Predicting a debt crisis in Selected Caribbean Countries

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Abstract

Within recent years, the incidence of debt default and debt restructuring has increased significantly, notably in countries such as Russia, Pakistan, Argentina and Ecuador. Even more recently, countries of the Caribbean have been affected and three Caribbean countries have embarked on debt restructuring programmes: the Dominican Republic in May 2005, Grenada in September 2005 and Belize in January 2007. Thus, the issues of debt, debt-carrying capacity, debt crisis and debt restructuring have once again become of critical concern in the Caribbean region. A debt crisis can have severe consequences for an economy; if only because there are many negative consequences of a debtor country’s inability or reluctance to repay its creditors. In this paper, we evaluate the usefulness of the Manasse-Roubini Binary Recursive Tree and the ‘Rules of Thumb’ derived from it in predicting a debt crisis in six Caribbean countries and we also apply a pooled logit model to a panel of data from the six Caribbean countries in order to predict the incidence of sovereign debt crises. In both empirical approaches, a country is deemed to be in debt crisis if it is classified as being in default by Standard and Poor’s or if it receives a large non-concessional International Monetary Fund loan.

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Introduction

Within recent years, the incidence of debt default and debt restructuring has increased significantly, notably in countries such as Russia, Pakistan, Argentina and Ecuador. Even more recently, countries of the Caribbean have been affected and three Caribbean countries have embarked on debt restructuring programs – the Dominican Republic (DR) in May 2005, Grenada in September 2005 and Belize in January 2007. Thus, the issue of debt and debt-carrying capacity has become a critical concern in the region.

The Caribbean, historically, has been plagued by excessively high debt burdens. Most of the small islands of the region are currently ranked in the top 15 most indebted emerging markets in the world and many Caribbean economies are struggling with the adverse impact of multiple shocks, for which they are not fully prepared. Some shocks are external and permanent – falling aid flows, erosion of preferential trade agreements for sugar and bananas, and interventions related to drug-trafficking and money laundering. Other external shocks, though not permanent, are known to wreak havoc, for instance high oil prices and rising global interest rates. Other shocks are domestic – intractable unemployment and poverty as well as a rising incidence of HIV/AIDS. Added to this mix is the marked frequency of natural disasters, especially hurricanes and floods, which often derail growth and impose substantial costs. All these phenomena have the potential to impose significant costs to government and place additional pressure on the fiscal accounts, further limiting fiscal flexibility and worsening the region’s debt profile.

Figure 1 below shows that the average public sector debt-to-GDP ratio in the Caribbean in 2007 was at an unsustainable 92%, with Guyana, Jamaica, Antigua and Barbuda and Grenada well in excess of 100%. At the end of 2007, Guyana’s public sector debt was estimated at 132% of GDP, more than 3 times that of Trinidad & Tobago, while St Kitts and Nevis has the highest level of debt in the Caribbean at close to 180% of GDP. (IMF 2007)
The subject of debt crisis and debt restructuring became very topical in the last two decades or so, when occurrences increased in number as well as in severity. The area of study is especially important as debt crisis and debt restructuring may have severe repercussions on the entire economy. The issue of debt crisis is wide ranging and can encompass several ideas. Debt crisis can have severe implications for the economy. There are many consequences of a debtor country’s inability or reluctance in repaying its creditors.

The rest of the paper proceeds as follows. Some stylized facts about Caribbean indebtedness and related issues are given in the following section. This is followed by some theoretical considerations about indebtedness, which in turn is followed by an outline of the methodology and data used in the paper. The results from the empirical exercises then follow, after which the paper is concluded.
Stylized Facts
This portion of the paper will examine the fiscal stance and the debt profile of six selected Caribbean countries: Barbados, Belize, the Dominican Republic, Grenada, Jamaica and Trinidad & Tobago. Among other factors, a country’s debt profile is crucial in determining whether or not it can repay its interest and principal obligations.

Barbados has long suffered high debt levels, consistently above the Latin America and Caribbean averages. About 75% of the country’s total public debt is domestic and denominated in domestic currency, which makes Barbados much less vulnerable to a possible debt crisis than countries with similar levels of debt but a larger share of external debt and debt denominated in foreign currency. The fiscal deficit is estimated to come in around 1.7% of GDP in 2005/2006, below the fiscal deficit of 2.6% of GDP in the previous year. By further controlling off-budget spending, the government can bring the overall fiscal deficit to near balance and so share the burden in tempering the strong expansion of domestic demand. Barbados’ fiscal flexibility is one of the most constraining factors to the country's credit rating. At 80% of GDP, the general government debt is at an unsustainably high level and could become increasingly incompatible with the fixed exchange rate system. In 2007, the country was rated by Standard and Poor’s as BBB+ (investment grade), which reflects the improvements that the government has made in the recent past, following the completion of the World Cup Cricket tournament. Barbados’ external accounts are highly susceptible to adverse external shocks, which have the potential to reduce the country’s foreign exchange earning capacity and place undue pressure on the external liquidity. International reserves are likely to increase to about US$750 million by the end of 2007 largely reflective of improvements in the current account balance and continued large foreign direct and equity inflows.

Belize’s external debt increased steadily in the first half of the 1980s moving from 25% of GDP in 1980 to 50% in 1985. It subsequently fell over the 1985–1993 period to 30% of GDP. Until the late 1990’s, most of Belize’s external debt was held by official creditors and a large share of it was bilateral debt. Belize’s debt-to-GDP ratio went from around 60% in 2000 to more than 95% in 2004. Due to fiscal mismanagement and poor economic policies, the country’s fiscal balances deteriorated rapidly, as the government racked up huge deficits on the fiscal accounts, and financing requirements started to soar, all in the context of a falling stock of foreign reserves. This forced the government to restructure its stock of debt in late 2006. The government officially
announced in August 2006 its intention to seek debt relief on its approximately US $1 billion outstanding external debt. The credit rating on Belize was upgraded to ‘B’ from ‘SD’ following the successful debt restructuring exercise by the government. Back in 2000, major infrastructure and capital projects in Belize, as well as private-sector capital import, resulted in a sharp rise in the country’s current account deficit as it pushed the trade deficit wider with the increase in the imports, particularly capital imports. The external accounts started a promising recovery since 2006, with the current account deficit improving significantly, being supported by developments in the real economy. Large gains from the nascent oil sector and growing tourism receipts helped to strengthen current account receipts to 72% of GDP in 2006 from 62% in 2005. External liquidity pressures have also subsided somewhat owing to the improvements in the current account and the amortization profile. The external financing gap decreased to about 123% of usable reserves.

The Dominican Republic’s stock of external debt mushroomed during the 1980s, increasing from 15% of GDP in 1980 to 70% of GDP by 1985. This was largely as a result of large swings in the value of the Dominican peso. The trend was reversed in the 1990’s, when the country’s external debt started to decline, and by 2000, it reached a minimum of 18% of GDP. During the period 1982 -1994, the Dominican Republic was in default. A Brady Swap implemented in 1993 helped to reduce foreign bank debt from 13% of GDP to 1% of GDP in 1994. The fiscal accounts and debt profile of the Dominican Republic have improved significantly since the crisis of 2003. The government has implemented important reform measures, which will improve the general government fiscal balances even further. The authorities have adhered strictly to the conditions set out in the IMF’s Stand-By Agreement with the country, which has now expired and was not renewed. Dominican Republic is rated as B+ with a negative outlook based on weakening fundamentals and increased concerns about the role of the IMF and the impact on fiscal policies.

Coming out of the financial crisis in 2003 and with modest economic expansion in 2004, the balance of payments current account ended the year with a surplus of US$1.40 billion, equivalent to 8.1% of GDP, as imports rose 21% in the final quarter of the year. Gross international reserves stood at US$824.8 million at the end of 2004, while net reserves closed at US$602.2 million. Foreign direct investments have played a major role in the Dominican Republic’s external accounts over the last five years. The Dominican Republic’s external vulnerability has lessened significantly over the past years. There has been a rapid accumulation in foreign exchange reserves which has improved the country’s external liquidity position, which has in the past been one of the Dominican Republic’s major weaknesses.
On 2 April 2007, Standard and Poor’s lowered its credit rating on Grenada to ‘CCC+’ from ‘B-’, while maintaining the outlook at stable. The downgrade was prompted by increasingly limited fiscal flexibility and a deteriorating payment culture, demonstrated by intermittent arrears on domestic commercial debt. Following the disruption caused by Hurricane Ivan in 2004, the country’s fiscal performance was significantly set back, as the government spent heavily on reconstruction efforts. The subsequent debt restructuring of 2005 alleviated the amortization and cost profile of Grenada’s debt, and the interest cost was cut by more than half, with the maturity of 45% of the total government debt postponed to 2025. However, the restructuring did not address the size of the debt (at least 121% of GDP). The government is heavily dependent upon the continuous inflow of grants. Donor support stood at 28% of government revenue and 11% of GDP in 2005, but was be lower in 2006; grant receipts fell to $100 million from a total of $145 million in the first nine months of 2005. Grenada is currently not rated by any of the international rating agencies. In recent years, Grenada has been running substantial deficits on the current account, frequently in excess of 20% of the country’s GDP. The country has had a rough run, with the external accounts being hit by a series of negative events, such as natural disasters and big capital projects associated with Cricket World Cup. The current account deficit has been financed by foreign direct investment inflows, which covered 67% of CAD in 2006, up from 57% in 2005. Grenada’s public sector external indebtedness has been consistently improving and is estimated at around 65% of current account receipts in 2008.

Jamaica has historically been plagued by high indebtedness and, up to 2008, the country’s stock of public sector debt remains in excess of 100% of GDP. Jamaica’s public sector debt peaked at 218% of GDP in 1985. It then decreased over 1986–1994, reaching a minimum of 72% of GDP in 1994, and subsequently increased again over the 1994–2004 period, returning to figures over 100% of GDP after 2001. Starting in the mid 1990s, Jamaica’s domestic debt increased steadily, and by the late 1990s, it had become larger than the country’s external debt (in 2004, domestic debt was 84% of GDP and 59% of total debt). The country’s high public sector debt is likely to constrain the economy and put pressure on fiscal accounts. This inherent risk places the country’s credit rating at ‘B’, by Standard and Poor’s, non-investment grade status. The Jamaican external account has always been a source of concern for many investors, as it has historically been extremely vulnerable to external factors. The macroeconomic instability during the 1990s contributed to large swings in the country’s real exchange rate, which acted as a deterrent to export and foreign investment growth. At the start of 2007, the external conditions also improved.
on the back of an impressive performance of the tourism sector as well as higher private remittance inflows. The higher surplus on the services account was attributed to growth in stopover and cruise passenger arrivals over the period, relative to the January - August 2005 (17.7% and 15.2% respectively), while the transfers account benefited from an increase of 6.8% in gross private remittance inflows. Remittances stood at US$1.2 billion in September 2006, accounting for about 19% of GDP. Given the vulnerability of the Jamaican external accounts, the Jamaican credit worthiness will always be constrained by its external liquidity position.

In 1980, at the height of an oil boom, Trinidad & Tobago was characterized by low levels of debt, but this was reversed after oil prices plummeted in the early 1980’s. The country’s external debt subsequently increased rapidly, with public debt as a ratio of GDP increasing from 6% in 1980 to almost 60% in 1990, reaching a peak of 67% in 1993 (Trinidad & Tobago was in default between 1988 and 1989). In 1993 when the TT dollar was floated, Trinidad & Tobago’s total debt stock started to decrease gradually reaching 25% of GDP in 2004. The rise in the country’s debt over the 1984–1993 period was financed by issuing both domestic and external debt. The buoyancy of oil prices on the international markets since 2001 has allowed Trinidad & Tobago to substantially improve its debt profile, with the stock of public sector debt falling to about 40% of GDP in 2006. The buoyancy of international oil and natural gas prices has helped to boost the Trinidad & Tobago fiscal as well as the external accounts and has made the country an attractive haven for investors. Trinidad & Tobago is currently rated by Standard and Poor’s as A– investment grade. Since the Atlantic LNG -1 project started in 1999, together with the expansion of other petrochemical projects, Trinidad & Tobago’s trade balance has been in surplus. Due to the development of the country’s energy base and the implementation of economic reform in the early 1990’s coming out of the recessionary period of the late 1980’s, the external current accounts have generally been performing well. Inflows of Foreign Direct Investment averaged 7.5% of GDP during 1999-2001, highlighting Trinidad & Tobago's strengths in terms of political stability and rich energy resources. (Standard and Poor’s, 2002). Trinidad & Tobago’s external debt burden has declined significantly during the past five years or so, with the public sector moving into net creditor position at the end of 2006.

Some theoretical considerations
One consequence of a debt crisis can be the need for debt renegotiation, and ultimately debt restructuring. The process has varying and distinct features. Multilateral financial institutions also play a major role in determining the success of a debt restructuring program, and so the role of
the International Monetary Fund (IMF) and the World Bank in debt crisis and eventual debt renegotiation and restructuring becomes very important.

Manasse and Roubini (2005) defined a country to be in debt crisis if it is classified as being in default by the international ratings agency, Standard and Poor’s, or if it receives a large non-concessional IMF loan (where ‘large’ means in excess of 100 per cent of quota). They undertook an empirical investigation of the set of economic and political conditions, which are associated with a probable occurrence of a sovereign debt crisis, and sought to provide answers to the following questions:

- What set of economic and political conditions is empirically associated with a likely occurrence of a sovereign debt crisis?
- Can one derive thresholds for vulnerability indicators that may signal a higher likelihood of a sovereign debt crisis?

The Manasse-Roubini study distinguishes between three types of debt crises: firstly episodes of insolvency (high debt and inflation) or debt unsustainability due to high debt and illiquidity; secondly, episodes of illiquidity, where near default is driven by large stocks of short term liabilities relative to foreign exchange reserves and thirdly, episodes of macro and exchange rate weaknesses (large over-valuation and negative growth shocks). Conversely, a relatively “risk-free” country is described by a handful of economic characteristics: low total external debt relative to ability to pay, low short-term debt over foreign reserves, low public external debt over fiscal revenue, and an exchange rate that is not excessively overvalued. Political instability and tight monetary conditions in international financial markets aggravate liquidity problems.

The Manasse-Roubini methodology employs a ‘binary recursive tree’ from which rules of thumb for vulnerability thresholds are derived, which can be used as early warning systems to predict a crisis. The Manasse-Roubini paper provides a comprehensive look at 47 countries with market access from 1970 to 2002. Three Caribbean countries which were covered by the authors: the Dominican Republic, Jamaica and Trinidad and Tobago.

The Binary Recursive Tree methodology is a process that looks for patterns and relationships in the data and is particularly suited for uncovering hidden nonlinear structures and variable interactions in complex datasets. It is a recursive process that splits ‘parent’ nodes into exactly two ‘child’ nodes and which further splits each into another pair of child nodes and so on. The
The main purpose for using this method for the early warning system is due to failure in the past to correctly assess the likelihood of a sovereign default.

Rose (2004) analyzes the effects of sovereign debt renegotiation on international trade, outlining the trade consequences of default. According to Rose (2004), because creditors deter default, or because trade finance evaporates, there are three primary reasons why countries pay their international debts. Klimenko (2001) also analyzed and articulated the effects a debtor country’s pattern of trade with commercial creditors’ home countries on the outcome of debt rescheduling negotiations. The author took the study one step further and also argued that the country’s market power also affects its threat point in bargaining with its creditors and the International Financial Institutions (IFI’s) over the terms of the rescheduling.

Cordella (2005) looked at the relationship between debt and economic growth. He looked at how the debt-growth relationship varies with indebtedness levels and other country characteristics in a panel of developing countries. The study looked at how indebtedness has affected growth and investment patterns in Highly Indebted Poor Countries (HIPC’s) as well as in countries with different levels of indebtedness or with policies or institutions of varying quality in the past 3 decades or so. Cordella (2005) concluded that at the intermediate levels of debt, there is a negative marginal relationship between debt and growth, but not at very low levels of debt. The findings suggest that there is a negative marginal relationship between debt and growth at intermediate levels of debt, but not at very low debt levels, below the “debt overhang” threshold, or at very high levels, above the “debt irrelevance” threshold.\(^2\)

The role of international financial institutions has become important over the past years. Marchesi (2002) sought to establish an empirical relationship between the adoption of an International Monetary Fund (IMF) program and the concession of a debt rescheduling by commercial creditors. A priori, if countries have arrangements with the IMF, they are more likely to obtain successful rescheduling of their external debt. The results of the study confirmed that the adoption of an IMF program (as well as the conditionality that are outlined) can work as a signal of a country’s good intention and may induce creditors to concede a rescheduling of a country’s

\(^2\) The authors denote the first threshold, i.e., the indebtedness level above which the marginal effect of debt on growth becomes negative, as the debt overhang threshold. The second threshold is defined, i.e., the indebtedness level above which the marginal effect of debt on growth becomes zero, as the debt irrelevance threshold.
external debt. Bulow and Rogoff (1990) ask whether taxpayers of the wealthier countries should finance a leveraged buyout of third world debt and investigated whether a debt discount facility will yield only minimal benefits. According to the authors, a debt discount facility would allow wealthier countries to buy up the debts at a discount and be able to forgive a large portion of the debt so that the debtor country could afford to repay the remainder. Boot and Kanatas (1995) looked at the importance of the International Monetary Fund and the World Bank as agencies that potentially can facilitate a pre-commitment. The involvement of an international agency in renegotiation of sovereign debt may be useful in terms of promoting credibility. To the extent that a sovereign sees pre-commitment as a valuable contract feature, deviations can be credibly punished by the IMF and World Bank by exclusions of such features from future renegotiations with any lenders.

Tillman (2005) on the other hand looked at the role of private sector involvement in the resolution of debt crises. Rather than being ‘bailed out’ by international agencies such as the IMF and the World Bank, banks and international investors should be bailed-in in order to realize some burden sharing. Advocates of private sector involvement (PSI) argue that the prospect of burden sharing between the public and the private sector in case of default discourages excessive risk taking of investors and limits the scope for moral hazard in anticipation of emergency assistance from the IMF.

**Data and Methodology**

Data from Standard and Poor’s and the IMF are used to determine whether and when the six countries in our study did in fact experience periods of crises, as defined previously. Table 1 summarizes the results so obtained:

<table>
<thead>
<tr>
<th>Country</th>
<th>Years of Crisis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barbados</td>
<td>NO CRISIS</td>
</tr>
<tr>
<td>Belize</td>
<td>2005, 2006</td>
</tr>
<tr>
<td>Dominican Republic</td>
<td>2003, 2004, 2005</td>
</tr>
<tr>
<td>Jamaica</td>
<td>1998, 1999</td>
</tr>
<tr>
<td>Trinidad and Tobago</td>
<td>NO CRISIS</td>
</tr>
</tbody>
</table>

*Source: Standard & Poor’s, International Monetary Fund*
The Manasse-Roubini Binary Recursive Tree will be applied to data covering the period 1998-2008 to six Caribbean countries: the Dominican Republic, Jamaica and Trinidad and Tobago, Barbados, Belize and Grenada. The data used will be divided into three types – macroeconomic fundamentals, variability indicators and political economy indicators. The data is drawn from the publications of the International Monetary Fund, Business Monitor International, and Standard and Poor’s (S&P). Information on sovereign credit rating will be also sourced from the latter to determine whether or not the country entered a period of crisis. According to S&P, “an obligation rated 'D' is in payment default. The 'D' rating category is used when payments on an obligation are not made on the date due even if the applicable grace period has not expired, unless Standard & Poor's believes that such payments will be made during such grace period. The 'D' rating also will be used upon the filing of a bankruptcy petition or the taking of a similar action if payments on an obligation are jeopardized.”

The macroeconomic fundamental indicators which will be used to measure liquidity and solvency will be gauged by debt indicators, such as public and external debt. Since repayment of debt consists of two elements, namely ability and willingness to pay, this set of data will give an idea of the ability of a sovereign to repay debt. The political indicators will to an extent provide a gauge of the willingness of the sovereign to honour debt obligations.

Ten important economic variables and political stability measures are used in the analysis. These are the external debt to GDP ratio, the ratio of short term debt (on a remaining maturity basis) to foreign reserves, the ratio of public external debt to government revenue, real GDP growth, inflation, the U.S. treasury bill rate, exchange rate overvaluation, exchange rate volatility, the ratio of external financial requirements to foreign reserves, and the number of years before a general election. These will be applied to the empirical tree as done by Manasse and Roubini during the different years to evaluate the effectiveness of the model. A crisis is predicted by the Binary Recursive Tree if the crisis probability exceeds 40%. The null hypothesis is that there is a crisis (and the alternative therefore is that there is none). A type I error occurs when the model predicts that there is no crisis and in fact there is one and the size of the error is the probability of incorrectly rejecting the null. A type 2 error occurs when the model predicts that there is a crisis and there is in fact none, which is, of course, a false alarm. This is summarized in Table 2 below:
Table 2: Type and size of errors

<table>
<thead>
<tr>
<th>Model prediction →</th>
<th>There is a crisis (decision: Do not reject Null)</th>
<th>There is no crisis (decision: Reject Null)</th>
</tr>
</thead>
<tbody>
<tr>
<td>State of Nature ↓</td>
<td></td>
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</tr>
<tr>
<td>There is a crisis (Null True)</td>
<td>No error (Size = 1-(\alpha))</td>
<td>Type I error (Size = (\alpha))</td>
</tr>
<tr>
<td>There is no crisis (Alternative true)</td>
<td>Type II error (Size = (\beta))</td>
<td>No error (Size = 1-(\beta))</td>
</tr>
</tbody>
</table>

The procedure will be judged on its ability to produce low \(\alpha\) and \(\beta\) scores. Of great interest is the value of (1-\(\beta\)), which in the statistical literature is called “the power of the test”. A test of low power implies that the model will frequently produce a false alarm (prediction of a crisis when there is none).

*Pooled Logit model*

The methodology described in this part of the paper will place emphasis on predicting debt crisis in selected Caribbean countries using a pooled logit model\(^3\) applied to a panel of data from the six countries and for the period 1998-2007. The general form of the model explains a debt crisis, Crisis, as:

\[
\text{Crisis} = f(Y, \text{Inf}, \text{Gov}, \text{Pub}, \text{Ext}, \text{Fin}, \text{Open}, \text{Rer}, \text{Tbill}, \text{Elect}) \quad (1)
\]

where \(Y\) = real GDP growth, \(\text{Inf}\) = Rate of Inflation, \(\text{Gov}\) = Ratio of general government interest expense to general government revenue, \(\text{Pub}\) = Ratio of net public sector debt to GDP, \(\text{Ext}\) = Ratio of total external debt to GDP, \(\text{Fin}\) = Ratio of gross financing requirement to reserves, \(\text{Open}\) = Openness of the economy, \(\text{Rer}\) = Real effective exchange rate, \(\text{Tbill}\) = US Treasury bill rate, \(\text{Elect}\) = Years to next general election. The level of risk is observed only across an index that takes on values of 0 (risk free), 1 (low risk), 2 (medium risk) and 3 (high risk). This means that the above equation may be viewed in the context of an ordered probit model in the classic way (Greene 2003, Daykin and Moffatt 2002). The variable Crisis has a value of 1 for the years in which a debt crisis is recorded and 0 if not. The model predicts a crisis will occur if the probability the crisis is larger than 50%. The predictions are compared with actual crises occurrences to determine the size of the type I and II errors.

\(^3\) Other panel data techniques, like the fixed effects and random-effects models, are theoretically feasible in studies like this one but in this case are not applicable since there are two cases (Barbados and Trinidad and Tobago) where no crisis is recorded.
Results

*Manasse-Roubini Binary Recursive Tree*

Table 3 below shows the probability of crisis for each year in the period under examination, derived using the empirical tree:

**Table 3: Probability of Crisis (Percent) Based on Analysis of Binary Tree**

<table>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Barbados</td>
<td>0.0</td>
<td>0.0</td>
<td>41.5</td>
<td>41.5</td>
<td>41.5</td>
<td>46.8</td>
<td>46.8</td>
<td>46.8</td>
<td>46.8</td>
<td>46.8</td>
</tr>
<tr>
<td>Belize</td>
<td>46.8</td>
<td>46.8</td>
<td>46.8</td>
<td>46.8</td>
<td>46.8</td>
<td>46.8</td>
<td>46.8</td>
<td>40.0</td>
<td>40.0</td>
<td></td>
</tr>
<tr>
<td>Dominican Republic</td>
<td>0.0</td>
<td>0.0</td>
<td>46.8</td>
<td>46.8</td>
<td>66.8</td>
<td>66.8</td>
<td>46.8</td>
<td>40.0</td>
<td>46.8</td>
<td></td>
</tr>
<tr>
<td>Grenada</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>46.8</td>
<td>46.8</td>
<td>46.8</td>
<td>46.8</td>
<td>40.0</td>
<td>46.8</td>
<td></td>
</tr>
<tr>
<td>Jamaica</td>
<td>46.8</td>
<td>46.8</td>
<td>40.0</td>
<td>40.0</td>
<td>40.0</td>
<td>66.8</td>
<td>66.8</td>
<td>40.0</td>
<td>66.8</td>
<td></td>
</tr>
<tr>
<td>Trinidad and Tobago</td>
<td>2.3</td>
<td>2.3</td>
<td>2.3</td>
<td>0.0</td>
<td>2.3</td>
<td>0.0</td>
<td>40.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

Appendix 2 provides an illustration in the use of the tree in calculating the 2000 crisis probability in Barbados (41.5%).

Table 4 below shows the cases where a country is determined to be crisis-prone or not crisis-prone, based on the criterion that it is crisis-prone if the probability of crisis exceeds 40%:

**Table 4: Prediction of Crisis Based on Analysis of Binary Tree**

<table>
<thead>
<tr>
<th></th>
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<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Barbados</td>
<td>Not</td>
<td>Not</td>
<td>Crisis prone</td>
<td>Crisis prone</td>
<td>Crisis prone</td>
<td>Crisis prone</td>
<td>Crisis prone</td>
<td>Crisis prone</td>
<td>Crisis prone</td>
<td>Crisis prone</td>
</tr>
<tr>
<td>Belize</td>
<td>Crisis prone</td>
<td>Crisis prone</td>
<td>Crisis prone</td>
<td>Crisis prone</td>
<td>Crisis prone</td>
<td>Crisis prone</td>
<td>Crisis prone</td>
<td>Not Crisis prone</td>
<td>Not Crisis prone</td>
<td></td>
</tr>
<tr>
<td>Dominican Republic</td>
<td>Not</td>
<td>Crisis prone</td>
<td>Not Crisis prone</td>
<td>Crisis prone</td>
<td>Crisis prone</td>
<td>Crisis prone</td>
<td>Crisis prone</td>
<td>Not Crisis prone</td>
<td>Crisis prone</td>
<td></td>
</tr>
<tr>
<td>Grenada</td>
<td>Not</td>
<td>Crisis prone</td>
<td>Crisis prone</td>
<td>Crisis prone</td>
<td>Crisis prone</td>
<td>Crisis prone</td>
<td>Crisis prone</td>
<td>Not Crisis prone</td>
<td>Not Crisis prone</td>
<td></td>
</tr>
<tr>
<td>Jamaica</td>
<td>Crisis prone</td>
<td>Crisis prone</td>
<td>Not Crisis prone</td>
<td>Not Crisis prone</td>
<td>Crisis prone</td>
<td>Crisis prone</td>
<td>Not Crisis prone</td>
<td>Not Crisis prone</td>
<td>Crisis prone</td>
<td></td>
</tr>
<tr>
<td>Trinidad and Tobago</td>
<td>Not</td>
<td>Crisis prone</td>
<td>Not Crisis prone</td>
<td>Not Crisis prone</td>
<td>Not Crisis prone</td>
<td>Not Crisis prone</td>
<td>Not Crisis prone</td>
<td>Not Crisis prone</td>
<td>Not Crisis prone</td>
<td></td>
</tr>
</tbody>
</table>

There are 10 cases where the null is true and there is a crisis, and only one case where a crisis is NOT predicted. The ‘alpha’ is then calculated to be 0.10. Then there are 50 cases where the alternative is true and 27 cases that were not predicted, so that the beta can be calculated as 0.54.
The error table is summarized as follows in Table 5:

<table>
<thead>
<tr>
<th>State of nature: There is a crisis (Null True)</th>
<th>Decision: Null true</th>
<th>Decision: null false</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1-α) = 0.90</td>
<td>α = 0.10</td>
<td></td>
</tr>
<tr>
<td>State of nature: There is no crisis (Null Not true)</td>
<td>β = 0.54</td>
<td>(1- β) = 0.46</td>
</tr>
</tbody>
</table>

From the table we can see that the degree of ‘false alarms’ were quite high when applied to the Caribbean, and using the definition of a state of ‘crisis’. Perhaps the reason for this is a flaw in the definition itself, or an insufficient number of observations for the countries. In this model, the level of indebtedness plays a major role in determining whether a country is debt-prone or not, and the Caribbean region has historically been home to some of the most highly indebted emerging markets in the world, with a Caribbean of just about 90% of GDP. The countries are highly dependent on the external environment and are open to vagaries of a dynamic global economy. Indeed, many of the countries do have issues in meeting financial obligations, but they are recipients of large inflows of foreign direct investment as well as multilateral financing, such as the Inter-American Development Bank (IADB), World Bank and the Caribbean Development Bank, in addition to low interest loans from large, wealthy countries. The role of multilateral financing and foreign aid has been pivotal in the Caribbean’s ability to finance debt. So indeed, while fundamentals may be consistently weak, indicated by the high frequency of ‘false alarms’, they are able to service their debt through various borrowing facilities including multinational lending agencies, like the IMF, World Bank and the Inter-American Development Bank (IADB) as well as foreign aid flows into the countries from the larger, wealthy more developed economies.

The (1-α) is very large, and indicates that the model accurately predicted nine out of the ten (90%) instances of actual crisis, but with such a high beta value, it will be difficult to predict when the model will be correct.

**Pooled Logit model**

Because of the high collinearity between Pub and Ext, they are treated as substitutes and separate equations are estimated involving each one separately. The public debt variable was highly insignificant (p-value 81%) and, for that reason, the results obtained from that model are not reported here. Two highly insignificant variables in the model containing the external debt

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4 The coefficient of correlation was 64%. No other pair of variables had as high a correlation.
variable, (\textit{Growth} and \textit{Gov}, p-values respectively 49\% and 97\%) were dropped from the model. The results of the final estimated model are given below in table 7:

\begin{table}[h]
\centering
\begin{tabular}{|l|c|}
\hline
\textit{Inf} & 0.26561 \hfill (0.1001) \hfill [0.008] \\
\hline
\textit{Ext} & 0.02738 \hfill (0.0182) \hfill [0.133] \\
\hline
\textit{Fin} & -0.00253 \hfill (0.0032) \hfill [0.434] \\
\hline
\textit{Open} & 0.00855 \hfill (0.0039) \hfill [0.039] \\
\hline
\textit{Rer} & -0.09276 \hfill (0.0632) \hfill [0.142] \\
\hline
\textit{Tbill} & 1.1383 \hfill (0.5374) \hfill [0.034] \\
\hline
\textit{Elect} & 0.60438 \hfill (0.5473) \hfill [0.269] \\
\hline
\text{Constant} & -12.46122 \hfill (5.3495) \hfill [0.020] \\
\hline
\text{Likelihood ratio} & 20.96 \hfill [0.004] \\
\hline
\text{Pseudo R}^2 & 0.405 \\
\hline
\end{tabular}
\caption{Results of Pooled Logit Regression (Dependent Variable: \textit{Crisis})}
\end{table}

Standard errors are in () parentheses and p-values in [] parentheses.

The model performs creditably: the size of the likelihood ratio indicates that the specification is a good one while the pseudo R\(^2\) values are quite high for this kind of model. The inflation, openness and treasury bill variables are highly significant and carry the correct sign. The exchange rate and external debt coefficients are significant at 14\% and 13\% respectively and are both correctly signed. There is no evidence the quality of the democratic systems influence the possibility of a debt crisis.

In determining the size of the \(\alpha\) and \(\beta\) coefficients, the total number of cases under consideration is reduced from 60 to 54 since the associated probabilities of crisis cannot be calculated for the 6 cases where the \textit{Rer} variable is not observed. Of these, there are 10 cases where the null is true and model fails to predict five of the cases. The \(\alpha\) is thus calculated to be 0.50, which is not encouraging. However, of the 44 valid cases where the alternative is true, only 3 cases were not correctly predicted so that the \(\beta\) is calculated as 0.068, giving a value of the power of the test as a very high 0.932. The error table is summarized as follows in Table 8 below:
Table 8: Summary of Type I Type II Errors using Pooled Logit Model

<table>
<thead>
<tr>
<th>State of nature: There is a crisis (Null True)</th>
<th>Decision: Null true</th>
<th>Decision: null false</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$(1-\alpha)=0.50$</td>
<td>$\alpha =0.50$</td>
</tr>
<tr>
<td>State of nature: There is no crisis (Null Not true)</td>
<td>$\beta =0.068$</td>
<td>$(1- \beta) = 0.932$</td>
</tr>
</tbody>
</table>

The power of the test using the pooled logit models is considerably improved when compared to the power using the Manasse-Roubini Binary Recursive Tree in that it increases from 46% to 93%. On the other hand, the significance level is 50% in the case of the pooled logit model while it is 10% in the case of the Manasse-Roubini Binary Recursive Tree method.

**Conclusion:**

In this paper we considered the usefulness of predicting debt crises in the Caribbean using the ‘rules of thumb’ approach of the Manasse-Roubini Binary Recursive Tree and a pooled logit model using a panel of data from the countries in question. The results are not convincing for either method although the pooled logit approach has the marked advantage of being clearly more powerful in that it results in fewer false alarms. We can safely trust this model to predict the non occurrence of a crisis. That may be cold comfort, however, as in 50% of the cases it will incorrectly predict one. Perhaps a possible solution is to use the Manasse-Roubini Binary Recursive Tree to predict the crisis, always comparing that prediction with that obtained using the pooled logit model, which has tremendous power in predicting a non crisis. One problem could be the paucity of data used in both approaches and the exercise should be repeated, and the conclusions updated, as more data become available.

**References**


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Appendix 2

Determining the crisis probability from the Empirical Tree and the Classification Table

Is total external debt > 50% of GDP? If: **True**?

→ Is inflation greater than 10.5%? If yes, the crisis probability is 66.8%

Is inflation < 10.47%?
→ If yes, is external financing requirement > 1.44? → If yes, the crisis probability = 46.8%

→ Is external financing requirement < 1.44? If yes, is public ext debt/ revenue > 2.15? If yes, the crisis probability = 40%, if no, crisis prob = 2%

Is total external debt < 50% of GDP? **False**?

→ Is short term ext debt/ reserves > 1.34? If yes, are years to next presidential election > 5.5 yrs? If yes, then US tbill rate > 9.72, if yes crisis prob = 40%, if no, crisis prob = 0%

→ Is years to next presidential elect < 5.5 yrs, if yes, is total external debt > 19.1% of GDP? If yes, is exchange rate volatility > 27.88? If yes, crisis prob = 0%, if no crisis prob = 41.5%

→ Is total ext debt < 19.1%, if yes crisis prob = 0%.

→ Is short term ext debt < 1.34, if yes, is public ext debt/ rev > 2.15? If yes, is inflation > 10.67%? If yes crisis prob = 55%, if no prob = 0%

→ Is public ext debt/ rev < 2.15, if yes, then is real GDP growth > -5.45? If yes, then crisis prob = 2.3%.

→ Is GDP < -5.25? If yes, is overvaluation > 48? If yes, then crisis prob = 100%, if overvaluation < 48, prob = 0%

Therefore, the probability of crisis for Barbados 2000 = 41.5%, derived from the following sequence:

<table>
<thead>
<tr>
<th>Total external debt &gt; 50% of GDP</th>
<th>NO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short term ext debt/ reserves &gt; 1.34</td>
<td>YES</td>
</tr>
<tr>
<td>Years to next presidential elections &gt; 5.5 years</td>
<td>NO</td>
</tr>
<tr>
<td>Total external debt &gt; 19.1% of GDP</td>
<td>YES</td>
</tr>
<tr>
<td>Exchange rate volatility &gt; 27.88</td>
<td>NO</td>
</tr>
</tbody>
</table>

This leads to a crisis probability of 41.5%.