“The effect of financial crises on stock market liquidity across global markets”

AUTHORS	Halil D. Kaya Engku Ngah S. Engkuchik
ARTICLE INFO	Halil D. Kaya and Engku Ngah S. Engkuchik (2017). The effect of financial crises on stock market liquidity across global markets . *Investment Management and Financial Innovations*, *14*(2), 38-50. doi:10.21511/imfi.14(2).2017.04
DOI	http://dx.doi.org/10.21511/imfi.14(2).2017.04
RELEASED ON	Friday, 02 June 2017
RECEIVED ON	Thursday, 02 March 2017
ACCEPTED ON	Wednesday, 29 March 2017
LICENSE	This work is licensed under a Creative Commons Attribution-NonCommercial 4.0 International License
JOURNAL	"Investment Management and Financial Innovations"
ISSN PRINT	1810-4967
ISSN ONLINE	1812-9358
PUBLISHER	LLC “Consulting Publishing Company “Business Perspectives”
FOUNDER	LLC “Consulting Publishing Company “Business Perspectives”

NUMBER OF REFERENCES	NUMBER OF FIGURES	NUMBER OF TABLES
25	0	5

© The author(s) 2026. This publication is an open access article.

BUSINESS PERSPECTIVES

LLC "CPC "Business Perspectives"
Hryhorii Skovoroda lane, 10, Sumy, 40022, Ukraine

www.businessperspectives.org

Halil D. Kaya (USA), **Engku Ngah S. Engkuchik** (Kingdom of Saudi Arabia)

THE EFFECT OF FINANCIAL CRISES ON STOCK MARKET LIQUIDITY ACROSS GLOBAL MARKETS

Abstract

In this study, using a widely available market liquidity measure, the "turnover ratio", the authors test for market liquidity contagion during the four financial crises that occurred between 1997 and 1999: The Thai crisis, the Hong Kong crisis, the Russian crisis, and the Brazilian crisis. It is found that while the liquidity levels decreased in approximately half of the sample markets, in the remaining half, the liquidity levels actually improved. The Granger causality tests show that while there is almost no evidence of causality (in both directions) before each crisis, during each crisis, approximately half of the pairwise tests were significant. The results show that most of these causalities are reverse feedback effects from the non-crisis-origin markets to the crisis-origin market. Therefore, it is concluded that the more crucial phenomenon during these crises is the "reverse feedback effects" rather than the liquidity contagion itself.

Keywords financial crisis, contagion, liquidity, turnover ratio

JEL Classification G01, G12, G15

Received on: 2th of March, 2017
Accepted on: 29th of March, 2017

© Halil D. Kaya, Engku Ngah S. Engkuchik, 2017

Halil D. Kaya, Ph.D., Associate Professor of Finance, Northeastern State University, USA.

Engku Ngah S. Engkuchik, Ph.D., Assistant Professor of Finance, Prince Sultan University, Kingdom of Saudi Arabia.

This is an Open Access article, distributed under the terms of the Creative Commons Attribution-Non-Commercial 4.0 International license, which permits re-use, distribution, and reproduction, provided the materials aren't used for commercial purposes and the original work is properly cited.

INTRODUCTION

This paper attempts to address four questions: (i) Does market liquidity deteriorate in the crisis-origin markets during financial crises? (ii) Does market liquidity change in other markets or the non-crisis-origin markets during financial crises? (iii) Does the change in the liquidity level in the crisis-origin market cause a change in the liquidity level in the other markets? (iv) Are there any reverse feedback effects during financial crises (meaning that the change in the liquidity levels in the other markets during the crises causes a change in the liquidity level of the crisis-origin market)?

We look into four financial crises that occurred in the 1990s: The Thai crisis, the Hong Kong crisis, the Russian crisis, and the Brazilian crisis. For each crisis, first we look at how the crisis has affected our liquidity measure, the "turnover ratio", in the crisis-origin country as well as in the other countries. Then, for each crisis, we run causality tests to see whether the liquidity level in the crisis-origin country causes the liquidity levels in the other countries, or vice versa (i.e. the liquidity level in any of the other markets Granger-causes the liquidity level in the crisis-origin market).

A financial crisis typically brings about a shock into a country's stock market, which is then transmitted to another, partly due to the financial market liberalizations which allow investment capitals to flow in and out of a country more freely than ever before. Market liquidity is an important

feature of stock prices, as verified by the strong relation between stock prices and liquidity in the market microstructure literature. Given the importance of liquidity as one of the measures used to gauge the proper functioning of a market and to determine asset returns, evidence of the increase in variability and co-movement of asset returns and other economic variables between country-markets during a crisis, and evidence of a common liquidity factor among stock markets, one would expect market liquidity to be adversely affected during a financial crisis.

In this paper, we provide some evidence of the real state of market liquidity across emerging and developed markets during a crisis. We find that while the liquidity levels decreased in approximately half of our sample markets, in the remaining half the liquidity levels actually improved. Our Granger causality tests show that while there is almost no evidence of causality (in both directions) before each crisis, during each crisis, approximately half of the pairwise tests were significant. The results show that most of these causalities are reverse feedback effects from the non-crisis-origin markets to the crisis-origin market. Therefore, we conclude that the more crucial phenomenon during these crises is the "reverse feedback effects" rather than the liquidity contagion itself.

Our paper proceeds as follows: section 1 discusses the previous literature. Section 2 explains the data and the methodology. Section 4 explains the empirical results. Final section concludes.

1. LITERATURE REVIEW

A contagion can be defined as a significant increase in the co-movements of prices and quantities across markets after a shock to one country or a group of countries. Contagion may also be defined as the volatility spillover from the crisis-origin country to other countries. This definition implies that a financial crisis can be identified as the most volatile period (or with the highest uncertainty), and therefore a contagion is measured as volatility spillovers from one country-market to another. In other words, contagion occurs when uncertainty spreads across international financial markets. Evidence of such spillover effect has been documented in studies which investigate financial contagion originating from e.g. the U.S. stock market crash in 1987, the Mexican peso crisis in 1994, the Asian financial crisis in 1997, the Russian financial crisis in 1998, the 9/11, and the subprime mortgage crisis (see e.g. King and Wadhwani, 1990; Lee and Kim, 1993; Baig and Goldfajn, 1999; Longin, 2001; Longin and Solnick, 2001; Forbes and Rigobon, 2002; Hon et al., 2004; Chudik and Fratzscher, 2012; Kaserer and Rösch, 2013).

King and Wadhwani (1990), and Lee and Kim (1993) provide evidence of financial market contagion during the 1987 stock market crash. King and Wadhwani (1990) examine whether correlation coefficient of stock returns increases during and immediately after the crash as volatility increases between three leading markets, i.e. the New York stock exchange, the London stock exchange, and the Tokyo stock exchange. They find significant increases in the association of stock market returns between London-New York and Tokyo-New York after October 1987. Lee and Kim (1993) conclude that the interrelation of price movements across different national stock markets has become stronger after the 1987 stock market crash, i.e. the evidence of financial market contagion is mainly caused by the increased co-movements across North America, Pacific Basin, and Europe rather than by the increased co-movements within the same region.

Interestingly, Forbes and Rigobon (2002) who examine whether there is evidence of contagion among 28 markets around the 1987 stock market crash, the 1994 Mexican crisis, and the 1997 Asian crisis find that in most cases, there seem to be little evidence of contagion between financial markets based on the unconditional correlation coefficients which they propose, but stress that the continued high level of market correlation merely suggests stronger interdependence among markets around the world. Using Forbes and Rigobon's (2002) bias-correction procedure and GARCH method, Hon et al. (2004) examine whether the 9/11 incident led to contagion into other markets, i.e. the Organization for Economic Cooperation and Development (OECD) and Asian countries. However, in contrast to Forbes and Rigobon (2001), they provide evidence of conta-

gion by showing that international stock markets (in terms of stock returns) move closely with U.S. stocks after the shock, but not before. In addition, they also show that volatility in the U.S. market does not seem to increase even though cross-country correlations strengthen after the shock.

Additional evidence of financial contagion across markets is also provided by several other studies including Baig and Goldfajn (1998), and Bae et al. (2001). Baig and Goldfajn (1998) investigate contagion during the Asian financial crisis among five financial markets in East Asia, i.e. Thailand, Malaysia, Indonesia, Korea, and the Philippines, and find that correlations in currency and sovereign spreads increase significantly during the crisis period, whereas the equity market return correlations offer mixed evidence. Bae et al. (2001) investigate financial contagion across Asian and Latin American countries during the Mexican crisis, the Asian crisis, and the Russian crisis. Using the multinomial logit model, they study the probability of observing a large return in a country on a particular day given that another country has a large return on that day. Their approach also draws on the extreme-value statistical theory that the behavior of the tail observation is different from the rest of the observations. They generally find evidence of contagion during all three crises, with the findings within regions to be higher than across regions.

More recently, Chudik and Fratzscher (2012) analyze the transmission of liquidity shocks and risk shocks to global financial markets. They find significant differences in the transmission strength and pattern between the U.S. sub-prime mortgage crisis in 2008, and the sovereign debt crisis in 2010. They show that emerging market economies have been much more resilient to adverse shocks in the latter crisis when compared to former. The authors also show that, during the latter event, the flight-to-safety phenomenon across asset classes has become strong (with bond yields down in advanced economies) compared to the earlier crisis.

Kaserer and Rösch (2013) examine the dynamics and the drivers of market liquidity during the recent financial crisis. They find that market liquidity suffers when stock markets decline and they show this as an evidence of a positive relation between market risk and liquidity risk. They also show that liquidity commonality increases during market downturns and peaks at major crisis events. In addition, they show that financial sector's funding liquidity tightness induces liquidity commonality which then leads to market-wide liquidity dry-ups, and they conclude that market liquidity can be a driving force for financial contagion.

In most cases, prior contagion studies seem to confirm the existence of contagion in financial markets during financial crises. In explaining these contagions, several channels of contagion have been suggested, but with no consensus as to the main channel through which contagion spreads. Dornbusch et al. (2000) distinguish between channels via fundamental links and financial agents' behavior. While fundamental-based contagion can be channeled via common shocks or common global cause, competitive devaluations, or direct financial links, investors' behavior-based contagion depends on the degree of international market integration. According to Kaminsky and Reihbart (2000), it is difficult to differentiate between the role of trade and financial links, since most countries which are linked in trade are also linked in finance (Kaminsky and Reinhart, 2000). However, they posit that financial linkage is perhaps the more likely culprit since the predictive power of predicting a crisis in another country is higher when countries are clustered based on a common lender, such as the U.S. or Japan.

Dornbusch et al. (2000), and Sell (2001) suggest several channels of contagion which include the liquidity and incentive problems, information asymmetries and coordination problems, and changing rules of assessment by investors regarding international financial transactions, herding behavior, rational investors hypothesis or cross-market rebalancing, integrated capital markets, rational speculators' behavior, regional trade partnership or competition, cooperation which lacks credibility, via balance of payments or money demand, and via political reasons.

King and Wadhwani (1990), in proposing the correlated information channel as an explanation for contagion, argue that uninformed investors are unable to distinguish whether changes in prices in one market are due to liquidity shocks or shocks to the fundamentals. In this situation, when traders observe a decline in prices in one market, they take it as a signal predicting a fall in other markets as well,

causing a shock in one market to be transmitted to other markets. Kodres and Pritsker (2002) argue that King and Wadhwani's correlated information channel seems to work well only if financial markets have strong links to each other, but not when explaining the pattern of co-movement between two weakly-linked markets, e.g. the crisis from Russia to Brazil. Alternatively, Kodres and Pritsker (2001) suggest contagion can be better explained through a cross-market rebalancing channel, which implies that when there is a shock in one market, investors also rebalance their portfolios in other markets, thereby transmitting the shock and causing contagion. Their model also explains why emerging markets (where information asymmetry is more acute) seem more vulnerable to contagions and why contagions are more likely to happen during a financial crisis.

Kyle and Xiong (2001) explain the Russian crisis' contagion with a theoretical model in which increased risk-aversion is based on the wealth effects of convergence traders who follow the short-term (but rational) trading strategies. In their model, traders are assumed to trade in two risky assets. When traders suffer trading losses in either asset, they have reduced capacity for bearing risks. This motivates them to liquidate positions in both markets, causing decreased market liquidity and higher price volatility, and increased correlation between the two asset markets, which leads to contagion. Similarly, Bookstaber (2000), also in reference to the Long-Term Capital Management (LTCM) debacle, argues that liquidity crisis cycle is the reason for such global shocks, and that the need for liquidation is the root of the problem during such crisis. Liquidity crisis cycle refers to the cycle involving risk, leverage, and illiquidity – where initial losses trigger the shock in a market. In order to cover for the losses and to meet creditors' margin requirements (due to leveraged positions), these investors are forced to liquidate their positions including in other markets.

2. DATA AND METHODOLOGY

Our sample consists of four crisis-origin markets (Thailand, Hong Kong, Russia and Brazil), and eleven non-crisis-origin markets (Indonesia, Malaysia, the Philippines, Singapore, South Korea, Argentina, Chile, Mexico, Venezuela, Japan and the U.S.). We include Japan and the U.S. because we also want to evaluate the impact of each crisis on developed markets.

Since all of these crises initially started when the Thai government devalued the baht on July 1, 1997, we take the period between January 1, 1996 and July 1, 1997 as our "normal" period for all four crises. After July 1, 1997, first the Thai crisis took hold, and then the Hong Kong crisis started when the Hong Kong stock market crashed on October 20, 1997. Therefore, in this study, we define the Thai crisis period as the period between July 2, 1997 to October 18, 1997, and the Hong Kong crisis period as the period between October 19, 1997 and January 16, 1998.

Although Russia had been under economic pressures since the beginning of 1998, the crisis really exploded after the announcements on August 17, 1998 involving the abandonment of ruble pegging to dollar. Therefore, for the Russian crisis, the crisis period is defined as the period from August 17, 1998 to November 14, 1998.

The Brazilian crisis started in January 1999 with the devaluation of the real and the resignation of the country's finance minister on January 13, 1999. Therefore, for the Brazilian crisis, we define the crisis period as the period between January 13, 1999 and April 12, 1999.

In this study we use the (natural log of) daily turnover ratio as our equity market liquidity measure. This measure of liquidity has been used in several previous studies (i.e. Datar et al., 1998; Bekaert et al., 2003; Chan and Faff, 2003; Chordia et al., 2001; Jun et al., 2003, and Rouwenhorst, 1999).

The turnover ratio measure is calculated as the ratio of the daily number of shares traded in a country's market to that country's stock market capitalization at the end of the day. We obtain the data from Thomson Financial's Datastream which provides a large number of market information around the world. Forbes and Rigobon (2002), and Hon et al. (2004) focus on the two-day rolling average returns in their studies to control for non-synchronous trading periods in different markets around the world. Similarly, we compute the two-day rolling average for our turnover ratio to account for the same concern.

The unit root tests indicate that the market liquidity measures employed in our study are integrated of order one. Therefore, we employ the percentage change of turnover ratio for the rest of this paper.

3. EMPIRICAL RESULTS

Table 1 shows the summary statistics of the percentage change in the turnover ratio in the fifteen stock markets (including Japan and the U.S. markets) during the Thai crisis, the Hong Kong crisis, the Russian crisis, and the Brazilian crisis. Panels A, B, C, and D show the summary statistics for the Thai, the Hong Kong, the Russian, and the Brazilian crises, respectively.

We can see that, in each panel, approximately half of the fifteen countries have positive means (and medians) for the percentage change in the turnover ratio, while the other half have negative means (and medians). Also, the magnitudes of these mean and median values are relatively small. For example, in Panel A (i.e. the summary stats for the Thai crisis), none of the mean values for these fifteen countries are above 2% in absolute value. The largest positive percentage change is 1.59% (which is for the Indonesian market), while the largest negative percentage change is -1.39% (which is for the Venezuelan market). When we look at the other panels (i.e. other crises), we see that most of the mean values are close to zero as well.

Considering the fact that we have very small percentage changes in the turnover ratio (i.e. liquidity) in these fifteen countries' stock markets and that almost half of the means (and the medians) are positive/negative, we contend that these four financial crises have not had a large impact on these markets' liquidity levels.

After examining the relation between the four financial crises and the liquidity levels in these fifteen markets, we turn our attention to the interaction between the liquidity levels in the crisis-origin markets and the liquidity levels in the remaining markets.

Table 1. Summary statistics

Panel A – Thai crisis (7/2/1997–10/18/1997)						
Country	**N**	**Mean**	**Std. dev**	**Median**	**Skewness**	**Kurtosis**
Thailand	78	-0.0106	0.2526	-0.0410	0.3415	-0.0256
Hong Kong	78	-0.0012	0.1422	0.0010	-0.1800	0.4814
Indonesia	78	0.0159	0.2685	0.0027	0.3740	0.3008
Korea	78	0.0070	0.1633	0.0054	0.4107	0.2236
Malaysia	78	0.0139	0.1983	0.0246	-0.0674	-0.2331
Philippines	78	0.0115	0.2391	-0.0301	0.4007	0.6578
Singapore	78	0.0109	0.2080	0.0031	0.9617	4.1761
Russia	78	0.0093	0.3100	0.0288	-0.0492	0.6973
Brazil	78	-0.0006	0.2364	0.0237	-0.0474	-0.3085
Argentina	78	0.0026	0.1879	0.0234	-0.0814	0.8742
Chile	78	0.0082	0.3214	0.0025	-0.0257	0.0256
Mexico	78	-0.0009	0.2407	0.0027	0.0996	0.0382
Venezuela	78	-0.0139	0.5586	-0.0176	-0.4160	6.2873
Japan	78	0.0029	0.1158	0.0038	0.2302	3.7069
US	78	0.0024	0.0919	-0.0017	0.0031	-0.1681

Table 1 (cont.). Summary statistics

Panel B – Hong Kong crisis (10/19/1997–1/16/1998)

Country	N	Mean	Std. dev	Median	Skewness	Kurtosis
Thailand	65	0.0258	0.2285	0.0173	0.2994	-0.4575
Hong Kong	65	0.0012	0.2062	-0.0070	0.2113	-0.5132
Indonesia	65	0.0221	0.2364	-0.0084	0.4508	0.3914
Korea	65	0.0243	0.1958	0.0266	-0.0742	1.2182
Malaysia	65	0.0088	0.2952	-0.0293	0.0645	0.3328
Philippines	65	0.0161	0.2149	-0.0140	0.2781	-0.4050
Singapore	65	0.0142	0.2338	-0.0233	0.3976	0.1946
Russia	65	0.0071	0.3083	0.0062	-0.0011	0.1702
Brazil	65	-0.0043	0.2320	0.0043	0.0089	-0.0267
Argentina	65	-0.0142	0.4466	-0.0208	0.9879	8.3562
Chile	65	-0.0016	0.6002	0.0216	-0.2042	3.1623
Mexico	65	-0.0032	0.2921	-0.0080	-0.0774	-0.1923
Venezuela	65	-0.0089	0.4881	0.0071	0.4415	1.1307
Japan	65	0.0091	0.1749	-0.0068	0.2088	2.2714
US	65	-0.0017	0.1835	-0.0066	0.3032	1.2726

Panel C – Russian crisis (8/17/1998–11/14/1998)

Country	N	Mean	Std. dev	Median	Skewness	Kurtosis
Thailand	65	-0.0003	0.3493	-0.0147	0.3468	0.3388
Hong Kong	65	0.0031	0.3074	-0.0171	-1.0830	8.0629
Indonesia	65	0.0063	0.3009	-0.0281	0.2540	0.4826
Korea	65	-0.0013	0.1875	0.0172	-2.0043	8.9555
Malaysia	65	-0.0013	0.2781	-0.0232	0.0381	-0.3038
Philippines	65	0.0170	0.2269	-0.0249	0.8254	1.0664
Singapore	65	0.0122	0.2692	-0.0083	0.0224	-0.4325
Russia	65	-0.0149	0.4698	0.0017	-0.5026	0.0814
Brazil	65	0.0074	0.2318	0.0083	-0.0212	1.0557
Argentina	65	-0.0145	0.2502	-0.0099	-0.4082	1.3370
Chile	65	-0.0082	0.3748	0.0016	-0.2503	0.1143
Mexico	65	0.0042	0.2194	-0.0229	0.6544	0.4590
Venezuela	65	0.0054	0.6550	-0.0213	0.5609	1.1213
Japan	65	0.0027	0.2146	0.0022	-0.4313	5.4062
US	65	-0.0008	0.1030	-0.0095	-0.0407	0.2719

Table 1 (cont.). Summary statistics

Panel D – Brazilian crisis (1/13/1999–4/12/1999)

Country	N	Mean	Std. dev	Median	Skewness	Kurtosis
Thailand	65	0.0008	0.3002	-0.0283	0.0100	0.2545
Hong Kong	65	0.0068	0.1714	0.0033	0.2106	-0.2313
Indonesia	65	0.0016	0.2502	0.0088	-0.3406	1.4554
Korea	65	-0.0011	0.1165	-0.0172	0.6160	0.5046
Malaysia	65	-0.0019	0.2007	0.0121	0.0358	0.3617
Philippines	65	-0.0082	0.2660	-0.0573	0.5178	0.8580
Singapore	65	-0.0078	0.2368	-0.0206	-0.1429	0.8895
Russia	65	0.0104	0.4129	0.0085	0.5077	0.3029
Brazil	65	-0.0073	0.2354	0.0151	0.1930	1.3292
Argentina	65	0.0003	0.2453	-0.0096	-0.2024	0.4819
Chile	65	-0.0080	0.3161	-0.0150	-0.0174	0.7444
Mexico	65	0.0063	0.2656	0.0096	0.2632	0.0259
Venezuela	65	-0.0022	0.5143	-0.0026	-0.6232	3.8831
Japan	65	0.0050	0.1481	-0.0124	0.0725	-0.3127
US	65	-0.0005	0.0646	-0.0069	-0.0290	-0.2942

Note: This table provides the summary statistics of the percentage change of the turnover ratio during the Thai crisis, the Hong Kong crisis, the Russian crisis, and the Brazilian crisis.

Tables 2, 3, 4, and 5 show the results of the Granger-causality tests that are performed for the Thai, the Hong Kong, the Russian, and the Brazilian crises, respectively. The first three columns in each table show the results for the normal period (i.e. the 1/96-7/97 period), while the next three columns show the results for the crisis period (i.e. the 8/97-12/99 period). The results for the entire period (i.e. the 1/96-12/99 period) are shown in the last three columns.

3.1. The Thai crisis

In Table 2, →Th indicates that a country Granger-causes the Thai market, while Th→ indicates that the Thai market Granger-cause the other market. When we compare the normal period results to the crisis period results, we see that more countries Granger-cause the Thai market's liquidity levels during the crisis period when compared to the normal period. Also, the statistical significance levels are much higher during the crisis period compared to the normal period. While during the normal period only five markets (Malaysia, Mexico, U.S., Argentina, and Japan) Granger-cause the Thai market, during the crisis period seven countries (Venezuela, Argentina, Mexico, Philippines, Brazil, Japan, and U.S.) Granger-cause the Thai market.

As we can see from the table, the results are much more significant during the crisis period compared to the normal period. During the normal period, Malaysia, Mexico and U.S. are significant at 10% level, and Argentina and Japan are significant at 5% level. During the crisis period, Venezuela is significant at 10% level, Argentina and Mexico at 5% level, and Philippines, Brazil, Japan, and U.S. at 1% level.

Table 2. Liquidity contagion after the Thai crisis

Country	1/96–7/97			Crisis period			Entire period		
	N	→Th	Th→	N	→Th	Th→	N	→Th	Th→
Thailand	–	–	–	–	–	–	–	–	–
Hong Kong	389	3.6	**11.16	75	7.35	**11.78	1031	5.63	***15.58
Indonesia	389	3.84	5.25	75	5.32	2.42	1031	*9.48	8.87
Korea	389	4.38	3.55	75	6.38	2.83	1031	2.84	*9.46
Malaysia	389	*11.05	8.53	75	6.02	2.06	1029	3.34	2.39
Philippines	389	3.45	4.16	75	***14.57	4.19	1031	1.41	5.36
Singapore	389	5.13	2.69	75	4.56	2.3	1029	3	9.21
Russia	385	8.47	**12.46	71	*9.9	5.15	1031	***19.57	*10.11
Brazil	389	3.75	**11.13	75	***20.66	***23.48	1031	*10.91	7.75
Argentina	389	**13.62	4.12	75	**12.89	**14.93	1031	**13.97	5.54
Chile	389	3.73	4.29	75	5.66	5.41	1031	8.93	2.25
Mexico	389	*10.96	1.35	75	**11.71	9.1	1031	***17.17	6.19
Venezuela	389	1.43	*9.5	75	*8.92	2.31	1031	0.55	6.22
Japan	388	**11.54	**12.09	74	***20.63	6.53	1031	7.58	***17.47
U.S.	389	*11.55	6.36	75	***15.67	5.11	1031	***26.29	4.83

Notes: This table provides the Granger-causality test results of the error correction model between the crisis-origin country, Thailand, and the other stock markets in the sample during the crisis period and the normal period. 1/96–7/97 is the normal period window, while 1/96–12/99 is the whole sample period. →Th indicates that a country Granger-causes the Thai market, while Th→ indicates that the Thai market Granger-causes the other market. The results presented below correspond to the lag-5 length. Percentage change of turnover ratio is the first difference of turnover ratio. Turnover ratio is the natural log of the ratio between the daily trading volume and the corresponding market value. ***, **, * indicate significance levels of 1 percent, 5 percent, and 10 percent, respectively.

Table 2 also shows that the Thai market Granger-causes five markets (Hong Kong, Russia, Brazil, Venezuela, and Japan) during the normal period and only three markets (Hong Kong, Brazil, and Argentina) during the crisis period. This result is the only exception in all four tables (Tables 2, 3, 4, and 5) where we have more countries affected during the crisis period when compared to the normal period.

3.2. The Hong Kong crisis

In Table 3, →Hk indicates that a country Granger-causes the Hong Kong market, while Hk→ indicates that the Hong Kong market Granger-causes the other market. Here, again we find that more countries Granger-cause the crisis-origin market's liquidity levels (i.e. Hong Kong's liquidity levels) during the crisis period when compared to the normal period. While, during the normal period, only four markets (Thailand, Indonesia, Argentina, and Mexico) Granger-cause the Hong Kong market, during the crisis period, seven countries (Philippines, Russia, Brazil, Argentina, Mexico, Venezuela, and U.S.) Granger-cause the Hong Kong market.

As we can see from the table, the results are much more significant during the crisis period compared to the normal period. During the normal period,

Table 3. Liquidity contagion after the Hong Kong crisis

Country	1/96–7/97			Crisis period			Entire period		
	N	→Hk	Hk→	N	→Hk	Hk→	N	→Hk	Hk→
Thailand	389	**11.14	3.81	65	2.84	3.13	1039	9.18	6.92
Hong Kong	–	–	–	–	–	–	–	–	–
Indonesia	389	*9.88	0.88	65	7.43	4.93	1039	8.73	3.86
Korea	389	1.55	4.16	65	3.48	**14.63	1037	0.5	7.13
Malaysia	389	1.51	3.43	65	2.14	7.83	1041	6.5	8.39
Philippines	389	3.81	4.29	65	**13.02	4.74	1040	6.94	7.18
Singapore	389	7.08	3.24	65	4.1	**12.22	1041	*10.42	4.4
Russia	385	3.38	4.62	65	*9.86	*10.87	1031	9.15	8.52
Brazil	389	5.47	3.89	65	*9.46	6.65	1041	*9.24	**11.72
Argentina	389	*10.61	8.15	65	***19.41	5.32	1041	***21.55	6.1
Chile	389	4.13	2.69	65	2.73	3.7	1041	***25.19	4.77
Mexico	389	*11	4.36	65	***27.46	***18.72	1041	5.91	19.75
Venezuela	389	1.95	7.12	65	*9.5	**12.97	1041	4.18	0.62
Japan	388	6.71	8.24	65	2.95	9.15	1037	7.99	8.28
U.S.	389	7.67	5.59	65	***35.99	5.44	1041	***40.09	6.44

Notes: This table provides the Granger-causality test results of the error correction model between the crisis-origin country, Hong Kong, and the other stock markets in the sample during the crisis period and the normal period. →Hk indicates that a country Granger-causes the Hong Kong market, while Hk→ indicates that the Hong Kong market Granger-causes the other market. ***, **, * indicate significance levels of 1 percent, 5 percent, and 10 percent, respectively.

Thailand is significant at 5% level, while the other three markets are significant at only 10% level. During the crisis period, however, Argentina, Mexico and U.S. are significant at 1% level, Philippines is significant at 5% level, and the remaining three markets are significant at 10% level.

Table 3 also shows that while the Hong Kong market does not Granger-cause any market during the normal period, it Granger-causes five markets (Mexico at 1% level, Korea, Singapore, and Venezuela at 5% level, and Russia at 10% level) during the crisis period.

3.3. The Russian crisis

In Table 4, →Rs indicates that a country Granger-causes the Russian market, while Rs→ indicates that the Russian market Granger-causes the other market. When we compare the normal period results to the crisis period results, we see that more countries Granger-cause the Russian market's liquidity levels during the crisis period when compared to the normal period. While during the normal period, only two markets (Thailand at 5% level and Singapore at 1% level) Granger-cause the Hong Kong market, during the crisis period, five markets (Hong Kong, Indonesia, and Brazil at 10% level, and Philippines and Singapore at 1% level) Granger-cause the Hong Kong market.

Table 4. Liquidity contagion after the Russian crisis

Country	1/96–7/97			Crisis period			Entire period		
	N	→Rs	Rs→	N	→Rs	Rs→	N	→Rs	Rs→
Thailand	389	**11.98	9.01	65	9.22	2.18	1031	6.41	***15.68
Hong Kong	389	4	3.55	65	*10.94	3.45	1031	9.01	8.29
Indonesia	389	7.44	2.03	65	*9.38	**14.56	1031	3.35	*9.84
Korea	389	1.86	1.93	65	2.85	8.05	1029	3.06	2.12
Malaysia	389	1.76	4.88	65	6.18	**12.08	1031	2.22	4.53
Philippines	389	5.43	*9.74	65	***18.16	0.9	1030	3.08	**11.18
Singapore	389	***17.78	6.09	65	***21.4	*10.35	1031	***20.27	*10.12
Russia	–	–	–	–	–	–	–	–	–
Brazil	385	3.57	2.67	65	*9.94	6.79	1031	*10.64	8.35
Argentina	389	6.04	2.96	65	5.76	*9.49	1031	**14.24	5.14
Chile	389	7.8	4.17	65	6	4.58	1031	8.26	2.73
Mexico	389	5.91	5.96	65	4.97	0.96	1031	***16.46	6.5
Venezuela	389	5.01	4.43	65	3.47	**12.81	1031	0.7	6.97
Japan	388	4.2	6.94	65	3.27	3.66	1031	7.12	***17.95
U.S.	389	6.88	3.45	65	6.38	4.6	1031	***26.92	4.9

Notes: This table provides the Granger-causality test results of the error correction model between the crisis-origin country, Russia, and the other stock markets in the sample during the crisis period and the normal period. →Rs indicates that a country Granger-causes the Russian market, while Rs→ indicates that the Russian market Granger-causes the other market. ***, **, * indicate significance levels of 1 percent, 5 percent, and 10 percent, respectively.

Table 4 also shows that while the Russian market Granger-cause only one market (Philippines at 10% level) during the normal period, it Granger-causes five markets (Indonesia, Malaysia, and Venezuela at 5% level, and Singapore and Argentina at 10% level) during the crisis period.

3.4. The Brazilian crisis

In Table 5, →Br indicates that a country Granger-causes the Brazilian market, while Br→ indicates that the Brazilian market Granger-causes the other market. When we compare the normal period results to the crisis period results, we see that more countries Granger-cause the Brazilian market's liquidity levels during the crisis period when compared to the normal period. While during the normal period, only two markets (Thailand at 5% and Argentina at 10% levels) Granger-cause the Brazilian market, during the crisis period, three markets (Thailand at 10%, and Chile and U.S. at 5% levels) Granger-cause the Brazilian market.

Table 5. Liquidity contagion after the Brazilian crisis

Country	1/96–7/97			Crisis period			Entire period		
	N	→Br	Br→	N	→Br	Br→	N	→Br	Br→
Thailand	389	**12.48	2.67	65	*9.29	6.46	1039	***24.09	1.1
Hong Kong	389	3.79	6.34	65	3.94	4.52	1041	**12.24	**11.55
Indonesia	389	8.51	5.07	65	6.05	2.17	1041	4.08	5.65
Korea	389	3.55	4.21	65	5.07	***26.76	1037	1.73	**11.08

Table 5 (cont). Liquidity contagion after the Brazilian crisis

Country	1/96–7/97			Crisis period			Entire period		
	N	→Br	Br→	N	→Br	Br→	N	→Br	Br→
Philippines	389	4	8.56	65	5.96	8.41	1040	6.95	8.4
Singapore	389	3.2	6.34	65	1.8	1.87	1041	6.28	6.07
Russia	385	3.17	3.56	65	6.4	7.96	1031	8.35	*10.64
Brazil	–	–	–	–	–	–	–	–	–
Argentina	389	*10.64	4.23	65	4.3	*10.73	1041	***16.47	6.11
Chile	389	2.95	8.17	65	**12.29	5.31	1041	***15.15	7.07
Mexico	389	3.65	8.77	65	5.77	4.87	1041	***19.42	**11.18
Venezuela	389	6.35	6.95	65	5.17	*10.86	1041	2.53	3.06
Japan	388	7.27	6.61	65	8.66	1.85	1037	8.01	**13.96
U.S.	389	1.57	1.35	65	**14.3	1.98	1041	6.22	7.42

Notes: This table provides the Granger-causality test results of the error correction model between the crisis-origin country, Brazil, and the other stock markets in the sample during the crisis period and the normal period. →Br indicates that a country Granger-causes the Brazilian market, while Br→ indicates that the Brazilian market Granger-causes the other market. ***, **, * indicate significance levels of 1 percent, 5 percent, and 10 percent respectively.

Table 5 also shows that while the Brazilian market does not Granger-cause any market during the normal period, it Granger-causes three markets (Korea at 1%, and Argentina and Venezuela at 10% levels) during the crisis period.

CONCLUSION

In this study, using a widely available market liquidity measure, the "turnover ratio", we test for market liquidity contagion during the four financial crises that occurred between 1997 and 1999: The Thai crisis, the Hong Kong crisis, the Russian crisis, and the Brazilian crisis. First, we classify the stock markets of these four countries as "crisis-origin" markets and the stock markets of several other countries (i.e. Indonesia, Korea, Malaysia, Philippines, Singapore, Argentina, Chile, Mexico, Venezuela, Japan and U.S.) as non-crisis-origin markets. Then, we examine the percentage change in the turnover ratio in both the crisis-origin markets and the non-crisis-origin markets during each financial crisis.

We find that while the liquidity levels decreased in approximately half of the sample markets, in the remaining half, the liquidity levels actually improved. We contend that the impact of these four crises on the liquidity levels of the other markets were not as large as the "liquidity contagion" literature suggests.

We then run Granger causality tests in order to see whether the liquidity level in the crisis-origin country causes the liquidity levels in the other countries, or vice versa (i.e. the liquidity level in any of the other markets Granger-causes the liquidity level in the crisis-origin market). We find that, for each of the four crisis, while there is almost no evidence of causality (in both directions) during the "normal" period (i.e. 1/96-7/97), during the "crisis" period, approximately half of the pairwise tests were significant. The results show that, interestingly, more than half of these causalities are reverse feedback effects from the non-crisis-origin markets to the crisis-origin market. Therefore, we conclude that the more crucial phenomenon during these crises is the "reverse feedback effects" rather than the liquidity contagion itself.

REFERENCES

1. Amihud, Y., and Mendelson, H. (1986). Asset pricing and the bid-ask spread. *Journal of Financial Economics*, *17*, 223-249. Retrieved from http://s3.amazonaws.com/academia.edu.documents/39998571/Asset_Pricing_and_the_BidAsk_Spread20151114-29851-oaei7d.pdf?AWSAccessKeyId=AKIAIWOWYYGZ2Y53UL3A&Expires=1495566120&Signature=vftZB%2BOlSF1Kr8aUJtNFTQkDI58%3D&response-content-disposition=inline%3B%20filename%3DAsset_pricing_and_the_bid-ask_spread.pdf
2. Bae, K., Karolyi, G. A., and Stulz, R. M. (2003). A new approach to measuring financial contagion. *Review of Financial Studies*, *16*(3), 717-764. Retrieved from https://fisher.osu.edu/supplements/10/10402/New-Approach-Measuring-Financial-Contagion.pdf
3. Baig, T., and Goldfajn, I. (1999). Financial market contagion in the Asian crisis. *IMF Staff Papers*, *46*(2), 167-195. Retrieved from http://pascal.iseg.utl.pt/~aafonso/eif/pdf/baig.pdf
4. Bekaert, G., Harvey, C. R., and Lundblad, C. (2003). *Liquidity and expected returns: Lessons from emerging markets.* Working paper, Duke University. Retreived from https://www0.gsb.columbia.edu/mygsb/faculty/research/pubfiles/2827/lessons.pdf
5. Bookstaber, R. (2000). Perspectives: Understanding and monitoring the liquidity crisis cycle. *Financial Analysts Journal*, *56*(5), 17-22. Retrieved from http://bookstaber.com/rick/AIMR1000.pdf
6. Calvo, S., and Reinhart, C. M. (1996). *Capital Flows to Latin America: Is There Evidence of Contagion Effects?* World Bank Policy Research Working Paper, 1619. Retreived from https://mpra.ub.uni-muenchen.de/7124/1/MPRA_paper_7124.pdf
7. Chan, H. W., and Faff, R. W. (2002). An investigation into the role of liquidity in asset pricing: Australian evidence. *Pacific-Basin Finance Journal*, *111*(5), 555-573. Retrieved from https://otago.ourarchive.ac.nz/bitstream/handle/10523/1513/AssetPricingIlliquidityPremium2002.pdf?sequence=2&isAllowed=y
8. Chordia, T., Sarkar, A., and Subrahmanyam, A. (2001). Common determinants of bond and stock market liquidity: The impact of financial crises, monetary policy, and mutual fund flows. *Federal Reserve Bank of New York Staff Reports, 141*.
9. Chordia, T., Subrahmanyam, A., and Anshuman, V. R. (2001). Trading activity and expected stock return. *Journal of Financial Economics*, *59*, 3-32. Retrieved from https://pdfs.semanticscholar.org/3b92/c4141d6212b367c0095678a19d5270087873.pdf
10. Chudik, A., and Fratzscher, M. (2012). Liquidity, risk and the global transmission of the 2007-08 financial crisis and the 2010-11 sovereign debt crisis. *European Central Bank Working Paper Series*, 1416. Retreived from http://edz.bib.uni-mannheim.de/daten/edz-ki/ezb/12/w-paper/ecbwp1416.pdf
11. Datar, V., Naik, N., and Radcliffe, R. (1998). Liquidity and asset returns: An alternative test. *Journal of Financial Markets*, *1*(2), 203-219.
12. Forbes, K., and Rigobon, R. (2002). No contagion, only interdependence: Measuring stock market comovements. *Journal of Finance*, *57*(5), 2223-2261. Retrieved from https://www.researchgate.net/profile/Kristin_Forbes/publication/4769210_No_Contagion_Only_Interdependence_Measuring_Stock_Market_Comovements/links/02e7e51a9e83d642f2000000.pdf
13. Hon, M. T., Strauss, J., Yong, S. (2004). Contagion in financial markets after September 11: Myth or reality? *Journal of Financial Research*, *27*(1), 95-114. Retrieved from https://www.researchgate.net/profile/Soo_Keong_Yong/publication/227375091_Contagion_in_financial_markets_after_September_11_myth_or_reality/links/558a87ed08aee1fc9174ec51.pdf
14. Jun, S., Marathe, A., and Shawky, H. A. (2003). Liquidity and stock returns in emerging equity markets. *Emerging Markets Review*, *4*(1), 1-24. Retrieved from http://s3.amazonaws.com/academia.edu.documents/36980443/Paper_1_-_liquidity_and_stock_return_1.pdf?AWSAccessKeyId=AKIAIWOWYYGZ2Y53UL3A&Expires=1495566625&Signature=C1i5uGwNzIIUSUexkEg8fDfA3cY%3D&response-content-disposition=inline%3B%20filename%3DLiquidity_and_stock_returns_in_emerging.pdf
15. Kaminsky, G. L., and Reinhart, C. M. (2000).On crises, contagion, and confusion. *Journal of International Economics*, *51*(1), 145-168. Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.466.5742&rep=rep1&type=pdf
16. Kaserer, C., and Rösch, C. G. (2013). Market liquidity in the financial crisis: The role of liquidity commonality and flight-to-quality. *Journal of Banking and Finance*, *37*(7), 2284-2302. Retrieved from https://www.researchgate.net/profile/Christoph_Kaserer/publication/228318387_Market_Liquidity_in_the_Financial_Crisis_The_Role_of_Liquidity_Commonality_and_Flight-to-Quality/links/0c960522f4b3f3eb9b000000.pdf
17. King, M. A., and Wadhwani, S. (1990). Transmission of volatility between stock markets. *Review of Financial Studies*, *3*(1), NBER Conference: Stock market volatility and crash, Dorado Beach, March 16-18, 1989, 5-33. Retrieved from http://www.finance.martinsewell.com/stylized-facts/volatility/KingWadhwani1990.pdf
18. Kodres, L. E., and Pritsker, M. (2002). A rational expectations

model of financial contagion. *Journal of Finance*, *57*(2), 769-799. Retrieved from http://www.haas.berkeley.edu/groups/finance/Mk-stress.pdf

19. Kyle, A. S., and Xiong, W. (2001). Contagion as a wealth effect. *Journal of Finance*, *56*(4), 1401-1440.
20. Lee, S. B., and Kim, K. J. (1993). Does the October 1987 crash strengthen the co-movements among national stock markets? *Review of Financial Economics*, *3*(1/2).
21. Longin, F. (2001). Stock market crashes: Some quantitative results based on extreme value theory, *Derivative Use, Trading and Regulation*, *7*(3), 197-205. Retrieved from http://longin.fr/Recherche_Publications/Articles_pdf/Longin_Stock_market_crashes.pdf
22. Longin, F., and Solnick, B. (2001). Extreme correlation of international equity markets, *Journal of Finance, 56*(2), 649-676. Retrieved from https://studies2.hec.fr/jahia/webdav/site/hec/shared/sites/solnik/acces_anonyme/home/extreme.pdf
23. Rouwenhorst, K. G. (1999). Local return factors and turnover in emerging stock markets. *Journal of Finance*, *54*(4), 1439-1464. Retrieved from https://pdfs.semanticscholar.org/d48c/6b8c4328a051a0123e1f9725cb72d7446b30.pdf
24. Sell, F. L. (2001). *Contagion in financial markets*. Northampton, MA: Edward Elgar Publishing, Inc. Retrieved from https://books.google.com/books?hl=en&lr=&id=zAChCCnCrt4C&oi=fnd&pg=PR7&dq=Contagion+in+financial+markets&ots=cGGjrYaOGJ&sig=pPa2JaOKxyoe0gzhXpuG2usxlek#v=onepage&q=Contagion%20in%20financial%20markets&f=false
25. Stahel, C. (2005). *Is there global liquidity factor?* Working paper, Ohio State University. Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.3.5941&rep=rep1&type=pdf