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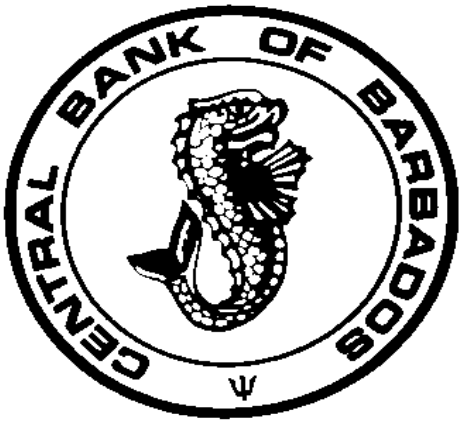
THE IMPACT OF NATURAL DISASTERS ON PUBLIC DEBT ACCUMULATION IN SELECTED ECCU COUNTRIES

BY

BEVERLY LUGAY AND RONALD JAMES



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THE IMPACT OF NATURAL DISASTERS ON PUBLIC DEBT ACCUMULATION IN SELECTED ECCU COUNTRIES

PREPARED BY

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EASTERN CARIBBEAN CENTRAL BANK

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THE IMPACT OF NATURAL DISASTERS ON DEBT ACCUMULATION IN SELECTED ECCU COUNTRIES

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ABSTRACT

This paper investigates whether natural disasters affect the accumulation of public debt in the six independent countries of the Eastern Caribbean Currency Union (ECCU) using panel data regression. The paper argues that the occurrence of natural disasters leads to the accumulation of public debt to finance reconstruction as fiscal resources are often times limited and expenditure structures are too rigid to absorb the effects of external shocks. Using panel data for the period 1993-2011 the results reveal that natural disasters have a significant impact on the growth of public debt in the ECCU. In a year when a natural disaster inflicting 2.0 per cent or more of GDP strikes, the debt to GDP ratio rises by 6.7 per cent, compared with a year when a disaster of lesser intensity or none strikes.

JEL CLASSIFICATION NUMBERS: H63; Q54

KEYWORDS: Natural Disasters, Debt Accumulation, Public Debt, Balanced Panel

1.0 INTRODUCTION

Natural disasters occur on an annual basis resulting in significant large scale damages to physical capital and loss of human life. In the last decade, instructive of the destructive nature of natural disasters were the Haiti earthquake and the Indian Ocean earthquake and associated catastrophic tsunami, which together, caused nearly half a million deaths and billions of dollars in damage. In the context of the Caribbean and in particular the Eastern Caribbean Currency Union (ECCU), which has a long history of relatively high natural disaster occurrences, these types of impacts are especially relevant. By virtue of their geographical location they lie squarely in the path of hurricanes and other wind storms, are exposed to drought as well as flooding with their attendant devastations. The archipelago also lies sufficiently close to fault lines in the Caribbean tectonic plates which suggest some vulnerability to geologic disasters such as earthquakes and volcanic eruptions.

Several negative impacts on the affected nations' economies, the retardation of their long-term development and their productive under-performances can be ascribed to the adverse impacts of natural disasters. Otero and Marti (1994) argues that generally, there are some intrinsic elements of the damaged nation, the society, or the economy that have implications for the efforts needed to face the emergency, undertake the reconstruction, and, finally, surmount the consequences of the disaster. Relative size of the economy affected, the magnitude and depth of the event, and the economic and sociopolitical conditions of the country at the time are some of these elements.

Over the last six decades, the region has been impacted by 187 natural disasters, mainly tropical cyclones for which the probability of occurrence is above 10 per cent per year (IMF, 2011). Moreover, according to Rasmussen (2004), the countries of the Eastern Caribbean are among the most disaster-prone in the world in terms of incidence, percentage of population affected, and the extent of damage. Based on experiences observed over the period 1970-2002, a natural disaster inflicting damage equivalent to more than two per cent of the affected country's GDP can be expected to hit the ECCU roughly once every two and a half years. The

very high exposure to natural hazards in the Eastern Caribbean has recently been exemplified in Grenada, which suffered devastating damage from Hurricane Ivan in September 2004 and in Saint Lucia where Hurricane Tomas, in October 2010 devastated the southernmost part of the country causing significant damages to life and property. Prior to that, several countries in the ECCU have been hit by severe storms. For instance, Hurricane David which struck Dominica in 1979 led to a 17.0 per cent contraction in GDP and a 31.0 per cent increase in central government current expenditure with capital expenditure increasing even more rapidly. Consequently, the fiscal deficit rose to 8.1 per cent of GDP in 1981 from 3.1 per cent in 1978, despite a significant increase in foreign grant receipts. Furthermore, the tourism industry, which was at the centre of the government's thrust for economic growth and development, suffered an extensive blow with growth halting in the industry for 5 to 6 years (Benson and Clay, 2003).

Beyond the direct impacts, natural disasters have shock effects on public finances and debt sustainability because of their impact on growth and the need for reconstruction expenditure (Rasmussen, 2004; World Bank, 2011). The rehabilitation of capital infrastructure destroyed by disasters induces surges in government expenditures at a time when government revenue is challenged by lower economic activity. Depending on the state of public finances prior to a disaster, governments may fund reconstruction from savings, international aid, or borrowing. While international aid may help mitigate some of the immediate effects of disasters, the amounts received or pledged may fall short of what is required for reconstruction and may not be promptly available (Melecky and Raddatz, 2011). Due to limited fiscal resources and the fragile state of public finances prior to disasters, many ECCU countries are unable to undertake the required reconstruction and rehabilitation after a natural disaster and in most instances resort to borrowing to complement the amounts received from international aid.

While there has been considerable research on predicting natural disasters, disaster mitigation and their impacts on growth and incomes, research on other impacts such as fiscal and debt effects, have been under-investigated (Cavallo and Noy, 2010). This paper adds to the literature by examining the effects of natural disasters on public debt accumulation in the six

independent countries[1] of the ECCU for which there is little empirical research. The high level of indebtedness which averages about 78.0 per cent of GDP over the period of study and exacerbated by the global crisis of 2007/08 has been the focus of many discussions within the Eastern Caribbean Central Bank (ECCB), the Caribbean Development Bank (CDB), the International Monetary Fund (IMF), the World Bank and renown credit rating agencies. Moreover, in light of recent debt restructuring exercises of countries such as Antigua and Barbuda, and St Kitts and Nevis and the announcement by Grenada, it is critical to understand the factors that contributed to the current debt situation.

This study reveals that natural disasters which inflict damage of two per cent of GDP or more will trigger a 6.7 per cent rise in the debt to GDP ratio. Given the negative impact of natural disasters on public debt sustainability, it is imperative that ECCU countries implement policies and programmes to mitigate the impact of natural disasters. Rasmussen (2004) indicated that mitigation efforts should include the use of insurance and capital markets to compensate for the loss of capital and income; the formulation of domestic public policy to reduce risks such as policies to encourage more widespread use of home insurance; strictly enforced building and zoning regulation; and maximize the use of external assistance from programmes sponsored by the CDB, the World Bank and CDERA which provide assistance for disaster relief, mitigation and preparedness projects.

The rest of the paper is organized as follows: section 2 gives a brief background on the history of natural disasters and trends in public debt over the last two decades in the ECCU; section 3 presents a review of the relevant literature; section 4 describes the data and methodology; section 5 presents and discusses the estimated results and finally section 6 draws some policy recommendations and conclusions.

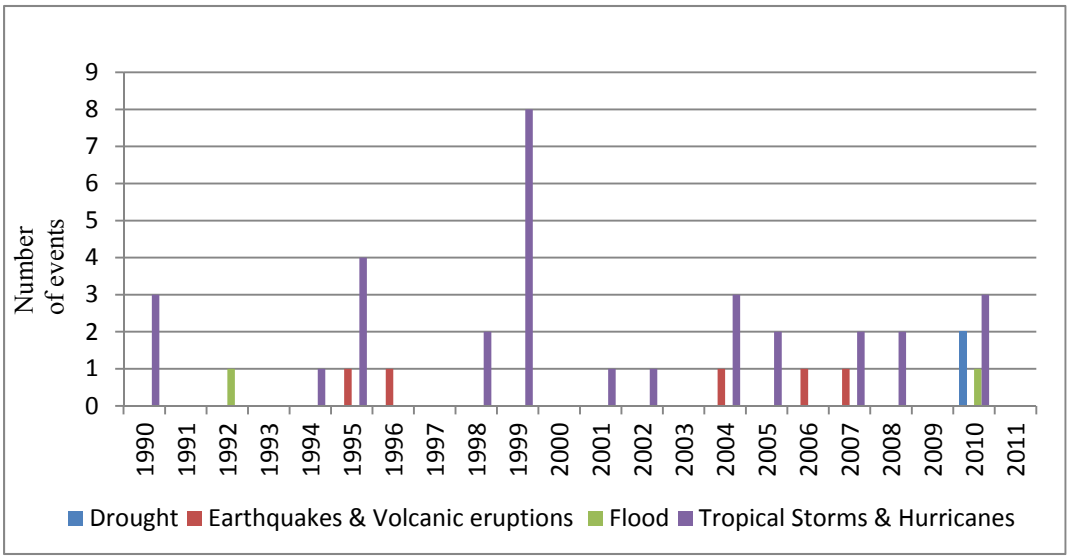
[1] Antigua and Barbuda, Dominica, Grenada, St Kitts and Nevis, Saint Lucia and St Vincent and the Grenadines.

2.0 BACKGROUND

2.1 History of Natural Disasters in the ECCU

The occurrence of natural disasters in the Caribbean have had devastating effects on the capital stock thereby, altering economic growth trends and placing extreme pressures on fiscal resources. Figure 1 shows the number of natural disaster events[2] which have taken place over the period 1990-2011. The data revealed that the most active years were 1995 (Hurricane Luis and Marilyn), 1999 (Hurricane Lenny) and 2010 (Hurricane Tomas along with and droughts and floods).

Figure 1: Natural Disaster Events in the ECCU, 1990-2011



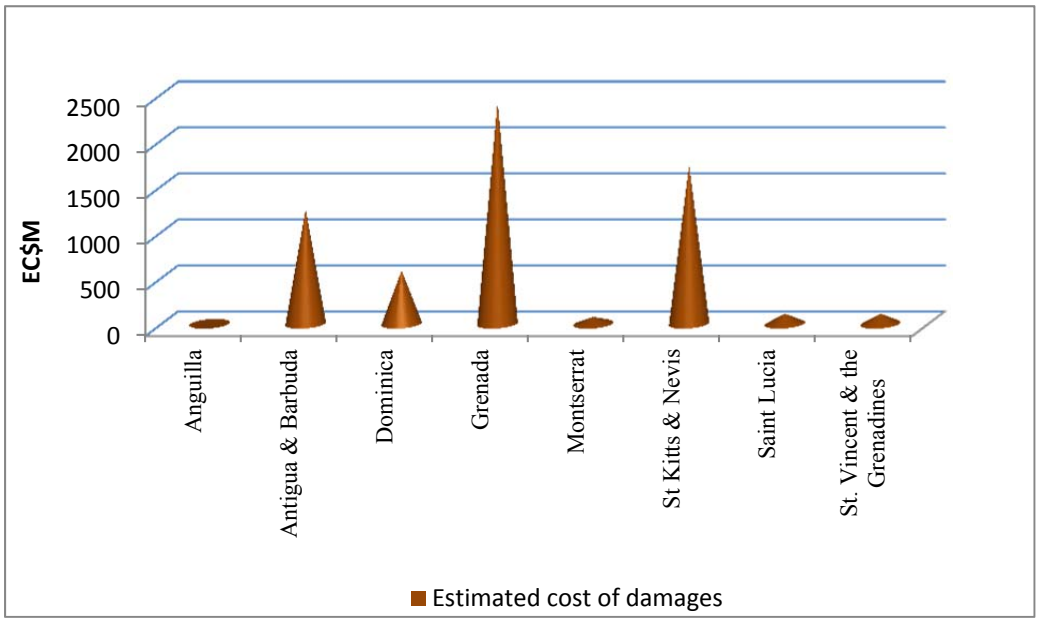
Source: Emergency Disasters Data Base (EM-DAT) [online], www.em-dat.net.

In addition to the frequency of natural disasters which occur almost on an annual basis, the costs associated with natural disasters were extremely high. Figure 2 shows the cumulative estimated cost of damages due to natural disasters. Over the period the countries that were

[2] An event reflects the number of disasters experienced by countries. A single event (such as a hurricane) may generate several disasters if it affects more than one country.

most severely impacted were Antigua and Barbuda (Hurricane Luis, 1995); Grenada (Hurricane Ivan, 2004) and St Kitts and Nevis (Hurricane Georges, 1998; and Hurricane Luis, 1995).

Figure 2: Cumulative Estimated Cost of Damages Caused by Natural Disasters in the ECCU, 1990–2011



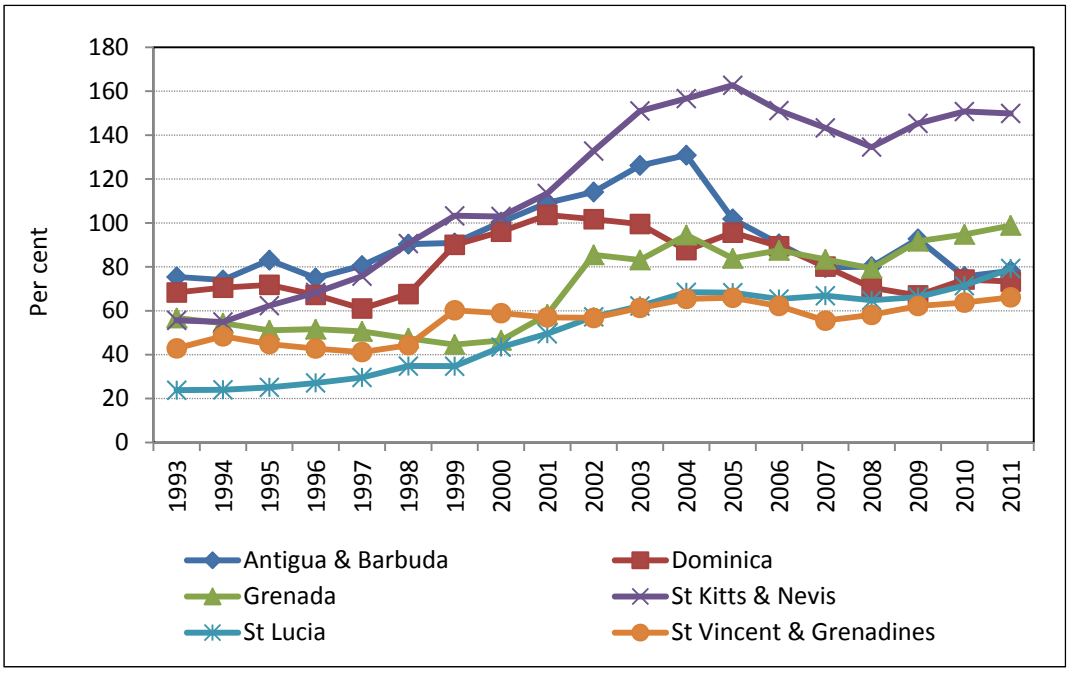
Source: "EM-DAT: The OFDA/CRED International Disaster Database, www.em-dat.net

The combined effects of higher frequency of global disasters and the impact of the global recession on both traditional and non-traditional donors have significantly constrained their abilities to give as before. A natural disaster could lead to acute liquidity pressures, stemming from lower fiscal and export revenues amid likely higher import and spending demands. In this context, fiscal and external flexibility can provide important cushions and are paramount in a country's ability to cope with adverse developments without undermining its fiscal position. Standard and Poor's (2010) highlighted that Chile's very low debt burden, with general government debt of 3.2 per cent of GDP in 2009, was an important component of the fiscal flexibility that allowed the country to absorb losses and spend on reconstruction without impairing its fiscal position in the aftermath of the 2010 earthquake.

2.2 Trends in Public Debt in the ECCU

Debt accumulation in the ECCU has been hastened by the deterioration of the fiscal positions of several countries over the last decade. Consequently, several countries have been characterized as highly indebted countries raising concerns about debt sustainability (Sahay, 2005). Most recently the global economic crisis has exacerbated the debt situation. At the end of 2011, all six independent countries of the ECCU recorded debt to GDP ratios in excess of 60 per cent with St Kitts and Nevis being the highest indebted country with a debt to GDP ratio of 150.5 per cent (see figure 3). In addition to the high debt ratios the level of economic growth has been moderate. In the 1990s the ECCU economies on average (simple) grew at a rate of 3.2 per cent trending downwards to 2.6 per cent in the 2000s. Due to the high debt levels coupled with low growth a number of countries have undergone sovereign debt restructuring over the last decade: Dominica 2004, Grenada 2005, Antigua and Barbuda 2010 and St Kitts and Nevis 2011.

Figure 3: Debt to GDP Ratios in Selected ECCU countries, 1993-2011



Source: Eastern Caribbean Central Bank Database

Research has shown that the main reason for debt accumulation in the ECCU has been worsening primary deficits. The IMF (2011) found that over the period 1991-2009 primary deficits accounted for over half of the total debt increase, while the differential between real interest rates and growth rates played a minor role. In 2005-2008, primary surpluses, economic growth and grants supported an average reduction in the debt ratio of about 4.5 per cent per year to 95.0 per cent in 2008. However, with the global downturn the debt to GDP ratio spiked to 112.0 per cent in 2010 due to declines in economic activity and the deterioration in fiscal balances Moreover, using the government budget constraint identity framework to investigate the debt carrying capacity of the ECCU, Leonce and Hope (2013) found that consecutive primary deficits contributed in a large part to the debt accumulation during the period 1990-2011 except for the years 2005-2007 when increases in GDP growth offset the impact of the primary deficit and interest payments, see table 1. They also found that the contribution of interest payments to an increasing debt burden grew over the period, moving from 1.4 per cent at the end of 1995 to an average of 3.0 per cent by the end of 2008.

Table 1: Debt Decomposition for the ECCU, 1993-2011

ECCU						
Debt Decomposition/ 3 yr averages	**1993-1995**	**1996-1998**	**1999-2001**	**2002-2004**	**2005-2007**	**2008-2011**
Change in debt (a+b+c)	**1.77**	**2.54**	**5.70**	**5.96**	**-6.13**	**1.88**
(a) Debt increasing factors (i-X)	**2.69**	**2.61**	**6.15**	**6.79**	**5.35**	**5.40**
Interest Payment (i)	1.44	1.64	2.62	3.56	3.03	2.95
Primary Balance (X)	-1.25	-0.96	-3.53	-3.22	-2.33	-2.46
(b) Debt reducing factors	**-2.24**	**-3.37**	**-2.80**	**-4.37**	**-8.44**	**-1.84**
Inflation Effect (π)	-1.16	-1.29	-1.31	-1.69	-3.91	-2.58
Growth Effect (g)	-1.08	-2.08	-1.49	-2.68	-4.53	0.74
(c) Other debt creating flows	**1.32**	**3.31**	**2.36**	**3.55**	**-3.04**	**-1.68**
Memo Item						
Standard Budget Deficit	2.69	2.61	6.15	6.79	5.35	5.40
inflation rate (percent)	2.38	2.48	2.01	1.95	4.59	3.29
real growth rate (percent)	2.28	4.16	2.55	3.23	5.57	-0.83

Source: Leonce and Hope (2013)

3.0 LITERATURE REVIEW

Economic research on the relationship between natural disasters and debt accumulation is relatively limited and the literature that exists suggest that natural disasters put extreme pressure on public finances which in turn leads to increased borrowing. In addition to the impact on public finances, natural disasters have consequences on the conduct of economic policy, on the sustainability of long-term development strategies, and on productive performance. These impacts are particularly relevant in Latin American and Caribbean countries, which frequently experience natural disasters of various origin and intensity, with the loss of human life and grave economic and social impact, (Otero and Marti, 1995).

In examining the macroeconomic performance of Caribbean countries from the 1990s, Sahay (2005) attributed the rapid buildup of debt in a large part to the deterioration in fiscal balances owing principally to increases in expenditures rather than declines in revenues. She found that the two most significant shocks that affected fiscal balances most negatively over the period 1998-2003 were natural disasters and the decline preferential agreements. The rapid increase in fiscal expansion appeared to be related to policy slippages, insufficient fiscal planning for anticipated adverse shocks, and to some extent unanticipated shocks. Greenidge et al (2010) came to a similar conclusion in assessing the accumulation of external public debt in the Caribbean over the period 1987-2005. They found that the high level of indebtedness was influenced by natural disasters, fluctuations in export prices, large amounts of development expenditure and events that affected international travel. The indirect effects of natural disasters on debt levels were found to be evident in Jamaica and several OECS countries, which experienced four hurricanes during the period of review. This was further supported by Heger et al (2008) who found that natural disasters had a fourfold impact on 16 Caribbean[3] countries during the period 1970-2005. These included contributing to the region's overall high level of indebtedness; deterioration in the fiscal balance; a collapse of growth; and a worsening external balance.

[3] Inclusive of the six independent countries in the ECCU.

According to Melecky and Raddatz (2011) natural disasters can be a major shock to public finances and debt sustainability due to their impact on output and the need for reconstruction and relief expenses. In assessing the impact of geological, climatic and other types of natural disasters on government fiscal accounts for high and middle income countries over the period 1975-2008, they found that on average, deficits increased only after climatic disasters but for lower-middle income countries the increase in deficits was widespread across all events. Moreover, disasters did not lead to larger deficit increases in countries with higher initial government debt. They also found that countries with higher financial development and high insurance penetration suffered smaller real consequences.

Many studies have shown that the impact of natural disasters is dependent on the level of social and economic infrastructure. Toya and Skidmore (2005) found that human and economic losses are lower in countries with higher levels of education, more competitive economies, better developed financial systems and smaller governments. As economies develop there are fewer disaster related deaths and damages. They concluded that in addition to more direct disaster mitigation efforts, long run disaster reduction policies should include efforts to improve education, increase openness and further develop financial markets. Kahn (2005) concluded that while richer countries do not experience fewer or less severe natural disasters, their death toll is substantially lower. Sen (1981) observed that the cost associated with natural disasters were largely determined by economic forces rather than predetermined by natural processes.

Specifically for the ECCU, Rasmussen (2004) in investigating the macroeconomic implications of natural disasters in the Caribbean over the period 1970-2002 found that the 12 natural disasters which occurred during the period were associated with a median reduction in same-year real GDP growth of 2.2 percentage points and a steep increase in the median public debt to GDP by a cumulative 6.5 percentage points over three years. The effect on central government finances was indeterminate with large variations in outcomes among countries. Nevertheless, the tendency appeared to have been a pronounced increase in expenditure and a marginal contraction in total revenue despite an increase in inflows of official assistance and

aid.

Acevedo (2012) in examining the effects that natural disasters have on per capita GDP and on the debt to GDP ratio in the Caribbean region over the period 1970-2009 found that in the six independent countries in the ECCU storms significantly increased debt in the short run. The immediate effect of a moderate storm was a decline in GDP growth of about 0.7 percentage points in line with the results for the broader Caribbean. However, unlike the rest of the Caribbean the ECCU countries do not seem to enjoy a strong recovery after moderate storms, instead seeing their economies decline further in the following year. The effect on debt was positive and significant. During the year that the ECCU countries were hit by a moderate storm the debt to GDP ratio grew faster by almost 5 percentage points with a cumulative effect that showed a debt to GDP level that is more than 5 percent of GDP higher after 8 years.

In conclusion, the literature suggests that the transmission mechanism through which natural disasters impact the debt level is via the primary deficit. Specifically, increasing expenditures for reconstruction purposes, especially in countries with significant fiscal constraints, will likely yield fiscal deficits or a deterioration of its' fiscal position.

4.0 DATA AND METHODOLOGY

4.1 Data

The dataset consists of a balanced panel of 114 observations covering the six independent countries of the ECCU for the period 1993-2011. The major source of data is the Eastern Caribbean Central Bank database from which data on debt, the primary balance, real GDP (supplemented by the IMF World Economic Outlook database) and the real implicit interest rate were taken. Data on natural disasters were extracted from the Emergency Disasters database (EM-DAT) collected by the center for Research on Epidemiology of Disasters

(CRED). EM-DAT is the most comprehensive global database on natural disasters available. To be included in the database a disaster has to meet one of the following conditions: 10 or more people reported killed; 100 or more people reported affected; and a state of emergency is declared or there is a call for international assistance. Two dummy variables were constructed, D1 to capture the year in which a natural disaster struck and D2, to capture the intensity of natural disasters, namely floods, droughts, storms and hurricanes, as follows:

$$D1_{it} = \begin{Bmatrix} 1, if\ a\ country\ was\ struck\ by\ a\ natural\ disaster\ \ in\ year\ t \\ 0, otherwise \end{Bmatrix}$$

$$D2_{it} = \begin{Bmatrix} 1, if\ natural\ disaster\ damages \geq 2\%\ of\ GDP\ in\ year\ t \\ 0, otherwise \end{Bmatrix}$$

Figure 1 in Appendix I shows the evolution of the independent variables at the country level, which all appear very volatile. Analyzing the variables in the latter years indicates that the primary surplus has been on a decline for all countries except St Kitts and Nevis; real GDP has improved for all countries except St Kitts and Nevis; Dominica and Grenada has seen an increase in the real implicit interest rate while the other countries recorded marginal declines. The summary statistics and correlation coefficients are presented in tables 1 and 2 in Appendix II, respectively. The correlation coefficients suggest relatively strong and significant relationships between the debt to GDP ratio and the primary balance, real GDP and the real implicit interest rate.

To check for the presence of unit root in the data series, several panel unit root tests were conducted. Those include the Levin, Lin and Chu test which has a common unit root process as the null hypothesis; the Im, Pesaran and Shin W-test and the ADF Fisher chi square for which the null hypothesis is an individual unit root process and the Hadri Z-statistic test which assumes the null that all individual series are stationary. The results of the panel unit root rests

are presented in table 3 in Appendix II. Upon analysis of the results it can be concluded that real GDP growth and the real implicit interest rate are stationary in levels while the log difference of the debt to GDP ratio and the primary balance are integrated of order one at conventional levels of significance[4].

4.2 Methodology and Model Specification

The model specification begins with the definitional equation of public debt as follows:

$$D_t = D_{t-1} + IP_t + PD_t + DF_t \qquad (1)$$

According to equation (1) the outstanding debt stock at time t (D_t) equals the stock of debt at the end of the previous year (D_{t-1}), the deficit in year t disaggregated into actual interest payment on the debt (IP_t) and the primary deficit (PD_t), and a stock flow adjustment factor (DF_t), which represents other influences such as exchange rate fluctuations and changes in the monetary base that are not captured by the other components. Dividing equation (1) by nominal GDP and defining lower case variables as upper case variables expressed as a share of GDP yields an expression for the debt ratio as follows:

$$d_t = \frac{1}{1+g} d_{t-1} + ip_t + pd_t + df_t \qquad (2)$$

Further calibrations to equation (2) and neglecting the stock flow adjustment yields public debt creation as follows:

$$d_t - d_{t-1} = \left[\frac{r_t}{1+g_t}\right] d_{t-1} - \left[\frac{g_t}{1+g_t}\right] d_{t-1} - p_t \qquad (3)$$

Equation (3) demonstrates that the evolution of the public debt ratio depends on the real interest rate, real GDP growth and fiscal adjustment. The inflationary effect on the debt ratio is transmitted through a lowering of the real interest rate paid by the government. To

[4] Note that there are conflicting results among the test statistics regarding the public debt and primary balance data series. While the Hadri test failed to reject the null of stationarity, the other three tests accepted the null of unit roots at differing significance levels.

ascertain the impact of natural disasters on public debt in the ECCU equation 3 was modified to include natural disaster dummies as explanatory variables. Consequently, the following parsimonious panel fixed effects model was estimated as in equation 4. Two different estimations were done, one with D1 and the other with D2.

$$Pdebt_{it} = \alpha_i + \beta_1 PB_{it} + \beta_2 RGDP_{it} + \beta_3 RIR_{it} + \beta_4 D_{it} + \varepsilon_{it} \quad (4)$$

where:

- Subscripts i and t represent country and time period respectively.
- Pdebt is the log difference of the public debt to GDP ratio.
- PB is the primary balance (surplus by definition) as a share of GDP.
- RGDP is the rate of growth of real GDP.
- RIR is the average real implicit interest rate on domestic and foreign debt.
- D is the natural disaster dummy.
- α_i is the fixed effect coefficient which captures the unobserved country heterogeneity invariant over time.
- ε_{it} is the error term.

The primary balance is anticipated to have a negative sign as an increase in the primary surplus would reduce the growth in the debt to GDP ratio; the growth coefficient should also be negative, indicating that real GDP growth would constrict the growth in the debt to GDP ratio. The relationship between the interest rate (assumed to be positive) and the debt to GDP ratio is expected to be positive, as higher interest rates increases the cost of debt. The natural disaster dummies, D1 and D2 are expected to contain positive signs as natural disasters should increase the debt level.

When using panel data, the estimation is dependent on certain assumptions about the intercept, the slope coefficients and the error term. If all the intercepts and slope coefficients are constant and the error term absorbs the group and time effects then a pooled estimation[5] technique

[5] Pooled regression assumes that the intercepts and slopes are the same across all countries; hence, there are no differences between the estimated cross sections.

should be used. If on one hand it is assumed that there are individual country effects that are time invariant (constant slope coefficients and variable intercepts) then the fixed effects method should be applied. The fixed effects model is also referred to as the Least Squares Dummy Variable (LSDV) estimator, because dummy variables are included in the model to control for the individual country effects. These dummies are assumed to be correlated with the regressors and if excluded from the model could result in misspecification. On the other hand if it is assumed that the individual country effects are unobserved random variables then the random effects model would be the most suitable (Gujurati, 2002). The estimation done by either technique would provide unreliable estimators if the data are non-stationary and if the explanatory variables and the error term are correlated. Both fixed and random effects models adjust for heteroskedasticity. The Durbin-Watson (DW) statistic is used to test for the presence of autocorrelation or serial correlation in the models.

In order to determine the panel data estimation technique, two tests were conducted. These are the Redundant Fixed Effects (RFE) test and the Hausman test. The RFE test which is an F-test assists in choosing between a pooled and a fixed effects regression. The F test verifies that the individual country effects are homogeneous under the null hypothesis, against the alternative that these effects differ across at least two countries. A rejection of the null would indicate that the fixed effects estimator is consistent and efficient. The Hausman test is a test for orthogonality of the random effects and the regressors, and thus helps to discriminate between the fixed effects and random effects estimators. The null hypothesis is that the random effects model is preferred (no correlation) against the alternative of the fixed effects model. A rejection of the null implies that the fixed effects model would be the appropriate model. The resulting F statistics from the RFE test for the two regressions ranged from 2.041 - 2.081 with probability values of 0.079 and 0.074, respectively. This led to a rejection of the null at 10 per cent significance level (see table 4 in Appendix II, an indication that the fixed effects were not redundant and thereby provided evidence, though weak, for the presence of individual country effects. The Hausman test yielded mixed results, with one regression failing to reject the null of random effects while the other regression rejected the null at 5 and 10 per cent significance levels (see table 5 in Appendix II). Given the conflicting results of the two tests, it

was decided that the fixed effect estimator was most appropriate to determine the impact of natural disasters on public debt accumulation in the ECCU. The test for autocorrelation using the Durbin Watson test statistic indicates the absence of first (1st) order serial correlation[6]. Cross section weights together with cross section heteroskedasticity robust standard errors were employed in the regression analysis to account for possible heteroskedasticity.

5.0 RESULTS

The estimation results for both models are presented in table 6 in Appendix II. The goodness of fit is indicated by the adjusted R-square which ranged from 0.365 to 0.403 per cent and is reasonably good for panel data. In addition both models are global significant indicated by the F statistics of 7.848 and 9.047 and probability values of 0.000, which means that the variables included in the models as a group significantly explain the relationships between the dependent and independent variables. All the variables possess the expected signs, a prior.

The primary surplus, real GDP and the real implicit interest rate all have a significant impact on the evolution of public debt in the six independent ECCU countries, coherent with the theoretical analysis and previous studies. In relation to natural disasters, the results indicate that natural disasters which cause damages in excess of 2.0 per cent of GDP (D2) causes the debt to GDP ratio to grow faster increase by 6.7 percentage points, compared with a year in which a disaster causes less damage or non occurs. In regard to D1 the debt to GDP ratio would increase by 2.2 per cent, but it is not statistically significant.

The findings of this study are similar to that of Acevedo (2012) who found that in the year that

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[6] The lower (d_L) and upper (d_U) bounds values of the DW test statistics at 0.05 level of significance are 1.592 and 1.780 respectively for n=4. A value less than the lower bound statistic is a sign of positive serial correlation and a value greater than the upper bound statistic indicates no evidence of serial correlation. A value in-between indicates inconclusive evidence of the presence or absence of positive 1st order serial correlation. In the two regressions the DW statistics ranged from a minimum of 1.735 to a maximum of 1.831, indicating that the error terms are not correlated with one another.

ECCU countries are hit by a moderate storm the debt to GDP ratio grew faster by almost 5.0 per cent. Melecky and Raddatz (2011), although they did not focus on debt, found that natural disasters had a significant impact on the fiscal deficit of middle income countries as governments in those countries react to disasters by engaging in deficit financing, thus increasing their overall debt levels. In both lower-middle and higher-middle income countries the budget deficit increased by 30.0 per cent and 20.0 per cent, respectively, after a climatic disaster.

6.0 POLICY RECOMMENDATIONS AND CONCLUSION

6.1 Policy Recommendations

In light of the ECCUs well-documented vulnerability to natural disasters and their impact on debt accumulation, as illustrated above, a more proactive and anticipatory posture should be adopted by the member states in order to do the following:

1. Mitigate against natural disasters, especially hurricanes which have the highest frequency of incidence in the sub-region so as to limit the adverse impacts on the country's output - prevention is better than cure;
2. Ease the pressure on the government's fiscal accounts and debt position, not only in terms of increasing its debt but also relative to its ability to service its existing debt;
3. Reduce the dependence on relief or aid flow, which is not always reliable or timely; and,
4. Allow the governments to respond to the needs of their people in a quick and decisive manner.

Mitigation efforts could include some ex-ante Catastrophe Risk Financing Options such as: the creation of a Reserve Fund; establishment of a Contingent Debt Facility; Insurance (both private households and government); Catastrophe Bonds; and Catastrophe Insurance Pools/Parametric Insurance.

The suggestion therefore is for the establishment of an ECCU Regional Disaster Contingency Fund[7] (RDCF) which can provide additional and immediate resources to the governments in the event of a disaster. The RDCF is not intended to be a substitute for the Caribbean Governments Insurance Fund for Earthquake and Hurricane Catastrophes (CCRIF) or any other form of disaster assistance that the authorities receive in the event of a disaster, it is instead intended to be a compliment to the existing arrangements and affords the government even more resources. In fact, the CCRIF indicates that "the Facility does not obviate the need for Caribbean governments to set up a National Disaster Fund" and further states that CCRIF provides a cost-effective solution for just one part of the larger comprehensive disaster management process. CCRIF has also posited that this contingency fund must be properly planned if economic targets such as GDP growth are to be met.

In summary therefore, provisions should be made for disaster contingency fund based on the following arguments:

1. It sends the right signals to multilateral agencies and development partners that the countries are willing to look after themselves and are serious about planning and fiscal management.

[7] A contingency fund is simply a reserve fund set aside to handle unexpected debts that are outside the range of the usual operating budget. This model of maintaining reserve money as protection against possible loss in the event of an emergency situation can be utilized in a number of situations. Governments, private businesses, and even individual households can establish and maintain a contingency fund as part of the overall financial plan of operation. In a government setting, the contingency fund is often identified as a disaster recovery fund or disaster assistance fund.

2. A contingency fund allows for immediate disbursements of funds to affected areas since it requires no outside evaluation or assessment. Disbursements will be made by internal authorities based on reasonable first estimates of damages.

3. Given the devastating nature of natural disasters, it makes prudent sense to factor in a premium for the effects of natural disasters on infrastructure which can form part of the proposed contingency. For example, where projects are undertaken by donors, a cost for repairs and renovations following a disaster should be included in the estimates and this money can be placed in the contingency fund.

6.2 Conclusion

This paper investigated the impact of natural disasters on public debt accumulation in the six independent countries of the ECCU using panel data regression analysis. Employing a fixed effects panel estimator to capture the individual country effects, the results indicate that meteorological, geological and other natural disasters are significant contributors to the increase in public debt. This finding is consistent with the results of other researches of similar types done for lower-middle-income countries, who also found that disasters have significant adverse impact on the fiscal positions and debt sustainability of the affected territories by decreasing output and increasing deficits. In particular, the results suggest that a natural disaster which causes damages with an estimated value of roughly 2.0 per cent or more of GDP increases the debt to GDP ratio by 6.7 percentage points, relative to a year in which the damage inflicted is less or there is no disaster. Natural disasters of lesser magnitude result in an equally lesser impact on the debt to GDP ratio of approximately 2.2 per cent; but this result was found to be statistically insignificant. An important policy implication of the results is that if the damages of natural disasters could be contained, then the likelihood of borrowing for reconstruction could be reduced. Hence, disaster mitigation becomes a critical aspect of containing the impact of natural disasters. Disaster mitigation may assume the form of insurance, contingency funds, enforcement of building codes and standards, and public education among others. According to Melecky and Raddatz (2011), insurance penetration

offers one of the best ex-post mitigation approaches against real and fiscal consequences of disasters. Therefore, it is imperative that the debt management strategy of ECCU member countries fully integrate the deployment of effective disaster mitigation strategies, which may include tapping into global financial resources for climate change adaptation.

REFERENCES

Acevedo, Sebastian, (2012), "Debt, Growth and Natural Disasters: A Caribbean Trilogy". Unpublished.

Benson, C and E. Clay (2003), "Economic and Financial Impacts of Natural Disasters: An Assessment of their Effects and Options for Mitigation". London Overseas Development Institute.

Cavallo Eduardo and Ilan Noy, (2010), "The Economics of Natural Disasters: A Survey". Inter-American Development Bank Working Paper Series # IDB-WP-124.

Greenidge Kevin, Drakes Lisa and Craigwell Roland, (2010), "*The External Public Debt in the Caribbean Community"*. Journal of Policy Modeling 32 (2010) 418-431.

Gujarati, Damodar (2002), "Introductory Econometrics with Applications", 5th Edition. McGraw Hill Inc.

Heger, M., A. Julca, and O. Paddison, (2008), "Analysing the Impact of Natural Hazards in Small Economies". UNU-WIDER Research Paper No.2008/25.

International Monetary Fund (IMF), (2013), "Caribbean Small States: Challenges of High Debt and Low Growth".

IMF (2011), "Eastern Caribbean Central Bank: Selected Issues", IMF Country Report No 11/32, January 2011. http://www.imf.org/external/pubs/ft/scr/2011/cr1132.pdf

Khan M.E (2005), "The Death Toll from Natural Disasters: The Role of Income, Geography and Institutions". Review of Economics and Statistics 87(2): 271-284.

Leonce, Janai and Kevin Hope (2013), "The ECCU Debt Carrying Capacity: An Empirical Investigation of its Debt Evolution and Debt Limits". ECCB Working Paper Series, Vol 2.

Melecky, Martin and Claudio Raddatz, (2011), "How Do Governments Respond After Catastrophes? Natural Disaster Shocks and the Fiscal Stance". World Bank, Working Paper Series #5564.

Rasmussen N, Tobias, (2004), "Macroeconomic Implications of Natural Disasters in the Caribbean". IMF Working Paper WP/04/224.

Romulo Caballeros Otero and Ricardo Zapata Marti (1994), The Impacts of Natural Disasters on Developing Economies: Implications for the International Development and Disaster Community.

Sahay, Ratna (2005), "Stabilization, Debt and Fiscal Policy in the Caribbean". IMF Working Paper WP/05/26.

Sen A. (1981), "Poverty and Famines: An Essay on Entitlement and Deprivation". Oxford University Press.

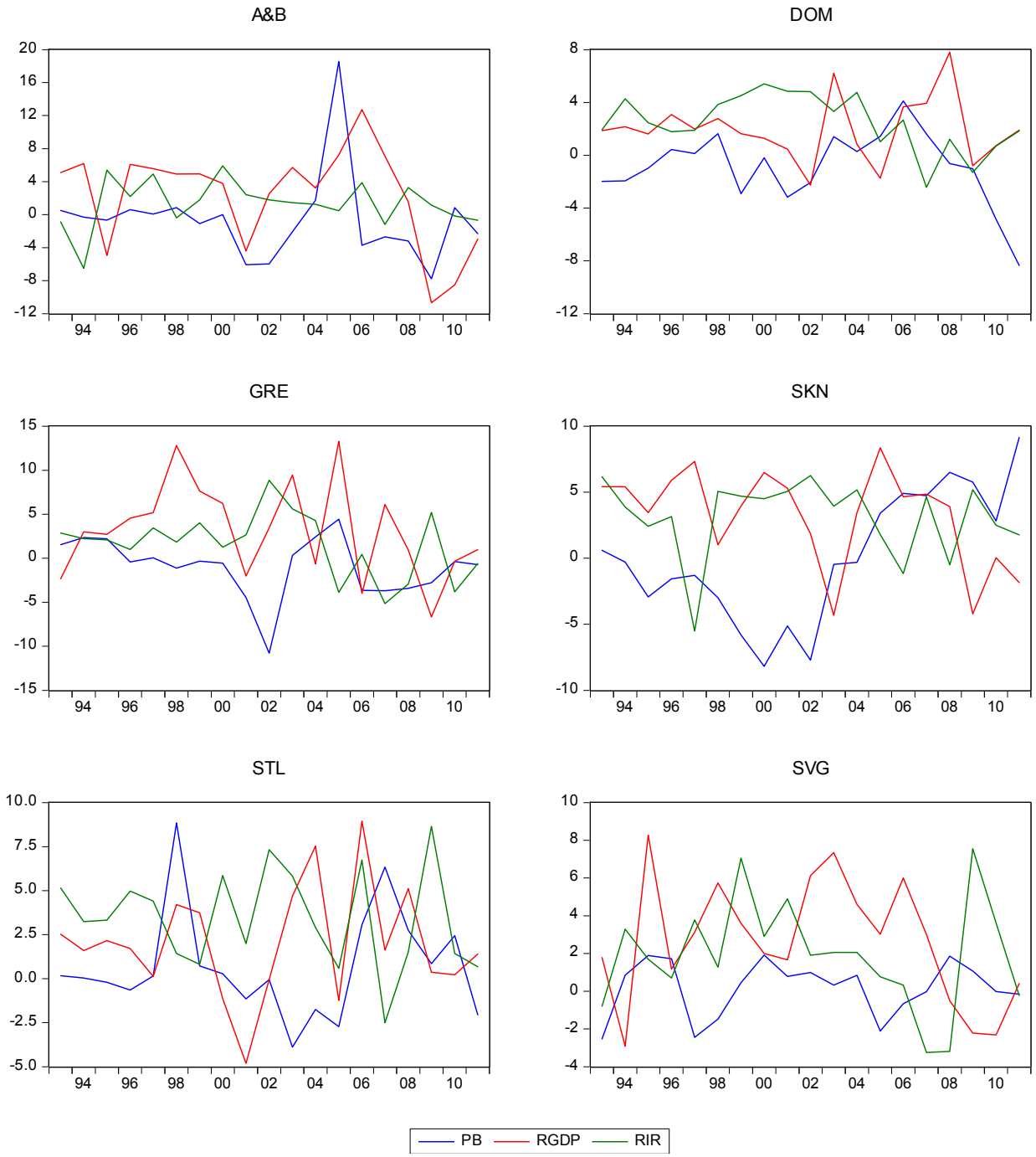
Standard and Poors. (2010), "Assessing the Impact of Natural Disasters on Sovereign Credit Ratings". Publication date: 14-Jun-2010 09:00:28 EST. http://www.standardandpoors.com/products-services/articles/en/us/?assetID=1245214634606

Toya, Hideki and Mark Skidmore, (2005), "Economic Development and the Impacts of Natural Disasters". University of Wisconsin- Whitewater, Working Paper 05-04.

World Bank (2011), 'Research Roundup Summary, Focus on Economic Effects of Natural Disasters' April. Development Research Group.

APPENDIX I

Figure 1: Evolution of RGDP, RIR and PB



A&B–Antigua and Barbuda; DOM–Dominica; GRE-Grenada; SKN- St Kitts and Nevis; STL- Saint Lucia; SVG- St Vincent and the Grenadines

APPENDIX II

Table 1: Summary Statistics of Variables

Variable	Mean	Std Dev	Max	Min
ΔPDEBT	77.65	30.64	162.72	23.80
PB	-0.27	3.69	18.54	-10.78
RIR	2.31	2.93	8.85	-6.50
RGDP	2.56	4.11	13.27	-10.67

Source: Generated by Eviews.
Note: ΔPDEBT is the log difference of the public debt to GDP ratio; PB is the primary balance; RIR is the real implicit interest rate and RGDP is real GDP growth.

Table 2: Correlation Coefficients

Covariance Analysis: Ordinary

Date: 10/17/13 Time: 14:32

Sample (adjusted): 1994 2011

Included observations: 108 after adjustments

Balanced sample (listwise missing value deletion)

Correlation t-Statistic Probability	DPDEBT	PB	RGDP	RIR
DPDEBT	1.000000			

PB	-0.393597	1.000000		
	-4.408142	-----		
	0.0000	-----		
RGDP	-0.322300	0.142878	1.000000	
	-3.505335	1.486272	-----	
	0.0007	0.1402	-----	
RIR	0.406490	-0.167489	-0.118374	1.000000
	4.580573	-1.749116	-1.227361	-----
	0.0000	0.0832	0.2224	-----

Source: Generated by Eviews

Table 3: Panel Unit Root Test Results

Variable	LLC	IPS	ADF- Fisher	Hadri
ΔPdebt	-1.920 (0.027)**	-2.070 (0.019) **	22.32 (0.034)**	0.628 (0.265)
PB	-1.176 (0.119)	-1.885 (0.029)**	26.34 (0.009)***	1.192 (0.116)
RGDP	-3.096 (0.001)***	-2.687 (0.003)***	26.65 (0.008)***	0.990 (0.161)
RIR	-3.139 (0.000)***	-3.574 (0.000)***	37.13 (0.000)***	0.886 (0.187)

Note: Table indicates test statistics with probability values in parentheses

* Statistically significant at 10%

** Statistically significant at 5%

*** Statistically significant at 1%.

Table 4: Redundant Fixed Effects Test Results

Redundant Fixed Effects Tests
Equation: PB, RGDP, RIR, D1
Test cross-section fixed effects

Effects Test	Statistic	d.f.	Prob.
Cross-section F	2.041769	(5,98)	0.0794

Redundant Fixed Effects Tests
Equation: PB, RGDP, RIR, D2
Test cross-section fixed effects

Effects Test	Statistic	d.f.	Prob.
Cross-section F	2.081100	(5,98)	0.0742

Table 5: Hausman Test

Correlated Random Effects - Hausman Test
Equation: PB, RGDP, RIR, D1
Test cross-section random effects

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	5.769724	4	0.2170

Correlated Random Effects - Hausman Test
Equation: PB, RGDP, RIR, D2
Test cross-section random effects

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	10.263425	4	0.0362

Table 6: Panel Fixed Effects Estimation Results

Cross section included: 6		
Total observations: 108		
Linear estimation after one-step weighting matrix		
White-cross section standard errors and covariance		
Variables	Model 1	Model 2
Constant	1.917	1.813
	(1.797)*	(1.7603)*
PB	-0.907	-0.905
	(-3.946)***	(-3.968)***
RGDP	-0.660	-0.607
	(-3.786)***	(-3.486)***
RIR	0.871	0.814
	(2.481)**	(2.298)**
D1	2.152	.....
	(1.448)	.....
D2	.....	6.651
	....	(4.387)***
R^2	0.418	0.453
Adj R^2	0.365	0.403
F statistic	7.848	9.047
Prob (F-stats)	0.0000	0.0000
DW Statistics	1.831	1.735
Robust t statistics are parenthesis		
* Statistically significant at 10%		
** Statistically significant at 5%		
*** Statistically significant at 1%.		