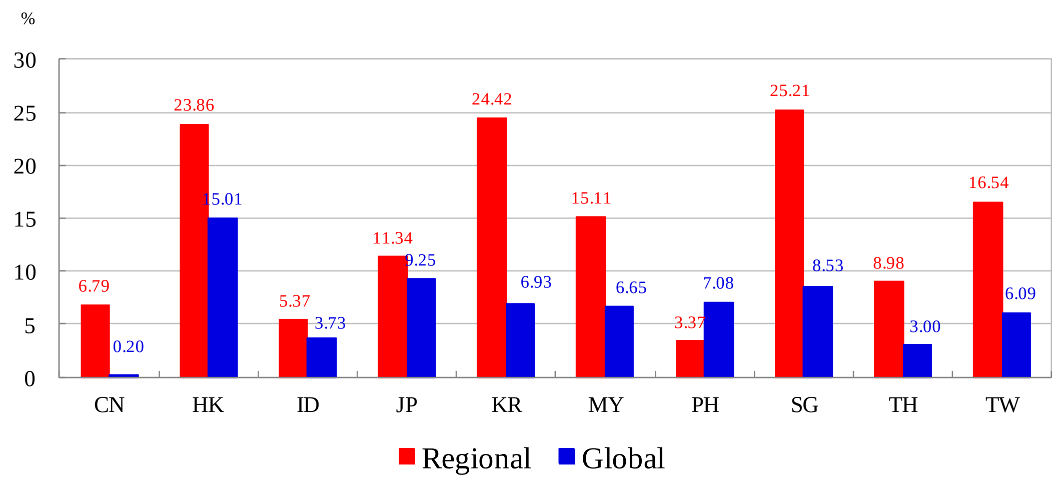
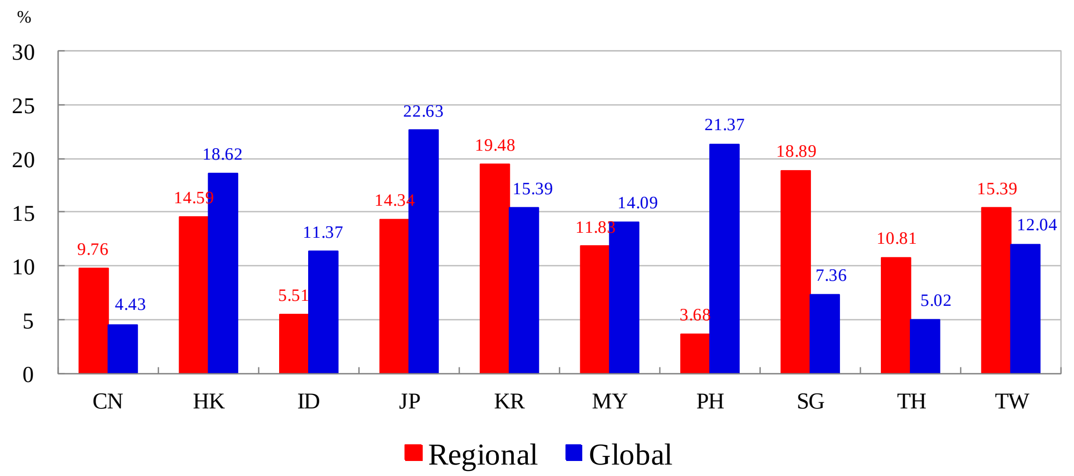


Figure 5 gives us a different picture. In the period of global financial turmoil (2008~2011), global variance ratios of all 10 economies increased with different degrees. However, only half of the economies, i.e., Hong Kong, Korea, Malaysia, Singapore, and Taiwan, had falling regional variance ratios in the same period.

Figure 5 Regional and Global Variance Ratios (2008~2011)



Of all 10 economies, Japan and the Philippines were subject to negative global shocks the most, with their global variance ratios both surpassing 20%. Hong Kong, Malaysia, Taiwan, and Indonesia were also influenced by the changing global environment, but their global variance ratios were lower.

Overall, judging from how individual economies have reacted to regional and global shocks in recent periods, it is evident that the degree of integration of the economies in the region is quite diversified, reflecting different underlying economic and financial structures. This suggests that efforts should be made to bridge the gaps among different economies. In this regard, it is important to broaden investor bases, encourage diverse financial products, and improve regulatory systems to foster equity market development. As a deeper equity market can help absorb external shocks, it would in turn contribute to a greater degree of regional integration.

4. Concluding Remarks

This paper uses the correlation matrix, σ-convergence, and a simple volatility spill over model to quantify degrees of regional and global financial integration in East Asia. Results from the correlation matrix show strong linkage across many local markets and the US market. Results from σ-convergence suggest that equity markets in East Asia are moving more toward regional integration than they are toward global integration.

The volatility spillover model further quantifies the impacts from global, regional, and idiosyncratic shocks to facilitate an evaluation of the degree of regional financial integration. Empirical findings show after year 2000 degrees of regional integration were quite stable. In particular, during a period when both global and regional financial conditions were favorable and relatively stable, the region as a whole achieved higher regional integration. On the other hand, East Asian economies were susceptible to negative prolonged global shocks, which hampered regional integration to some degree. Broader regional financial stability mechanisms, such as an exchange rate coordination mechanism and a capital flows monitoring system, may be needed to shield against global shocks.

The study also shows that the degree of financial integration of the economies in the region is quite diversified. Efforts should be made to bridge the gaps among different economies. It is also important to foster equity market development. As a deeper equity market can help absorb external shocks, such improvement of market resilience would in term contribute to a greater degree of regional integration.

Finally, a drawback of this analysis is that it does not consider the possibility that coefficients in the mean equation may change over time. The volatility spillover model used in this paper is essentially a fixed-parameter model in mean equations. However, over the years if there were changes in the pattern of equity returns, estimated variance ratios from the model without considering the changes may not be reasonable. One way to address this issue is to turn the fixed-parameter model into a time-varying parameter one by assuming that coefficients in mean equations follow a random walk process to. Another issue is that, although using the US equity returns to represent global shock in the model is able to deliver satisfactory explanation, the European debt crisis suggests that European equity returns might be another important source of global shock. In other words, allowing two types of global shock in the model may provide richer explanations regarding the global financial linkages of the East Asian region, as long as the interaction between US and European equity returns are clearly specified. These considerations will be the future direction of this study.

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Appendix A Equity Market Data Sources

Economies	Equity Markets	Equity Index
China	Shanghai SE	Shanghai Stock Exchange's A share Index
Hong Kong	Hong Kong Exchanges	Hong Kong Hang Seng index
Indonesia	Indonesia SE	Jakarta Composite index
Japan	Tokyo SE	Tokyo Nikkei Stock Average
Korea	Korea Exchange	Seoul Korea Stock Exchange Composite index
Malaysia	Bursa Malaysia	Kuala Lumpur Composite index
The Philippines	Philippines SE	Manila Composite index
Singapore	Singapore Exchange	Singapore Straits Times index
Thailand	Thailand SE	Bangkok Stock Exchange of Thailand index
Taiwan	Taiwan SE Corp.	Taiwan Stock Exchange weighted price index
United States		Standard and Poor's stock 500 index

Source: Datastream, Yahoo Finance.

Appendix B Estimation of Individual Economies' Equity Returns

	CN	HK	ID	JP	KR	MY	PH	SG	TH	TW
	mean equation: $\varepsilon_{i,t}=\left(\delta_{0,i}^{us}+\delta_{1,i}^{us}D_{1,i}\right)\varepsilon_{us,t-1}+\left(\delta_{0.i}^{ea}+\delta_{1.i}^{ea}D_{2,i}\right)e_{ea,t}+e_{i,t}$									
$\delta_{0,i}^{us}$	0.085 (0.023)	0.523 (0.020)	0.325 (0.030)	0.466 (0.024)	0.449 (0.027)	0.240 (0.017)	0.429 (0.060)	0.347 (0.017)	0.289 (0.024)	0.368 (0.024)
$\delta_{1,i}^{us}$	0.123 (0.039)	-0.062 (0.036)	0.064 (0.067)	0.083 (0.040)	0.080 (0.050)	0.0167 (0.024)	0.031 (0.064)	-0.122 (0.034)	-0.081 (0.037)	-0.015 (0.038)
$\delta_{0.i}^{ea}$	0.384 (0.021)	0.503 (0.015)	0.328 (0.020)	0.470 (0.023)	0.694 (0.021)	0.288 (0.014)	0.239 (0.019)	0.481 (0.017)	0.415 (0.022)	0.496 (0.020)
$\delta_{1.i}^{ea}$	-0.459 (0.057)	-0.001 (0.106)	0.810 (0.810)	-0.016 (0.078)	-0.546 (0.143)	0.647 (0.175)	0.349 (0.105)	-0.046 (0.078)	0.327 (0.127)	-0.182 (0.065)
variance equation: $E_{t-1}\left(e_{i,t}^2\right)=\sigma_{i,t}^2=\delta_{i,0}+\delta_{i,1}e_{i,t-1}^2+\delta_{i,2}I\left(e_{i,t-1}<0\right)e_{i,t-1}^2+\delta_{i,3}\sigma_{i,t-1}^2$										
$\delta_{i,0}$	0.024 (0.015)	0.015 (0.003)	0.057 (0.014)	0.051 (0.014)	0.034 (0.009)	0.013 (0.003)	0.046 (0.012)	0.020 (0.003)	0.071 (0.025)	0.026 (0.006)
$\delta_{i,1}$	0.051 (0.011)	0.057 (0.011)	0.127 (0.035)	0.056 (0.012)	0.065 (0.014)	0.079 (0.015)	0.040 (0.028)	0.079 (0.021)	0.073 (0.020)	0.045 (0.010)
$\delta_{i,2}$	0.063 (0.028)	0.076 (0.018)	0.065 (0.049)	0.068 (0.021)	0.067 (0.021)	0.078 (0.027)	0.092 (0.049)	0.071 (0.024)	0.101 (0.053)	0.059 (0.017)
$\delta_{i,3}$	0.920 (0.015)	0.901 (0.009)	0.841 (0.018)	0.887 (0.015)	0.893 (0.010)	0.882 (0.014)	0.899 (0.018)	0.876 (0.014)	0.858 (0.034)	0.917 (0.010)
$\bar{R}^2$	0.053	0.309	0.141	0.273	0.205	0.136	0.166	0.295	0.137	0.171

Note: Number in brackets is Bollerslev-Wooldridge heteroskedasticity consistent standard error.
Source: Author's estimation.

Appendix C Residual Tests

The followings two tables are results from the Ljung-Box Q test and the ARCH LM Test, respectively. In general, the TGARCH (1, 1) is a proper model. However, a couple of economies (Singapore and Thailand) still exist remaining ARCH.

Table C.1 Ljung-Box Q Test

	CN		HK		ID		JP		KR	
	Q-stat	p-value	Q-stat	p-value	Q-stat	p-value	Q-stat	p-value	Q-stat	p-value
1	0.090	0.764	0.104	0.748	0.109	0.741	5.689	0.017	0.009	0.924
2	1.129	0.569	0.426	0.808	0.129	0.938	5.727	0.057	1.673	0.433
3	2.549	0.466	0.426	0.935	0.248	0.969	5.874	0.118	1.905	0.592
4	2.574	0.631	2.838	0.585	0.761	0.944	6.137	0.189	2.153	0.708
5	2.687	0.748	2.841	0.724	0.789	0.978	6.141	0.293	2.234	0.816
6	2.691	0.847	3.000	0.809	0.960	0.987	6.920	0.328	2.268	0.894
7	3.076	0.878	4.424	0.730	2.560	0.923	7.933	0.339	2.420	0.933
8	3.312	0.913	5.101	0.747	3.517	0.898	9.051	0.338	2.809	0.946
9	3.929	0.916	7.868	0.548	3.735	0.928	10.557	0.307	3.462	0.943
10	4.144	0.941	9.204	0.513	6.403	0.780	10.626	0.387	7.538	0.674
	MY		PH		SG		TH		TW	
	Q-stat	p-value	Q-stat	p-value	Q-stat	p-value	Q-stat	p-value	Q-stat	p-value
1	2.878	0.090	0.342	0.559	0.001	0.971	12.283	0.000	0.123	0.726
2	4.622	0.099	0.372	0.830	17.377	0.000	12.354	0.002	0.322	0.851
3	4.750	0.191	0.382	0.944	18.155	0.000	12.464	0.006	1.811	0.613
4	6.151	0.188	0.389	0.983	18.446	0.001	13.605	0.009	2.460	0.652
5	6.272	0.281	0.477	0.993	18.470	0.002	15.890	0.007	2.821	0.728
6	7.323	0.292	0.677	0.995	20.931	0.002	16.776	0.010	3.444	0.751
7	9.966	0.191	0.754	0.998	21.294	0.003	16.935	0.018	4.418	0.731
8	11.599	0.170	0.780	0.999	21.681	0.006	16.956	0.031	4.749	0.784
9	11.617	0.236	1.240	0.999	21.828	0.009	19.119	0.024	6.825	0.655
10	11.910	0.291	1.357	0.999	21.831	0.016	19.480	0.035	7.423	0.685

Source: Author's estimation.

Table C.2 ARCH LM Test

	TR^2	p-value
CN	4.022	0.946
HK	9.059	0.527
ID	6.335	0.789
JP	10.761	0.376
KR	7.689	0.659
MY	11.283	0.336
PH	1.336	0.999
SG	22.561	0.012
TH	19.211	0.038
TW	7.488	0.679

Note: test up to 10 periods.
Source: Author's estimation.

Appendix D Degree of Regional and Global Integration

Table D.1 Degree of Regional Integration (Variance Ratios)

unit: %

	CN	HK	ID	JP	KR	MY	PH	SG	TH	TW	Regional
1993	1.98	13.36	11.53	4.78	17.88	8.84	4.21	23.63	10.54	10.27	10.70
1994	1.55	8.52	8.15	10.40	21.24	3.72	2.12	17.66	6.56	7.79	8.77
1995	3.60	19.45	12.74	6.27	25.48	8.70	4.40	26.27	12.60	13.21	13.27
1996	1.89	18.25	6.21	7.06	13.72	9.73	3.24	18.52	6.72	9.48	9.48
1997	1.77	17.19	17.79	8.05	8.78	14.96	8.42	20.21	8.81	12.92	11.89
1998	9.49	14.28	6.22	13.56	7.70	10.68	9.35	13.75	11.45	15.78	11.23
1999	8.42	13.12	2.10	10.03	9.57	4.33	3.13	14.16	5.03	11.42	8.13
2000	12.76	10.79	3.21	11.16	7.97	7.05	3.27	14.26	6.59	7.37	8.44
2001	18.34	17.88	4.76	6.69	21.51	11.59	3.50	22.89	11.42	12.94	13.15
2002	10.59	17.31	5.04	6.75	16.09	12.81	3.83	19.62	10.70	11.26	11.40
2003	11.62	20.14	6.38	6.72	20.21	14.54	4.07	18.41	11.13	16.76	13.00
2004	8.79	25.13	5.25	9.82	22.88	16.85	4.38	28.79	8.36	14.68	14.49
2005	5.32	23.41	5.12	8.02	22.78	14.28	2.87	25.50	9.40	15.89	13.26
2006	9.38	28.92	5.36	7.89	25.89	18.56	3.44	28.75	10.17	16.96	15.53
2007	3.69	17.97	5.75	19.61	26.12	10.74	2.78	17.81	7.98	18.63	13.11
2008	5.80	11.26	5.70	18.77	22.88	10.79	4.18	17.91	11.58	15.42	12.43
2009	9.83	12.01	4.27	13.56	17.52	12.69	3.28	15.87	10.62	13.20	11.29
2010	9.42	18.21	5.69	12.03	20.19	12.45	3.49	21.52	10.97	17.69	13.17
2011	13.99	16.88	6.37	12.98	17.32	11.38	3.76	20.27	10.05	15.26	12.83
1993~1995	2.38	13.78	10.81	7.15	21.54	7.09	3.58	22.52	9.90	10.42	10.91
1996~1999	5.39	15.71	8.08	9.68	9.94	9.93	6.03	16.66	8.00	12.40	10.18
2000~2003	13.33	16.53	4.85	7.83	16.44	11.50	3.67	18.79	9.96	12.08	11.50
2004~2007	6.79	23.86	5.37	11.34	24.42	15.11	3.37	25.21	8.98	16.54	14.10
2008~2011	9.76	14.59	5.51	14.34	19.48	11.83	3.68	18.89	10.81	15.39	12.43
1993~2011	7.80	17.06	6.72	10.22	18.20	11.30	4.09	20.31	9.51	13.52	11.87

Source: Author's estimation.

Table D.2 Degree of Global Integration (Variance Ratios)

unit: %

	CN	HK	ID	JP	KR	MY	PH	SG	TH	TW	Global
1993	0.03	5.49	5.24	5.07	3.39	2.73	5.66	5.37	2.12	2.13	3.72
1994	0.04	5.29	4.33	6.90	5.33	1.52	3.81	5.41	1.90	2.33	3.69
1995	0.04	5.16	2.95	3.63	2.57	1.52	3.61	3.54	1.51	1.60	2.61
1996	0.09	14.91	5.18	10.12	5.36	5.30	9.44	8.29	3.18	4.04	6.59
1997	0.21	9.18	4.05	7.21	4.74	2.37	6.44	6.55	1.43	4.83	4.70
1998	0.52	6.50	0.97	7.48	3.19	0.83	4.02	4.17	1.97	6.16	3.58
1999	0.37	12.45	1.85	11.28	3.66	2.74	9.36	6.66	2.33	5.74	5.64
2000	0.69	13.95	4.36	15.15	4.48	6.29	12.49	8.86	4.34	5.24	7.58
2001	0.95	19.90	5.22	12.76	10.42	8.91	12.47	13.05	6.44	7.71	9.78
2002	1.00	29.46	9.06	20.08	12.35	15.08	20.67	18.16	9.82	10.97	14.67
2003	0.54	19.88	6.31	12.53	8.18	10.18	13.48	9.65	5.74	8.10	9.46
2004	0.20	13.02	3.16	8.01	5.50	6.13	7.41	8.53	2.18	4.27	5.84
2005	0.19	17.30	3.90	9.92	7.24	7.44	7.00	10.05	3.42	6.55	7.30
2006	0.21	14.07	2.68	6.43	5.74	6.38	5.72	7.46	2.57	4.72	5.60
2007	0.20	15.63	5.17	12.64	9.26	6.67	8.17	8.08	3.83	8.83	7.85
2008	2.30	18.38	10.51	21.89	15.06	13.83	23.98	11.32	6.64	13.53	13.74
2009	5.16	17.85	11.94	23.77	16.11	16.40	22.46	5.87	5.39	11.80	13.68
2010	3.60	19.09	10.15	18.70	15.52	12.28	17.13	6.02	3.77	11.21	11.75
2011	6.66	19.14	12.89	26.15	14.86	13.88	21.89	6.22	4.26	11.60	13.75
1993~1995	0.04	5.31	4.17	5.20	3.76	1.92	4.36	4.77	1.85	2.02	3.34
1996~1999	0.30	10.76	3.01	9.02	4.24	2.81	7.32	6.42	2.23	5.19	5.13
2000~2003	0.79	20.80	6.24	15.13	8.86	10.12	14.78	12.43	6.58	8.01	10.37
2004~2007	0.20	15.01	3.73	9.25	6.93	6.65	7.08	8.53	3.00	6.09	6.65
2008~2011	4.43	18.62	11.37	22.63	15.39	14.09	21.37	7.36	5.02	12.04	13.23
1993~2011	1.21	14.56	5.78	12.62	8.05	7.39	11.33	8.07	3.83	6.91	7.98

Source: Author's estimation.

Appendix E　Estimation from the Model without Time Dummies

unit:%

Year	Global	Regional	Local
1993	3.37	10.64	85.99
1994	3.76	8.65	87.59
1995	2.63	13.13	84.24
1996	6.63	9.42	83.95
1997	4.75	10.72	84.53
1998	3.62	10.36	86.02
1999	5.70	7.84	86.46
2000	7.69	8.04	84.27
2001	9.87	12.60	77.53
2002	14.75	11.10	74.15
2003	9.54	12.62	77.84
2004	5.87	14.20	79.93
2005	7.31	13.05	79.64
2006	5.60	15.18	79.22
2007	7.94	12.85	79.21
2008	13.73	12.18	74.09
2009	13.34	10.73	75.93
2010	11.61	12.49	75.90
2011	13.33	12.14	74.53
1993~1995	3.39	10.81	85.81
1996~1999	5.17	9.58	85.24
2000~2003	10.46	11.09	78.45
2004~2007	6.68	13.82	79.50
2008~2011	13.00	11.89	75.11
1993~2011	7.97	11.47	80.56

Source: Author’s estimations.