

**CURRENCIES' EXCHANGE RATE TREND-BEFORE AND AFTER  
FINANCIAL CRISIS**

by

Kyung Hee Koh

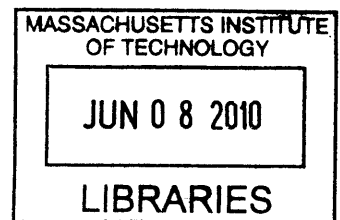
Bachelor of Law, Ewha Womans Unviersity, 2005

**ARCHIVES**

Submitted to MIT Sloan School of Management on May, 7 2010 in Partial  
Fulfillment of Requirements for the Degree of

**Master of Science in Management Studies  
At the Massachusetts Institute of Technology**

**June 2010**



**©2010 Massachusetts Institute of Technology. All rights reserved.**


Signature of Author

---

Kyung Hee Koh  
M.S. in Management Studies Program  
May 7, 2010


Certified by:

---

  
Roberto Rigobon  
Professor of Applied Economics  
Thesis Supervisor

Accepted by:

---

  
Michael A. Cusumano  
Faculty Director, M.S. in Management Studies  
Program  
MIT Sloan School of Management

# Currencies' exchange rate trend - before and after financial crisis

by

Kyung Hee Koh

Submitted to MIT Sloan School of Management on May, 7 2010 in partial fulfillment of requirements for the degree of Master of Science in Management Studies

## ABSTRACT

Do financial crises tend to arise together? Recent financial crisis that has originated from credit crisis in US in 2008 spread throughout countries ranging from Asia, to Europe, to Africa. Generally a shock to one country's asset market that causes changes in asset prices in another country's financial market is called financial contagion.

While financial turbulence from Lehman bankruptcy spread crisis over a large number of countries, can we say that there is financial contagion? Were countries in different regions of the globe affected in the same way? This thesis will analyze credit crisis by looking into the extent to which it affected 34 countries in six different regions of the world. Foreign exchange markets are often in conjunction with a banking system crisis. In recent credit crunch a banking problem led exchange rate movement. The thesis is particularly focusing on recent volatility of exchange rates in the world.

Thesis Supervisor: Roberto Rigobon

Title: Professor of Applied Economics

# Table of Contents

Abstract.....	2
Table of Contents.....	3
1. Introduction.....	4
1.1 Motivation.....	6
1.2 Overview.....	6
2. Literature Review.....	7
3. Analysis of crisis from Lehman Bankruptcy .....	9
3.1 Data and approach.....	9
3.2 Co-movement of thirty four currencies.....	10
3.3 Correlation test.....	11
3.4 Summary Measure.....	12
3.5 Results.....	13
3.6 Summary.....	16
3.7 Comparison.....	17
4. Conclusion.....	20
5. Appendix.....	22

## 1. Introduction

In the history there were several sharp changes in equity prices from DJIA crash in 1987, huge changes in exchange rate from South East Asian crises in 1997-98, and dot com bubble burst in 2000, large shifts in bond markets from Russian crisis in 1998 and Latin American crisis in 1999. Do financial crises tend to arise together? Recent financial crisis that has originated from credit crisis in US in 2008 spread throughout countries ranging from Asia, to Europe, to Africa. Not only emerging markets in Asia but also developed markets in North America and Europe were affected. Banks and financial institutions from around the world wrote down billions of dollars of losses. Housing markets fell in the US, the UK, Spain and Ireland. The crises actually arise together.

Investment funds lost billions betting on risky credit instruments. Financial institutions have sustained over \$500 billion dollars of write-downs since the crisis. Two of Bear sterns' hedge funds collapsed in July 2007<sup>1</sup>. The collapse of Sowood Capital<sup>2</sup> followed these failures. The spreading global financial crisis has led the demise of leading investment banks.<sup>3</sup> And the aftermath of Lehman bankruptcy in September of 2008 is still remained in 2010.

Especially emerging markets have experienced steep stock market losses. Rapid growth in Asian nations experienced capital outflows after enormous capital inflows during 1990s. Countries with critical fiscal imbalances have been hit hard because many emerging markets

---

<sup>1</sup> The funds had invested \$1.5 billion in subprime CDO(Collateralized Debt Obligations)'s

<sup>2</sup> A prominent \$3 billion hedge fund

<sup>3</sup> Bear Sterns was acquired by JP Morgan Chase in March 2008, Merrill Lynch was acquired by Bank of America, Goldman Sachs and Morgan Stanley changed to Bank Holding companies, Lehman Brothers filed for bankruptcy in September 2008,

depend on foreign capital inflows to finance huge current account deficits. In addition, countries on the receiving end of capital inflows have suffered the greatest difficulties as capital flows reversed the direction and current account deficits because they are impossible to finance. South Korea, where half of all domestic stock market capitalization was owned by foreigners has seen its market crash as those foreigners withdrew their funds in order to avoid their financial distresses.

Generally a shock to one country's asset market that causes changes in asset prices in another country's financial market is called financial contagion<sup>4</sup>. Contagion is also defined as a significant increase in cross-market linkages after a shock to an individual country, as measured by the degree to which asset prices or financial flows move together across markets relative to this co-movement in tranquil times.<sup>5</sup> However, there is disagreement about the term financial contagion.<sup>6</sup> Strict definition is used here because many economists especially those performing empirical tests prefer a very strict definition.<sup>7</sup>

Prior to the East Asian financial crisis, the issue of financial contagion was not caught the attention of researchers and policy makers in the world even though there were several crises in 1990s: Mexico peso crisis in 1994, devaluation of Thai Baht in Thailand of 1997,

---

<sup>4</sup> The Cause, Effects, and Implications of Financial Contagion from Jonathan Lhost(2004)

<sup>5</sup> Contagion: Understanding How It Spreads by Rudiger Dornbusch, Yung Chul Park, Stijn Claessens(2000)

<sup>6</sup> Broad definition: Contagion is the cross- country transmission of shocks or the general cross-country spillover effects, Strict definition: Contagion is the transmission of shocks to other countries or the cross-country correlation beyond any fundamental link among the countries and beyond common shocks, Very strict definition: Contagion occurs when cross-country correlations increase during 'crisis times' relative to correlation during 'tranquil times', World Bank

Contagion: Understanding How It Spreads by Rudiger Dornbusch, Yung Chul Park, Stijn Claessens(2000)

<sup>7</sup> "Measuring Contagion: Conceptual and Empirical Issues", in International financial contagion by Kristin Forbes, Roberto Rigobon (2002)

Russian default in 1998. However many articles have been written on the financial contagion since 1997-98 Asian crisis that spread further to Russia and Latin America.

## 1.1 Motivation

South Korea has mostly suffered from KIKO(Knock-in Knock-out) contracts<sup>8</sup>.South Korean KRW's exchange rate against USD has gone up a lot after credit crisis. Since KIKO contract was not explained to customers in detail and was created to relieve the loss from falling exchange rate without considering rise in exchange rate, the corporations who utilized KIKO contracts for hedging have suffered from financial distress. Since then volatility in exchange rate has attracted huge attention of investors and policy makers in South Korea. Before credit crunch economists or policy makers in South Korea have also paid attention to diffusion of financial crisis since East Asian crisis. And they are interested in managing risk and measuring the damaging impact of global financial turbulence such as credit crunch.

While financial turbulence from Lehman bankruptcy spread crisis over a large number of countries, can we say that there is financial contagion? Were countries in different regions of the globe affected in the same way? Transmission of shock from recent credit crisis in the US was not researched deeply yet. Therefore, this thesis will analyze credit crisis by looking into the extent to which it affected 34 countries in six different regions of the world. Foreign exchange markets are often in conjunction with a banking system crisis. In recent credit crunch a banking problem led exchange rate movement. The thesis is particularly focusing on recent volatility of exchange rates in the world.

## 1.2 Overview

---

<sup>8</sup> A currency option product that sells foreign currencies at a fixed exchange rate which falls in a certain range imposed by companies and banks

The existence of contagion in relation to the crisis is addressed throughout this thesis. As a way of measuring the evidence of contagion correlation test was used because definition of contagion is a significant increase in the correlation between assets during a period of crisis, compared with a period of calm.<sup>9</sup> Chapter 2 covers literature reviews on the research of financial contagion. Chapter 3 describes the data used in the thesis which is followed by correlation test. Results will be also discussed in this chapter. Chapter 4 summarizes the results and shows the conclusion.

## 2. Literature Review

Prior to 1997 there was relatively little analysis of diffusion of country-specific crises. Since East Asian crisis empirical work has focused on financial contagion by showing evidence of significant increase in cross-country correlations of stock returns and volatility in the region.<sup>10</sup> Academic researchers and empirical work have tried to identify the channels of shock transmission across countries and to measure the damage of crises on each country. However, whether there is contagion in relation to crisis is not conclusive. Some researchers insist that there is contagion by providing the evidence of significant increase in correlation coefficients during East Asian crisis.<sup>11</sup> Other study concludes that there was no contagion by

---

<sup>9</sup>“Measuring Contagion: Conceptual and Empirical Issues”, in International financial contagion by Kristin Forbes, Roberto Rigobon (2002)

<sup>10</sup> Financial Crises in Emerging Markets: The Lessons from 1995 by Jeffrey D. Sachs, Aaron Tornell, Andres Velasco(1996)

<sup>11</sup> Financial Market Contagion in the Asian Crisis by Baig and Goldfajn(1999)

suggesting that there is no significant increase in correlation between asset returns in pairs of crisis-hit countries.<sup>12</sup> The existence of contagion, therefore, remains to be discussed.

The existing literatures have also tried to identify the reason why contagion arises. The causes of contagion can be explained by two conceptual models.<sup>13</sup> The first emphasizes transmission of shock across countries because of financial and trading linkage. In this model, investors can't recognize underlying signals driving investment decision and can rationally decide to mimic the behavior of others. Dornbusch, Park, and Claessens term this type of cause "fundamental causes".<sup>14</sup> The second model ascribes the contagion to the result of the behavior of international investors. This model considers the potential for destabilizing collective action by herding investors. Some studies say that there can be multiple equilibria with symmetric information if investors are sufficiently forward-looking.<sup>15</sup> In the second model international investors covering loss in other markets can lead to contagion. Therefore, this is related to liquidity problem.

Many articles have been written on the empirical evidence on financial contagion. Empirical examination of the evidence on contagion seeks co-movements in asset prices. The methods of testing contagion are various. There are correlation tests, conditional probability

---

<sup>12</sup> "Measuring Contagion: Conceptual and Empirical Issues", in International financial contagion by Kristin Forbes, Roberto Rigobon (2002)

<sup>13</sup> Contagion: Understanding How It Spreads by Rudiger Dornbusch, Yung Chul Park, Stijn Claessens(2000)  
Masson 1998;Wolf 1999;Forbes and Rigobon 2000;Pritsker 2000

<sup>14</sup> Fundamental causes of contagion include macroeconomic shocks that have repercussions on international scale and local shocks transmitted through trade links, competitive devaluations, and financial links.  
Contagion: Understanding How It Spreads by Rudiger Dornbusch, Yung Chul Park, Stijn Claessens(2000)

<sup>15</sup> Currency Crises, Sunspots and Markov-Switching Regimes By Jeanne and Masson(2002)



tests, change in volatility tests, extreme returns tests and others.<sup>16</sup> This thesis measures the correlation among different countries in foreign exchange rates under correlation test. A remarkable increase in correlations is considered evidence of contagion. However, a noticeable increase in correlations cannot ensure that there is contagion. If markets are historically cross-correlated, correlations during crises are considered natural.<sup>17</sup>

### 3. Analysis of crisis from Lehman Bankruptcy

#### 3.1 Data and approach

The data used in the thesis are daily currency exchange rate from Jan 1, 2005, through Dec, 31, 2009, for thirty four countries that use floating exchange rate. The countries such as China, Venezuela, and Malaysia are excluded for this reason. All the data were obtained from Bloomberg.<sup>18</sup> The data set consists of currency exchange rate of ten countries in Asia including Japan(JPY), South Korea(KRW), Thailand(THB), Philippine(PHP), Hong Kong(HKD), Taiwan(TWD), India(INR), Singapore(SGD), Israel(ILS), and Indonesia(IDR), twelve countries in Europe including Euro zone(EUR), Britain(GBP), Czech(CZK),

---

<sup>16</sup> Correlation tests see contagion as a significant increase in the correlation between assets during a period of crisis, compared with a period of calm by Forbes and Rigobon(2002)

Conditional probability tests recognizes contagion if the probability of a domestic crisis is affected by the occurrence of a foreign crisis by Eichengreen, Rose, and Wyplosz(1996) and Sachs, Tornell, and Velasco(1996)

Change in volatility recognizes contagion if there is cross-market movements in asset prices by Edwards(1998) and Park and Song(1999)

Extreme returns tests recognizes contagion if the transmission between asset markets is different in times of extreme returns from that of calm times

<sup>17</sup> Forbes and Rigobon(2002)

<sup>18</sup> Bloomberg data as of February 8<sup>th</sup>, 2010

Slovakia(SKK), Denmark(DKK), Sweden(SEK), Norway(NOK), Poland(PLN), Hungary(HUF), Turkey(TRY), Russia(RUB), and Switzerland(CHF), six countries in America including Colombia(COP), Costa Rica(CRC), Mexico(MXN), Peru(PEN), Chile(CLP), Argentina(ARS), Brazil(BRL), and Canada(CAD), two countries in Oceania including Australia(AUD) and New Zealand(NZD), and two countries in Africa including Kenya(KES) and South Africa(ZAR).

Countries in the data set include both developing countries and developed countries. Eighteen countries are classified as developed countries and sixteen countries are classified as developing countries.<sup>19</sup> The stage of development was considered in the test because the degree of financial market development is related to contagion. Generally developed markets seem less affected and developing markets have larger contagion effects.

Following the conventional approach, exchange rates are calculated as the first difference of natural log of each currency, and the exchange rates are expressed against US dollars. When data were unavailable, because of holidays or any other reasons, exchange rates were assumed to stay the same as those of the previous trading day. The data are divided into twenty periods which show quarterly results and ten periods which show semiannual results. In this thesis I use the date of September 15<sup>th</sup> 2008 which triggered a panic in the financial markets to break the entire data into two sub-periods: pre-crisis and post-crisis.

### 3.2 Co-movement of thirty four currencies

---

<sup>19</sup> World Bank classified countries by the stage of development. South Korea, Japan, Hong Kong, Taiwan, Singapore, Israel, EU, Great Britain, Czech, Slovakia, Denmark, Sweden, Norway, Hungary, Switzerland, Canada, Australia, and New Zealand are classified as developed countries.

Looking at Appendix 1, co-movement of daily currency exchange rate from Jan 1, 2005, through Dec, 31, 2009, for thirty four countries comes into the sight. With the exceptions of EUR, GBP, AUD, and NZD, the same trend is seen for the graphs around Lehman bankruptcy. A sharp increase in exchange rates for all currencies after September of 2008 shows the possibility that there is financial contagion after the crisis. In other words, all currencies depreciated abruptly after the crisis. Deduced from the graphs the crisis seems to spread across wide range of currencies. EUR, GBP, AUD and NZD show a huge decrease in exchange rate after September of 2008 because their direction is different from other currencies. These currencies appreciated sharply.

Finally, these four currencies also reacted in the same way. In correlation test, therefore, I used reciprocal of exchange rate for these four currencies In order to confirm the existence of financial contagion

### 3.3 Correlation test

Correlation test of Mexican Peso crisis in 1994 and East Asian crisis during 1997-98 in the existing literatures provided the evidence of contagion<sup>20</sup>. Even though there are various methods of testing contagion this thesis measures the existence of financial contagion with correlation of exchange rates. Correlation analysis has been widely used to measure the degree of financial contagion. Therefore, it is convenient to start the investigation by checking pair-wise correlation between the exchange rates for thirty four countries under

---

<sup>20</sup> Correlation test of Mexican Peso crisis in 1994 : Calvo and Reinhart(1996), Frankel and Schmukler(1998),Valdes(1997),Agenor, Aizenman, and Hoffmaister(1999),

Correlation test of East Asian crisis during 1997-98: Baig and Goldfajn(1998)

investigation. A significant increase in correlations among pairs after the date of Lehman bankruptcy provides the evidence on contagion. There are five hundred and fifty four results because data are consists of thirty four countries.

### 3.4 Summary Measure

The most frequently used numerical summary measures for a single variable are mean, median and mode. Each of measures gives a slightly different interpretation to the term central location. In this thesis mean and median for pair-wise correlation between the exchange rates for thirty four countries are used.

The mean of all values of pair-wise correlation between the exchange rates for the countries under investigation is calculated. Mean is a representative measure of central location if the distribution of correlations is nearly symmetric. However, the mean is often misleading when there are outliers in the data set. If a few of the pair-wise correlation got abnormally high value, these large values would tend to overstate the mean and make it unrepresentative of the majority of the correlations. In such cases, the median is often a more appropriate measure.

The middle observation of the all values of pair-wise correlation between the exchange rates for the countries under investigation is calculated. Typically in symmetric distributions, the median is almost the same as the mean. But it's not true for skewed distributions. Unlike the mean, the median would not be affected at all by outliers. Therefore, the median represents the middle of the distribution even there are outliers.

### 3.5 Results

#### Mean correlation

The results are reported in Table 1. Evidence shows a sharp increase in mean correlation after September 2008.

#### Quarterly results

The inter-quarter fluctuation before and after Lehman bankruptcy in September 2008 is substantial. There was a sharp increase in mean correlation from 0.21 of the second quarter of 2008, pre-crisis period, to 0.28 of the third quarter of 2008, post-crisis period. During post-crisis period in the fourth quarter of 2008 mean correlation has even increased from 0.28 to 0.34. Quarterly mean correlations in 2009 remained at high level between 0.32 and 0.38.

When these two sub-periods are compared, therefore, mean correlations are generally higher during the post-crisis period. The collapse of two of Bear sterns' hedge funds in July 2007 would be another noteworthy date because it was the starting point of the crisis. The mean correlation increased from 0.19 of the second quarter of 2007 to 0.28 of the third quarter of 2007. This fact is also worthy of notice. On the other hand, there were no remarkable increases in quarterly mean correlation before the crisis.

#### Semi-annual results

Semi-annual results are consistent with quarterly results. There was a sharp increase in mean correlation from 0.22 of the first half of 2008, pre-crisis period, to 0.32 of the second half of 2008, post-crisis period. During post-crisis period in 2009 semi-annual mean correlation has even increased from 0.323 to 0.329 to 0.3771.

After the collapse of Bear stern's hedge funds semi-annual mean correlation also yielded the same conclusion. Semi-annual mean correlation increased from 0.20 of the first half of 2007 to 0.26 of the second half of 2007. There were no remarkable increases in semi-annual mean correlation before the crisis.

### Summary

Hence, both quarterly and semiannual results show evidence that the exchange rates of thirty four currencies displayed co-movement after the crisis than before. And significant increase in the mean correlation among pair-wise exchange rates during a period of crisis compared with a period of calm provides the evidence of contagion.

The mean, however, is often misleading if the distribution is skewed. If a few of the pair-wise correlation were outliers, these values would tend to distort the mean and make it unrepresentative of the majority of the correlations. The median correlation would be more appropriate than the mean correlation because the distribution of correlation among the exchange rates for currencies is not perfectly symmetric.

<b>Period</b>	<b>Mean</b>	<b>Period</b>	<b>Mean</b>
2005'1	0.3157	2005 B	0.299
2005'2	0.2849	2005 E	0.2483
2005'3	0.3003	2006 B	0.2669
2005'4	0.1863	2006 E	0.2255
2006'1	0.2486	2007 B	0.2014
2006'2	0.2923	<b>2007 E</b>	<b>0.267</b>
2006'3	0.2547	2008 B	0.2285
2006'4	0.1822	<b>2008 E</b>	<b>0.323</b>
2007'1	0.2128	2009 B	0.3291
2007'2	0.1983	2009 E	0.3771
<b>2007'3</b>	<b>0.281</b>		

2007'4	0.2458
2008'1	0.2466
2008'2	0.2137
<b>2008'3</b>	<b>0.285</b>
<b>2008'4</b>	<b>0.343</b>
2009'1	0.3206
2009'2	0.3449
2009'3	0.3686
2009'4	0.3865

**Table 1: Quarterly mean correlation and semiannual mean correlation among the exchange rates against USD for thirty four currencies**

#### Median Correlation

The results are reported in Table 2. Like the preceding evidence shows a sharp increase in median correlation after September 2008.

#### Quarterly results

Both Lehman bankruptcy in September 2008 and the collapse of two of Bear sterns' hedge funds in July 2007 had a sizeable effect on movements in the exchange rates just like the results from the mean correlation. Furthermore, the increase in median correlation from 0.17 of the second quarter of 2007 to 0.31 of the third quarter of 2007 is even larger than that in the mean correlation. Also, there was a marked increase in median correlation from 0.16 of the second quarter of 2008, pre-crisis period, to 0.27 of the third quarter of 2008, post-crisis period. During post-crisis period in the fourth quarter of 2008 median correlation increased further from 0.27 to 0.37. Quarterly median correlations in 2009 remained at high level

between 0.31 and 0.42. However, there were also no remarkable increases in median correlation before the crisis even though inter-quarter fluctuation is larger than that in mean correlation during those periods.

#### Semi-annual results

Semi-annual results are consistent with quarterly results. There was a sharp increase in median correlation from 0.17 of the first half of 2008, pre-crisis period, to 0.32 of the second half of 2008, post-crisis period. During post-crisis period in 2009 semi-annual median correlation has even increased from 0.32 to 0.33 to 0.37.

After the collapse of Bear stern's hedge funds semiannual median correlation produced the same outputs. Semiannual median correlation increased from 0.16 of the first half of 2007 to 0.23 of the second half of 2007. There were no noticeable increases in median correlation before the crisis.

#### 3.6 Summary

Therefore, the same is true for the results of median correlation. Hence, the results provide evidence of large co-movements in the exchange rates of thirty four currencies after the crisis than before.

From the results, the degree of increase in median correlation is larger than that in the mean correlation. An even more tremendous increase in the median correlation than in the mean correlation among pair-wise exchange rates during a period of crisis compared with other periods provides the evidence of contagion strongly.



<b>Period</b>	<b>Median</b>	<b>Period</b>	<b>Median</b>
2005'1	0.272936	2005 B	0.261064
2005'2	0.259041	2005 E	0.187376
2005'3	0.251626	2006 B	0.212569
2005'4	0.128269	2006 E	0.161969
2006'1	0.17411	2007 B	0.162946
2006'2	0.260715	<b>2007 E</b>	<b>0.23407</b>
2006'3	0.221761	2008 B	0.175291
2006'4	0.1146	<b>2008 E</b>	<b>0.32632</b>
2007'1	0.17689	2009 B	0.333865
2007'2	0.17323	2009 E	0.378667
<b>2007'3</b>	<b>0.319602</b>		
2007'4	0.174681		
2008'1	0.221164		
2008'2	0.16147		
<b>2008'3</b>	<b>0.272382</b>		
<b>2008'4</b>	<b>0.378883</b>		
2009'1	0.342043		
2009'2	0.318627		
2009'3	0.362598		
2009'4	0.422328		

**Table 2 : Quarterly median correlation and semiannual median correlation among the exchange rates against USD for thirty four currencies**

### 3.7 Comparison

Mean correlation and median correlation

Both mean correlation and median correlation show the evidence of contagion after the crisis. However there is the difference between two results. Figure 1 and Figure 2 demonstrates the difference of movements of mean correlation and the median correlation. Quarterly mean correlation and quarterly median correlation from January 2005 to December 2010 for movement of the exchange rates for 34 currencies are depicted in Figure 1 and Figure 2. These figures shed some light on the degree of the movement. The median correlation shows more substantial movement than the mean correlation.

The reason behind the figures is that the distribution of correlation is not symmetric. The results from the mean correlation are susceptible to distortion. Therefore, the results of the median correlation represent more precise answers.

#### Quarterly results and semi-annual results

Most companies report their quarterly results and semi-annual results. In the thesis, therefore, quarterly and semi-annual results are calculated for correlation test. The evidence shows that quarterly results are consistent with semi-annual results. Only difference between two results is that quarterly results are more volatile than semi-annual results because quarter is shorter period. Actually semi-annual mean correlation 0.267 in the second half of 2007 is almost equal to the average of quarterly mean correlation 0.281 in the third quarter of 2007 and quarterly mean correlation 0.2458 in the fourth quarter of 2007. The analysis would show the spread of contagion more clearly if weekly results or daily results were used in correlation test.

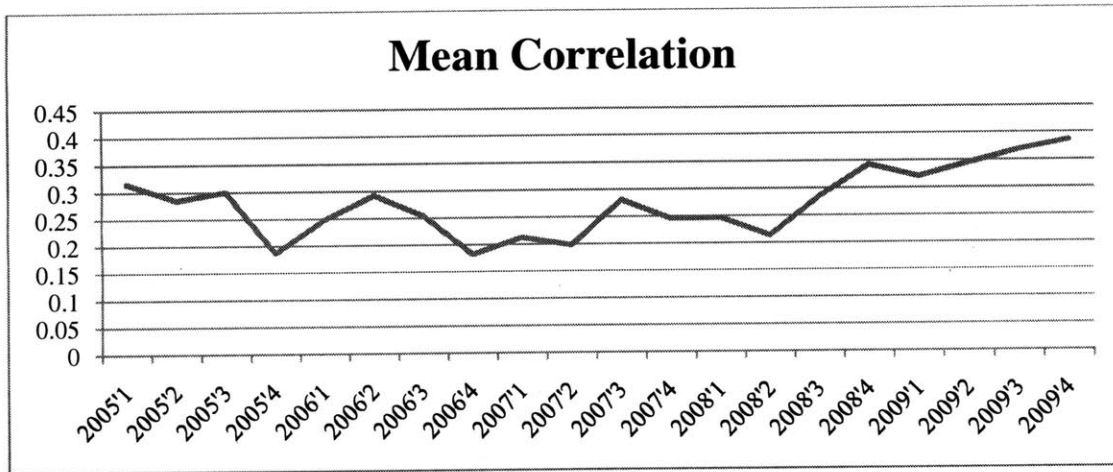


Figure 1a: Quarterly mean correlation among the exchange rates against USD for thirty four currencies

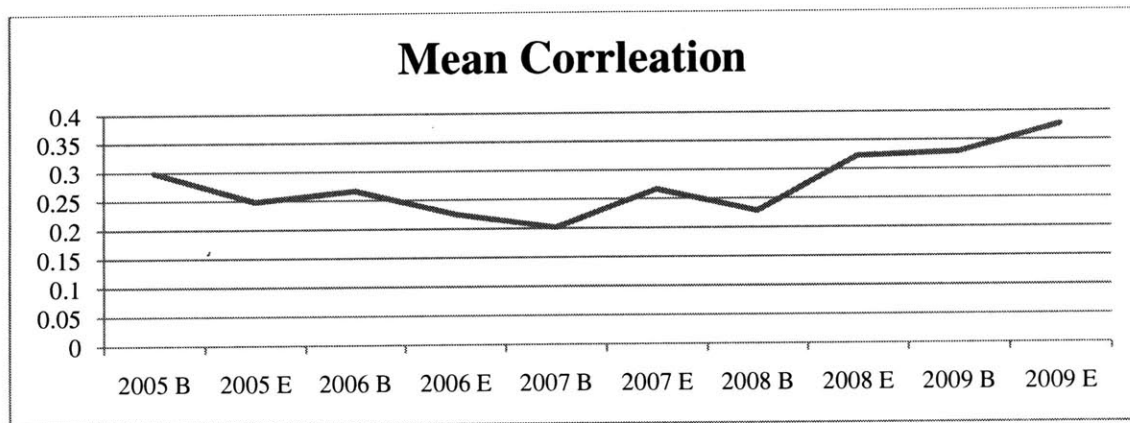


Figure 1b: Semiannual mean correlation among the exchange rates against USD for thirty four currencies

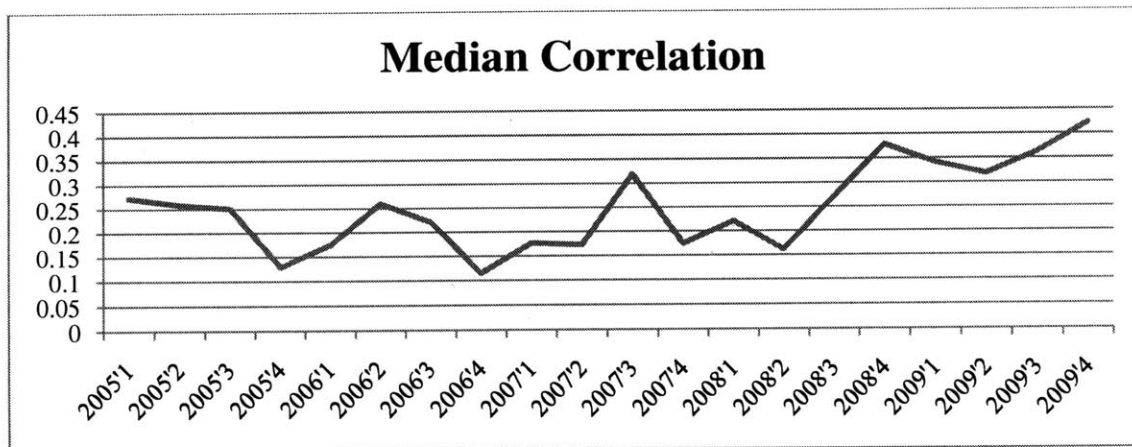


Figure2a: Quarterly median correlation among the exchange rates against USD for thirty four currencies

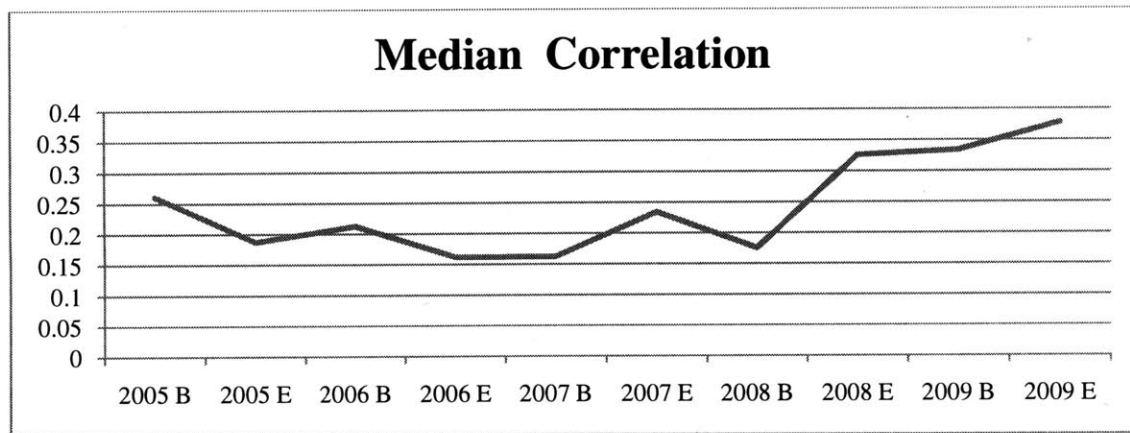


Figure2b: Semiannual median correlation among the exchange rates against USD for thirty four currencies

#### 4. Conclusion

The thesis examined an idea about how similarly markets react to Lehman bankruptcy for the past years. Empirical examination of the evidence on contagion using mean correlation and median correlation for Lehman crisis gave the same results. Both mean correlation and median correlation increased significantly after Lehman filed for bankruptcy. In other words, all currencies tend to move together in the event of Lehman bankruptcy. Looking through currencies' movement before and after this event, the movement was maximized at the occurrence of the event. A sharp increase in correlations is considered evidence of contagion. And results say that there is the evidence of large co-movements in exchange rates for currencies. Therefore, the crisis from Lehman bankruptcy in 2008 was contagious.

The thesis addressed only whether there is contagion in relation to Lehman bankruptcy. However, comparison of contagion in developing and developed markets in relation to credit

crisis was not covered. Further research about how largely developing countries were affected by Lehman bankruptcy in relation to developed countries may be the next step.

In the thesis only semi-annual and quarterly results are used for correlation tests. The transmission of contagion from Lehman bankruptcy would be more precise if with daily or weekly results in correlation test because shorter period shows more volatility. The analysis of contagion from Lehman bankruptcy using daily or weekly results would be expected in the further study.

# Appendix 1. Currencies' trend

