CONSTRUCTION OF A COMPOSITE INDEX: METHODOLOGICAL ISSUES IN MEASURING ASIAN FINANCIAL CRISIS

K.V. Bhanu Murthy[1] and Anjala Kalsie[2]

This study is about the A5 (Indonesia, South Korea, Malaysia, Thailand and Philippines) countries during the Asian Financial Crisis of 1997. A financial crisis is a wide spread episode measured through a conglomerate of many factors. The attempt to explain such a complex phenomenon in terms of a single (variable) indicator would be partial and simplistic. Moreover, these variables tend to be correlated and they possess common information.

This paper has developed a methodology for the construction of a composite index that captures crisis. The composite index that is based on a large number of variables, involves a three stage procedure, through Granger causality, correlation and Principal Component Analysis.

Key words: Currency Crisis, Financial Crisis, Causality Test, Principal Component Analysis, Correlation and Composite Index.

INTRODUCTION

The decade of the 1990s was certainly marked by a rather unusual number of financial and economic crises such as the Mexican Peso Crisis of 1994-95, the Asian Crisis of 1997. While the different types of crises could range from the "garden variety" currency crises to rather esoteric real estate bubbles, studies of such crises exhibit empirical and theoretical commonalties. The literature distinguishes three varieties of financial crises: currency crises, banking crises, and debt crises. The analysis in this study is primarily focused on currency crises.

[1] Department of Commerce, Delhi School of Economics, University of Delhi, 110007

[2] Faculty of Management Studies, University of Delhi, Delhi 110007

Our task at hand is to analyze and measures the financial crisis in the A5 countries[1] during 1997. A financial crisis is often characterized by an episode of intense foreign exchange market pressure. This phenomenon is known as a currency crisis and can be defined simply as an episode in which a country experiences a substantial nominal devaluation or depreciation. This criterion, however, would exclude instances where a currency came under severe pressure but the authorities successfully defended it, by intervening heavily in the foreign exchange market, by raising interest rates sharply, or by both. Extant approaches have sometimes constructed an index of speculative market pressures [Kaminsky, Reinhart and Lizondo (1998), Edison (2000), Goldstein, Kaminsky and Reinhart (2000)].

The indices that have been developed in the earlier studies suffer from three problems:

1. Conceptually they include only exchange related variables[2] and not other relevant variables that are crucial for international trade and international finance.
2. The extant studies do not use a causal framework as a methodology for the selection of variable.
3. Empirically they do not use more evolved statistical tools such as Principal Component Analysis for constructing a composite index.

Our paper is a part of larger study that looks into a new approach to measure and analyze international financial crisis. A crucial part of the study is to develop a new composite Index of Crisis. This index is based on a large number of variables and involves a three stage procedure which shall be discussed later.

The study consist of twelve sections section 1 talks about introduction, section 2 about rationale, section 3 about conceptual issues, section 4 about methodology, section 5 talks about causality test, section 6 about correlation matrix, section 7 principal component analysis, section 8 composite index, section 9 result and analysis, section 10 analysis of index of crises, section 11 about graphical interpretation and finally section 12 contains conclusion.

---

[1] Malaysia, Philippines, Korea, Thailand and Indonesia.

[2] Weighted average of ER changes, Weighted average of RER changes, Reserves changes and Interest rate changes.

RATIONALE

An attempt to explain a wide spread and complex phenomenon in terms of a single dependent variable would be incomplete and partial, where dependent variables which represents the crisis is itself a conglomerate of many factors. Since it is a complex phenomenon it cannot be represented by one single variable. Moreover, these variables tend to be correlated. Thus, the ordinary regression framework results in the problem of mulicollinearity. Therefore an essential methodology is to measures the phenomenon of the crisis with the help of composite indices, which would adequately represent the complex phenomenon. This applies to both the cause and the effects of a crisis.

Among an array of factors which are quoted by different studies, as being related to crisis we would like to conduct a causality test to determine which of these factors causes are and which are the effects. In the further part of our larger study we have constructed indices for both causal variables and impacted variables so as to relate them in a regression framework, after having addressed the problem of multicollinearity. However for the present paper we concentrate on the index of the impacted variable, namely, the index of crises.

The final selection of variables is done on the basis of an elaborate procedure, which ensures that the variables which are entering in the construction of the index of crisis are the variables that are theoretically relevant, as they are drawn from extant studies and empirically sound as they are tested for causality. In addition they are appropriate because they have been checked for data redundancy.

CONCEPTUAL ISSUES

Prior Procedure

Several steps were undertaken as a part of the larger study to ensure the above considerations:

1. A literature survey of empirical and conceptual studies was undertaken[3]. On the basis of a literature survey we had arrived at a data set consisting of a large number of crises variables (30 variables including financial and macroeconomic variables).

[3] Moreno (1995), Berg and Pattillo (1999) and Frankal and Rose (1996)

2. We checked for data redundancy amongst a set of available variables. By data redundancy we mean that many of the define variables in the data set are different version of the same variable. We have used our judgment to retain some version while dropping the other versions. For instance, which variables have been defined in PPP $ or US $ or LCU, we have chosen only one of them.

3. A correlation exercise was carried out on these 30 variables. The purpose of this exercise was to establish that crisis variables are ordinarily correlated[4].

4. We also undertook a dummy variables exercise wherein the data series for 6 countries for each of the 30 variables were tested to see whether there was any structural break at 1997-98[5], which is the crises window in the Asian financial crisis.

5. However the prior correlation analysis and dummy variable exercise did not tells us any thing about the causality amongst the variables. The dummy variable exercise is a univariate analysis that does not capture the complexity of the phenomenon.

Measurement of Crisis

After having undertaken the above empirical steps we proceeded with the measurement of crisis. There are two parts of our methodology for the measurement of crises. In the first part, which is the core of this paper we have developed, constructed and measured the index of crises. In the second part this index has been used to model crises and predict it. The second part of our measurement is not dealt with in this paper[6]. However, there is a relevant link between the two parts the index of crises that is being developed in this paper is also the dependent variable in the modeling and prediction of the crises. It is necessary to clarify the link between these two aspects. In the following discussion we are therefore looking at some aspects of the regression framework and the crises definition.

---

[4] The result of correlation exercise is not reported.

[5] In the dummy variable exercise the crises window is taken as 1997-98. The crises develop in November 1997 and it peaked in 1998, in many countries. Therefore, neither can 1997 nor can 1998 be ignored. This is vindicated by the dummy variable exercise which shows a significant structural break across variables during this crises window. The result of dummy variable exercise has not been reported.

[6] Malik (2008) 'Measurement and Analysis of International Currency Crises: Lesson for India.', unpublished Phd. Thesis, University of Delhi.

Crisis Definition

In certain other studies the crisis variables themselves have been defined in discrete terms[7]. Therefore, their understanding is that the dependent variable has a built-in discrete change or kink. It should not be forgotten that the dependent variable is an effect and not a cause. Our own understanding is that whatever change comes in the dependent variable is not on its own account but on account of the causal variables. This includes changes in the intercept, because the intercept also contributes towards the explanatory power of the equation. In extant literature the distinction between discrete and continuous crisis definitions has been captured only through having either a discrete or continuous dependent variable. In a causal framework the mechanism to capture discrete change has to necessarily rest upon the causal variables and not the dependent variables. Accordingly, our methodology imputes to discrete change during crises to the indicators of crisis and this would necessarily come from the causal variables. Our methodology, hence, been tailored in such a manner that it does not pre-suppose the nature of dependent variable that represent crises as being discrete. On the other hand the explanatory variables are so endowed that they are capable of inducing discrete change in the indicator of crises.

Our methodology is that the discrete definition has to be captured and measured in and through the independent variable and not through the dependent variable. Essentially, the understanding is that certain continuous changes can be captured through the causal variables, which lead up to the crises. Our understanding is that this continuous change is manifest in the volatility of the crises variables. In effect it implies that those countries which were crises ridden had experienced a continuous trend of volatility to the extent, that this built up continuously to discrete change resulting in a crises.

The merit in using a continuous crisis definition lies in its ability to capture both the continuous influence on the crises variable (dependent variable) as well as its ability to explain discrete change which is occurring in the crises variables during crises, due to the causal variable.

Crises window

The crises window is taken as 1997-98. The crises develop in November 1997 and it peaked in 1998, in many countries. Therefore, neither can 1997 nor can 1998 be ignored.

---

[7] Eliasson, Ann-Charlotte and Krevter, Christof (2000).

This is vindicated by the dummy variable exercise which shows a significant structural break across variables during this crises window. Some of the extant study have used monthly data and define the crises window in terms of particular months. In our case we were using annual data, therefore, it is not possible to have a crises window that pinpoints the precise period of crises, nor are we interested in the process of the crises. Therefore, our crises window is defined in annual terms.

Relevance of Control

An important issue of research design was the introduction of a control. It was noted that in the case of India none of the relevant variables showed any statistically significant change during the crises period[8]. On this basis we established India as the control or as a benchmark.

In the case of extant studies with a discrete crises definition the control was established with reference to the pre-crises period since a control is meant to represent a normal period or normal observation. In the present study by 'control' we mean a 'benchmark country' that was not affected by the crises. For identifying the control we have used the dummy variables exercise, wherein we found that in the case of India none of the relevant variables (relevant variables means those variables which are identified through literature review) were affected by the crises therefore we chose India as a control. In other words none of the variables have shown any structural break in India, during the crisis period 1997-98. Such an approach has the advantage of allowing both inter-temporal as well as international comparisons. The extant studies permit only inter-temporal comparisons[9].

Since India was established as a control it is reasonable to examine that all the relevant variables would display a normal behavior in terms of cause and effect. Hence, the causality tests were applied to the relevant variables in the case of India only. Often, during crisis the co-variances get exaggerated. Therefore, the causality test must be conducted on a 'normal country'. This is not possible if the comparisons are only inter-temporal.

---

[8] Through the dummy variables exercise (not reported).

[9] Moreno (1995) and Kaminsky, Reinhart, Lizondo (1998)

METHODOLOGY

To account for such a conception of the phenomenon of crises and causes of the phenomenon, we felt the need for evolving an appropriate methodology. The two most desirable feature of the methodology are that: firstly, it should capture the volatility or variance in the relevant variables, because we believe that it is this volatility that leads up to and results in crisis; secondly, it should also work with a large number of related variables because a crisis according to our understanding is a complex phenomena resulting from a large number of inter correlated variables.

The third dimension of methodology is that given the constraints of the data points and degrees of freedom, the methodology should allow working with a parsimonious set of variable. The statistical technique which possesses all these features is a PCA (Principal Component Analysis). Unlike OLS wherein the procedure is to minimize the sum of the squares of deviations in the case of PCA the procedure is to *maximize the variance.* Second feature of PCA is that it segregates inter correlated variables in to the separate orthogonal factors or Principal Components. Thirdly PCA can be used for developing a composite index which collapses a set of variables into a single variable that represents a complex phenomenon like financial crises.

Procedure of estimation

Our empirical procedure involves five distinct steps:

1. Granger causality test was applied to the data on India in respect of all the relevant variables to find out which the causal variables are and which the impacted variables are. The causality tests were carried out in the case of India, since it was the control.
2. From step 1 the variables were separated into dependent, independent and common variables. Through correlation we have found that a set of common variables were correlated with the purely dependent variables. These would have similar information.
3. Due the presence of a large number of correlated dependent variables we have undertaken the next step in the procedure, that is, the application of Principal Component Analysis, which helps in (i) data reduction and (ii) making the dependent variables uncorrelated with other.
4. The next step was the formation of a composite index. The Composite index helps

in representing the crises phenomenon where the crises phenomenon is manifest in a large number of variables. This is the unique feature of our study.

CAUSALITY TEST

For developing a causal framework it is therefore essential to adopt a procedure by which causal variables can be distinguish from impacted variables. Once the set of crises variables have been sorted through this procedure it would be possible to develop an index of crisis.

In the true spirit causality test tells us about the precedence of one variable over the other it is therefore sometimes cautioned that the result of such tests may not be interpreted as cause and effect relationship. Here, we would like to point out that in the present study we are not depending on the Granger Causality Test; after using the test and after sorting the variables as causal and impacted variables we use a structured causal framework with the appropriate regression technique for establishing cause and effect. At present, it was necessary to differentiate between the causal and impacted variables. This necessitated the testing of causality among the relevant variables.

Granger Causality Test: For carrying out the granger causality test the following two equations were tested the joint hypothesis for all the variables:

Ho: X does not cause Y.

Ho: Y does not cause X.

We test the null hypothesis against an F-statistic, namely,

$$F = \left\{\left(RSSr - RSSur\right) / \ m\right\} / \ \left(RSSur / \left(n - k\right)\right).....(1)$$

where the degree of freedom are m and (n-k), RSSr =Residual Sum of Square restricted

RSSur = Residual Sum of Square Unrestricted, m = number of linear restrictions, n= number of observation and k= number of parameters in the unrestricted regression

The restrictions are respectively:

$\Sigma ai = 0$; and .....(2)

$\Sigma di = 0$ ..... (3)

while test of causality is carried out through the following equation:

$$Yt = \Sigma\, ai\, Xt - i + \Sigma\, bi\, Yt - i + u1t \quad \ldots\ldots\ldots\ldots\ldots\ldots (4)$$

$$Xt = \Sigma\, ci\, Xt - i + \Sigma\, di\, Yt - i + u2t \quad \ldots\ldots\ldots\ldots\ldots\ldots (5)$$

$i = 1, 2$

It was also ensured that there was no two way causality among the relevant variables. As a consequence of the causality test three sets of variables could be identified: (i) pure causal variable (ii) pure impacted variable (iii) common variables which alternatively appeared as causal and impacted variables although not as two way causality.

CORRELATION MATRIX

Through the causality test, it was found that there were some variables which were common, that is, they were both impacted as well as causal variables, and thus making it difficult to decide which variables is to be selected for constructing an index of crisis. To solve this problem correlation matrix was used.

There are two objectives of studying the correlation matrix:

1. To segregate the set of dependent and independent variable.
2. To identify a set of crisis variables.

There were certain problems in the selection of variables as dependent and independent variable. To meet these problems the following steps were undertaken:

1. Firstly, on bilateral basis, it was ensured that none of the variables were considered for the modeling that had 'bi-way causality'. This precaution was taken so that causal and impacted variable does not have a problem of one to one endogeneity.
2. Secondly, despite this that there was a set a variable that appear both as a causal and impacted variables these have been labeled as common variables. The first objective of studying the correlation matrix was to study this problem. Therefore, the criteria used for selection of crisis variables was; that amongst the set of common variables those variables which were correlated with the pure dependent variable, were treated as dependent variables (or LHS variables) - that would go into the formation of the Index of Crisis.

PRINCIPAL COMPONENT ANALYSIS

Principal Components Analysis (henceforth PCA) is based on a linear transformation of the variables so that they are orthogonal to each other; hence, no information contained in the points in the event space is lost. The normality assumption is not essential in PCA and with such a dispersed set of outcomes. PCA is ideally suited because it maximizes the variance rather than minimizing the least square distance. Since we want to develop a composite 'Index of Crisis' and relate it to two other indices of financial variables and macro variables, we need to choose the essential variables and arrive at relative weights for the purpose of consolidating these variables into a single index. This is facilitated by PCA.

PCA linearly transforms an original set of variables into a smaller set of uncorrelated variables representing most of the information in the following form:

$$y_1 = a_{11}x_1 + a_{12}x_2 + \ldots + a_{1p}x_p = \sum_{i=1}^{p} a_{1i}x_i \qquad (6)$$

The first principal component, is defined such that the variance of y_1 is maximized. Consider the p random variables x_1, x_2,.. x_p subject to the constraint that the sum of squared weights is equal to 1, i.e., $\sum_{i=1}^{p} a_{1i}^{\ 2} = 1$. If the variance of y_1 is maximized then the sum of the squared correlations, i.e., $\sum_{i=1}^{p} r^2_{y,xi}$ is also maximized. PCA finds the optimal weight vector (a11, a12, a1p) and the associated variance of y1 (which is denoted as $\lambda 1$).

If the objective is a simple summary of the information contained in the raw data, the use of component scores is desirable. It is possible to represent the components exactly from the combination of raw variables. The scores are obtained by combining the raw variables with weights that are proportional to their component loadings. In our case the component scores have been used for determining the weight of each of the raw variables in constructing a composite index. As more and more components are extracted, the measure of the explanatory power increases but it is necessary to strike a balance between parsimony and explanatory power.

The goal of the Principal Components Analysis (PCA) is to reveal how different variables change in relation to each other, or how they are associated. This is achieved by transforming correlated original variables into a new set of uncorrelated *(orthogonal)* underlying variables (termed principal components) using the covariance matrix, or its standardized form – the correlation matrix. The lack of correlation in the principal

components is a useful property because it means that the principal components are measuring different "statistical dimensions" in the data. The new variables are linear combinations of the original ones and are sorted into descending order according to the amount of variance that they account for in the original set of variables. Each new variable accounts for as much of the remaining total variance of the original data as possible. Cumulatively, all the new variables account for 100% of the variation. PCA involves calculating the Eigen values and their corresponding eigenvectors of the covariance matrix or correlation matrix. Each Eigen value represents the total remaining variance that the corresponding new variable accounts for. The expectation from conducting PCA is that correlations among original variables are large enough so that the first few new variables or principal components account for most of the variance. If this holds, no essential insight is lost by further analysis or decision making, and parsimony and clarity in the structure of the relationships are achieved. Each factor is a combination of variables which are correlated with the principal component.

This methodology has two purposes. Firstly, we have seen that both macro and financial variables were correlated. Under such circumstance it is not possible to use the variables in a regression framework on account of mulicollinearity. Secondly, when there were a large number of impacted variables we need to collapse them into a single dependant variable.

There is a relevance of using PCA analysis in our modeling. It allows for data reduction. The reduced data set would contain the maximum information in all the variables, which were being considered as dependent variable. As a result of PCA the reduced data sets consists of variables which were not correlated to each other, since the principal component are orthogonal (perpendicular) to each other.

The purpose of principal component analysis is:

1. Firstly to extract from amongst impacted variables that are correlated as reduced set of principal components that are uncorrelated.
2. Secondly this set of principal components is used through Joliffe method for selecting a reduced set of principle variables which are representatives of the retained principal components.
3. The third step involves the extraction of the three sets of weights of the retained principle variables that represent a phenomenon namely, the crisis.

4. Fourth step is to collapse the principle variables into a composite index with the help of weights derived from step three.

Finally the PCA methodology enables us the construction of composite index. The crux of our methodology is to represent complex interrelated phenomena such as a crisis with the help of a single composite index, which could act as a unique dependent variable. It may be argued that there are many other factors that influence crises, but our PCA ensures that the variables which were chosen to construct crises index which was constructed with the help of composite index as explained latter in the section by using the weights, effectively represent the impact of all the crises variables. Since the principal variables are highly correlated to the principal components they contained the same information. One measure of the explanatory power of the index of the index formed by this procedure is given by the variation explained by the retained principal component.

COMPOSITE INDEX

Method for Construction of the Index

The main aim of our empirical work is to evolve a composite IOC (*Index of Crisis*) as per the Jha and Murthy (2003 & 2006) procedure. Hence, we need to choose the essential variables by a data reduction procedure and arrive at relative weights for the purpose of consolidating these variables into a single index.

$$IOC = \sum_{j}^{3} wjxj \ldots (7)$$

Xj = retained variables

Wj = component scores (weights).

The crux of our methodology is to represent complex interrelated phenomena such as a crisis with the help of a single composite index, which could act as a unique dependent variable.

Scale and Code

It must be ensured that index does not suffer on account of problem relating to scale and code. The problem of scale arises out of the difference in scale of the variables that were

components of the composite index. In our case the problem of the scale has been handled by normalizing the variables[10]. As a result variables are expressed in percentage term. The code of the variable refers to the interpretation of the direction of change with respect to the value or the measure of the index. For instance a high number in the index should represent an increase in the phenomena that the composite index stands for higher number should also be generated by the higher value of the component of the index, which implies a rise in the phenomena. For instance if exchange rate is expressed as a local currency unit per $ than we expect that during the crises there would be a sharp devaluation or depreciation of the currency hence the magnitude of the variable should rise. It is therefore necessary that there must be a consistency between the magnitude of the code and the interpretation of direction of change of the phenomenon on the one hand and also the consistency with- in the code in relation to the individual variables that constitute the code. Therefore a composite index would be representative only if the components of the index are representative and the scale and code both are consistent.

Advantage of the composite index:

To ascertain whether the composite index functions better than the individuals variables we estimated as a regression equations by including the principal variable directly in the regression. The results were not satisfactory and to the contrary a composite index performs better. Apparently the complexity of the phenomenon was better represented by a composite index that represents the combined information content. At the same time it reduces the number of variables and permit higher degrees of freedom.

RESULT AND ANALYSIS

So far we have explained what would be our methodology and how it was different from the earlier studies. The following sub-section interprets the results of various procedures which were applied to the data set in order to arrive at some meaningful conclusion from the raw data which was taken from the World Development Report and World Development Indicators (World Bank).

[10] Through the dummy variables exercise (not reported).

Causality Test

The Granger causality test consists of testing pairs of equations expressed below:

$$Y_t = a_1 X_{t-1} + a2\,Xt\text{-}2 + b1\,Yt\text{-}1 + b2\,Yt\text{-}2 + u1t \quad \ldots\ldots (8)$$

$$Xt = c1Xt\text{-}c2\,Xt\text{-}2 + d1\,Yt\text{-}1 + d2\,Yt\text{-}2 + u2 \quad \ldots\ldots (9)$$

Causality test has been conducted on a set of 30 variables. There were a total of 435 combinations. Accounting for own covariance which are 15 (in pair) in number, we have left with 420 combinations. Since the procedure of testing involves testing in pair it implies that there were 210 causality tests that were applied. On account of transitivity the number of combination are halved[11]. Those variables which have shown two ways causality were dropped. If there were two way casualties one cannot identify which variable is to be taken as dependent variable and which variable as independent variable. The result of the causality exercise shows that there are 19 causal variables (Table 1 and 2). As far as impacted variables are concerned there were sixteen impacted variables (Table 3 and 4).

The common variables which were occurring both as a cause and as an impact variable were shown in Table 5[12]. In all there are fifteen common variables. Thus out of sixteen impacted variable only one variable was left as pure impacted variable, that is, M9 (FP.CPI.TOTL.ZG–Inflation, consumer prices (annual %)).

Correlation Analysis

At this stage of analysis we do not know with surety which variables were impacted variables and which were causal variables. Through causality test we know that there were 15 common variables. Which out of these variables would be retained as impacted variables and would form a part of the index of crisis would be sorted out through correlation analysis.

First of all correlation among the pure impacted variable M 9, Inflation, consumer prices (annual %) and the 15 common variables was calculated[13]. Out of the list of 15 common variables only 14 were retained. Variable F15 - Total debt service (% of GNI) was

[11] Result not reported. The result were tested at 10% level of significance

[12] Marked as C in Table 5.

[13] By using SPSS 15.

dropped because of non availability of data in case of some countries. Common variables that were correlated with the single impacted variable M9 Inflation, consumer prices (annual %) were retained as impacted variable. One can afford that correlation could be high in case of impacted variable, since we have to construct a composite index out of it with he help of PCA that ensures that the correlation is removed. After applying correlation analysis the variables which were found to be highly correlated with the pure impacted variables have been reported in Table 6. At this stage we know which table is to be considered for the construction of the index.

Formation of index of crises:

PCA was applied on impacted variables shown in Table 6. The purpose of applying PCA was to arrive at a set of dependent variables that are inter-correlated and that retained the maximum possible information contained in all the impacted variables, which were being considered as dependent variables. The final procedure for the formation of the index involved the following steps:

1. Determination of number of principal components to be retained. In this step we use the Kaiser criteria and retain three principal components where eigen value was greater than one. Table 7 shows the total variance explained by the extracted principal component. It is evidenced that over 72% of the information is captured by the retained component.
2. Rotation of component: with the help of varimax rotation with Kaiser Normalization the component were rotated. This was done with a view to obtain the clear interpretation of the components. This resulted in a set of component scores of each of the nine variables with respect to the three retained components. Table 8 gives the component scores coefficient matrix.
3. Selection of principal variables: We have used the Joliffe procedure explained earlier to select the principal variables. We have selected three variables in the descending order beginning with the largest component. Accordingly the three principal variable selected were; M 3 Exports of Goods and Services (% of GDP), M 10 Official Exchange Rate (LCU per US$, period average, % change over the previous year) and F 8 Lending Interest Rate (%).
4. By using the weights from the component score coefficient matrix, which has been given by the PCA analysis in step three we would construct the index of dependent variables. Composite index of impacted variables (Y variable the LHS variable) was

calculated by multiplying the variables M 3 Exports of goods and services (% of GDP) by .315, variable M 10 Official exchange rate (LCU per US$, period average, % change over the previous year) by .402 and F 8 Lending interest rate (%) by .694 as weights .

$$IOC = \sum_{j}^{3} wjxj \quad \text{..... (10)}$$

Working of the Index

The code of the variable refers to the value and direction of each included variable in relation to the value and direction of the index. IOC measures the crises therefore a higher value of the index should represent a higher degree of crises. Percentage change in the Official exchange rate over the previous year has been expressed as LCU/$ therefore a rise in its value would represent depreciation of domestic currency. In affect a higher value implies an increase in the degree of crises. With depreciation it may be expected that value of exports of goods and services as a percentage of GDP increases which also adds to the value of the crises index. Similarly we could expect a higher lending interest rate as well during the period of crises. Hence all the three variables conform to the desired code of IOC. That is the entire three variables rise in value term when the rises increase. So also does the index of crises. Therefore the code of the components of the index and the crises index itself share the same interpretation.

During crises in general there would be a tendency to inflation. Secondly there could be a speculative bubble therefore it is expected that after monetary authority resort to tight money policy. Hence the interest rate is likely to increase. The purpose of adopting this elaborate procedure was dual. Firstly it was aimed at developing a composite index. Secondly it was important to ensure that a correlation amongst retained variables is minimized which is a merit of PCA methodology. After having constructed an index it was necessary to verify the degree of correlation. Table 9 shows that the correlations among the retained principal variables that have been used for constructing an index were low and not statistically significant. Thus, our methodology summarizes information from amongst the most important financial and macroeconomic variables without distorting the estimates since the variables post PCA are uncorrelated.

ANALYSIS OF THE INDEX OF CRISIS

In the following section we shall be analyzing the trends in the index – across phases of the crisis, namely, pre-crisis, crisis and post crisis. The first observation is that clearly

during the crises window all countries have been affected including India. This is evidence from a discrete jump in the index of crises across countries. However it can be seen that the impact on India was minimal. One conclusion is that this justifies treating India as the base because it was least effected yet it was not a country that was unrelated to the crises.

The pre-crises period showed different patterns which can also be gauged by subsequent analysis of mean and standard deviation. The index witnesses a marginal declining trend in the case of Thailand. A stable but increasing trend was observed in the case of Korea. A declining trend with stagnancy for four years in the case of Indonesia and a very similarly trend in the case of Malaysia was observed. In the case of India there was a slight rise in early 1990's and thereafter there was a declining trend during pre crises period.

The highest index was that of Korea which was in the range of 63-64 while the lowest was of India which was slightly less than half at 31-32. Most of the countries during the crises were in the range of 60's. In fact the highest index was of Indonesia which stood at 64.74. Another feature was that the index rose from between 1997-98 uniformly. In the case of India the rise was less than one point on the scale. The maximum rise was in the case of Indonesia that was around 17 points. Although the Korea has the highest index on an average the jump was just about one point. Similarly in the case of Thailand and Philippines the appreciation was around 3.5 points.

During the recovery phase the patterns were more stable in the case of India there was a decline down to 40% and the recovery was almost complete except for a marginal overall rise in comparison to the pre crises period. Philippines and Thailand both experienced a halving of the index after crises and a mild decline towards pre crises levels in the next three years. In the case of Korea while the dip in the index was down by one third there was a marginal rise and a stable trend which resembled the late 80's. In both Malaysia and Indonesia the decline was less than half and there was a mild tendency towards a falling index which approximated there state at the end of 80's and beginning of 90's. (All the results of the above analysis are reported in Table 10).

GRAPHICAL INTERPRETATION

Most of the above trends were visible in the graph shown below (Figure 1 to Figure 5). However, since the analysis only reveals the average we would like to comment on some of the extreme points in the graphs. In Thailand the trend started around 23 points and

went up to high of 50. Even immediately after the crises it went down to 25. This shows that the recovery was pretty fast and complete. At the end point the index interestingly came back to 22. Philippines showed a much more volatile pattern it began at 32 and went up to almost 35 in 1990 then it sharply fell to 18 at the beginning of the crises. During crises it short up to 40 but the recovery was good because it stabilize around 20. Korea showed a distinct pattern of a high level of the index hovering around 40 with a sudden kink during a crises from 45 to 65. Indonesia clearly shows a slump with the pre crises period having a low of 24. It peaked up to 65 and gradually tapered of to 33, which was around the pre crises levels. The pattern of Malaysia was a mixture of Korea and Indonesia. .It started around 40 and ended around 35. The general pattern was like Korea with a long period of slump like Indonesia. It peaked up to 61.4 and the recovery period was somewhat turbulent. Interestingly India's pattern was similar to that of Philippines. There was an initial high of 24 in 1990 similarly to Philippines. There was a relatively small period of stagnancy when the index went down to 10.

India started at a level of under 20 while other countries started at about twice that of India's level of IOC. India faced an internal shock in 1990-91 because of which it witnessed a peak in that year. However, it can be noticed that even this peak was well below the entire range of all other countries in the pre-crisis period. The second peak of India was around 31, in 1998. India's 'crisis peak' was below the average of other countries. The highest peak was 64 (Indonesia). It must be noted that all these comparisons are based on normalized variables and an in index form. Therefore, there is no bias on account of size of the economy. If at all this should inflate India's values. On the whole the level of the curve in India was consistently below, all other countries. During the post crisis period also India's performance was much better. The IOC came down to 12.62 and finally, India landed up at 12, in 2002, which is below where it had started in 1987. The worst value of IOC during recovery in India was 14 whereas in Korea it was 44.

In the final graph (Figure 7) that compares the pattern of all the countries the differences in pattern and levels are apparent before and after crisis. However the similarity during the crises was also striking. During crisis all countries behave similarly. The implication is that for drawing lessons the period of crisis does not provide any differential basis. It only shows the 'contagion effect'. During crisis expectations are flat. There are no incentives in the economy. This instills a commonality amongst countries. Therefore they can mainly be drawn from the pre-crisis behavior.

CONCLUSION

The foregoing study demonstrates that PCA and the particular use of principles variables along with other attendant empirical procedure leads to the construction of composite index that is bias free, representative and easy to interpret. The trends both empirical and graphical clearly show how a complex phenomenon of crisis has been captured by this index. It depicts the general phenomenon of crisis. It captures the distinct kinks that have occurred during different crises. Yet it is capable of showing the individual variations and finally, it discriminates between crisis ridden countries and India which happens to be a control.

REFERENCES

Andrew Berg & Catherine Pattillo, (1999) Are Currency Crises Predictable? A Test, *IMF Staff Papers, International Monetary Fund, vol. 46(2).*

Berg, Andrew and Catherine Pattillo (1999) Predicting Currency Crises: The Indicators Approach and an Alternative, *Journal of International Money and Finance 18.*

Calvo, Guillermo and Caelos Vegh (1998) Inflation Stabilization and Balance of Payment Crises and Developing Countries, J. Taylor and M. Woodford eds. *Handbook of Macro Economics, Amsterdam.*

Carramazza, F.L. Ricci and R. Salgado (2000) Trade and financial contagion in currency crises, *IMF WP 00/55.*

Cartapanis, Andre, Vincent Cropsy and Sophie Mametz (1998) Asian Currency Crises and Leading Indicators of Vulnerability and Unsustainability, *Working Paper, Universite de la Mediterrane..*

Chakravarty Committee (1985). *Working of the Monetary System*. Reserve Bank of India, Mumbai.

Chang, R. & Velasco, A., (1998) Financial Crises in Emerging Markets: A Canonical Model, *C.V. Starr Center for Applied Economics, New York University Working Papers, 98-21.*

Corsetti, Giancarlo; Prsenti, Paolo and Roubini, Nouriel (1998b) What Caused the Asian Currency and Financial Crisis? Part 1: A Macro-Economic Overview, *NBER Working Paper 6833.*

Craig Burnside, Martin Eichenbaum and Sergio Rebelo (eds.) Prospective Deficits and the Asian Currency Crisis, *NBER Working Paper No. 6758.*

Dooley, Michael P. (1997) A Model of Crises in Emerging Markets, *NBER Working Paper no. 6300.*

Edison, H. (2000) Do Indicators of financial crises work? An evaluation of an early warning system, *Board of Governors of the FRS International Finance Discussion Paper 675.*

Eliasson, Ann-Charlotte and Krevter, Christof (2000) On currency crisis model: A Continuous Crisis Definition, *Deutshe Bank Research.*

Evans, Martin D. D. and Lyons, Richard K. January (2003) How is macro news transmitted to exchange rates? *NBER Working Paper 9433.*

Frankel, Jeffrey and Andrew Rose (1996) Currency Crashes in Emerging Markets: An Empirical Treatment, *International Finance Discussion Papers, Board of Governors of the Federal Reserve System, 534 (January).*

Frankel, Jeffrey and Andrew Rose (1996) Currency Crashes in Emerging Markets: An Empirical Treatment, *International Finance Discussion Papers, Board of Governors of the Federal Reserve System, 534..*

Giancarlo Corsetti, Paolo Pesenti and Nouriel Roubini (1998) What Caused the Asian Currency and Financial Crisis? Part 1: A Macroeconomic Overview, *NBER Working Paper No. 6833.*

Goldstein, M., G. Kaminsky and C. Reinhart (2000) Assessing Financial Vulnerability: An Early Warning System for Emerging Markets, *Institute of International Economics Washington D.C.*

Gujarati, Damodar (2007) Basic Econometrics, 4th Edition, *Tata McGraw Hill International Editions Economic Series.*

Jha, R. and K.V. Bhanu Murthy (2006) Environmental Degradation Index, A Survey of Composite Indices Measuring Country Performance: 2006 Update, *A UNDP/ODS Working Paper,* By Romina Bandura With Carlos Martin del Campo, Office of Development Studies, United Nations Development Programme, New York, pp. 35-36.

Kaminsky, Graciela and Lizondo, Saul and Reinhart, Carmen M., (1997) Leading indicators of currency crises, Policy Research Working Paper Series *1852, The World Bank.*

Kaminsky, Graciela; Lizondo, Saul; Reinhart, Carmen M. (1998) Leading Indicators of Currency Crises, *IMF Staff Papers. Vol. 45 (1). pp. 1-48.*

Malik (2008) Measurement and Analysis of International Currency Crises: Lesson for India., *unpublished Phd. Thesis*, University of Delhi.

Moreno, Ramon (1995) Macroeconomic Behavior during Periods of Speculative pressure or Realignment: Evidence from Pacific-Basic Economies, *Federal Reserve Bank of San Francisco Economic Review, pp. 3-16.*

Moreno, Ramon, Gloria Pasadilla and Eli Remolona (1998) Asia's Financial Crises: Lessons and Policy Response, in Asia: Responding to Crises, *Asian Development Bank Institute* pp. 1-27,

Radelet, Steven and Jeffrey Sachs (1998a) The Onset of the East Asian Currency Crisis, *NBER Working Paper No. 6680.*

Sebastian Edwards (1999) On Crisis Prevention: Lessons from East Asia and Mexico, *NBER Working Paper No. 7233.*

Vaghul Group, (1987) The Working Group on the Money Market. Reserve Bank of India, Mumbai.

World Development Indicators (World Bank), Various Issues.

Y.V. Reddy 2006, Monetary Policy Operating Procedures in India. Reserve Bank of India, Mumbai.

Figure 1

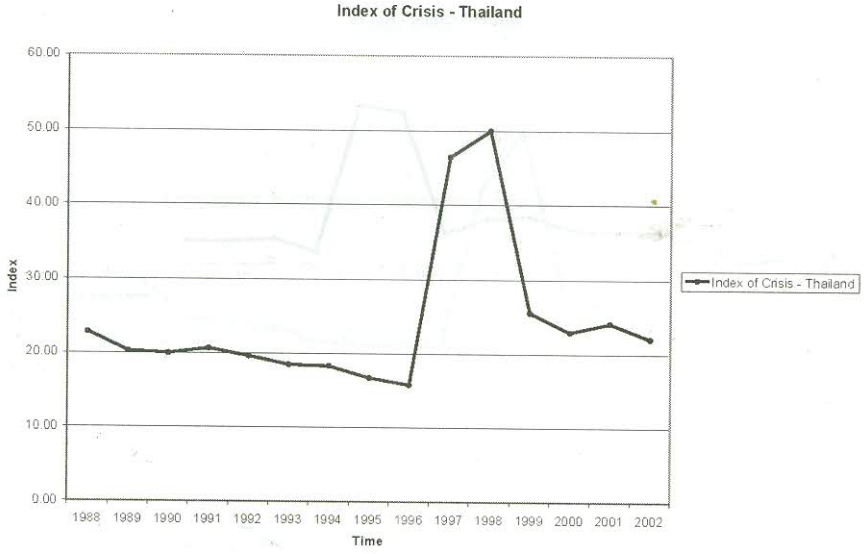

Figure 2

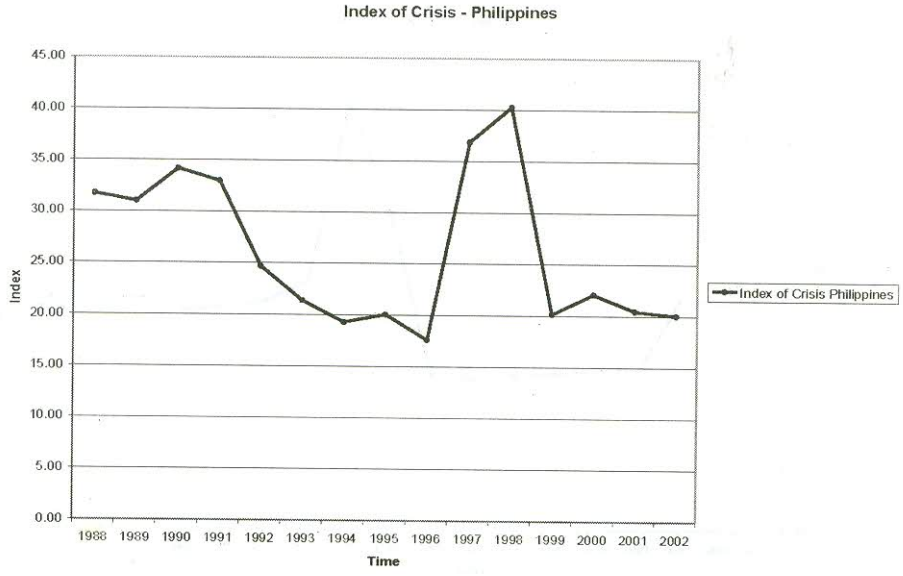

Figure 3

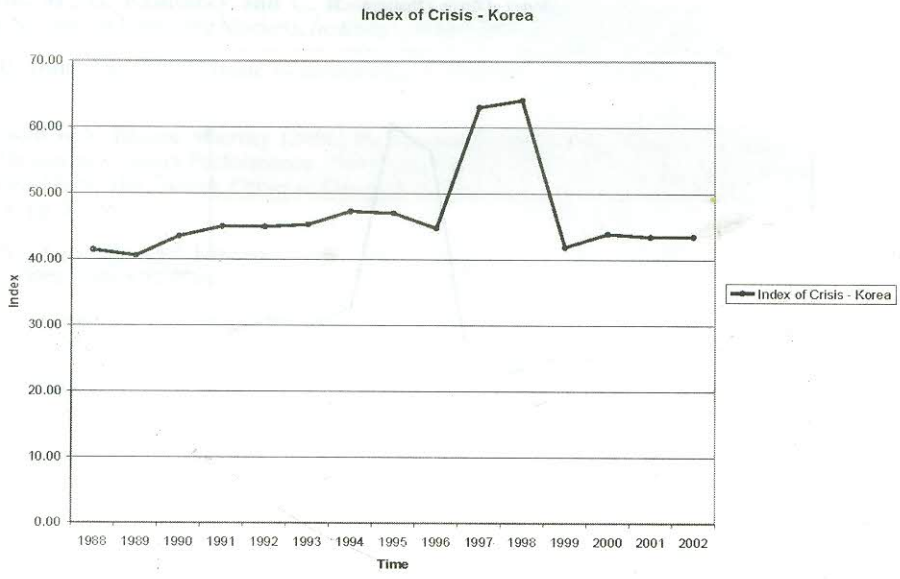

Figure 4

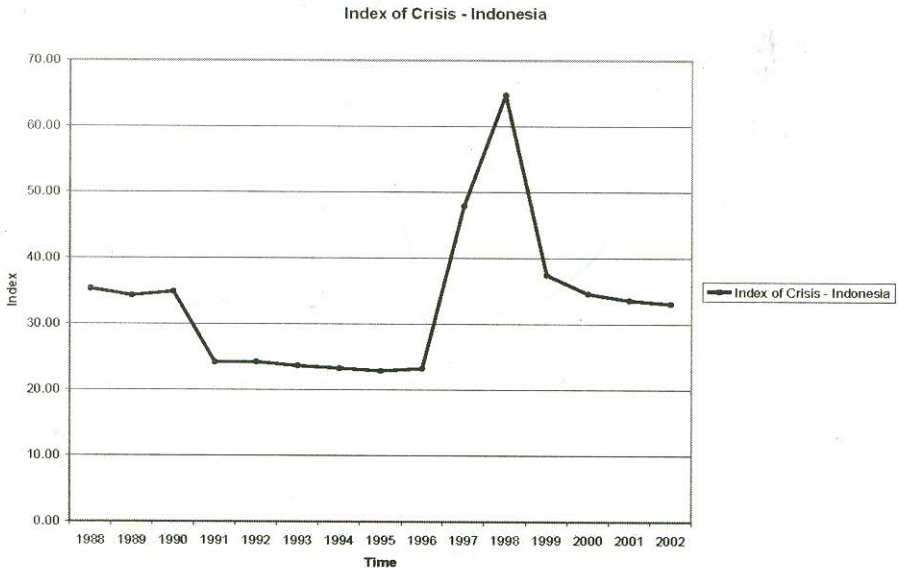

Figure 5

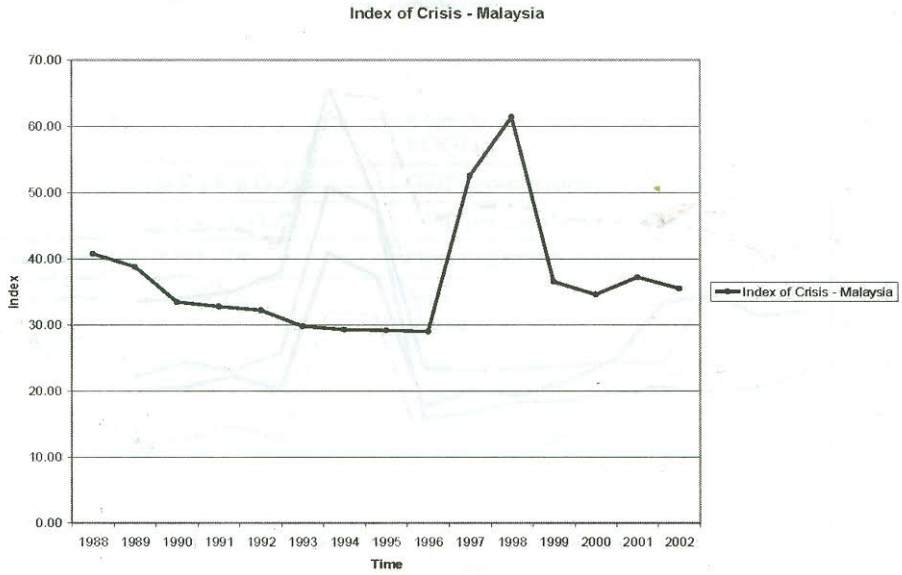

Figure 6

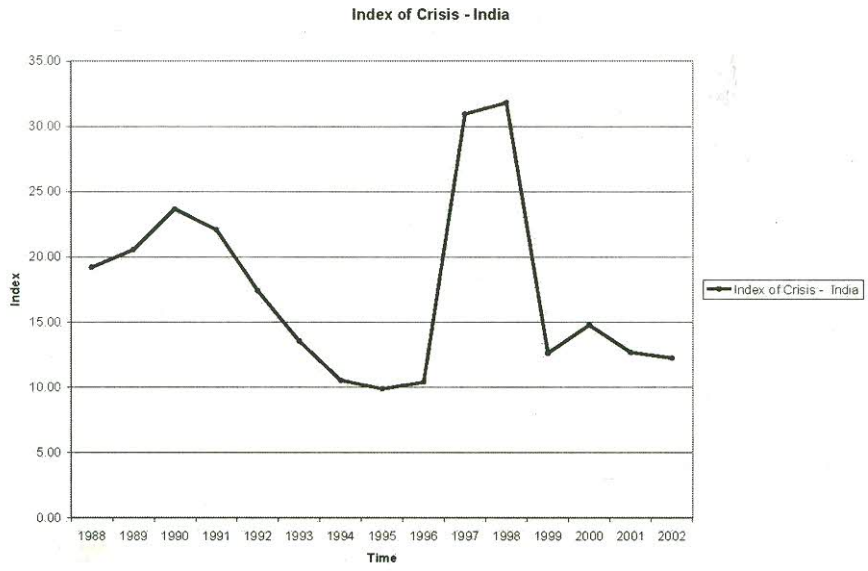

Figure 7

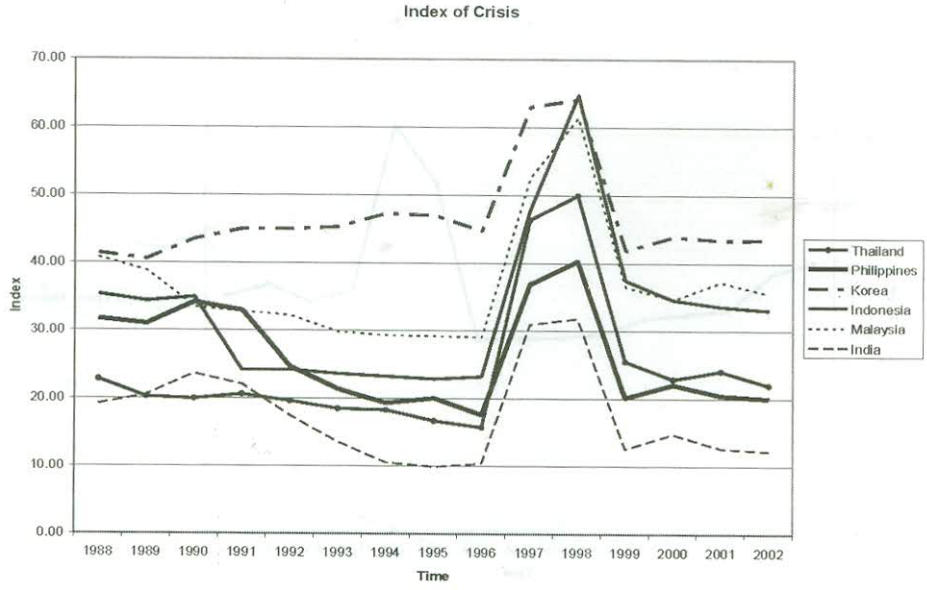
Index of Crisis
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Index
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
Time
Thailand
Philippines
Korea
Indonesia
Malaysia
India

Table 1: Macro Causal Variables (Code and Name of the Variable)

Code	Abbreviation of the Variable	Name of the Variable
M1	BN.RES.INCL.CD	Changes in net reserves (BoP, current US$)
M2	BN.CAB.XOKA.GD.ZS	Current account balance (% of GDP)- CAB
M3	NE.EXP.GNFS.ZS	Exports of goods and services (% of GDP)- EOGD
M4	NY.GDP.MKTP.KD.ZG	GDP growth (annual %)- GDPG
M5	NY.GDP.PCAP.KD.ZG	GDP per capita growth (annual %)- GDPPC
M6	NE.GDI.TOTL.ZS	Gross capital formation (% of GDP)- GCF
M7	NE.IMP.GNFS.ZS	Imports of goods and services (% of GDP)- IOGS
M10	PA.NUS.FCRF	Official exchange rate (LCU per US$, period average)- OER
M11	GB.BAL.OVRL.GD.ZS	Overall budget balance, including grants (% of GDP)- OBB
M13	FR.INR.RINR	Real interest rate (%)- RI

Table 2: Financial Causal Variables (Code and Name of the Variable)

Code	Abbreviation of the Variable	Name of the Variable
F2	FS.AST.PRVT.GD.ZS	Domestic credit to private sector (% of GDP)- DCTPS
F3	GB.FIN.DOMS.GD.ZS	Domestic financing, total (% of GDP)- DFT
F4	BX.KLT.DINV.DT.GI.ZS	Foreign direct investment, net inflows (% of gross capital formation)- FDI
F6	IQ.ICR.RISK.XQ	ICRG composite risk rating (0=highest risk to 100=lowest)- CRR
F8	FR.INR.LEND	Lending interest rate (%)- LR
F10	CM.MKT.LCAP.GD.ZS	Market capitalization of listed companies (% of GDP)- MC
F12	DT.DOD.DSTC.ZS	Short-term debt (% of total external debt)- STD
F13	CM.MKT.TRAD.GD.ZS	Stocks traded, total value (% of GDP)- ST
F15	DT.TDS.DECT.GN.ZS	Total debt service (% of GNI)- TDS GNI

Table 3: Impacted Macro Variables (Code and Name of the Variable)

Code	Abbreviation of the Variable	Name of the Variable
M1C	BN.RES.INCL.CD	Changes in net reserves (BoP, current US$)- CINR
M2C	BN.CAB.XOKA.GD.ZS	Current account balance (% of GDP)- CAB
M3C	NE.EXP.GNFS.ZS	Exports of goods and services (% of GDP)- EOGD
M5C	NY.GDP.PCAP.KD.ZG	GDP per capita growth (annual %)- GDPPC
M7C	NE.IMP.GNFS.ZS	Imports of goods and services (% of GDP)- IOGS
M10C	PA.NUS.FCRF	Official exchange rate (LCU per US$, period average)- OER
M13C	FR.INR.RINR	Real interest rate (%)- RI
M9	FP.CPI.TOTL.ZG	Inflation, consumer prices (annual %)

Table 4: Impacted Financial Variables (Code and Name of the Variable)

Code	Abbreviation of the Variable	Name of the Variable
F2C	FS.AST.PRVT.GD.ZS	Domestic credit to private sector (% of GDP)- DCTPS
F4C	BX.KLT.DINV.DT.GI.ZS	Foreign direct investment, net inflows (% of gross capital formation)- FDI
F5C	BG.KAC.FNEI.GD.ZS	Gross private capital flows (% of GDP)- GCF
F6C	IQ.ICR.RISK.XQ	ICRG composite risk rating (0=highest risk to 100=lowest)- CRR
F8C	FR.INR.LEND	Lending interest rate (%)- LR
F12C	DT.DOD.DSTC.ZS	Short-term debt (% of total external debt)- STD
F13C	CM.MKT.TRAD.GD.ZS	Stocks traded, total value (% of GDP)- ST
F15C	DT.TDS.DECT.GN.ZS	Total debt service (% of GNI)- TDS GNI

Table 5: List of Common Variables

Code	Abbreviation of the Variable	Name of the Variable
M1C	BN.RES.INCL.CD	Changes in net reserves (BoP, current US$)- CINR
M2C	BN.CAB.XOKA.GD.ZS	Current account balance (% of GDP)- CAB
M3C	NE.EXP.GNFS.ZS	Exports of goods and services (% of GDP)- EOGD
M5C	NY.GDP.PCAP.KD.ZG	GDP per capita growth (annual %)- GDPPC
M7C	NE.IMP.GNFS.ZS	Imports of goods and services (% of GDP)- IOGS
M10C	PA.NUS.FCRF	Official exchange rate (LCU per US$, period average)- OER
M13C	FR.INR.RINR	Real interest rate (%)- RI
F2C	FS.AST.PRVT.GD.ZS	Domestic credit to private sector (% of GDP)- DCTPS
F4C	BX.KLT.DINV.DT.GI.ZS	Foreign direct investment, net inflows (% of gross capital formation)- FDI
F5C	BG.KAC.FNEI.GD.ZS	Gross private capital flows (% of GDP)- GCF
F6C	IQ.ICR.RISK.XQ	ICRG composite risk rating (0=highest risk to 100=lowest)- CRR
F8C	FR.INR.LEND	Lending interest rate (%)- LR
F12C	DT.DOD.DSTC.ZS	Short-term debt (% of total external debt)- STD
F13C	CM.MKT.TRAD.GD.ZS	Stocks traded, total value (% of GDP)- ST
*F15C	DT.TDS.DECT.GN.ZS	Total debt service (% of GNI)- TDS GNI

* Variable which was dropped due to non-availability of data in case of some countries.

Table 6 Variables which were Significantly Correlated with Variable M9 (Retained as Y Variable LHS)

Code	Abbreviation of the Variable	Name of the Variable
M13	FR.INR.RINR	Real interest rate (%)
M1	BN.RES.INCL.CD	Changes in net reserves (BoP, current US$)
M3	NE.EXP.GNFS.ZS	Exports of goods and services (% of GDP)
M2	BN.CAB.XOKA.GD.ZS	Current account balance (% of GDP)
M7	NE.IMP.GNFS.ZS	Imports of goods and services (% of GDP)
M10	PA.NUS.FCRF	Official exchange rate (LCU per US$, period average)
F2	FS.AST.PRVT.GD.ZS	Domestic credit to private sector (% of GDP)
F8	FR.INR.LEND	Lending interest rate (%)
*M9	FP.CPI.TOTL.ZG	Inflation, consumer prices (annual %)

Table 7 Total Variance Explained

	Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.143	34.921	34.921	3.013	33.482	33.482
2	2.352	26.137	61.058	2.300	25.553	59.035
3	1.052	11.687	72.745	1.234	13.709	72.745

Extraction Method: Principal Component Analysis

Table 8 Component Score Coefficient Matrix

	Component		
	1	2	3
CINRM1	-.055	-.072	.366
CABM2	.236	-.002	.485
EOGDM3	.315	.022	-.019
IOGSM7	.297	.021	-.062
ICPM9	-.098	.361	.048
OERM10	.009	.402	-.030
RIM13	-.053	-.384	.147
DCTPSF2	.299	-.051	.104
LRF8	.069	-.044	.694

Extraction Method: Principal Component Analysis
Rotation Method: Varimax with Kaiser Normalization

Table 9 Correlations

		EOGDM3	OERM10	LRF8
EOGDM3	Pearson Correlation	1	.048	-.268*
	Sig. (2-tailed)	.	.654	.011
	N	90	90	90
OERM10	Pearson Correlation	.048	1	.094
	Sig. (2-tailed)	.654	.	.379
	N	90	90	90
LRF8	Pearson Correlation	-.268*	.094	1
	Sig. (2-tailed)	.011	.379	.
	N	90	90	90

* Correlation is significant at the 0.05 level (2-tailed).

Table 10

Index of Crisis

Year	Thailand	Philippines	Korea	Indonesia	Malaysia	India
1988	22.79	31.70	41.40	35.34	40.79	19.18
1989	20.24	30.98	40.55	34.34	38.83	20.53
1990	19.95	34.16	43.50	34.93	33.48	23.64
1991	20.61	32.95	45.00	24.17	32.79	22.06
1992	19.59	24.68	44.95	24.20	32.22	17.41
1993	18.46	21.40	45.29	23.64	29.80	13.55
1994	18.28	19.31	47.29	23.26	29.28	10.53
1995	16.72	20.05	47.01	22.88	29.17	9.88
1996	15.77	17.59	44.73	23.24	29.01	10.39
1997	**46.41**	**36.87**	**63.03**	**47.85**	**52.54**	**30.94**
1998	**49.98**	**40.31**	**64.09**	**64.74**	**61.41**	**31.80**
1999	25.51	20.17	41.89	37.45	36.52	12.62
2000	22.90	22.10	43.91	34.60	34.62	14.78
2001	24.08	20.49	43.45	33.62	37.22	12.69
2002	22.02	20.04	43.48	33.09	35.51	12.25

THE
INDIAN
JOURNAL
OF
INDUSTRIAL
RELATIONS
A Review of Economic & Social Development

CONTENTS | VOLUME 50 | NUMBER 2 | OCTOBER, 2014

ARTICLES

A Quarterly devoted to dissemination of knowledge in the fields of Industrial Relations and Human Resources, including releveant aspects of labour relations, personeel management and social and econmic issuies. Besides, communications from policy makers, socialand economic thinkers, managers and union leaders and Book reviews are also incorporated.

EDITOR : N.K. NAIR

Subscription Rates : for India - Rs. 1500.00 for one year; 4000.00 for three years; Rs. 6500.00 for five years; and Rs. 375.00 for a single copy. For foreign countries (Air Mail)-$100 for one year; $275 for three years and $375 for five years. For foreign courntires - (Sea mail)- $65 for one year; $175 for three years; and $250 for five years.

SRC

SHRI RAM CENTRE FOR INDUSTRIAL RELATIONS AND HUMAN RESOURCES, ECONOMIC & SOCIAL DEVELOPMENT
Unit No.1078 (F/F), Central Square, Plaza-II, M. L. Khurana Marg
(Barahindu Rao), Delhi-110 006
Ph.: 011-23635815; Telefax: 23635816 e-mail: src@srcirhr.com; www.srcirhr.com