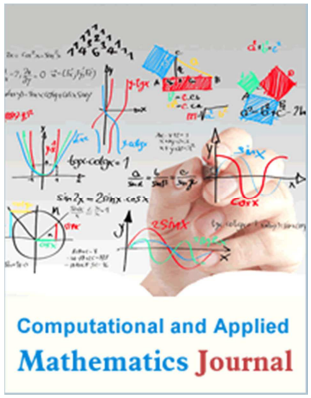
Computational and Applied Mathematics Journal
2015; 1(2): 16-20
Published online January 30, 2015 (http://www.aascit.org/journal/camj)



Keywords
Foreign Exchange Rate,
Asian Crisis, Recession,
Nonlinearity,
Lyapunov Exponent,
Chaos

Received: December 05, 2014
Revised: January 19, 2015
Accepted: January 20, 2015

Revisiting the Asian crisis (1997) in the light of present global recession: A chaotic analysis paradigm

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Citation
Pritha Das, Atin Das. Revisiting the Asian Crisis (1997) in the Light of Present Global Recession: A Chaotic Analysis Paradigm. *Computational and Applied Mathematics Journal.* Vol. 1, No. 2, 2015, pp. 16-20.

Abstract
Asian financial crisis gripped much of Asia beginning in July 1997. Within ten years, entire global economy entered into the present recession that had started around July 2008. Four years after the eruption of the global financial crisis, the world economy was still struggling to recover, actually during 2012, global economic growth has weakened further. In this context, we like to analyze the Foreign Exchange (ForEx) market which observed most hectic activities in this periods. We have selected eight Asian Countries, Hong Kong, Indonesia, South Korea, Malaysia, Philippines, Singapore, Taiwan and Thailand. We computed Largest Lyapunov Exponent (LLE) which is the best tool to quantify chaos from ForEx rate to US Dollar data of these countries during the Asian crisis (1997-1999), then during the first three years of global recession (2007-2009) and finally during next three years during ongoing recession (2010-2012). Our purpose is to compare the amount of chaotic behavior the ForEx markets show in these three distinct periods. We find that the ForEx market became more chaotic during global recession than it was in the Asian crisis. We also find, comparing LLEs that global recession is continuing till end of observation, that is December 2012.

1. Introduction

Many East Asian countries recorded extraordinary economic growth during the 1990s [1]. Immediately after this, beginning in July 1997 financial crisis gripped much of Asia. Within ten years of the Asian crisis, entire global economy entered into the present recession, starting around July 2008 and is still struggling to recover. In this work, we like to analyze and compare these two events by looking into the Foreign Exchange (ForEx) markets as they reliably reflect the economy of the respective countries in present globalized system. Before that, we shall briefly outline the events mentioned above. ForEx market and mathematical methods to quantify its chaotic behavior will be explained also in this section. Survey of literature attempting this type of analysis as well as difference of opinion among researchers regarding such chaotic analysis will be briefly presented later in the section.

The crisis starting in 1997 was so acute that it even raised fears of a worldwide economic meltdown due to financial contagion. The countries that were affected most by the crisis include Indonesia, South Korea and Thailand. Countries like Hong Kong, Malaysia, Laos and the Philippines were also hurt by the slump. China, Taiwan, Singapore etc. were less affected, although all suffered from a loss of demand and

confidence throughout the region. There was an intense period of speculation in ForEx markets, in the respective countries. Foreign and domestic investors withdrew funds. The region experienced a collapse in the level of economic activity while the number of bankruptcies and level of private sector debt escalated. Details of such activities in 1997 to 1998 are listed in, for example, [2,3,4]. This crisis was termed as Asian Crisis.

The International Monitory Fund (IMF) in the perspective of the Asian crisis noted that serious financial crises are not a new phenomenon, and they will occur again in the future [5]. The IMF also warned that the risk of crises is rising, including the scope for international contagion. In fact present global recession started around July 2008. Four years after this, during 2012, global economic growth has weakened further. A growing number of developed economies have fallen into a double-dip recession. Those in severe sovereign debt distress moved even deeper into recession, caught in the downward spiraling [6]. This global recession also affects the Asian countries.

1.1. Literature Review

We have two events: one is the Asian crisis and the other is the ongoing Global recession. To the best of our knowledge little work has been done to compare these two events in paradigm of nonlinear data analysis. In some works, different financial indicator values were compared. Zeman (2013) compared the chaotic behaviors of Thailand (in Asia) in 1998 and Greece (in EU) in 2013 in terms of economic indicators like GDP, unemployment, exports, government debt etc. without any further analysis [7]. He observed many similarities could be found in the creation of both crises. In a slightly different context, another study in ECB Bulletin, May 2012 [8] compared crisis in Japan to the present one in the US, terming both as 'balance sheet recessions' with focus on different aspects of debt problems in Japan, US and Euro Area up to 2011. With simple comparison of relevant statistics, it takes into account changed growth trajectory in the United States and the euro area. It rightly concluded that the recovery in both economies is thus likely to be sluggish and prone to uncertainty, in line with previous episodes following financial crises. Baily and Elliott (2009), while analyzing the US financial and economic crisis, commented that the global crisis occurring a decade later made the Asian crisis look trivial by comparison [9]. Krugman (2013) while comparing crisis in Indonesia (in Asia) and Greece (in EU), reasoned the recovery of the former as it had its own currency. By this point in the aftermath of the Asian crisis, even Indonesia was well on the road to recovery; Greece, Spain etc. are still sinking [10].

In the above mentioned studies, no mathematical or statistical analysis was undertaken. To study the nonlinear relationship of different elements in complex dynamics of ForEx market, we will concentrate to quantify chaos in ForEx market. This can be done only through nonlinear data analysis. Largest Lyapunov Exponent (LLE) which is the best tool to quantify chaos, as it measures the loss of information through evolution of time. This is explained later in this paper. Chaotic nature of the two crises under study remains unaddressed so far our knowledge runs. Probably due to this, sometimes wrong conclusion is arrived. For example, Baily et al. (ibid) hoped in 2009 that it is possible or even likely that the worst is over in financial markets and the economy will slowly start to mend. Another example of failure to capture the access the depth of recession in terms of data analysis is the International Monetary Fund (IMF) Report in 2007. Just few months before the recession started in 2008, it although noted the "Downside risks have increased significantly", but was confident that "So far, despite the significant ongoing correction in financial markets, global growth remains solid, though some slowdown could be expected" [11].

In this work, we are not attempting to investigate causes and effects of the crisis or recession, rather we like to analyze the Foreign Exchange (ForEx) markets which are 24-hour financial market.. The trading in the foreign exchange markets generally involves the US dollar. In globalized economy, most countries accept pegging their currencies to the US dollar. The global demand crumpled and led to an imbalance in the global economics. There are several reasons for this creeping return to pegged exchange rates. Most of the countries are buying the US dollar in order to curb the appreciation of their currencies [12]. There is plenty of literature showing basic factors - called fundamentals that influence changes in the exchange rate. Some examples of fundamentals are listed in Das [13].

There is some difference of opinion regarding the presence of chaos in ForEx market. Some of the related earlier works found evidence of chaotic structures in foreign exchange rates (for example, in case of the Canadian and Australian dollars over their floating rate periods), some studies found little evidence of chaos, however, many of them showed evidence of nonlinear structure. Some studies found little evidence of chaos, however, many of them showed evidence of nonlinear structure [14]. Bask [15,16] considered Swedish Kroner versus Deutche Mark, ECU, US $ and Yen in his study using data of daily observation from January 1986 to August 1995 (2409 points). By measuring the LLE, the study found indication of deterministic chaos in all exchange rate series. De Grauwe et al. [17] stressed that it is generally difficult to conclusively find evidence for the existence of chaotic dynamics because the available techniques do not allow separating the exogenous noise from chaos. In a series of work, we investigated the chaotic property of Foreign Exchange Rates of several countries [13,18-20] where we calculated the LLE to characterize and measure chaotic properties of ForEx rate data sets.

In this work, we have selected following eight Asian Countries: Hong Kong, Indonesia, South Korea, Malaysia, Philippines, Singapore, Taiwan and Thailand. We computed LLE from ForEx rate to US Dollar for these countries during the Asian crisis, then during the first three years of current recession and finally during next three years till 2012. Our purpose is to compare the amount of chaotic behaviour the ForEx markets show in these three distinct periods. More

specifically we like to find which event affected this market more and how it is going till 2012.

The paper is organized as follows: The source and period of data are given in Section 2. LLE and algorithm used are explained under Section 3. Results are given in Section 4 and some concluding remarks are made in Section 5.

2. Data Collection

Access to one of the world's largest historical, high frequency, filtered currency databases are made freely available for download by OANDA [21]. The data are available in XLS format. We collected daily data for eight Asian countries as mentioned earlier. The periods for which data collection was done (starting from 1st January of beginning year and ending on 31st December of concluding year in each case) are: i) To assess the Asian crisis effect, data from 1997 to 1999, and to assess the global recession, ii) during first three years, that is data from 2007 to 2009 and iii) next three years, that is to data from 2010 to 2012 are considered. While converting ForEx, financial institution charges a different rate when one sells a currency (called the Bid) or buys a currency (called the Ask). The Midpoint rate is the average of the Bid and Ask rates for a currency pair. In this work, data sets are midpoint rates on daily basis. Thus we have for each country, three datasets- each consisting of little over 1000 points for each of the three periods. All data are suitably plotted in Fig 1 (left panels). We have plotted the ForEx rate taking number of data points as horizontal axis, omitting the standard time option so that the rates can be easily compared during the discussed three periods.

3. Methodology: Finding Lyapunov Exponent Using TSTOOL Package

Chaotic processes are characterized by positive Lyapunov Exponent (LE). LE measures the rate at which information is lost from a system. Positive LE means that information about initial conditions are easily lost, implying chaos. The larger the LE, the faster is the loss and hence system is more chaotic. [22]. There are several approaches to calculate the LE, here we follow the approach of Wolf et al. [23]. For details, please refer to our earlier work [13]. Again, we used the TSTOOL to find the largest LLE. The function used is largelyap which is an algorithm based on work by Wolf [ibid], it computes the average exponential growth of the distance of neighboring orbits via the prediction error. The increase of the prediction error versus the prediction time allows an estimation of the LLE. For details, please refer to our previous work. In the particular MATLAB [24] code, largelyap, the average exponential growth of the distance of neighboring orbits is studied on a logarithmic scale, this time via prediction error p(k). Dependence of p(k) on the number of time steps may be divided into three phases. Phase I is the transient where the neighboring orbits converges to the direction corresponding to the λ_1 the LLE. During phase II, the distance grows exponentially with $\exp(\lambda_1 t_k)$ until it exceeds the range of validity of the linear approximation of the flow. Then phase III begins where the distance increases slower than exponentially until it decreases again due to folding in the state space. If the phase II is sufficiently long, a linear segment with slope λ_1 appears in the p(k) versus k diagram [25,26].

While calculating the LLE, we have obtained the prediction error p(k) versus k diagrams as output and are given in Fig.1 (Right panel). By finding the slope of the phase II, we estimate LLEs in each case. The LLE values are plotted against number of nearest neighbors used in calculation.

4. Results

Table 1. *Showing LLE values of the eight countries for Three periods*

		LLE values		
		Time period in years		
Country	**Currency**	**1997 to 1999**	**2007 to 2009**	**2010 to 2012**
Hong Kong	HKD	3.2	3.8	4.4
Indonesia	IDR	3.8	4.1	4.3
South Korea	KRW	3.3	4.1	4.2
Malaysia	MYR	3.5	4.3	4.5
Philippines	PHP	4.2	4	3.3
Singapore	SGD	4.1	4	4.4
Taiwan	TWD	3.8	4.5	4.4
Thailand	THB	3.7	4.5	4.4

From the Table 1 showing LLE values of the eight countries for the mentioned three period, it is observed that LLE values in 1997 to 1999 was in the range of 3.5 to 4.1, during 2007 to 2009, they range 4 to 4.5 (except Hong Kong) while during 2010 to 2012, they are in the range of 4.2 to 4.5 (except Philippines).

Particularly, for all the countries,

LLE in 1997-1999 period < LLE during 2007-2009.

So we can safely say that comparing the 1997 Asian crisis and 2007 Global recession, the

LLE values increased for the Asian countries. So the ForEx market became more chaotic during global recession than it was in the Asian crisis. Also comparing the 2007 LLE values to that in 2010, we see that there is no much difference. So we can say that effect of global recession is continuing till end of observation, that is December, 2012.

Some observations from the ForEx rate plots:

ForEx rates in 1997-1999 period is still higher than rates in other two periods indicating the extent of Asian crisis. This point demands further study in some future work.

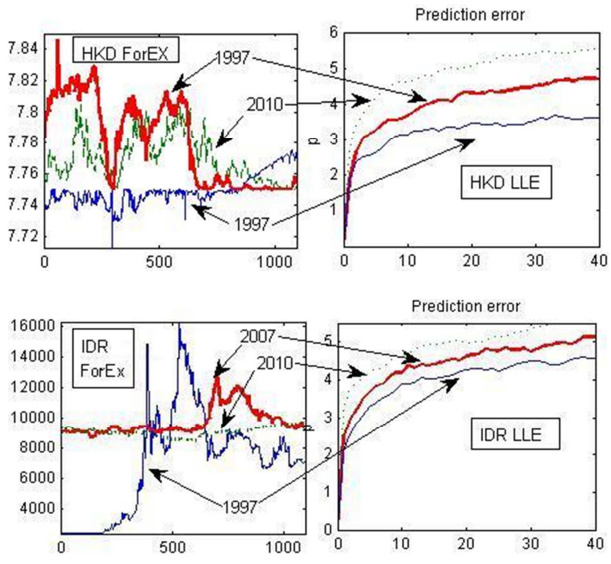
For countries like Malaysia, Singapore and Thailand, follow the relation

ForEx rates in 1997> 2007>2010.

This again shows that 1997 crisis was much acute; though in 2007 LLE values are higher. This means that LLE values are more concerned about the chaotic nature that is unpredictability of the ForEx market rather than the statistical divergence of the data. Fundamental news governing present recession plays this role rather than the calculated steps (like change in interest rate, IMF stimulus, loan etc. [3]) during Asian crisis, making them a bit more predictable and hence less chaotic. This is the reason behind LLE slopes are not very clearly measurable in Fig 1 for countries like Malaysia and Philippines.

5. Conclusion

Chaotic nature of the ForEx markets is not generally investigated. This work demonstrates that financial data analysis including analysis of current recession is not complete without measuring chaotic nature of data. Otherwise, that may be a reason to comment in a study [27] that for three members, namely South Korea, Malaysia and Thailand, Asian economies recovered from the financial crisis in 1999 and 2000, far quicker than anticipated by most forecasts. Even it adds in 2007: Ironically, the absence of another crisis of a similar nature and scale to the Asian crisis has probably contributed to the lack of momentum for reform of the international financial system. In reality within one year of this, the entire world plunged into deep recession that is still ongoing, this is also true for the Asian countries. Periodic calculation of chaos through finding LLE could prevent such false optimism. Thus we suggest, therefore, to more in-depth studies in ForEx market based on chaotic properties of the markets- if at all we are to learn some thing from previous crises.



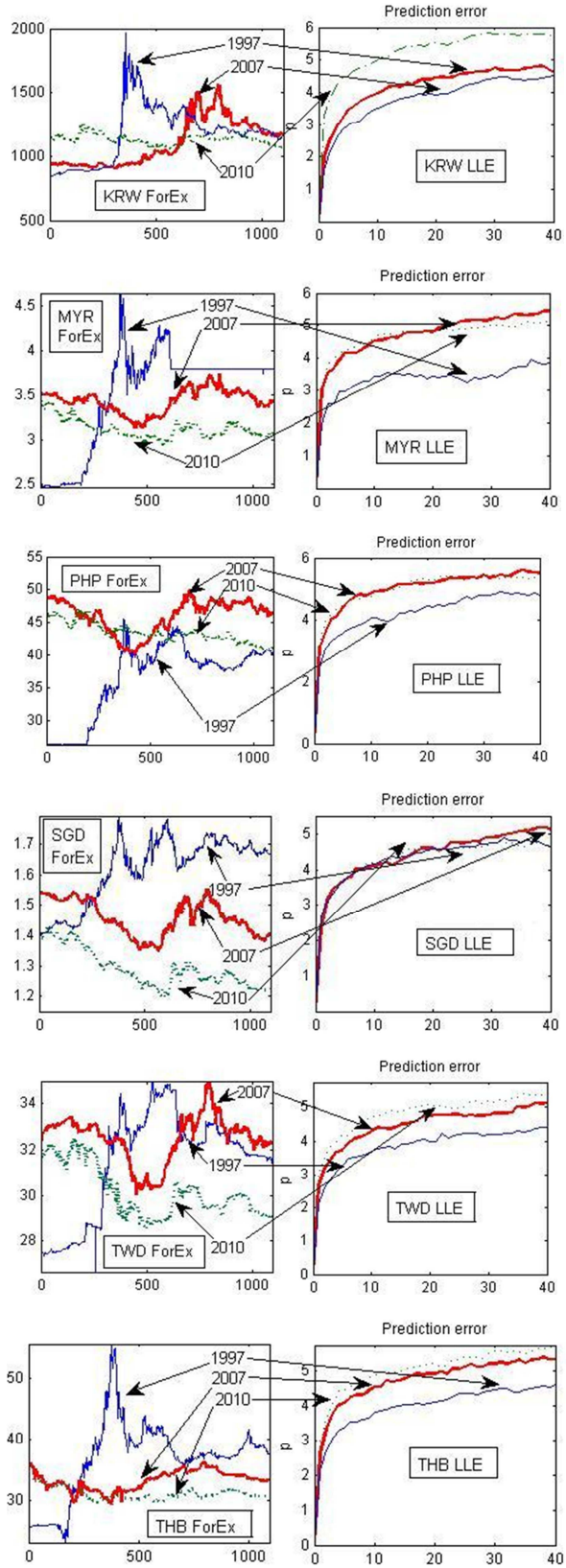


Fig 1. *Three curves in each panel is for three periods as mentioned, each curve is indicated using arrows showing starting year of the period. The name of the currency is shown on text box. Blue line indicates crisis period (1997 to 199), red thick line is for global recession (2007 to 2009) and dotted green is for period 2010 to 2012. (Left Panels) Shows plot of ForEx rate, horizontal axis is number of data points. (Right panels) Shows plot to estimate LLEs against nearest neighbors used in calculation (See Sec. 3).*

References

[1] Krugman, P. (1994) "The Myth of Asia's Miracle". Foreign Affairs 73 (6): 62–78. JSTOR 20046929.

[2] Krugman, P. "What Happened to Asia?, Jan. 1998, http://web.mit.edu/krugman/www/DISINTER.html)

[3] Gabriel P., The Three Routes to Financial Crises: The Need for Capital Controls., Center for Economic Policy Analysis, Cambridge University, Nov. 2000.

[4] Wikipedia, 1997 Asian financial crisis, http://en.wikipedia.org/wiki/1997_Asian_Financial_Crisis (visited May, 2013).

[5] IMF, World Economic Outlook, May 1998.

[6] United Nations, Global Economic Outlook, 2013.

[7] Zeman M., (2013) A comparative analysis of 1997 East Asian Tigers crisis and EU sovereign debt crisis, Main study cases: Thailand and Greece, University of Vienna April 2013.

[8] European Central Bank, Comparing the recent Financial Crisis in The United States and the Euro Area with the Experience of Japan in the 1990s, Monthly Bulletin May 2012

[9] Baily M. N., Elliott D. J. (2009). Where Does It Stand and Where Do We Go From Here?, Initiative on Business and Public Policy at Brookings.

[10] Krugman P., The Asian Crisis Versus The Euro Crisis, The New York Times, August 28, 2013

[11] International Monetary Fund (IMF) (2007), "World Economic and Financial Surveys, Financial Market Turbulence, Causes, Consequences, and Policies", Washington DC, Oct. 2007.

[12] Grauwe De P., Grimaldi M., (2003). Intervention in the foreign exchange market in a model with noise traders. Draft at Univ. of Leuven.

[13] Das A., Das P., (2007). Chaotic Analysis of the Foreign Exchange Rates. Appl. Math. & Compu. 185(1): 388-396.

[14] LeBaron B., (1994). Chaos and nonlinear forecastability in economics and finance. Phil. Tran. of Royal Soc. London. Ser. A . 348: 397-404.

[15] Bask M., (1996). Dimensions and Lyapunov exponents from exchange rate series. Chaos, Solitons & Fractals. 7(12): 2199-2214.

[16] Bask M., (2002). A positive Lyapunov exponent in Swedish exchange rates? Chaos, Solitons & Fractals. 14(5): 1295-1304.

[17] Grauwe De P, Vansteenkiste I., (2001). Exchange rates and fundamentals A non-linear relationship? Center for Econ. Studies & Ifo Inst. for Econ. Res. Working Paper No. 577 available at <www.CESifo.de> Visited April 2006, Jan., 2010.

[18] Das A, Das P., Gürsan Ç., (2012). Chaotic analysis of the foreign exchange rates during 2008 to 2009 recession, AJBM Vol. 6(15), pp. 5226-5233.

[19] Das P., Das A., (2013) Comparison of Recession During 2008 - 2009 and 2009-2013: A Chaotic Analysis Of The Foreign Exchange Rates, Journal of Contemporary Management. May, 100-112.

[20] Das P., Das A., (2014). Investigating the Existence of Chaos in Inflation Data in Relation to Chaotic Foreign Exchange Rate, Economics Research International. Volume 2014, Article ID 783505.

[21] OANDA- A trusted source for currency data.http://www.oanda.com Visited May, 2013.

[22] Chris B. (1998). Chaos in Foreign Exchange Markets: A Skeptical view, Computational Economics 11:265-281.

[23] Wolf A., Swift J. B., Swinney L. H., Vastano J. A., (1985). Determining Lyapunov exponent from a time series. Physica D. 16: 285–317.

[24] MATLAB Release13, The MathWorks, Inc., 2002.

[25] Parlitz U., (1998). Nonlinear time series analysis, in: Suykens JAK, Vandewalle J (Eds.) Nonlinear Modeling - Advanced Black-Box Techniques. Kluwer Acad. Pub. Boston.

[26] Parlitz U., Wedekind I, Lauterborn W, Merkwirth C (2001). TSTOOL & User Manual, Ver. 1.11, DPI Göttingen, download at <www.physik3.gwdg.de/tstool/gpl.txt>

[27] Jomo K. S., (2007). What Did We Really Learn from the 1997-98 Asian Debacle? in *Ten years after: Revisiting the Asian Financial Crisis*, Ed. Bhumika M., Asia Program, Woodrow Wilson International Center for Scholars, October.