Bankruptcy of Lehman Brothers: Determinants of Cross-country Impacts on Stock Market Volatility

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ABSTRACT

We empirically examine the determinants of the short-term cross-country impacts of Lehman Brothers' bankruptcy on the volatility of stock prices. According to the results of this study, countries with lower financial openness and greater stock market depth experienced a smaller increase in stock price volatility. This suggests that capital control and greater stock market development were relatively more useful in maintaining the stability of stock markets at the time of Lehman's failure. On the other hand, we find little evidence for the role of international imbalances, trade openness, economic sizes and income levels, and macroeconomic fundamentals.

Keywords: Lehman Brothers, Volatility of Stock Prices, Financial Openness, Stock Market Development
JEL Classifications: F32, F36, F38, F41

1. INTRODUCTION

The bankruptcy of Lehman Brothers on September 15, 2008 led the global crisis that started about a year earlier to face a new stage of acceleration. Lehman Brothers was the fourth largest investment bank in the US at the time of filing bankruptcy, and its collapse was the largest failure in the US history.[1] It materialized the systemic risk and nearly brought about the collapse of the financial system in the US through a "domino effect" (counterparty risk) and subsequent "fire sales" (Acharya et al., 2009; Helwege, 2010). The effects of Lehman's collapse were not limited to the US economy. It immediately triggered abrupt and large disruptions in the financial markets of foreign economies, including both advanced and emerging economies. Large drops in local currency values and equity prices were observed in almost all other countries. The severe and rapid spread of the crisis initiated by Lehman's failure was related to the fear of contagion and its possible link to global economic depression.

Despite their global character, the impacts of Lehman's failure on overseas financial markets varied widely across different countries.

In this paper, we empirically investigate the determinants of the cross-country differences in short-term impacts of Lehman's bankruptcy on the financial markets. To this end, we focus on the impacts on the volatility of the stock markets. We compare the volatilities of stock prices over the 1-month period each before and after Lehman's failure and explore factors that may be responsible for their cross-country differences. All the countries considered in our empirical analysis showed an increase in the volatility of stock prices after Lehman's bankruptcy, although the magnitude of these changes differed among countries. The rise in volatility may be attributed to an increase in net outflows of foreign capital from local stock markets as well as a sell-off by panicked domestic investors.

A number of authors have examined whether the pre-crisis conditions affected the severity of the impacts of the global financial crisis (GFC), and have reached rather contradictory conclusions. For example, Rose and Spiegel (2010; 2011; 2012) report that pre-crisis conditions, whether real or financial, were not of much consequence. On the other hand, Lane and Milesi-Ferreti (2011) find that many of the economic and financial indicators help to explain the cross-country differences in macroeconomic impacts.

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1 Dumontaux and Pop (2013. p. 270) for the list of the 20 largest U.S. bankruptcy filings between 1980 and 2009.

We revisit the above analysis, but with a focus on short-term impacts on stock market stability. Most of the existing studies focus on the medium-term consequences on both real and financial sectors: 1-year gross domestic product (GDP) and other financial indicators in Rose and Spiegel (2010; 2011) and Lane and Milesi-Ferreti (2011), multi-year GDP growth and other measures in Claessens et al. (2010) and Giannone et al. (2011). In this paper, by focusing on a much shorter term of 1 month, we hope to supplement the evidence on the relevance of the pre-crisis conditions. In particular, our short-term focus may allow us to better understand the roles of financial openness and financial deepening - a point of contention among many economists - since they are likely to be more visible in the short term.

One challenge in analyzing short-term impacts is the need to identify a short time window in which the crisis spread from the originator country to the rest of the world. It is unavoidable to have some arbitrariness, but fortunately, in the case of the GFC, we have a rather obvious reference point - the collapse of Lehman Brothers. A number of authors - Chakrabarty and Zhang (2012), Dumontaux and Pop (2013), Fernando et al. (2012), and Raddatz (2010) - use the collapse of Lehman as the reference point, though their research questions are not identical to ours.[2]

Lehman's collapse was the largest bankruptcy in US history in terms of asset size, and it exerted exceptionally synchronized and extensive influences on the world economy. As Claessens et al. (2010) point out, only countries with direct exposures to US assets suffered from the US financial turmoil before Lehman's failure. However, the spillover effects of Lehman's failure were global. Thus, we need to distinguish the impacts of Lehman's collapse on other countries from those of earlier incidents. We are also interested in the empirical regularities and implications that are specific only to the episode of the unprecedentedly large bankruptcy, Lehman's collapse.

We have considered the change in the stock market volatility as a measure of the impacts. A number of authors have examined the impacts of financial crises in terms of stock market volatility (Caporale et al., 2006; Nam et al., 2008; Yilmaz, 2010; Valls and Chulia, 2012). The first two papers examine the effects of the Asian financial crisis, whereas the latter two papers examine the GFC. As Karunanayake et al. (2010) have noted, the impact from the financial crisis is more clearly reflected in volatility than return. This is probably related to the well-known difficulty of precisely estimating the mean return. Estimates of mean returns are sensitive to the choice of sample periods. After the GFC, stock market indexes around the world declined significantly. However, the magnitude of decline cannot be precisely determined from

short time-series data, where volatility estimates are more reliable. Following King and Wadhwani (1990) and Chakrabarti and Roll (2002), we take the change in volatility as our main dependent variable. Our specification also corresponds to that of Bekaert and Harvey (1997), whose primary interest is to explain the cross-country differences in volatility.

Based on previous studies, we have selected four types of explanatory variables: Financial linkage, trade linkage, depth of stock market development, and international imbalances. It may be argued that the rapid and extensive spread of Lehman's bankruptcy to other countries was mainly attributed to contagion effects. Countries with strong financial or trade linkages to the crisis-hit country are known to be more vulnerable to financial contagion (Eichengreen et al., 1996; Kaminsky and Reinhart, 1998; Park and Song, 2001; van Rijckeghem and Weder, 2001; Schmukler, 2008). As general indicators of financial linkages and trade linkages to the rest of the world, we use the financial openness and trade openness variables, respectively. On the other hand, the depth of stock market development is related to the capacity of absorbing shocks while international imbalances are linked to the ability of managing shortage of international liquidity. Countries with better stock market depth or more favorable international imbalances are more capable of maintaining stock market stability with increasing net capital outflows.

We also introduce additional explanatory variables related to a country's economic size, macroeconomic fundamentals, crisis experiences, institutional environment, and geography. Even though we use a number of explanatory variables, we find only two variables significant in determining the cross-sectional differences: Financial openness and depth of stock market development. Countries experienced a larger increase in stock price volatility to the extent that financial openness was greater or stock market deepening was lesser.

The rest of this paper is organized as follows: Section 2 introduces previous studies that investigate the cross-country impacts of the GFC. Section 3 explains in detail the estimation model and data used in our empirical investigation, and Section 4 discusses our empirical results. Concluding remarks are presented in Section 5.

2. LITERATURE SURVEY

There are a number of previous studies that empirically investigate cross-country impacts of the GFC, though none of them focus on the short-term impacts around Lehman' bankruptcy. The existing studies first measure the extent of the GFC's impacts on each country and then examine macroeconomic or financial indicators as control variables for explaining their heterogeneity among different countries. In those studies, output growth is often used to measure the impacts of the GFC (Berkmen et al., 2012; Blanchard et al., 2010; Claessens et al., 2010; Lane and Milesi-Ferretti, 2011). Financial indicators, such as exchange rates, equity prices, and capital flows are also used (Obstfeld et al., 2009; Fratzscher, 2012). In some other studies, both output and financial variables are used to quantify the severity of the crisis effects (Frankel and Saravelos, 2012; Rose and Spiegel, 2010; 2011; 2012).

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2   Analyzing abnormal stock returns of the firms that disclosed their financial exposures to Lehman Brothers, Chakrabarty and Zhang (2012) find strong evidence for channel of counterparty risk in the transmission of contagion effects triggered by Lehman's bankruptcy. Fernando et al. (2012) also find relatively large drops in the abnormal stock returns of the firms that used to be Lehman's equity underwriting clients. According to the results obtained by Raddatz (2010), those banks that depended more on non-deposit funding showed relatively large declines of stock returns immediately after Lehman's bankruptcy, while Dumontaux and Pop (2013) find that non-banking financial services were the most affected by Lehman's failure.

The empirical results regarding the determining factors of the cross-sectional differences in impacts vary among the studies. Frankel and Saravelos (2012) and Obstfeld et al. (2009) suggest an important role of international reserves. The former study provides evidence that the level of international reserves in 2007 was consistently and significantly related to the size of impacts in 2008-2009, as measured by currency depreciation, equity market returns, GDP growth, and change in industrial production. The latter study finds a negative relationship between the international reserves in 2007 and the currency depreciation rate in 2008. According to the results of Berkmen et al. (2012), a considerably leveraged domestic financial system, stronger credit growth, and more short-term debt in 2007 are associated with a larger negative effect on output growth in 2009.

On the other hand, Claessens et al. (2010) show that asset price bubbles, current account deficit, increased financial integration, and more dependence on wholesale funding can explain larger negative impacts on the performance of real growth in 2008-2009. The results of Lane and Milesi-Ferretti (2011) also suggest the importance of pre-crisis conditions on macroeconomic and financial variables. That is, the negative effects on the GDP growth in 2008-2009 were larger to the extent that the current account deficit was larger, trade openness was higher, or the increase in the ratio of private credit to GDP over the period 2004-2007 was greater. Rose and Spiegel (2010) find evidence of the country-specific contagious response that is related to the trade linkage channel; countries with relatively larger exports to the US experienced greater negative impacts on the economy in 2008. Meanwhile, Rose and Spiegel (2011; 2012) fail to find any significant financial or macroeconomic factors related to the cross-sectional impacts of the GFC on GDP growth or financial indicators.

3. ESTIMATION MODEL AND DATA

We use the following cross-sectional econometric model to investigate the determinants of cross-country impacts on the volatility of stock prices caused by Lehman's bankruptcy:

$$DVol_i = \alpha + \beta_1 FO_i + \beta_2 TO_i + \beta_3 FD_i + \beta_4 IM_i + \varepsilon_i \qquad (1)$$

The dependent variable, $DVol_i$ denotes the change in volatility of stock prices in country i. Independent variables in equation 1 indicate initial conditions prior to Lehman's collapse. We use four types of explanatory variables. FO_i and TO_i denote the degree of financial and trade openness, respectively. FD_i represents the depth of financial market development, while IM_i denotes the variables for international imbalances.[3] ε_i is an error term.

We measure the volatility of the stock prices by standard deviation of daily stock returns and compute $DVol_i$ by log difference of

volatility measures. In order to analyze the short-term effects on the stock markets, we compare volatility over the 1-month period before and after Lehman's bankruptcy.[4] We use the MSCI local index for computing daily stock returns of each country.[5] Out of the original 70 countries (23 developed markets and 47 non-developed markets), only 66 countries are left for consideration in our regression analysis, since four countries are to be excluded because of limited data availability or unsuitability for this paper's purpose.[6]

We use degree of financial openness as an indicator of financial linkage. Countries that are financially more open are more likely to have stronger financial linkages or to be financially integrated with the rest of the world. Greater financial openness refers to a higher degree of capital mobility and less capital controls. Countries with more open financial markets are more vulnerable to the risks of drastic and disruptive changes in capital flows even in the absence of domestic problems (Stiglitz, 2002; Epstein, 2005; Kaminsky, 2008). We expect that they were more prone to financial contagions triggered by Lehman's bankruptcy, and experienced greater increase in stock price volatility. Furthermore, Lehman's bankruptcy greatly escalated the risks in financial investments globally. Consequently, it resulted in massive sell-off and net capital outflows from the stock markets in many countries, leading to an increase in instability in the global capital market. This type of financial turmoil is expected to have been more prevalent in countries with more open financial markets. Overall, we expect that the degree of financial openness to have a positive effect on the volatility of stock prices.

For our empirical investigation, we use three measures of financial openness. The first one, which is mainly used in our analysis, is Chin and Ito (2008)'s index.[7] The other two measures are adopted from Schindler (2009) and Abiad et al. (2010), respectively. All three measures are defined such that a higher value is assigned to a country with higher financial openness or less capital control.

The impacts of Lehman's bankruptcy may also differ depending on the countries' degree of real linkage to the world economy that can be well represented by the degree of trade linkage. We measure trade linkage by trade openness. Countries with higher degree of trade openness have stronger trade linkage to the world economy and are more susceptible to financial contagions. Thus, Lehman's bankruptcy was likely to raise the volatility of stock prices in these countries to a relatively greater extent. On the other hand, Lehman's failure generated a great fear of worldwide depression

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3   Studies of King and Wadhwani (1990) and Chakrabarti and Roll (2002), which also consider the change in volatility as the dependent variable, include the volatility of the originators of the crisis as one of the explanatory variables. In our case, this is not necessary since the GFC originates from a single country (the U.S.), and adding the volatility of one country simply replaces the constant term in the cross-sectional regression.

4   The volatilities are measured for the periods between August 15 and September 12, 2008 and between September 16 and October 14, 2008, respectively.

5   Appendix for data sources.

6   We leave out Bangladesh since the MSCI index for this country is not available for the period around Lehman's bankruptcy. We exclude Pakistan and Nigeria as the index values do not appear to be properly updated in September and October of 2008. The Pakistani index is constant for this period; the Nigerian index declines at a constant rate without exception, possibly reflecting a price band. We also exclude U.S. since it was the epicenter of the crisis.

7   The measure from Chin and Ito (2008) is the most updated compared with the other two measures.

and huge reduction in global trade, thereby exerting greater negative effects on the stock markets of countries with considerable trading interests. In overall, we expect the degree of trade openness to have a positive effect on the volatility of equity prices at the time of Lehman's bankruptcy. Trade openness is measured by the sum of total exports and imports relative to the GDP.

Considering that the US economy was the epicenter of the Lehman shock, we also employ the countries' trade linkage to the US economy as an alternative measure. According to the empirical results of Forbes (2010), the greater the trade relation of the countries with the US, the more closely they are integrated with the US equity market. We measure a country's trade linkage to the US by computing the product of its US share in total exports and trade openness.

The volatility of stock prices may also be related to the depth of the stock market development. Market deepening may tend to stabilize rather than destabilize the prices due to a greater capacity of providing liquidity and absorbing shocks efficiently (Denizer et al., 2002; da Silva, 2002; Weller and Zulfiqar, 2013). Given the same magnitude of external shocks, more developed stock markets are expected to show smaller variations of the stock prices. Thus, we expect countries with more developed stock markets to show less increase in volatility after the Lehman shock. As proxies for stock market development, we use two indicators: The size of the stock traded per year and the value of market capitalization. Both indicators are scaled by GDP.

International or external imbalances are related to the ability to manage international liquidity problems. The bankruptcy of Lehman Brothers immediately resulted in the collapse of the US financial markets and exacerbated the shortage of US dollar liquidity in the rest of the world economy (Cetorelli and Goldberg, 2010). After the incident, to what degree the US crisis transmitted to other countries may have depended on their ability to cope with this problem (Obstfeld et al., 2009; Frankel and Saravelos, 2012). Thus, the impacts of Lehman's bankruptcy on the local stock markets may have been affected by the size of the respective countries' international imbalances. In this paper, we measure international imbalances with three indicators: Current account balance, foreign exchange reserve, and net foreign asset. They are all measured as a share of GDP. Higher values of these indicators imply economies are better prepared for and able to deal with international liquidity crisis. Thus, they are expected to be associated with lower volatility changes in stock prices.

We use lagged values of explanatory variables to avoid possible endogeneity problems. The values in 2007 are used in most of the explanatory variables except two financial openness indexes from Schindler (2009) and Abiad et al. (2010). Owing to limited availability of data, we use the 2005 for these two indexes. It should also be noted that Taiwan and Serbia are excluded from our sample because of the lack of financial openness index, even though the stock price indexes of both these countries are listed in MSCI.[8] Thus, this finally leaves us with 64 countries for our empirical analysis.

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8   Table 1 for the list of countries.

4. EMPIRICAL RESULTS

We compute the ratio of stock price volatility in the post-Lehman period (1 month) relative to the pre-Lehman period (1 month) for each country, and present the results in Table 1. We also estimate P-values by testing the equality of the volatility between the two periods. Given that the ratio exceeds 1 in all countries, the difference of volatility between the two periods is also statistically significant, except in Malaysia. This indicates that the volatility of the stock price increased significantly in almost all of the local stock markets. The average ratio for all countries is 2.8. However, it is noteworthy that the magnitudes of the effects on the volatility were heterogeneous across the countries, as can be seen in Table 1. The ratio, which is highest in Croatia and lowest in Malaysia, varies from 1.244 to 7.905. From our sample, 34% of the countries recorded ratios higher than 3 while the corresponding figure between 1 and 2 is 22%.

Table 2 reports the volatility ratios for the country groups classified by region as well as market development. Average ratio and its variation are relatively higher in non-developed stock markets compared to developed markets. We can also find that the average ratio is highest in Eastern Europe and lowest in East Asia. The difference between the two regions seems to be large. Eastern Europe also displays the largest variation within the region. This finding is consistent with the facts found in Table 1 that four of the top five countries with the highest ratios (Croatia, Mauritius, Slovenia, Bulgaria, and Lithuania) belong to Eastern Europe and that three out of the five countries with lowest ratios (Malaysia, Vietnam, Lebanon, Estonia, and Korea) are from East Asia.[9] It seems that emerging markets in Eastern Europe were hit the hardest by the Lehman incident while those in East Asia were least impacted in terms of stock price volatility.

We estimate equation 1 with ordinary least squares and present the results in Table 3. The index of Chin and Ito (2008) and the ratio of stock traded to GDP are used as the variables of financial openness and stock market development, respectively. On the other hand, we have three indicators for international imbalance and two for the trade variable. As can be seen from Table 3, only two variables, financial openness and stock market development, enter with statistically significant coefficients across the specifications. As was expected, countries experienced a greater increase in the volatility of stock prices when financial openness was higher or stock market deepening was smaller. However, we cannot find statistical significance of any indicators for international imbalances and trade linkage. In other words, we find no evidence that either the ability to manage international liquidity or the trade linkage explain the cross-sectional differences in the changes in the volatility of stock prices.

The results in Table 3 indicate strong importance of financial openness and stock market depth, and we re-estimate equation 1

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9   This finding is consistent with the results of Fratzcher (2012). Using a dataset of high-frequency capital flows of portfolio, he found that emerging economies in Eastern Europe experienced the strongest net outflows of equity compared to those in other regions through the 2007-2008 global financial crisis.

Table 1: Ratios of stock price volatility between pre-Lehman and post-Lehman periods

Rank	Country	Volatility ratio	P values
1	Croatia	7.905	0.000***
2	Mauritius	7.279	0.000***
3	Slovenia	6.222	0.000***
4	Bulgaria	5.496	0.000***
5	Lithuania	5.296	0.000***
6	Philippines	4.198	0.000***
7	Qatar	3.978	0.000***
8	Chile	3.929	0.000***
9	Mexico	3.570	0.000***
10	Sri Lanka	3.530	0.000***
11	Netherlands	3.472	0.000***
12	Kuwait	3.445	0.000***
13	U.A.E	3.411	0.000***
14	Switzerland	3.356	0.000***
15	Austria	3.317	0.000***
16	Morocco	3.272	0.000***
17	Egypt	3.199	0.000***
18	Czech Republic	3.155	0.000***
19	Portugal	3.145	0.000***
20	Italy	3.135	0.000***
21	New Zealand	3.076	0.000***
22	Germany	2.946	0.000***
23	Colombia	2.882	0.000***
24	Russia	2.873	0.000***
25	Bahrain	2.852	0.000***
26	Denmark	2.743	0.000***
27	Thailand	2.738	0.000***
28	Belgium	2.673	0.000***
29	France	2.671	0.000***
30	Peru	2.649	0.000***
31	United Kingdom	2.624	0.000***
32	Israel	2.559	0.000***
33	Hungary	2.558	0.000***
34	Japan	2.486	0.000***
35	Spain	2.412	0.000***
36	China	2.403	0.000***
37	Brazil	2.399	0.000***
38	Canada	2.359	0.000***
39	Tunisia	2.307	0.000***
40	Oman	2.302	0.000***
41	Ireland	2.300	0.000***
42	Argentina	2.269	0.000***
43	Kazakhstan	2.268	0.000***
44	Norway	2.219	0.000***
45	Australia	2.176	0.000***
46	Romania	2.140	0.001***
47	Indonesia	2.087	0.001***
48	Turkey	2.064	0.001***
49	Hong Kong	2.015	0.001***
50	Ukraine	1.969	0.002***
51	Poland	1.957	0.002***
52	Finland	1.939	0.002***
53	Kenya	1.901	0.003***
54	Sweden	1.896	0.003***
55	Singapore	1.882	0.003***
56	Greece	1.861	0.004***
57	India	1.825	0.005***
58	South Africa	1.787	0.006***
59	Jordan	1.699	0.011**
60	Korea	1.653	0.014**
61	Estonia	1.596	0.020**
62	Lebanon	1.367	0.084*
63	Vietnam	1.354	0.090*
64	Malaysia	1.244	0.167

P values are computed from F-test. ***,** and * indicate statistical significance at 1%, 5%, and 10%, respectively

Table 2: Ratios of stock price volatility by type of markets and regions

Classification	Average	SD
Categorized by development		
Developed markets	2.577	0.507
Non-developed markets	2.990	1.501
All Countries	2.848	1.267
Categorized by Region		
Western Europe	2.670	0.516
Eastern Europe	3.752	2.014
South America	2.963	0.663
East Asia	2.206	0.805
Other regions	2.792	1.195

SD: Standard deviation

using the alternative measures of these two variables. We have three indicators for financial openness and two for stock market development, as was explained earlier. To be simplistic, we include only these two explanatory variables in our new regressions. The results in Table 4 show that the signs and significance of these two variables found earlier remain intact for any combination of indicators. This implies that the degree of financial openness and stock market depth categorically influenced the cross-country difference of volatility changes initiated by the collapse of Lehman Brothers.

Our empirical result on financial openness seems to be related with the massive capital inflows to non-developed countries between 2003 and 2007 before the GFC. Countries with higher financial openness experienced larger capital inflows during this period and, consequently, were more vulnerable to larger reversals when Lehman's failure unfolded. In other words, lower financial openness or stronger capital control was helpful in reducing the inflow of foreign capital during the surge period (Coelho and Gollagher, 2010) and protecting the domestic equity market from the spillover effects of Lehman's collapse. Our result is consistent with the earlier finding by Claessens et al. (2010) that countries with greater financial linkages to the advanced economies were more negatively affected by the GFC. However, most of the existing studies on the impacts of the GFC, which also consider financial openness as one of the control variables, reveal different outcomes. Berkmen et al. (2012), Blanchard et al. (2010), Fratzscher (2012), and Lane and Milesi-Ferretti (2011) fail to find robust evidence for an important role of financial openness measures in the impacts of the GFC. Furthermore, Rose and Spiegel (2010) even show that greater financial linkages to the US rather mitigated the negative effects of the GFC.

Regarding stock market deepening, our result is different from that of Rose and Spiegel (2010) who report no significant relationship between the GFC impacts and the depth of stock market development. Our result is more consistent with the finding by Demirguc-Kunt and Levine (1996) that stock market development is associated with more liquidity, less volatility, and an effective legal system. As emphasized in the literature on finance and macroeconomic stability (Denizer et al., 2002; da Silva, 2002; Weller and Zulfiqar, 2013), these are the characteristics that strengthen an economy's ability to absorb shocks. As discussed

Table 3: Determinants of changes in stock price volatility

Explanatory variables	(1)	(2)	(3)	(4)	(5)	(6)
Constant	0.972***	0.980***	1.032***	0.964***	0.992***	0.986***
	(10.850)	(11.201)	(10.793)	(13.160)	(11.915)	(13.197)
Financial openness						
Chin and Ito (2008)	0.102***	0.087**	0.087**	0.099***	0.093**	0.082**
	(3.013)	(2.422)	(2.716)	(3.018)	(2.828)	(2.605)
Trade openness						
(Exports+imports)/GDP	−0.059	0.023	−0.102			
	(−0.803)	(0.229)	(−1.388)			
(Export to US/total export)*				−0.538	−0.004	−0.006
				(−1.469)	(−1.036)	(−1.707)
Stock market depth						
Stock traded/GDP	−0.094*	−0.090*	−0.095*	−0.085*	−0.076	−0.086*
	(−1.855)	(−1.889)	(−1.962)	(−1.691)	(−1.598)	(−1.764)
International imbalances						
Current account/GDP	0.222			0.215		
	(0.457)			(0.456)		
Reserve/GDP		−0.393			−0.230	
		(−1.075)			(−0.826)	
NFA/GDP			0.092			0.073
			(1.447)			(1.224)
R^2	0.168	0.182	0.177	0.189	0.190	0.190
Number of observations	64	64	64	64	64	64

Figures in parentheses are t-statistics. ***·** and * indicate statistical significance at 1%, 5%, and 10%, respectively, GDP: Gross domestic product

Table 4: Effects of financial openness and stock market depth on the changes in stock price volatility

Explanatory variables	(1)	(2)	(3)	(4)	(5)	(6)
Constant	0.923***	0.944***	1.146***	1.140***	0.273	0.333
	(13.608)	(11.852)	(15.235)	(13.908)	(1.306)	(1.628)
Financial openness						
Chin and Ito (2008)	0.096***	0.090***				
	(2.929)	(2.746)				
Schindler (2009)			0.262**	0.208*		
			(2.035)	(1.164)		
Abiad et al. (2010)					0.823***	0.863***
					(3.373)	(3.367)
Stock market depth						
Stock traded (Share of GDP)	−0.100**		−0.102**		−0.095**	
	(−2.118)		(−2.300)		(−2.487)	
Market capitalization (share of GDP)		−0.091*		−0.097*		−0.122**
		(−1.677)		(−1.862)		(−2.774)
R^2	0.158	0.136	0.125	0.094	0.209	0.228
Number of observations	64	64	56	56	56	56

Figures in parentheses are t-statistics. ***·** and * indicate statistical significance at 1%, 5%, and 10%, respectively, GDP: Gross domestic product

by Arestis et al. (2001),[10] stock market development may have a negative influence on stability if the stock market generates "excessive volatility," perhaps through "noise trading." Our result does not support such view.

It may be argued that our results seem to be less convincing because stock market deepening may be positively related to financial openness, as suggested in previous studies such as Stultz (1999) and Claessens et al. (2002). If this is the case, then contrary to our results, those two variables should have shown the same sign in their coefficients. However, the correlation coefficients

show that those variables are very weakly correlated even though they show a positive association as reported in Table 5. This is consistent with the finding of Chin and Ito (2008) that a higher level of financial openness does not necessarily contribute to equity market development unless countries are equipped with legal and institutional capability. Thus, our regression results on those two variables do not contradict each other. It should also be noted from Table 5 that high positive correlations can be found among the three indicators of financial openness as well as among the two indictors of stock market development.

Next, we extend our baseline model to examine whether there are other domestic variables significantly associated with the cross-sectional differences of changes in stock price volatility. The new group of explanatory variables includes population size, per capita

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10 Arestis et al. (2001) traces this viewpoint back to Keynes (1936) who compared stock market to casinos. The excess volatility idea of Shiller (1981) and the noise trader idea of De Long et al. (1989) are in line with Keynes' view.

Table 5: Correlation of measures for financial openness and stock market depth

Variables	Chin and Ito (2008)	Schindler (2009)	Abiad et al. (2010)	Stock traded	Market capitalization
Chin and Ito (2008)	1.000	0.832	0.683	0.202	0.145
Schindler (2009)	0.836	1.000	0.723	0.297	0.163
Abiad et al. (2010)	0.683	0.723	1.000	0.325	0.269
Stock traded	0.202	0.297	0.325	1.000	0.749
Market capitalization	0.145	0.163	0.269	0.749	1.000

GDP, inflation rate, country indebtedness, growth expectation, exchange rate regime, dummy variables for banking and currency crises, institutional quality, and dummy variables for regional effects.

Economic size as well as income level may have affected the cross-country impacts of Lehman's bankruptcy. According to the results of Rose and Spiegel (2010), countries with higher income levels were significantly less impacted by the GFC while their economic sizes did not matter. Hence, we also examine the role of these two variables. Economic size and income levels are measured by population size and per capita GDP.[11] Meanwhile, inflation rate, country indebtedness, and growth expectation have relevance on the macroeconomic soundness of the countries. Countries with lower inflation rate, smaller country indebtedness, or higher growth expectation are likely to experience smaller increase in stock price volatility. We use the inflation rate of consumer price index, and measure the country indebtedness as the ratio of public debt to GDP.[12] Growth expectation in this paper refers to how the prediction on a country's GDP growth over 2011-2012 changed after Lehman's bankruptcy. To measure this variable, we divide the difference between new and old expectations by old expectation. Negative values of this variable imply a drop in expected growth rates. The expected growth rate for each country is taken from the IMF World Economic Outlook, and old and new expectations are based in April 2008 and April 2009, respectively.

It has often been argued that capital flows are more stable under the more flexible exchange rate system (Ghosh et al., 2012). Following the updated dataset of Ilzetzki et al. (2008), we classify the exchange rate regimes of all sample countries into two groups and construct a dummy variable. It takes the value 1 when the country's exchange rate regime is managed or freely floating, and 0 otherwise (fixed or pegged). Thus, it is expected that change in stock price volatility is negatively related with this dummy variable.

Countries with better institutions are less likely to experience sharp capital flow reversals (Fratzscher, 2012; Fratzscher et al., 2013). We expect that countries with better institutions showed smaller volatility increase in stock market after Lehman's bankruptcy. We use the Worldwide Governance Indicator as a proxy for institutional quality where higher values are assigned to better quality. In this paper, we also investigate whether any past crisis affected the cross-country differences in stock market volatility. To this end, we construct dummy variables for banking and currency crises relying on information from Reinhart and Rogoff (2011). The banking (currency) crisis dummy takes the value 1 if any banking (currency) crisis is detected at least once since the year

2000, and 0 otherwise. We also consider the validity of regional effects. The world is divided into five regions as in Table 2: Eastern Europe, Western Europe, South America, East Asia, and other regions. Based on this classification, we generate four regional dummy variables where East Asia is the benchmark.

We conduct regressions by adding new explanatory variables one by one to our baseline model. In order to maintain higher degree of freedom, we do not include international imbalance and trade openness, which have shown no statistical significance in earlier regressions presented in Table 3, and retain only financial openness and stock market development. It should also be noted that all newly added explanatory variables are measured by values in 2007.

The results in Table 6, however, do not provide any new findings in particular. None of the new variables enters significantly in all specifications while signs and significance of financial openness and stock market depth found earlier remain intact. From Table 2, we could observe relatively large increase of volatility in Eastern European countries compared with East Asian countries, but Table 6 indicates that the difference is not statistically strong when we control the effects of financial openness and depth of stock market development. Moreover, country specifics, such as economic and income sizes, macroeconomic fundamentals, exchange rate regime, institutional quality, and experience of banking or currency crisis, were not important in influencing the cross-country difference of volatility changes.

5. CONCLUDING REMARKS

In this paper, we empirically examine whether the short-term cross-country impacts of Lehman's bankruptcy on the volatility of stock prices were related to countries' initial macroeconomic and financial conditions. According to our empirical results, countries that had lower financial openness and greater stock market depth experienced a smaller increase in stock price volatility. This suggests an important policy implication that capital control might be a useful tool in stemming large capital outflow and, thereby, maintaining the stability of stock markets, at least, when there is a huge global shock similar to Lehman's failure. Our empirical outcomes are consistent with the argument that capital controls can be used to limit the volatility of short-term capital as suggested by Grabel (2003), Ocampo et al. (2008) and Ostry et al. (2010).

While some of the previous studies offer strong evidence for an important role of international imbalances, income size, macroeconomic fundamentals, and trade linkages in explaining cross-country impacts of the GFC,[13] our findings provide little

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11   Population is measured in unit of 1 million. Per capita GDP is measured in terms of constant US$ in 2005, and expressed in unit of US$ 10,000.
12   Appendix for data sources.

13   Claessens et al. (2010), Frankel and Saravelos (2012), Lane and Milesi-Ferretti (2011), and Rose and Spiegel (2010).

Table 6: Regressions with additional explanatory variables

Explanatory variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Constant	0.915***	0.923***	0.946***	0.895***	1.004***	0.946***	0.946***	0.934	0.924***	0.821***
	(12.389)	(12.520)	(8.847)	(7.572)	(8.407)	(12.736)	(12.072)	(11.689)	(13.294)	(5.567)
Financial openness Chin and Ito (2008)	0.101***	0.097***	0.080**	0.096***	0.090***	0.093***	0.065*	0.071	0.093**	0.084**
	(2.783)	(2.850)	(2.204)	(2.744)	(2.671)	(2.830)	(1.858)	(2.210)	(2.286)	(2.366)
Stock market depth Stock traded (share of GDP)	−0.997**	−0.094*	−0.092	−0.094*	−0.104**	−0.087*	−0.076*	−0.075	−0.100*	−0.062
	(−2.116)	(−1.898)	(−1.640)	(−1.883)	(−2.226)	(−1.844)	(−1.657)	(−1.626)	(−1.922)	(−1.066)
Additional variables	Population	Per capita GDP	Public debt	Inflation	Growth expectation	Exchange rate regime	Banking crisis	Currency crisis	WGI	Eastern Europe Western Europe South America Others
	0.072	−0.004	0.013	0.731	−0.002	−0.072	−0.059	−0.018	0.001	0.250
	(0.317)	(−0.145)	(0.088)	(0.492)	(−0.827)	(−0.767)	(−0.506)	(−0.213)	(0.101)	(1.344)
										0.062
										(0.395)
										0.160
										(0.786)
										0.056
										(0.368)
R²	0.159	0.158	0.166	0.164	0.167	0.166	0.138	0.133	0.158	0.193
Number of observations	64	64	42	60	64	64	46	46	64	64

Figures in parentheses are t-statistics. ***,**, and * indicate statistical significance at 1%, 5%, and 10%, respectively, GDP: Gross domestic product

empirical support for it. Not many country-specific factors can explain the heterogeneity in cross-country impacts of a global event such as Lehman's collapse. This difference suggests that determinants of short-term impacts are different from those of longer-term effects.

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APPENDIX TABLE

Appendix: Data sources

Variables	Sources
Banking crisis	Reinhart and Rogoff (2011)
Consumer price index	WDI, World Bank
Currency crisis	Reinhart and Rogoff (2011)
Current account balance (% of GDP)	WDI, World Bank
Exchange rate regime	Ilzetzki et al. (2008)
Financial openness	Chin and Ito (2008), Schindler (2009), Abiad et al. (2010)
Foreign exchange reserve (% of GDP)	WDI, World Bank
Foreign reserve (% of GDP)	WDI, World Bank
Institutional quality	WGI, World Bank
Net foreign asset (% of GDP)	Lane and Shambaugh (2010)
Per capita GDP	WDI, World Bank
Population size (unit of 1 million)	WDI, World Bank
Public debt (% of GDP)	Reinhart and Rogoff (2011)
Size of stock traded (% of GDP)	WDI, World Bank
Stock prices	MSCI Indexes, http://www.msci.com/
Trade openness (% of GDP)	WDI, World Bank
US share in total export	DOT, IMF
Value of market capitalization (% of GDP)	WDI, World Bank

DOT: Direction of trade, WDI: World development indicators, WGI: World Governance index, GDP: Gross domestic product