# Predicting Sovereign Debt Crises: A Panel Data Approach Using Composite Indices

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#### Abstract

We use a panel Logit model and various macroeconomic and financial variables to develop an Early Warning System (EWS) for 60 emerging and developed countries over the period 1973-2010. We identify the most significant determinants that predict sovereign debt crisis by combining different methodologies. First, we extract a broad set of potentially relevant sovereign crisis indicators, which are combined using Principal Component Analysis. Next, we compare different EWS models based on their prediction performance and their corresponding Type I and II errors. Furthermore, we assess the performance of a model given the sensitivity and specificity measures (AUC). The resulting model is able to predict over 90% of crisis episodes while sending 14.42 % of false alarms. Finally, we combined macro-economic and financial variables into composite indexes in order to predict sovereign debt crises.

## JEL Classification: H63, C53

Keywords: Early Warning indicators, Sovereign debt Crisis, Crisis prediction.

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### **1-Introduction**

A number of financial crises in recent decades had disruptive effects on the economies: the Mexican crisis in 1994-1995 with 'tequila effects', the Asian crisis of 1997-1998, the Russian crisis in 1998 and more recently the subprime crisis of 2007-2010.... These financial crises have led to a debate on the best approach to identify the leading indicators of debt crises (Kaminsky and Reinhart, 1999; Manasse et al, 2003). This debate was intensified in reaction to large costs of such events. Those studies have searched for the establishment of an empirical model that can not only explain and identify vulnerabilities but also predict the onset of a financial crisis, the so-called early warning systems (EWS). The literature on the EWS on identifying and predicting difficulties prior to sovereign debt crisis (Manasse et al, 2003) is quite small compared with the large body of empirical and theoretical work on EWS of currency and banking crises (Frankel and Rose, 1996; Kaminsky et al, 1998; Demirgüç-Kunt and detragiache, 2000). The analysis in this study is primarily focused on sovereign debt crises.

These studies share a few key elements. They are all based on regressions where the dependent variable is a measure of severity of the crisis as well as a set of explanatory variables of the domestic and external sectors for different sub-sample of countries<sup>1</sup> (Appendix 2). They focus on the serious consequences of these episodes on debtors and creditors, as well as on the stability and the health of international financial markets (Rogoff, 1999).

We collected a new comprehensive dataset on sixty countries in Africa, Asia, Europe, Latin America, North America and Oceania over the period 1973 to 2010. This new database is then, used to analyse the influence of crisis definition in improving forecasting power of an Early Warning System by building an aggregated crisis occurrence index which refer to the definition adopted by Leaven and Valencia (2008, 2012), De Paoli and Saporta (2009), Reinahrt et Rogoff (2003, 2010), and Detragiache and Spilimbergo (2001). We define crisis occurrence if at least one of the four main sources indicates such an event.

Our main contribution includes the followings: First, the main feature of this empirical work is that we identify most significant variables that predict sovereign debt crisis by combining different econometric methodologies: We also test how

<sup>&</sup>lt;sup>1</sup> Kaminsky and Reinhart, 1999 ; Aghion, Bachetta and Banerjee, 2001

accurately the selected determinants predict sovereign debt crisis by a stepwise Logit analysis. We begin our analysis by a set of 47 variables that encompass external and domestic debt, trade, GNP, inflation, exchange rates, and interest rates... Then we identify the relationships amongst the explanatory variables by implementing Principal Component Analysis (PCA). We focus on the links between variables by constructing several components that aggregate correlated variables explaining sovereign debt crisis.

This study also implements the PCA methodology for constructing a composite index of macro-economic and financial variables in order to predict the occurrence of sovereign debt crisis.

The findings of this study are partially consistent with the previous findings of other similar studies in terms of prediction quality<sup>2</sup>; there are some significant differences, which may largely reflect differences in methodology, This study is the last of my knowledge which implement multivariate statistical for a large sample of countries and for a long period (4 decades from 1973 to 2010) in order to explore the basic financial characteristics of sovereign debt crisis and to construct an early warning signal using publicly open financial and macroeconomic data to predict the probability of sovereign debt crisis.

In sum, our results show that: (1) some variables which are important to predict sovereign debt crisis in other studies (like current account balance/ GDP) are found to be insignificant in our study. (2) Comparing to the literature, our model have high quality of prediction about 90% of episodes of sovereign debt crisis. (3) Combining variables into different factors improves the choice quality of variables (4) with the help of the financial and macro-economic composite indexes our logit panel regression have a high prediction quality of sovereign debt crisis (84.49 %)

Further, our paper moves beyond simple analysis and proposes new statistical criteria to evaluate EWS (Candelon et al, 2012). We propose Sensitivity as well as Specificity analysis to assess the performance of the chosen model (AUC). This approach offers a unified framework to compare different EWS models.

The paper is structured as follows. Section 2 reviews the literature on the definition of sovereign debt crisis, which motivates the choice of our indicators. Section 3

<sup>&</sup>lt;sup>2</sup> The Logit model of Manasse, Roubini, and Schimmelpfennig (2003) predicts 74 percent of all crises.

describes the data. Section 4 presents our methodology and results, whilst section 5 concludes.

### 2- Literature review on sovereign debt crises

To estimate the default risk, the literature on debt crises is divided into different groups. Each study focuses on a particular aspect of the debt crisis and a particular set of macroeconomic and institutional determinants. All these empirical studies start with a definition of the sovereign debt default or a sovereign debt crisis. Although they have adopted different definitions of sovereign debt crises depend to the issue at hand and the availability of data (Sachs, 1984). It is very heterogeneous ranging from debt restructuring to sovereign debt defaults. The main concern of researchers is to answer the question what do we really mean by "sovereign credit event"?

Through this literature review, we contribute by addressing an answer to this question. A priori, there is no agreement on the definition of what should constitute a sovereign debt crisis and how to debate such events. In fact, debt defaults can take different forms: A country is considered as insolvent if it defaults on a part or all of the stock of external or public debt (Fernandez, 2012). Detragiache and Spilimbergo (2001) define sovereign debt crisis as a state of restructuring or rescheduling with private creditors (Uruguay 2002). Also, a default event can be prevented by a substantial support provided by the IMF (e.g. Turkey in 2001 and Brazil in 2002) (Ciarlone et Trebeschi, 2005).

## 2-1 Debt Crises defined as Sovereign Default

To define a debt crisis, a part of the literature focuses on the event of payment of interest and / or principal. Moreover, defining debt crises is based on credit ratings as a proxy of the probability of default. Degradation in scores of countries is therefore perceived as an increase in the probability of default. Fernandez et al (2012) provide a definition that reflects the use sovereign risk concept by Standard and Poor's (S & P). S & P defines sovereign risk as the probability that a country that issued a loan does not honor its obligations and doesn't respect the repayment of principal and interest at maturity. S & P consider that: i) "for local currency bonds, foreign debt of each issuer is considered in default when payment of debt is not due at maturity or when there is an exchange of the debt under less favourable conditions." ii) "For bank loans, when

the payment of debt service does not made at the due date of payment or when rescheduling of principal and / or interest is accepted by creditors under less favourable conditions than the original issues." Reinhart, Rogoff and Savastano (2003) adopted the definition of S & P the authors identify 36 episodes out of the 53 episodes of debt crises in emerging economies over the period 1970-2001.

In other words, it is a measure of the credit quality of government, i.e. its "ability" (Detragiache and Spilimbergo, 2001) and / or its "willingness" (Eaton and Gersowitz 1981, Bulow and Rogoff, 1989) to honour its commitments at the due date. Therefore, to assess sovereign risk, it is important to define each of the terms "ability" and "willingness" to pay. The first term often refers to quantitative parameters and usually evaluated through macroeconomic stability of a country (measured for example in terms of GDP, exports or government revenues), and which makes the borrower unable to meet its obligations in regard of creditors. According to Menéndez (2012), a country may renegotiate or default on its debt if interest rates reach very high levels. In this case, a country will be unable to repay its debt or borrow more money to repay its existing debt. Renegotiation of sovereign debt involves a rescheduling or restructuring of a country debt. Hence, the government may, unilaterally, reduce the nominal value of the debt to pay.

The second term refers qualitative parameters such as the payment habits of a country in the past, the transparency and the reliability of information reported to national economic entities. The willingness to pay is reflected by the fact that the borrowers have sufficient means to pay its debt, but refuses to do so because of its bad faith. Willingness to pay is, in fact, a choice between the loss that comes from a default and the money saved for the debt payments.

In general, this loss is equal to the sanctions that will be imposed by lenders when borrowers default. In other words, borrowers compare the cost incurred by a public default (more access to international financial markets) and the costs of continuing to pay the debt (e.g. paying taxes). The macro-economic measures such as GDP growth and inflation affect not only the ability to pay but also the willingness to pay. These measures reflect the credibility of borrowers and thus influence the attitudes of investors 'country risk. When growth is low, being excluded from international markets is less expensive. Indeed, international openness may increase the costs of default and therefore the willingness of a country to repay its debt. So, the most opened economies lose benefit from economic disruption caused by the event of default. It should be noted that financial markets punish debtors if the defect is caused by a willingness to pay and will be more forgiving if the debtors are unable to pay.

A debt crisis can occur if a country is illiquid rather than insolvent (Manasse, Roubini and Shimmelpfennig, 2009). Indeed, the theoretical distinction between the notion of "illiquidity" and "insolvency" is relatively simple: an illiquid borrower has no cash to meet its obligations even if he is able to repay its debt in future; an insolvent borrower is unable to repay its debt at maturity given future income. Creditors are considered as insolvent if the present value of future income is greater or equal to the current stock debt. In other words, illiquidity is the temporary inability to pay debt while solvency is guaranteed in the long term. Consequently liquidity measures such as the ratio of short-term debt to reserves or M2 are included in the analysis of the creditworthiness of the borrower.

Beim and Calomiris (2001) adopt a variety of data sources to compile a list of the most important periods of debt from 1800 to 1992. The authors include in their data requirements, suppliers credit, sovereign and bank loans they excluded intergovernmental loans. They focused on long periods (6 months) and for which all or part of the interest and / or principal has been reduced or rescheduled. The period of default or debt rescheduling ends when the entire debt is paid or when restructuring was approved. The end of each episode of default or debt rescheduling was recorded when the full payment of the debt is made. Episodes of default or rescheduling separated by at least five years were combined because the beginning of a new crisis can sometimes be a continuation of a previous crisis.

Candelon and Palm (2010) consider that being unable to pay interest and principal on its foreign debt is too restrictive. According to the authors, this definition has the advantage of being simple, but it is too simplistic to be used as an operational tool to detect the debt crisis at an advanced stage and therefore take the necessary measures to avoid a sovereign default.

#### 2-2 Debt Crises defined as Large Arrears

Peter (2002) considers that the ratings of credits provided by rating agencies such as Moody's Investors S & P as an approximation of the probability of sovereign default are not good indicators. The author uses information published by the World Bank on the increase in arrears of payments and debt rescheduling from 78 emerging countries over the period 1984-1997. He built a Panel Logit model and estimated the probability of sovereign default. By comparing the results with those found by S & P and Moody's, the author concluded that the approximations of the probability of default (Cantor and Packer 1996). Indeed, the comparison shows that 79% of countries rated by both agencies had a default rate lower than the estimated probability of default.

The author defines sovereign default using changes in levels of arrears of debt and the amount rescheduled. In other words, it defines the default threshold in terms of increase in the stock of arrears. A sovereign borrower in an emerging economy is considered to be in default on its foreign debt if the following three conditions are met:

1) First, an increase in the total stock of long term debt arrears (i.e. interest and principal) to the official and private creditors is more than 2% of the total external debt.

2) Second, the total amount of long-term debt rescheduled in any given year exceeds 2.5% of the total external debt.

3) Third, if the second condition is fulfilled, but at the same time the total stock of arrears decreases more than the total amount of rescheduled debt, the country is not considered to be in default, i.e. the reduction of arrears payment is less than the amount of debt rescheduled. This last condition avoids classifying as defaulter a country that has paid a significant portion of its debt, but the stock of arrears is still above the threshold fixed in the definition.

The threshold value of 2% in the first condition and the threshold of 2.5% in the second condition correspond to the average of the two data sets, which are the increase in the total arrears, and the total amount of debt rescheduled compared to the

total external debt of the sample considered by the author. However, a disadvantage of this definition is that a country can be considered in crisis if the country has not paid a small portion of its debt but the most important part has been paid.

By studying a sample of 69 countries for which data are available and putting in place a probit model, Detragiache and Spilimbergo (2001) sets a threshold for the beginning of sovereign debt crisis until an amount of 5% of the outstanding arrears for the payment of principal and / or interest. The authors argue that the minimum threshold of 5% is determined so that share of debt in default is negligible. In addition, they define the crisis as a state of restructuring or rescheduling with private commercial creditors. The motivation of the second criterion is to include countries that have no arrears when they restructured or rescheduled their debt before the default.

Although this definition has the merit of simplicity, Detragiache and Spilimbergo (2001) do not discuss how they have chosen these thresholds.

According to De Paoli and Saporta (2009), a sovereign debt crisis occurs when arrears exceeds 15% of amount of principal and 5% for the interest. The chosen thresholds come from the distribution of arrears for all sovereign debtors in the author's sample over1970-2000, and identify thresholds that occur with low probability.

The sovereign debt crisis may also start by an agreement on debt restructuring. The authors identify 40 sovereign debt crisis over the period 1970-2000 for a sample of 41 countries. According to the definitions adopted by De Paoli and Saporta (2009) and Detragiache and Spilimbergo of (2001), a crisis can last on average around 8-11 years, and are associated with a deep recession at least 5 % per year on average Amadou and Pescatori (2004) propose an alternative definition of the debt crisis that takes into account the problems of emerging bond markets. More precisely, they define debt crises when one of these two events occurs: either there is a sovereign default or when spreads exceed a critical threshold in secondary bond markets.

#### 2 -3 Debt Crises as Large IMF Loans

Manasse, Roubini and Schimmelpfenning (2003) consider that there are different types of difficulties on sovereign debt services. According to these authors, the debt crises can start with a simple default on domestic and / or external debt (Russia in

1998, Argentina in 2001). Then, these problems are transformed into a debt restructuring that is almost coercive under the implicit threat of a default and therefore a liquidity crisis (Mexico in 1994-95, Thailand in 1997-98, Turkey 2000-2001). In other words, a country may be solvent but illiquid i.e., it may default on its debt due to the reluctance of investors to pay their short term debts at due time. These crises are partially avoided thanks to the substantial support from the international financial institutions as well as from private sector (Mexico in 1995, Turkey in 2001 and Brazil in 2001).

Manasse, Roubini and Schimmelpfenning (2003) argue that the difficulties in debt servicing were severe in the 1980s. They have become relatively common in the 1990s. Therefore, the authors believe that the data adopted by Detagriache and Spilimbergo (2001) may exclude some crises that were actually avoided thanks to aid provided by official creditors. They consider that a country is in crisis not only if it is classified as being in default by S. & P, but also if it has ready access to non-concessional loans from the IMF and it exceeds 100% of its quota. The authors were able to identify 54 debt crises on a sample of 76 transition countries that have access to the international market over the period 1995 to 2002.

## 2 -4 A comprehensive definition of debt crisis

The above definitions are adapted only to countries that have market access and can issue international bonds. But it is not the case for many low-income countries. In this context, Kraay and Nehru (2004) include in their definition, agreements with certain countries to take into account the debt structure of low-income countries. According to these authors, a sovereign crisis is set if at least one of the three following events occur. First, the amount of the payment arrears of principal and interest is greater than 5% of the country debt stock. Second, the country receives debt relief in the form of rescheduling or reduction from the Paris Club bilateral creditors. Third, the country receives substantial support (over 50%) from the International Monetary Fund (IMF) to allow adjustment of the balance of payments. These aids are types of "Stand by Arrangement" (SBA) or « Extended Fund Facility) (EFF). The authors identify 94

crisis episodes for which the period exceeds three years and 286 quiet period episodes from 1970 to 2001 and for 57 low-income countries.

The definition of sovereign defaults according to MacFadden et al (1985), Hajivassiliou (1989, 1994) includes three elements. Indeed, the country is facing a problem of debt repayment in a given year if one of three conditions occurs: 1) the country reschedules its debt with private creditors or officials; 2) When financial support from the IMF exceeds 125% of the country quota;

3) Arrears on interest and principal exceed 0.1% and 1%, respectively, of the total external debt.

McFadden (1985) and Hajivassiliou (1989) specify a model of sovereign default where the external loan demand depends on net international reserves, the current account balance and the debt service. This model suggest that rescheduling occurs when the demand for new credit in poor and developed countries exceeds the new credit supply in developed countries. So if the curves of offer and demand intersect below the interest rate, a country is able to borrow to service its debt. The authors note that the habits of payment of previous debts are an important determinant of actual behaviour of borrowers.

Ciarlone et Trebeschi (2005) defined the debt crisis when one of these five events occurs: First, when a country declares a moratorium on the payment of debts; secondly when a country defaults on the payment of principal and / or interest of its external debt to official and commercial creditors for an amount greater than 5% of the ratio of total debt service for the entire year; Third, when a country has debt payment arrears in interest and / or principal to external commercial and officials over 5% of total external debt over the year; Fourth, when a country signs a contract or a debt rescheduling agreement with a commercial and / or official creditor; Fifth, when a country receives aid from the IMF, it is considered significant if it exceeds 100% of its quota. The authors were able to identify 44 episodes of the debt crisis on a sample containing 28 emerging countries and cover the period from 1980 until 2002.

#### 3- Data

Our study treats annual data on a panel of 60 advanced and emerging economies during the period going from 1973 to 2010. The countries on 5 continents: Africa, Asia, Latin America, North America and Oceania. Indeed, the choice of our sample of countries and the period of the study is guided by data availability.

Based on the literature, several patterns can be observed in order to select the variables to include in the predicting debt crises model (appendix 2):

- Measures of solvency that assess a country's ability to honour its commitments, such as external and public debt, loans granted to the private sector, exports relative to GDP etc.
- Measures of liquidity as the services of the external debt, short-term debt relative to foreign exchange reserves, the ratio M2 / reserves.
- Variables involved in currency crisis models
- Macroeconomic indicators such as inflation, such as GDP, GDP per capita.
- Variables measuring commercial relations as imports / GDP, trade openness, foreign direct investment.

Also, we construct a number of indicators, which are found to have a significant impact on sovereign debt crisis. We use four main sources to collect data on the economic and financial variables: IFS "International Financial Statistics", WDI "World Bank Development Indicators", WEO "World Economic Outlook Database", GFD "Global Financial Data". Only Data on public and external debt are taken from the database of Reinhart and Rogoff (2009). Public debt includes, on the one hand central, government debt i.e. the total liabilities of the government debt to domestic and foreign creditors. On the other hand, the external debt comprises total liabilities of a foreign country with public and private creditors.

The definition of sovereign debt crisis is very heterogeneous, ranging from debt restructuring to sovereign debt defaults. This leads us to construct an aggregated crisis occurrence index. For this purpose this paper relies on several datasets in order to not omit crisis episodes. We will refer to the definitions of Leaven and Valencia (2008, 2012), Reinhart and Rogoff (2003, 2010), Detragiache and Spilimbergo (2001), De Paoli and Saporta (2009). In other words, we define crisis occurrence if at least one of the four main sources indicates so (dates of crises in list below).

The goal of this paper is to explain and forecast sovereign debt crises; for this reason, most explanatory variables enter in lagged form. Thus, explanatory variables run from 1973 to 2009, whereas our dependent variable goes from 1974 to 2010.

Country	Year of Sovereign debt crises	Country	Year of Sovereign debt crise
Africa		Poland	1981-1994
Algeria	1990-1996	Portugal	2008-2010
Cote D'Ivoire	1983-1998/2000-2005	Romania	1981-1983/1986-1987
Egypt	1984/1986	Russia	1973-1986/1990/2000
Morocco	1983/1985-1990	Spain	
Nigeria	1982-1992/2001/2004-2005	Sweden	1992
South Africa	1985-1987/1989/1993	Switzerland	
Tunisia	1979-1982/1993	Turkey	1987-1979:1982
Asia		United Kingdom	
China		Latin America	
India	1973-1976	Argentina	1982-1993/2001-2005/2007-2009
Indonesia	1997-2000/2002	Bolivia	1980-1984/1986-1997
Japan		Brazil	1983-1994/2002
Korea	1998	Chile	1973-1976/1982-1990
Malaysia		Colombia	1985
Philippines	1981-1992	Costa Rica	1981/1983-1990
Singapore		Dominican Republic	1975-2001/2003/2005
Sri Lanka	1979/1981-1983/1990/1992/1996	Ecuador	1982-1995/1999-2000/2008
Thailand	1992	El Salvador	1981-1996
Europe		Honduras	1976/1981-2010
Austria		Mexico	1982-1990
Belgium	1990-1991	Nicaragua	1978/1980/1985
Denmark		Panama	1983-1996
Finland		Paraguay	1982-1984/1986-1992/2003-2004
France		Peru	1976/1978/1980/1983-1997
Germany		Uruguay	1983-1985/1987/1990-1991/2002-2003
Greece	2010	Venezuela	1982-1988/1990/1992/1995-1998/2004-2005
Hungary	1982/1984/1988/2008	North America	
lceland		Canada	
Ireland	2010	United States	
Italy	1981	Oceania	
Netherlands		Australia	
Norway		New Zealand	

#### 4- A sequential approach to early warnings about sovereign debt crises

The goal of this paper is to construct a model of early warning to prevent the sovereign debt crises. For this, we adopt a method in 3-steps in order to select the most relevant variables. Indeed, building a Logit model with a large number of explanatory variables may not have a good prediction of sovereign debt crises. We start our analysis with a set of 47 macroeconomic and financial variables.

## 4-1 Selection of variables correlated with the occurrence of debt crises

Subsequently, we exclude from the analysis all variables that are not significant determinants of debt crises and those who do not have the expected sign. (Appendix1). A positive (negative) sign indicates that this indicator has more significant value than the probability of a debt crisis is high (low).

Based on a Univariate Panel Logit model, we regress each variable in our sample, individually to have an idea on how they are correlated with the occurrence of sovereign debt crises. First we remove the variables that include missing values more than 50% of the observations.

So we describe our approach in estimating the determinants of sovereign debt crises. The variable to be explained is  $y_t$  it takes the value of 1 if a sovereign debt crisis occurred during the year t and 0 otherwise:

 $y_{it} = \begin{cases} 0, & No \ crisis \\ 1, & Crisis \end{cases}$ 

Our equation is as follow:  $y_{it} = \alpha_i + \beta_i x_{it-1} + u_{it}$ 

Where  $x_{it-1}$  represent a vector of explanatory variables for country *i* in period.  $u_{it}$  is a normally distributed error term with zero mean and unit variance

Our Panel Logit Model supposes that the probability of sovereign debt crisis is specified as:

$$P(crisis = 1) = \frac{\exp(\alpha_i + x_{it-1}\beta)}{1 + \exp(\alpha_i + x_{it-1}\beta)}$$

Based on this procedure we selected 15 variables:

Variables	Coefficient	Std.error	P Value
Total gross central	.00098	.00032	0.003
government debt/GDP			
Total gross external debt/	.00037	.00016	0.024
GDP			
FDI	01027	.00390	0.009
GDP growth	01547	.00236	0.000
Gross saving (% GNI)	00864	.00165	0.000
M2/ total reserves	.00428	.00080	0.000
Foreign exchange reserves	-4.39e-07	1.02e-07	0.000
Stock of total assets	-2.54e-09	8.07e-10	0.002
Trade Openness	00204	.00035	0.000
Central Bank assets/GDP	.01633	.00182	0.000
Financial openness	07258	.00653	0.000
Domestic credit provided by	.00053	.00016	0.001
banking sector (% GDP)			
Imports/ GDP	0043	.00078	0.000
Exports/ GDP	00178	.00063	0.005
General government	00578	.00234	0.014
expenditure (% growth)			

Table 1 variable most correlated with dependant variable

## 4-2 Principal Components Analysis

In order to define the profile of data and to form coherent groups of variables to highlight their similarities and differences, we adopt the technique known as "The principal components analysis." It is a powerful tool for data analysis. The advantage of PCA is that it eliminates the multi co-linearity between the data by reducing them to a set of underlying dimensions, without loss of information. In addition, ACP selects the factors according to their contributions to the total variance. Indeed, the first factor is the linear combination of variables maximum variances. The second factor is the linear combination with maximum variance of all linear combinations uncorrelated with the first factor, and so on. The eigenvalue for a given factor measures the variance in all the variables that are present in this factor. If a factor has a low eigenvalue (less than 1) it must be ignored.

By applying principal component analysis on 15 variables selected in the first step we identify five factors for which the eigenvalue is greater than 1, 68.31% of the total variance.

**Figure 1**: Choosing principal factors



After selecting main factors, the next step in The PCA is to use rotated factor matrix the coordinate system since the initial eigenvectors are orthogonal and therefore constitute a new coordinate system. This method allows not only to know the weight of each variable in each factor but also to identify the correlation between variables and the factor

Variables	Factor1	Factor2	Factor3	Factor4	Factor5	Uniqueness
Total gross central government	0.1828	0.1125	-0.2068	0.6376*	-0.1024	0.4941
debt/GDP						
Total gross external debt/ GDP	0.3255	0.3448	-0.4465	0.0845	0.0818	0.5620
FDI	0.4452*	0.1510	-0.1359	-0.0724	0.265	0.6849
GDP growth	0.0935	-0.0502	0.2971	-0.1802	0.309*	0.7723
Gross saving (GNI %)	0.2737	0.1244	0.6115*	-0.2613	0.0385	0.4659
M2/ total reserves	-0.1628	0.4846*	-0.2443	0.0669	-0.0339	0.6733
Foreign exchange reserves	-0,0134	-0.4563	0.3730	0.1591	-0.0095	0.6271
Stock of total assets	0,1116	0.6222*	-0.1358	-0.0313	0.1155	0.5677
Trade Openness	0,9896	-0.0142	0.0193	0.0096	0.0168	0.0197
Central Bank assets/GDP	-0.0898	-0.0719	-0.0241	0.5859*	0.0941	0.6341
Financial openness	0.1915	0.4513	-0.1116	-0.1965	-0.1051	0.6975
Domestic credit provided by banking sector (% GDP)	0.0163	0.7877*	0.1156	0,0273	-0,0385	0,3637
Imports/ GDP	0.9767*	-0.0341	-0.0156	0.0271	0.0378	0.0426
Exports/ GDP	0.9808*	0.0312	0.0560	-0.0151	-0.0460	0.0315
General government expenditure/ GDP	0.0861	0,1126	-0,0393	-0,02	-0,2396	0,9206

Table 2: Rotated Component Analysis Factor Matrix

The indicators are grouped into five factors:

*Factor1 (economic relationships):* Foreign direct investment net inflows (%GDP), trade openness, imports/GDP, and exports/GDP

*Factor 2 (liquidity):* M2/ Total reserves, stock of total assets; Domestic credit provided by banking sector (% GDP), Financial openness, Foreign exchange reserves *Factor 3(political and institutional variable):* Gross saving (%GNI), total gross external debt / GDP.

*Factor 4 (Public Debt):* Total gross central Government debt/GDP, Central Bank assets/GDP

Factor 5 (Growth): GDP Growth, general government expenditure/ GDP

The method of principal components analysis may not provide indicators the most significant crises indicators or variables, which have the greatest impact on the dependent variable (occurrence of a debt crisis). For this reason we perform a Logit regression stepwise. Our results show persistence in the significance of these four variables:

Total gross central government debt / GDP, Total gross external debt/ GDP, Foreign exchange reserves/GDP, Imports/ GDP.

We include these variables in a single model that we call "benchmark" then we conduct various Logit Panel regressions of several models adding variables from each component found in the PCA analysis.

Finally we perform a signal analysis to assess the quality of models prediction and to try to find a compromise between the errors of type I and type II errors. Indeed, the model can indicate a high probability when, in fact, the probability is low. In other words, it would wrongly miss a crisis. This error usually called the  $\alpha$  type I error. On the other hand, the model can indicate a low probability, whereas in fact the probability of a crisis is high. This error generally corresponds to a type II error or risk  $\beta$ . It is the probability to wrongly detect a crisis (false alarms).

In selecting the best model, the following criteria are enforced: (i) low Type II error should be achieved because achieving low Type II error is more important than achieving low type I error. In fact, Type II errors are more dangerous than Type I

errors. It is worse to classify a crisis as a quiet episode when it is critical than to classify a quiet episode as a period of crisis when there is no crisis. So we accord more importance to the second error type because the main objective of the early warning system is to identify crisis episodes (ii) high overall prediction accuracy should also be achieved. (iii) Variables in the model must have the predicted signs.

Receiver Operating Curve (ROC) is generally used to measure the predictive model power. This curve presents the percentage of episodes of crisis correctly predicted relative to the percentage of episodes of crisis non-correctly predicted.

Wrongly predicted crises are non- crisis episodes that are signalled as crisis by the model. It is considered as a good model if it can capture as much as possible of true crises and the lowest percentage of false crisis episodes. For this aim we calculate both of the sensitivity and the specificity of each model: the model specificity is defined as the probability to detect correctly a crisis and the model sensitivity is correspond to the probability to detect correctly no crisis episodes.

We built three models which have a very good quality of prediction and which have the greatest impact on the dependent variable (occurrence of a debt crisis):

≻ the first model includes the variables of the basic model

➤ the second model includes fixed variables and we added variables from the other components: the Gross saving (GNI %), General government expenditure, Domestic credit provided by banking sector (% GDP)

➤ the third model includes the most significant variables obtained from model I and II and we added two variables which were found to have a significant impact on the dependent variable: Trade openness, Financial openness

The results of each model are summarized in the following table:

## Table 3: Estimation Results

Variables	Model I	Model II	Model III
Total gross central government debt/GDP	0.02167*	0.02568*	0.01931*
Imports/ GDP	-0.07814*	-0.13124*	-0.26028*
Foreign exchange reserves /GDP	-0.00014*	-0.00007*	-0.00005*
Total gross external debt/ GDP	0.05273*	0.01875*	0.02277*
Gross saving (GNI %)		-0.14685*	-0.18511*
General government expenditure/GDP		5.49 E -07*	3.36 E -06*
Domestic credit provided by banking sector (% GDP)		-0.01664*	
Trade Openness			0.09253*
Financial openness			-0.98708*
Constant	-0.05273*	3.60494*	2.18593*
Model Performance			
Peudo R2	0.2926	0.4778	0.5747
Prediction quality	86.06 %	90.25%	93.10 %
Type I error	21,00%	20%	14.42 %
Type II error	12.92 %	8.09 %	5.47 %
Sensitivity	47.02 %	61.54 %	74.79 %
Specificity	96.62 %	96.91 %	97.19 %





Figure 3: ROC of model II



Figure 4: ROC of model III (the best model):



All variables identified in the model 1 (benchmark) have the expected signs: Total gross central government debt / GDP is highlighted by literature as an important indicator of a country's solvency. Essentially, the higher is this ratio, the less likely a country will become insolvent. Imports/ GDP are further negatively correlated with sovereign debt crisis probability. Foreign exchange reserves has a negative sign that means that the growth of foreign exchange reserves can lead to serious difficulties in assessing the adequacy of reserves especially in periods of crisis. As expected total gross external debt /GDP is positively correlated with sovereign debt crisis.

Although, all these variables are highly significant at the level of 5% percent. The prediction power of these significant variables in the model is 86.06% of correct classification. Indeed, this model indicate a substantially high type I error (21 %). In other Word, the model represent a high probability of debt crisis when, in fact, the probability is low. However, the type II error is relatively low (12.92 %).

The predictive power increases markedly when measures of terms of gross saving (GNI %), General Government expenditure, and domestic credit provided by banking sector(% GDP) are added to the second model. Type I and II Error was higher in the first model it has decreased reaching 20 % and 8.09 % respectively. Therefore, the result predicted by this model was relatively satisfactory (90.25 %). All explanatory variables are highly significant at the level of (5%).

An interesting finding is that domestic credits provided by banking sector (% GDP) do not have the expected sign in model II. According to the literature this ratio can be used as an indicator of vulnerability of the banking system. The central bank injects liquidity to banks in the periods of banking to improve their financial situations.

In Model II and III, the ratio of General Government expenditure (% growth) shows the expected sign. According to literature a large level of this ratio increases the probability of sovereign debt crisis. We can take the example of Greece over the past six years to show the impact of this ratio to the economy. According to the Greek Ministry of Finance, 2010 central Government expenditures increased by 87%, however, revenues grew by only 31%. This leads to budget deficit and current account deficits that can't be no more financed by international capital borrowing and leading to sovereign debt crisis.

The third Panel Logit model correctly predicts 74.79% (sensitivity) of debt crisis across the whole sample while sending only 14.42% and 5.47% of false alarm (type I and II errors respectively). Comparing the two last models, Model III outperform model II. In Model III the type I error decreased by almost <sup>1</sup>/<sub>4</sub>.

Trade openness in the third model has a positive sign. One explanation could be ambiguous effect of this variable. Indeed, countries with commercial openness have low probability of entering or being into a debt crisis. The measure of trade openness allows to the economy to have more controls on capital flows and interest rates especially when the occurrence of debt servicing problem are associated with depreciation of the exchange rate. Another explanation is that the more a country with commercial links have a very high level of imports, it will be more vulnerable to foreign shocks.

Further, observing the ROC of the three models (figure2), we note that the curve of the third model is quite close to the superior part of the square, which means that the separation between the false and correct classification is satisfactory. We find that by increasing the percentage of false alarms (sensitivity) we also increase the percentage of crises correctly predicted (1- specificity). The Area under the ROC of the third model is equal to 0.9469 compared to 0.8459 and 0.9162 for model I and model II respectively.

Based on the criterion of selection models above it seems that the third model is the best performer model.

### 4-3 Predicting Sovereign debt Crises:

Another evaluation of the predictive performance of the three models is tested by comparing the average separately one step ahead of crisis probabilities for both tranquil periods and crises periods. The principle of the method is to test whether the empirical results of the third model contain valuable information on the occurrence of debt crisis in the near future. The decision rule is as follows: when the average Predicted probability of a crisis is higher in periods when a crisis actually occurs in the next year than in periods when there is none, in this case we can say that the predictive performance of our model is good.

Table 4 presents some summary statistics of the predicted probabilities of tranquil periods and crisis episodes. It shows the difference between means for both periods. The result strongly support the fact that forecast based on our third model have valuable information about the occurrence of sovereign debt crisis. Interestingly the average predicted probabilities of a crisis occurring next year is statistically higher (0.68155) compared to tranquil periods (0.0709).

Model III	Tranquil	Crises
	periods	periods
Observations	533	119
Mean	0.0709	0.68155
Max	0.935	0.999
Min	0	0.0009
Std.dev	0.1377	0.3158

**TABLE 4: Predicted Probabilities of crisis** 

## 4-4 Do Composite Indexes can predict sovereign debt crisis?

In the first part of our empirical method we have estimated an equation by including principal variables directly in the regression. In this part we will verify if by employing a composite index that will perform better the prediction of sovereign debt occurrence.

In fact, the main objective of Principal Component Analysis is to decrease the dimensionality in data. In other words, it is a method to reduce data and choose the essential variables, which will be summarized by a number of independent principal components. This is for the purpose of consolidating these variables into a single index, which could act as a unique independent variable. Therefore, it will help to represent sovereign debt crisis event in combined information content.

We divided the variables that were found to have a significant impact on the occurrence of debt crises (table 1) into two groups: Macroeconomic variables and financial variables.

The empirical procedure to construct the two composite indexes involves in 3 steps:

- The first step is the determination of the number of principal components to be retained (eigenvalue greater than one)
- The second step consists on the rotation of the components in order to obtain a clear interpretation of the retained factors.
- The third step is to assign scores to each variable to indicate where that variable stands on the retained component. We obtain, then, a component score coefficient matrix where a factor score is a linear composite of the optimally weighted observed variables.

$$CI_n = w_1 y_{1n} + w_2 y_{2n} + \dots + w_p y_{pn} = \sum_i w_i y_{in}$$

 $CI_n$  corresponds to the composite score in the unit n.

 $Y_{in}$  corresponds to the individual indicator for the variable i in unit n,

 $w_i$  specifies the weight attached to the variable i

It should be noted that the normalization of variables is generally required prior to their aggregation, because the data often have different units of measure. In our case, the indicators of debt crises represent heterogeneous units (percentage and local currency) it is essential to standardize them, ie bring them to a common scale. There are different normalization methods, which may lead to different results. In our case the problem of the scale has been solved by adopting a method that converts variables in a common scale with the mean and standard deviation, which gives a reduced centered, variable. This method is advantageous when there is an intention to show the values standing out.

We had combined a list of 10 macro-economic and a list of 6 financial variables into two composite indexes, which called respectively IMV and IFV.

The following tables show the rotated component score coefficients of the 10 macroeconomic variables and the 6 financial variables

Macro- economic variables	Components				
	1	2	3		
Total gross central government debt/GDP	-0.01252	0.36470	0.08774		
Total gross external debt/GDP	0.00378	0.34249	0.02426		
FDI	-0.00596	0.04969	0.07679		
Gross saving (%GNI)	-0.04605	-0.16049	0.42884		
GDP growth	0.01777	-0.07362	0.25494		
Trade openness	1.02772	-1.74431	-1.71375		
Imports/GDP	-0.08595	1.26463	0.55172		
Exports/GDP	0.07448	0.46120	0.97654		
General government expenditure (% Growth)	-0.00464	0.02679	0.14019		

Table5: Component Score Coefficient Matrix

Table 6: Component Score Coefficient Matrix

Financial variables	Components			
	1	2		
M2/ total reserves	0.13794	0.32643		
Foreign exchange reserves	0.16121	-0.31197		
Stock of total assets	0.23638	0.13228		
Central bank assets/ GDP	-0.02848	-0.02338		
Financial openness	0.13567	0.01940		
Domestic credit provided by banking sector/GDP	0.47894	-0.07632		

The main propose of composite index construction is intended at estimating a structured model which predict sovereign debt crisis despite individual differences among countries through a set of explanatory variables. For this propose a panel Logit regression has been estimated and the results of the predictive power of our model have been reported in the next table:

The estimated equation is:

 $IC_{SC} = \alpha_i + \beta_1 IMV + \beta_2 IFV + u_{it}$ 

#### Predictive power of model with composite indexes

Sensitivity	Pr( +  D)	34.22%
Specificity	Pr( - ~D)	97.13%
Positive predictive value	Pr( D  +)	75.00%
Negative predictive value	Pr(~D  -)	85.45%
False + rate for true ~D	Pr( + ~D)	2.87%
False - rate for true D	Pr( -  D)	65.78%
False + rate for classified +	Pr(~D +)	25.00%
False - rate for classified -	Pr( D  -)	14.55%
Correctly classified	84.	49%

Our classifications of variables for creating a composite index to predict sovereign debt crisis was different from the previous section: macro and financial variables were separated. The inclusion of composite index of financial variables with a composite index of macro-economic variables in a single model have a relatively high prediction power (84.49%) with a type II error equal to 14.55%.

This model has a lower prediction quality compared with the estimated models with individual variables in the previous section. This may be due to the relatively large size and the Long time period of sample analysis.

The most important conclusion to be drawn from the implementation of this method is that the sovereign debt crisis can be predicted through two sets of explanatory variables, which are macro-economic variables and financial variables. As shown in table of component score coefficient matrix for macro economic variables are derived by three main variables, which have the higher score: Trade openness, imports/GDP and Exports/GDP. It means that a small change in these variables can cause greater changes in the stability of the economy. Although from the table of component score coefficient matrix for financial variables we can show that Domestic credit provided by banking sector/GDP and M2/ total reserves are the most potential financial causes of sovereign debt crisis.

#### **5- Conclusion:**

The empirical evidence presented above constitutes an incremental step toward understanding indicators that predict sovereign debt crisis of 60 countries in 5 continents (Africa, Asia, Latin America, North America and Oceania) during the period 1973-2010. Our literature review of sovereign debt crisis shows that there is no agreement on the definition of what should constitute a sovereign debt crisis. In order to not omit country-specific issues we refer to sovereign debt crisis definition in the literature to construct an aggregated crisis occurrence index.

We use a panel logit model and different macroeconomic and financial variables to develop an EWS. Our extensive review of sovereign debt definitions an early warning indicators literature found a set of variables that are consistently useful to predict sovereign debt crisis. Our results show that Total gross central government debt/ GDP, Total gross external debt/ GDP, Foreign exchange reserves, and Imports/GDP represent the most consistent early warning indicator of sovereign debt crisis. Our main contribution to the existing EWS models is the use of a large single panel dataset over the most recent period: our data covers 60 countries in Africa, Asia, Europe, Latin America, North America, and Oceania. We test different Early warning system models based on the criterion of prediction quality and the Type I and II errors. Second, unlike previous studies we define most significant variables that predict sovereign debt crisis by combining different econometric methodologies. The results of the study show that PCA is a useful tool for explaining economic characteristics of countries that are experiencing serious problems. Based on PCA, our study is the first witch built financial and macro-economic composites indexes, which summarized information about the occurrence of sovereign debt crises. These indices are regrouped in a single regression framework and are based on a large number of variables and requires a crucial procedure in three steps.

Our findings may be partially consistent with other studies, which deal with early warning Systems. But this article is the first study that uses multivariate statistical techniques on a large set of country sample as well as on very long period. This approach also provides new criteria to compare candidate EWS models based on sensitivity and specificity measure (AUC curve).

We leave for future research assessing the quality of prediction model for different sub-samples of different countries and sub-periods, which contain many crisis episodes. In order to take into account more specific financial variables that we were obliged to exclude the model given the large number of missing values. It will be interesting also to build a standard model for developing countries and testing the predictive power in the developed countries for the recent period (2000-2010).

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ariables	Impact of the sovereign debt crisis occurrence according to literature			bund ngic	omments
Λ	Positive	Negative	Positive	Negative	Ŭ
Total (domestic+ external) gross central government debt /GDP	*		*		An increase in the public debt leads to an increase in the probability of a debt crisis
Total (Public+ private) debt)gross external debt/ GDP	*		*		An increase in the external debt to GDP ratio leads to an increase in the likelihood of unsustainable debt and therefore of debt crisis
Inflation	*		*		An increase in inflation causes a reduction of domestic debt but an increase in external debt and therefore in the sovereign debt crisis
Foreign direct investment net inflows (% GDP)		*		×	An increase in this ratio causes an increase in the resources available for debt servicing which reduces the probability of a debt crisis
GDP growth (annual %)		*		*	The more the GDP growth is higher the more the probability of occurrence of the debt crisis is minimal.
Gross saving (% GNI)		*		*	An increase in gross savings decreases the probability of a debt crisis.
Official exchange rate (average) per USD	*		*		An increase in the money that occurs in the case of a current account deficit is a source of vulnerability of a country.

# Appendix 1 : Expected variables sign

M2/ total reserves	*			*	In the case of a currency crisis: individuals addressed to convert their domestic currency deposits in foreign currency. This ratio measures the liquidity of banking system's capacity to support its commitments in foreign currency. The higher the ratio, the higher the probability of a debt crisis increases.
Foreign exchange reserves		*		*	Growth of foreign exchange reserves can lead to serious difficulties in assessing the adequacy of reserves especially in periods of crisis
Consumer Price index	*			*	Inflation is usually measured through the CPI. Where a high level of the latter leads to an increase in the probability of debt crises.
Net external position/net foreign assets		*		*	A significant decrease in this ratio suggests that countries will need to run large trade surpluses in order to ensure its external debt
Trade Openness	*	*	*	*	Impact ambiguous: a low degree of openness can affect the trade surplus and thus increase the likelihood of an external default. High trade openness makes an economy highly vulnerable to external shocks.
Central Bank assets/ GDP	*		*		The side of assets, the central bank can diversify the composition of its portfolio of sovereign assets and therefore over-exposure to default risk.
General Government expenditure (% Growh)	*		*		Large Government Expenditure can increase the probability of public debt.

Public debt	*		*		An increase in the public debt leads to an increase in the probability of a debt crisis.
Financial openness		*		*	Ambiguous: This variable measures the degree of access to foreign capital. This creates a temptation for the state not to pay their debts to all creditors. This can be interpreted in another way financial openness may reduce the likelihood of a debt crisis as a result of the government's reputation and therefore will be obliged to repay its debt.
Domestic credit provided by banking sector (% GDP)	*		*		This ratio can be used as an indicator of vulnerability of the banking system. The central bank injects liquidity to banks in the phases of banking crises to improve their financial situations.
GDP Per capita growth (annual %)		*		*	It is a measure of the size of the economy of a country. There is thus an inverse relationship between GDP per capita and the likelihood of debt crises.
Total debt service (% of GNI)		*		*	Negative relationship between debt service and total debt crises
Imports / GDP		*		*	Same comment as trade Openness

Studies				ereign
Authors	Periods	Countries	Methodologies	Indicators of sov debt crisis
Fuertes (2006)	1983-2002	96 emergent and developing	Logit Model	- Trade / GDP - External debt / GDP - Offřcial debt / total debt - Credit IMF / export - Credit to private sector / GDP
Detragiache et Spilimbergo (2001)	1970-1998	69 countries (for which data is available)		<ul> <li>* Liquidity Variables</li> <li>- Share of ST debt</li> <li>- Debt coming to maturity</li> <li>- foreign exchange</li> <li>reserves</li> <li>* Characteristics of</li> <li>Debt</li> <li>- Total debt</li> <li>- Interest Rate</li> <li>* Macroeconomic</li> <li>Variables:</li> <li>- Current Account</li> <li>Balance</li> <li>- IDE</li> <li>- Revenue Growth</li> <li>- Growth in loans.</li> <li>- Trade Openness</li> </ul>
Ciarlone et Trebeshi (2005)	1980-2002	28 emerging countries	Multinomial Logit	* Macroeconomic Variables: -Interest on external debt / international reserves. - Total External Debt / GDP. - GDP Growth. - ST-debt / total external debt Total Private capital flows / GDP. -Annual inflation. -International reserves / total external debt.
Manasse, Roubini et Schimmelpfennig (2003)	1970- 2002	47 countries that have access to international markets	-Modèle Logit /Arbre de régression (CART)	* External debt variables -ST-external debt / reserves -Interest on external debt (% of GDP) -Services of the external debt / reserves -Total external debt (% of GDP) * Macroeconomic Variables - US treasury Bills -Real GDP Growth -FDI (% of GDP) - Trade openness Volatility of inflation- * Other variables: - Current Account Balance
Laušev et al (2011)	1990-2005	15 countries of Eastern Europe	Logit Panel model	<ul> <li>Total debt / GDP</li> <li>Exports / GDP</li> <li>Current account / GDP</li> <li>IDE</li> <li>Total Government expenditure</li> <li>Total Government</li> <li>expenditure</li> <li>Credit to private</li> <li>sector</li> <li>ST debt</li> <li>ST debt</li> <li>Bebt rescheduled - GDP Growth</li> <li>M2/reserves</li> <li>The ICRG</li> <li>Composite Index</li> </ul>

# Appendix 2: Potential explanatory variables in literature

## Variables and Data sources:

-	Variables	Main Sources
1	Total gross central government debt/PIB	Reinhart et Rogoff (2010)
2	Total gross external debt/ PIB	Reinhart et Rogoff (2010)
3	Inflation	Reinhart et Rogoff (2010)
4	FDI net inflows (% GDP)	WDI
5	Domestic credit to private sector (% GDP)	WDI
6	GDP growth (annual %)	WDI
7	Gross saving(% GNI)	WDI
8	Industry value added (% of GDP)	WDI
9	GDP per capita growth (% annual)	WDI
10	Current account balance (% of GDP)	WDI
11	General government revenues	WEO
12	General government expenses	WEO
13	Lending interest rate	IFS
14	Money market interest rate	IFS
15	Nominal effective exchange rate	IFS
16	Money and quasi money (M2) to total reserves	WDI
17	Depreciation(currency/USD)	IFS
18	Exports/GDP	IFS
19	Imports/GDP	IFS
20	Official exchange rate (Average) Per USD	IFS, GFD
21	Treasury Bills Yield (3 month maturity) (%)	IFS, GFD
22	Money stock M1 (million LCU)	IFS
23	Foreign exchange reserves(Million USD)	IFS
24	Growth of housing price (%)	Reinhart et Rogoff (2010)
25	Exchange rate (average)(per USD)	IFS/ GFD
26	Stock of total assets/GDP	IFS/ Lane & Milesi-Feretti (2010) / reinhart et rogoff (2010)
27	Government size	http://www.freetheworld.com/2008/2008Dataset.xls
28	CPI	IFS
29	Total reserves excluding gold	IFS
30	Net external position(% GDP)/ Net foreign assets (NFA)	Lane & Milesi-Feretti (2010)
31	Trade openness (percent of GDP)	Penn World Tables 7.0
32	Liquid liabilities (% GDP)	IFS
33	Central bank assets/ GDP	IFS
34	External debt stocks (% of exports of goods and services)	WDI
35	Government interest payments	EIU (Reinhart et Rogoff (2010))
36	Bank liquid reserves to bank assets ratio (%) (Million LCU)	WDI
37	Debt stock rescheduled (current US\$)	WDI
38	Debt forgiveness or reduction (current US\$)	WDI
39	Debt stock reduction (current US\$)	WDI
40	External debt stocks (% of GNI)	WDI
41	Short-term debt (% of total reserves)	WDI
42	Debt service ( % of exports)	WDI
43	Public debt	http://www;imf.org/rxternal/ns/cs;aspx?id=262
44	Financial openness	http://web.pdx.edu:~ito/chinn-ito_website.htm
45	Bank nonperforming loans to total gross loans (%)	WDI
46	Domestic credit provided by banking sector	WDI
47	Interest rate spread (lending rate minus deposit rate %)	WDI