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Financial crises management by the International Monetary Fund: Was external and public debt sustainable ?

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Abstract

The main contribution of this paper is to analyze whether the absence of restructuring programs during some financial crisis episodes was justified. In other words, was the countries' debt sustainable, allowing an intervention through only an IMF bailout ? Using a non- parametric methodology (Classification And Regression Tree or CART), the fiscal and the external solvency of countries facing financial troubles since the 80's was assessed. It is found that, in some crisis episodes, like the one faced by Argentina in 1995, Brazil in 1999 and Turkey in 2001, a debt restructuring plan was necessary while the countries clearly exhibited solvency problems. This can explain the inefficiency of the IMF intervention during some crises.

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1- Introduction

Over the last three decades, a significant surge of international financial crises has been noticed. This has raised the issue of the optimal way to intervene in order to prevent contagion.

Barkbu, Eichengreen & Mody (2012) have listed five main crisis episodes since the early 80's :

- The 80's Debt Crisis : Mexico, Chile, Argentina, Uruguay, Brazil, Philippines
- Tequila Crisis (94): Mexico, Argentina
- The Asian Crisis (97-98): Thaïland, Indonesia, Korea, Philippines
- The Russian Crisis and its contagion (98-01): Russia, Brazil, Argentina, Uruguay, Turkey
- The European Sovereign Debt Crisis (2008): Ukraine, Hungary, Iceland, Latvia, Romania, Greece, Ireland, Portugal

During these crises, the intervention took different forms: Restructuring (default, Debt restructuring, Policy adjustments…), IMF bailout or both.

But despite the changing in the crises' nature, we noticed a pic of IMF interventions in the early 80's. The institution has even created new lines since 2009, to cope with the crisis' nature : the Flexible Credit Line (Mexico, Poland, Colombia) and the Precautionary and Liquidity Line (Macedonia).

Alternatives to these emergency bailouts also exist: Sovereign Debt Restructuring Mechanism (SDRM), Collective Actions Clauses (CAC), Sovereign « Cocos » (Contingent Convertible Bonds) allowing to automatically reducing bonds payments in case of debt sustainability problems.

According to the table below, 60% of crisis' episodes were managed without any restructuring plan (exclusively IMF lines): Mexico and Argentina (Tequila crisis), Thailand, Korea and Indonesia (Asian crisis), Brazil and Turkey (Russian crisis), Ukraine, Hungary, Iceland, Latvia, Romania, Ireland and Portugal (European crisis). During the last European crisis, only one restructuring plan has been observed (Greece).

Table 1- Debt Restructuring and IMF Programs during financial crisis

	Restructuring	IMF Financing
Debt Crisis		
Mexico	1	1
Chile	1	1
Argentina	1	1
Uruguay	1	1
Brazil	1	1
Philippines	1	1
Total	**6**	**6**
	100%	**100%**
Tequila Crisis		
Mexico	0	1
Argentina	0	1
Total	**0**	**2**
	0%	**100%**
Asian Crisis		
Thailand	0	1
Indonesia	1	1
Korea	0	1
Philippines	0	1
Total	**1**	**4**
	25%	**100%**
Russian Crisis and Contagion		
Russia	1	1
Brazil	0	1
Argentina	1	1
Uruguay	1	1
Turquie	0	1
Total	**3**	**5**
	60%	**100%**
European Crisis		
Ukraine	0	1
Hungary	0	1
Iceland	0	1
Latvia	0	1
Romania	0	1
Greece	1	1
Ireland	0	1
Portugal	0	1
Total	**1**	**8**
	13%	**100%**

Note that the crisis management depends on its nature. Before lending liquidity, the IMF must indeed assess country's eligibility to a loan. According to recent literature, assessing eligibility is a condition for the efficiency of the official sector's intervention: it includes external, fiscal and financial sustainability. These conditions, called ex ante conditionality, needs eligibility rules in order to help the IMF to distinguish between illiquid and insolvent countries. These rules have to be quantitative, like Maastricht ones, in order to speed bailout, a prerequisite for the efficiency of a loan of last resort.

But the notion of sustainability has to be distinguished from those of liquidity and solvency.

According to the academic definition of debt sustainability, "Debt is sustainable if the intertemporal solvency condition is satisfied, that is, if the expected present value of future primary balances covers the existing stock of debt". According to the IMF, "Debt is sustainable if the country (or its government) does NOT, in the future, need to default or renegotiate or restructure its debt or make implausibly large policy adjustments"

We define an entity as liquid if, regardless of whether it satisfies the solvency condition, its liquid assets and available financing are sufficient to meet or roll-over its maturing liabilities. The Debt Burden is assessed by examining the projected evolution of a set of debt burden indicators over time.

Debt Sustainability Assessment (DSA) has been recently developed by the IMF (2002): it consists in a framework to assess a country's public and external sustainability. However, the assessment needs projections. Projected trajectory and the level of debt should be based on realistic assumptions about the underlying macroeconomic variables. The resulting gross financing needs have to be evaluated and the market perception of the sovereign risks has to be factored in based on debt maturity structure, its currency composition, its creditor base, etc

It turns out that the debt sustainability is hard to assess since it is based on future scenarios and the aim of this study is to assess countries' sustainability is the past (the 80's, the 90's and the early 2000). This is why we won't use sustainability to assess the nature of crisis in this paper but rather solvency.

Indicators often used to assess a country' solvency are in general ratios of the debt stock (or debt service) relative to what we define as measures of the ability to service debt (repayment capacity), like GDP, export proceeds, fiscal revenue…or by looking at the gross financing needs, the amount of financing necessary to cover the deficit plus amortization of debt, either in level or scaled by the above measures.

Thresholds are then calculated to serve as early warning signals. The signal approach methodology aims to find the level of an indicator that best predicts a debt crisis based on past experience (IMF, DSA). The signal warning benchmarks are derived by minimizing the type I (false alarms) and Type II errors (missed crises). For any given threshold X, a signal is considered to have been sent if the indicator in that year is greater than X (see Appendix A).

These are the benchmarks obtained by the IMF when conducting its DSA.

Table 2- Signal Approach- Benchmarks for Emerging Countries

Debt Burden Indicators	Indicative Benchmarks
Gross government Debt (% GDP)	**60**
Gross Public Sector Financing Requirements (% GDP)1	**15**
Debt Profile Indicators	
EMBI Global spreads (basis points)	**800**
External Financing Requirements (% GDP)	**20**
Public Debt in foreign currency (share of total)	**80**
External Debt/ GDP	**70**
Annual Change in the share of short term public debt at original maturity	**1,5**
Additional Analysis	
3-year cumulative primary balance adjustment (%GDP)	**2**
Coefficient of variation of growth	**1**

1: Current account balance plus amortization of short term external private and public debt at remaining maturity

The main disadvantage of a signal approach framework is its inability to capture interactions between variables. In other words, a solvency problem becomes more likely as the number of fragilities increases (Kaminsky, 2006). For example, high debt leads to a further deterioration of the country's solvency if accompanied by a high inflation rate. In this paper, a different methodology allowing for ex-ante unknown non-linearities is used. Classification and Regression Tree (CART) methodology is used here to identify potential non- linear interactions between explanatory variables. The obtained tree classifies observations into two categories: "crisis- prone" (if default probability is higher than the sample average, i.e 39.71%) and "not crisis prone" (see Table 3). The features of final nodes will allow us to classify crises episodes into liquidity or solvency ones. Then we will compare our results with the actual bailout set up then to manage the crisis (restructuring, IMF bailout or both).

2- The Model and Data: Using CART Methodology for the Determination of External, Fiscal and Financial Vulnerability Thresholds

To identify the possible multiple varieties of crises, a regression tree analysis was conducted. The regression tree, a data mining concept, is nowadays a popular tool of information management. It's commonly used in many fields where decision taking is very important, mainly finance (credit scoring), loans management and financial forecasts.

A classification and regression tree is a structure with the form of a tree, splitting a set of input observations, on the basis of certain features, into narrower sets. A decision tree stocks certain classification rules into branches nodes, in order to gather similar observations of the sample in the same node (or leaf).

CART has the advantage of intercepting all interaction effects existing between the different variables, mainly when such interactions represent very important determinants of crises occurrence. CART takes into account the non-linearities and the complementarity of explaining variables.

This methodology has been recently used to detect companies failures (Williams, De Silva, 1991 ; Hung and Chen, 2009) ; to intercept debt crises (Iscanoglu, Weber and Taylan, 2007 ; Manasse P, Roubini N. and Schimmelpfenning A., 2003), to classify financial crises (Kaminsky, 2006) to assess credit markets (Gabbi, Bocconi, Matthias and De Lerma, 2006), for credit scoring (Kočenda and Vojtek, 2009)….

This technique allows searching for an unknown number of sample splits using multiple indicators. As in the conventional signal approach, the algorithm first chooses thresholds for each indicator to minimize its noise-to-signal ratio. All observations are then separated into two groups: those for which the chosen indicator is signaling and those for which the indicator is not signaling. For each group, the methodology is repeated. Again, for each of the remaining indicators, new thresholds are selected to minimize the noise-to-signal ratio. The threshold that converts a fluctuation of an indicator into a signal of an upcoming crisis is conditioned on the selection of the first indicator and its threshold. This allows finding complementarities between variables. This process continues, classifying observations into more tightly defined groups.

The data of 41 emerging countries is used for the period 1975- 2014. The debt crisis indicator is obtained from data provided by Standard and Poor's as well as IMF lending Arrangements. A country is defined to be in debt crisis if it is classified as being in default by Standard and Poor's, or if it has access to non concessional IMF financing in excess of 100% of quota (Manasse, Roubini and Schimmelpfennig, 2003). The definition of debt crisis is used because it represents the insolvency of a country that should be distinguished from the illiquidity one. The intervention of the IMF is in fact effective only in case of liquidity problems.

According to Standard and Poor's, a country is defined to be in default if the government fails to pay the principal and the interests of external bonds on due date. This definition shouldn't capture "quasi- defaults", i.e cases when defaults were prevented thanks to an adjustment program and a large financial package from the IMF (Manasse, Roubini and Schimmelpfennig, 2003). Therefore, information with data on IMF non concessional lending from the IMF's Finance Department1 have been completed. Information collected is mainly related to loans approved, approval dates and the actual disbursements of the loans.

Hence, the definition of a debt crisis includes actual defaults on debts, recorded by Standard and Poor's as well as defaults that were prevented through a "substantial" financial support from the IMF. For Manasse & al., an IMF "substantial" loan is the one exceeding 100% of the country's quota. According to this definition, sixty- five (65) crisis episodes were identified.

The choice of the explanatory variables is based on Sustainability Geithner framework (2002). These variables allow the study of external and fiscal sustainability as well as the soundness of financial sector (see Appendix B).

The dataset includes information on 41 emerging economies with market access for the period 1975 to 2014. The results of the regression tree are shown in the Figure below, the oblongs show the various criteria dividing the sample while the squares are the final groups of

[1] Mainly Stand- By Arrangements (SBA) and Extended Fund Facility (EFF) lending.

homogenous observations. The tree algorithm classifies all observations into 17 final groups or *nodes*. Only eleven indicators are used to catalogue all observations: Debt/ Exports; Debt/ GDP; Inflation rate; Short term debt/ foreign reserves; Real GDP; Short term Interest payments/ GDP; M2/ GDP; US Interest rates; private credit growth; Public Debt/ GDP; Debt Service/ foreign reserves. Variables belonging to the three sustainability levels are found, i.e external, fiscal and financial, as well as macro- economic variables, like growth and inflation rates.

3- Results and Interpretation

Results are shown in the figure below:

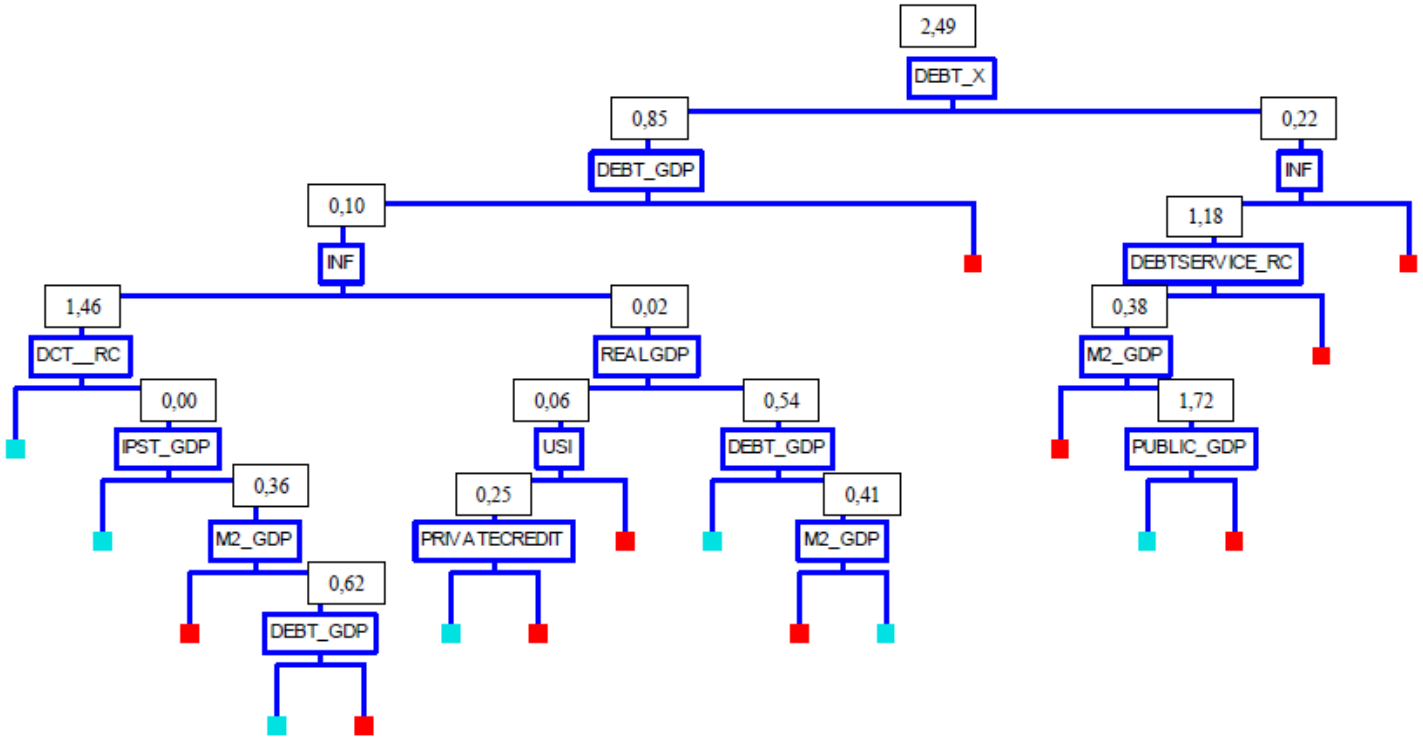

Figure 1- Classification and Regression Tree of Debt Crises

As shown in the Figure 1, the first split is based on the Debt/ Exports ratio, indicating that debt is the most important signal of a forthcoming crisis, with the lowest noise-to-signal ratio of all 11 indicators (see Appendix A). Then, those observations with a debt/ exports ratio exceeding 2.49 are classified on the right, those lower than 2.49 on the left. For those observations with a low debt ratio, the groups are further split on the basis of Debt/ GDP ratio; Inflation rate, Short term debt/ Foreign Reserves ratio; Short term Interest Payments/ GDP ratio; M2/ GDP ratio; Real GDP growth; US Interest rate; Private credit growth; Debt service/ Foreign reserves ratio; Public Debt/ GDP ratio and Debt Service/ Foreign Reserves ratio.

The first classification criterion divides our sample into two branches:

1- Episodes with substantial external debt, i.e exceeding 2.49 times the GDP. These episodes are classified on the right of the tree. The average probability of default reaches here 64.58% versus 39.71 for the whole sample;

2- Episodes with lower external probability are classified on the left of the tree with a default probability falling to 29.34%.

Table 3- Nodes' Classification

Nodes	Default Probability	Crisis prone (NO if Default Probability > 39.71%)
N1	3.2%	NO
N2	0%	NO
N3	72%	YES
N4	2.4%	NO
N5	47.10%	YES
N6	3.30%	NO
N7	36.70%	NO
N8	63%	YES
N9	12.20%	NO
N10	45.90%	YES
N11	5.90%	NO
N12	60.40%	YES
N13	53.30%	YES
N14	4%	NO
N15	100%	YES
N16	81%	YES
N17	84.60%	YES

According to nodes' features (Appendix B), the nodes 15, 16 and 17 seem to be the "perfect" combination for debt crisis occurrence. A high public debt, combined with a substantial external debt and an expansionary monetary policy (Node 15) leads inevitably to a default. Node 17 is associated with high inflation (more than 20%) and an external debt/ exports ratio exceeding 2.49. This level of external debt is also observed for node 16, combined moreover with a high service debt (exceeding 1.18 time the foreign reserves).

Admittedly, the external debt level is huge for the three nodes (observations classified on the right). But the default seems to be imminent when debt problems are associated with fiscal or/ and financial problems (node 15) or bad fundamentals like a high inflation rate

(node 17). Even if an inflation rate exceeding 2% is not necessarily alarming, its interaction with a very high debt level can lead to default.

On the other hand, even a moderate debt level can lead to default. Node 3 is classified on the left of the tree (with a low debt ratio). However, it is associated with a very high default probability (72%). Here, the vulnerabilities come from liquidity problems, i.e a short term debt exceeding the foreign reserves associated with high short term interest payments.

Node 5 is also classified on the left of the tree. However, it is associated with a quite high crisis probability (47%). In this case, crises are mainly due to liquidity problems (high debt and short term interest payments) combined with a monetary expansion and a very high external debt (exceeding 62% of the GDP). Similarly, crises classified in Node 8 mainly come from high inflation, low economic growth and high foreign interest rates.

Thereby, observations were classified into "crisis- prone" and "not- crisis prone" ones. To do so, the default probability for the whole sample is assessed (39.7%). Then, observations of a particular node are classified as "crisis prone" (if its default probability exceeds the sample's one); or "not crisis prone" otherwise.

3-1 Classification of Nodes :

The 17 nodes can be classified into groups. First, two main groups should be distinguished: "crisis prone" and "not crisis prone" nodes (Table 3). The first bloc can be broken up into three sub- groups: relatively sound nodes, nodes with liquidity problems and nodes characterized by solvency problems. The classification of Manasse, Roubini and Schimmelpfennig is indeed taken up (2003) since it will help us to capture situations where IMF intervention would be optimal.

3-1-1 First Group of Nodes : Relatively sound fundamentals:

It consists in nodes classified as "not crisis prone", i.e nodes 1, 2, 4, 6, 7, 9 11 and 14. Except for the Node 14, all observations classified in this group are associated with a moderate external debt, in terms of exports and GDP (respectively less than 2.49 and 0.85). Nodes 1, 2 and 4 are associated with a very low inflation rate (less than 10%), combined with a reasonable short term debt (less than 1.46 of foreign reserves) for the Node 1, with low short term interest payments for Node 2, and even an external debt ratio lower than 62% of GDP (Node 4). Otherwise, and even Node 7 suffers from inflation problems, interaction with low interest rates (less than 6%) and limited private credit growth (less than 25%) has offset the negative effect of high inflation and weak growth (lower than 2%). Similarly, Node 9 takes advantage from a quite high growth rate and an external debt lower than 54% of the GDP.

Node 14 seems to be an exception, in that it consists in the only group whose external debt is huge (more than 2.49 times the exports). However, the node 14 is not classified as « crisis prone ». In fact, only 4% of observations belonging to this node represent crisis episodes. This situation shows that a moderate inflation, associated with low debt service and weak long term public debt (in terms of GDP) appears to be sufficient to prevent crises, even if external debt is huge.

3-1-2 Second Group of Nodes : Liquidity problems

It consists of observations classified within Nodes 3 and 5. In spite of moderate debt ratios, in terms of exports (less than 2.49) and GDP (less than 85%), the high level of short term debt in terms of GDP (more than 1.46) as well as short term interest payments exceeding the computed threshold have considerably increased crisis probability to 72% for Node 3.

3-1-3 Third Group of Nodes : Solvency Problems :

This group is partly represented by Nodes 13, 15, 16 and 17, i.e all observations which external debt exceeds 2.49 times the exports (on the right of the tree except for Node 14). All these nodes are associated with extremely high default probabilities, 80% in average (versus nearly 40% for the whole average). This high level is due to the interaction between high debt ratios (Node 13), monetary expansion associated with high long term public debt (Node 15), a high service debt (Node 16) or an unbridled inflation (Node 17).

However, Nodes 10 and 12, on the left of our classification tree, are also associated with solvency problems: an external debt ranging from 54% to 85% combined with an inflation rate exceeding 10% (Node 10); and an external debt in excess of 85% of GDP (Node 12).

For both nodes, the external debt ratio in relation to exports remains under the threshold (2.49). However, the use of this ratio is questionable because of problems related to exports valuation. Hence, Debt/ Exports ratio can be under- estimated simply because of hikes in global prices, which can be only temporary, and this despite of the presence of high external debt levels.

3-1-4 Fourth Group of Nodes : Pure Macro- economic problems :

Node 8 does not exhibit any evident vulnerability due to liquidity or solvency problems. However, node 8 is associated with a high default probability (68%) and classified hence as “crisis prone”. External debt is inferior to computed thresholds, but interaction with high inflation rate (more than 10%), a weak economic growth (less than 2%) and high American interest rates (exceeding 6%) may lead to a crise.

***3-2: The Historical Record*:**

The next step is to classify the major crises episodes according to their nature (solvency/liquidity) using the nodes features we got from the Classification Tree.

3-2-1 The 80’s Debt Crisis :

All episodes have been managed through IMF lines and restructuring programs. Using our CART methodology, one can notice that these crisis episodes showed solvency problems (Nodes 10, 12, 13, 16, 17). Restructuring was hence unavoidable to guarantee the bailout success. Even if macroeconomic fundamentals have been sometimes relatively sound (Mexico from 80 to 83, Uruguay in 82 and 83, Brazil in 90 and Philippines from 80 to 82), debt levels were quite high, exceeding sometimes 2.49 times national exports (Mexico, Uruguay and Philippines).

Table 4- Debt Crisis

Crisis	Country	Timing of Crisis	Node	Crisis Nature	Restructuring ?	Date of Restructuring
Debt (80's)	Mexiso	February 82	N14 (80 to 83)	Sound but High Debt	Yes	83 to 89 & 90
			N13 (84 to 88)	**Solvency**		
			N16 (87)	**Solvency**		
	Chile	June 82	N12 (80)	**Solvency**	Yes	85 to 90
			N13 (81)	**Solvency**		
			N17 (82)	**Solvency**		
			N16 (83 to 88)	**Solvency**		
	Argentina	82 & 89	N10 (80 to 83)	**Solvency**	Yes	85 to 92 & 93
			N13 (84)	**Solvency**		
			N10 (85 to 88)	**Solvency**		
			N16 (89)	**Solvency**		
	Uruguay	November 82	N1 (82)	Sound Fundamentals	Yes	83 to 91
			N5 (79 to 81)	**liquidity**		
			N14 (83)	Sound but High Debt		
			N16 (84)	**Solvency**		
	Brazil	January 90	N13 (89)	**Solvency**	Yes	83 to 89 & 94
			N9 (90)	Sound Fundamentals		
			N13 (91)	**Solvency**		
			N10 (80 & 88)	**Solvency**		
	Philippines	October 83	N14 (80 to 82)	Sound but High Debt	Yes	84 to 94
			N16 (83 to 91)	**Solvency**		

3-2-2 Tequila Crisis:

During both episodes of the Tequila crisis (Mexico in December 94 and Argentina one month later), the bailout has been achieved only through an IMF financing, without any restructuring program. This type of bailout turns out to be efficient in case of liquidity problems. Unlike the Debt crisis, our results show that this was not the case for Argentina. While liquidity problems seem to be the only cause triggering the crisis in Mexico, Argentina suffered from solvency difficulties from the early 90's (Node 10). This shows that contagion from Mexico was not behind Argentina crisis in January 90, the country clearly exhibits high debt levels combined with an inflation rate exceeding 10%. Note that Argentina was hit by a

debt crisis in 2001. Perhaps this could have been prevented if a restructuring program has been put in place during Tequila crisis.

Table 5- Tequila Crisis

Crisis	Country	Timing of Crisis	Node	Crisis Nature	Restructuring ?
Tequila	Mexico	December 94	N5 (94 & 96)	**liquidity**	No
			N6 (95 & 97)	Sound Fundamentals	
	Argentina	January 95	N10 (90 to 97)	**Solvency**	No
			N14 (98 to 2000)	Sound but High Debt	

3-2-3 Asian Crisis:

Four countries were hit by Asian crisis (Thailand, Indonesia, Korea and Philippines). Since our study focuses only on emerging markets, Korea is out of our sample. Only Indonesia has been bailout using a restructuring plan. Our results show that the country was indeed the only one experiencing high debt levels exceeding 85% of the GDP (node 12 in 96 and 97) and a high debt service.

Table 6- The Asian Crisis

Crisis	Country	Timing of Crisis	Node	Crisis Nature	Restructuring ?	Date of Restructuring
Asian	Thaïland	July 97	N6 (75 to 97)	Sound Fundamentals	No	
	Indonesia	December 97	N13 (90 to 95)	**Solvency**	Yes	98 to 2000
			N12 (96 & 97)	**Solvency**		1999 and 2000
			N16 (98 to 2002)	**Solvency**		
	Philippines	December 97	N6 (95 to 98 & 2001)	Sound Fundamentals	No	

3-2-4 Russian crisis and Contagion:

For Argentina, two rounds of debt treatments were negotiated in 2001 and a global bond exchange offered in 2005.The Default was announced in November 2001. This was an obvious income of deep solvency problems, especially high debt levels and huge debt services. The same goes for Uruguay which faced the same type of solvency problems from the early 2000's (nodes 14 and 16). A single global bond exchange was put in place in 2003 in response. However, Brazil and Turkey seem to suffer from the same type of difficulties, from 1991 to 2003 and from 2001 and 2002 respectively. No restructuring programs have been implemented in both countries. The crisis was managed through exclusively IMF credit lines.

While recovery occurred a few months after the bailout in Brazil, Turkey experienced many difficulties before managing to get out the crisis.

Table 7- The Russian Crisis and Contagion

Crisis	Country	Timing of Crisis	Node	Crisis Nature	Restructuring ?	Date of Restructuring
Russian & Contagion	Brazil	January 99	N13 (91 to 2003)	**Solvency**	No	
	Argentina	December 2011	N14 (98 to 2000)	Sound but High Debt	Yes	2001 & 2005
			N13 (2001)	**Solvency**		
			N16 (2002 & 2003)	**Solvency**		
	Uruguay	July 2002	N14 (2000 & 2001)	Sound but High Debt	Yes	2003
			N16 (2002)	**Solvency**		
	Turkey	February 2001	N14 (99 & 2000)	Sound but High Debt	No	
			N16 (2001 & 2002)	**Solvency**		
			N11 (2003)	Sound Fundamentals		

4- Conclusion

In this paper, we used a Regression Tree method to classify the major financial crises from the early 80's. The classification was made according to the nature of crises: solvency *versus* liquidity. This classification allows one to find the optimal way to manage crises. Restructuring is indeed required in case of solvency problems while IMF lines turn to be efficient in case of liquidity vulnerabilities.

It is found that, in some crisis episodes, like the one faced by Argentina in 1995, Brazil in 1999 and Turkey in 2001, a debt restructuring plan was missing while the countries clearly exhibited solvency problems. This can explain the inefficiency of the IMF intervention during some crises.

However, the determination of a crisis nature, which seems to be critical to set up the adequate bailout program (default, restructuring, IMF financing…) is not straightforward: it seems far to be a simple technical thresholds calculus. First, the nature of lenders (public, private) has to be detailed. The same goes to the debt instruments used by the country (bonds, bank credit lines…). Then, one has to focus on the level of the private involvement in the country, especially banks one, in order to determine the optimal degree of IMF interventions.

Finally, one interesting way to use thresholds in assessing the solvency of countries is to derive country specific thresholds, i.e thresholds for each country and not for a group of countries (in our case, the thresholds are the same for all the emerging countries of our sample).

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Appendix A: Signal Approach Methodology and Indicative Benchmarks (Kaminsky, Reinhart, 1999)

The definition of noise-to-signal ratio used throughout is best illustrated by considering the following two-by-two matrix:

	Crisis occurs in the following 24 months	No crisis occurs in the following 24 months
Indicator issues a signal	*A*	*B*
Indicator does not issue a signal	*C*	*D*

If a variable signals and a crisis occurs in the following 24 months (counted in cell A) the signal is considered accurate. If a variable signals and no crisis occurs in that time frame (counted in cell B), the signal is said to be a false alarm or noise. Hence, a perfect indicator would only have entries in cells A and D. More generally, the noise-to-signal ratio for any indicator is given by the number of entries in [B/(B 1 D)]/[A/(A 1 C)]. Hence, it is the ratio of false signals to all possible bad signals divided by the ratio of good signals to all possible good signals. An extremely noisy indicator would have few entries in A and D, many in B and C.

Appendix B- Variables used in CART methodology

Variables	Source
I-External Sustainability:	
Total External Debt / Exports (DEBT_X)	GDF
Total External Debt / GDP (DEBT_GDP)	GDF
Debt Service/ GDP (DEBTSERVICE_GDP)	GDF
Debt Service / Foreign Reserves (DEBTSERVICE_RC)	GDF and WDI
Short Term Interest Payments / GDP (IPST_GDP)	GDF and WDI
Short Term Debt/ Foreign Reserves (DCT_RC)	GDF and WDI
Exports (EXPORTS)	GDF
Current Account / GDP (CURRENT)	GDF and WDI
II- Fiscal Sustainability:	
Fiscal Deficit / GDP (FISCALCASH)	GFS
PPG/ PIB (PPG_GDP)	GDF
Public/ PIB (PUBLIC_GDP)	
III- Financial Sector Soundness :	
Credit to private sector (PRIVATECREDIT)	*IFS* line 22D / GDP (WDI)
M2/ GDP (M2_GDP)	*WDI*
M2 Multiplier (MULTIM2)	IFS lines (34+35) /IFS line 14
Bank Deposits (DEPOSITS)	IFS lines (24+25) /IFS line 64
Domestic Credit / GDP (DOMESTIC)	(IFS line 52 / IFS line 64) / IFS line 99
IV- Macroeconomic Variables :	
Domestic Currency Overvaluation (TCR)	Real Exchange Rate deviation from HP (*Hodrick-Prescott*) filter
International interest rates (USI)	IFS line 60 / IFS line 64
Real GDP growth (REALGDP)	WDI
Inflation rate (INF)	IFS line 64

Appendix C: Nodes' Features

Nodes	Features	Sound Fundamentals	Liquidity Problems	Solvency Problems	Fiscal, Exchange, Macro Risks
1	Low Short term Debt <= 1,46	*			
	Moderate Inflation <= 0,1				
	Low Debt level (Debt/ GDP<= 0,85)				
	Low Debt / Exports <= 2,49				
2	Low short term interest payments (<= 0,00152)				
	High short term debt > 1,46		*		
	Moderate Inflation <= 0,1				
	Low Debt level (Debt/ GDP<= 0,85)				
	Low Debt / Exports <= 2,49				
3	Low M2/GDP <= 0,36				
	High short term interest payments > 0,00152				
	High short term debt > 1,46		*		
	Moderate Inflation <= 0,1				
	Low Debt level (Debt/ GDP<= 0,85)				
	Low Debt / Exports <= 2,49				
4	LOW Debt/ GDP <= 0,62				
	High M2/GDP > 0,36				*
	High short term interest payments > 0,00152				
	High short term debt > 1,46		*		
	Moderate Inflation <= 0,1				
	Low Debt / Exports <= 2,49				
5	**High M2/GDP > 0,36**				*
	High short term interest payments > 0,00152				
	High short term debt > 1,46		*		
	Moderate Inflation <= 0,1				
	0,62< High Debt/ GDP <= 0,85			*	
	Low Debt/ Exports <= 2,49				
6	Low private credit <= 0,25				
	Low US interest rates <= 0,06				
	Low Real GDP Growth <= 0,02				*
	very High Inflation > 0,10				
	Low Debt/ GDP <= 0,85				
	Low Debt/ Exports <= 2,49				
7	**High Private Credit > 0,25**				*
	Low US interest rates <= 0,06				
	Low Real GDP Growth <= 0,02				
	very High Inflation > 0,10				

	Low Debt/ GDP <= 0,85		
	Low Debt/ Exports <= 2,49		
8	**High US interest rates > 0,06**		*
	Low Real GDP Growth <= 0,02		
	Very High Inflation > 0,10		
	Low Debt/ GDP <= 0,85		
	Low Debt/ Exports <= 2,49		
9	Low Debt/ GDP <= 0,54		
	High Real Growth Rate > 0,02		
	Very High Inflation > 0,10		*
	Low Debt/ Exports <= 2,49		
10	Low M2/ GDP <= 0,41		
	High Real Growth Rate > 0,02		
	very High Inflation > 0,10		*
	0,54< High Debt/ GDP <= 0,85	*	
	Low Debt/ Exports <= 2,49		
11	**High M2/ GDP > 0,41**		*
	High Real Growth Rate > 0,02		
	very High Inflation > 0,10		
	0,54< High Debt/ GDP <= 0,85	*	
	Low Debt/ Exports <= 2,49		
12	**Very High Debt/ GDP > 0,85**	*	
	Low Debt/ Exports <= 2,49		
13	Low M2/ GDP <= 0,28		
	Low Debt Service / Reserves <= 1,18		
	Inflation <= 0,20		
	Very High debt/ Exports > 2,49	*	
14	Low Public sector/ GDP <= 1,72		
	High M2/ GDP > 0,28		*
	Low Debt Service / Reserves <= 1,18		
	Inflation <= 0,20		
	Very High debt/ Exports > 2,49	*	
15	**Very High Public sector/ GDP > 1,72**	*	
	High M2/ GDP > 0,28		*
	Low Debt Service / Reserves <= 1,18		
	Inflation <= 0,20		
	Very High debt/ Exports > 2,49		

16	**Very High Debt Service / Reserves > 1,18**	*	
	Inflation <= 0,20		
	Very High debt/ Exports > 2,49		
17	**Very High Inflation> 0,20**		*
	Very High debt/ Exports > 2,49	*	