

**Inflation and the variability of relative prices  
in the Caribbean:  
Evidence from panel threshold models**

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## Abstract

The impacts of inflation are well known and among these are the distortion of decision making by entrepreneurs due to uncertainty and the direct impact on the incomes of the poor and most vulnerable. Pressures for increased wages and conflict over the size of the public sector wage bill are additional consequences of inflation. Recently, Espinoza et al (2011) investigated the issue of the level at which inflation should be a concern and if unheeded would undermine growth. They found that for developing countries inflation above 10% harmed growth.

This paper examines the impact of inflation and its variability<sup>1</sup> for eight Caribbean countries; Antigua and Barbuda, Bahamas, Barbados, Dominica, Grenada, Jamaica, Saint Kitts and Nevis and Saint Vincent and the Grenadines. The paper goes beyond the standard approach to examine the variability of relative prices (VRP) within the context of a threshold effects framework, since it was recognized that whether inflation was low or very high was significant in determining its impact on an economy. The paper employed a panel threshold effects model to capture the non-linear nature of the relationship, which exists between inflation and its variability. The findings are that inflation variability is high at both low and high rates of inflation and that inflation targeting could have an upper-bound of at most 10% for the Caribbean. It was also found that such variability could even exist in a low inflation environment, which added to inflation uncertainty. Of course this conclusion is subject to the fact that there is considerable variation in inflation rates among countries in the Caribbean subregion and therefore policies to address inflation would have to be country specific.

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<sup>1</sup> Change in inflation (inflation measured by the change in the Consumer Price Index).



## I. Introduction

This paper examines the relationship between inflation and its variability for eight Caribbean countries; Antigua and Barbuda, Bahamas, Barbados, Dominica, Grenada, Jamaica, Saint Kitts and Nevis and Saint Vincent and the Grenadines for the period January 2002 to January 2010 using a threshold panel data framework. This approach is employed to capture a possible non-linear relationship between inflation and its variability. The issue of inflation underpins macroeconomic theory which argues that the variability of relative prices (VRP) was the central distortion of inflation. It is recognized that there are considerable benefits to price stability as there were costs to inflation. Apart from the fact that it affects investment decisions, inflation also affects the most vulnerable as it reduces purchasing power.<sup>2</sup> It can be argued that since uncertainty springs from difficulties in knowing the future, higher uncertainty may reflect higher volatility or a higher variability around the mean of a variable such as inflation. There is considerable literature that links inflation with uncertainty and its ultimate impact on growth. Friedman (1977) suggested that higher inflation may influence inflation uncertainty and this lowered welfare and growth. The reformulation of this hypothesis by Ball (1992) in a model of monetary policy showed that high inflation created uncertainty about future monetary policy and this resulted in higher inflation variability.

Based on this hypothesis a number of studies have been done to examine the relationship between inflation and its variability and the results tend to vary considerably. One of the earliest studies, which was in line with the Friedman-Ball hypothesis, was done by Okum (1971). The study which was conducted on 17 Organisation for Economic Co-operation and Development (OECD) countries from 1951-1968 reported a positive relationship between the average inflation rates and a measure of inflation variability.

Davis and Kanago (1998) using survey data for a larger set of countries over a 20-year period confirmed the hypothesis, however, this relationship tended to be less strong for individual country data. Studies such as those of Davis and Kanago (1996) found that for the OECD and high-inflation countries that the relationship was quite weak at best.

A variety of studies along the lines of Engle (1982, 1983) which incorporate autoregressive conditional heteroskedasticity effects have also produced less convincing results (see Grier and Perry (1998); Conrad and Karanasos (2005) and Baillie et al (1996)) for developed and developing countries.

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<sup>2</sup> Standard Neo Keynesian dynamic general equilibrium models, interpreted price stability as an outcome of optimal monetary policy since inflation increased the VRP.

Nautz and Scharff (2006) pointed out that despite the importance of the role of inflation in determining the VRP, empirical work in this area has been meager. In the case of the Caribbean this is the first paper that employs this particular methodology to empirically assess the issue.

While research in this area also employed variables to capture the expected and unexpected impact of inflation, it is common to examine the inflation variability relationship in a linear fashion which implies that the marginal impact of inflation on VRP does not depend on the level of inflation. The fact is that this relationship is likely to be non-linear. It is reasonable to expect posits, for example, that higher levels of inflation is likely to create more inflation uncertainty and exact higher costs relative to when inflation was low. Caglayan and Filiztekin (2003) considered the relationship between inflation and its variability for Turkish provinces using simple approaches to non-linearity. In their study, the data were divided into two parts based on a high and low inflation segment. As a consequence they could neither estimate the number of inflation regimes nor the threshold level of inflation.

Another approach which has been employed is the use of quantile regression along the lines of Fang et al (2010). In contrast to studies which employ time series for individual countries, they employed quantile regression to investigate the relationship between inflation and its variability for a cross section of 152 countries from 1993-2003. In their study, a variety of measures for inflation and its variability were used including the mean and relative variation of inflation. They found a positive relationship between inflation and its variability across quantiles and that higher inflation was associated with more variability which supported the Friedman-Ball hypothesis. In addition, the VRP raised the rate of inflation and the results were robust for various levels of inflation. In terms of thresholds, they found that for inflation rates under 3%, higher inflation did not lead to more variability.

To be able to capture multiple regimes in the same framework, the panel threshold model developed by Hansen (1999) was employed to capture the non-linear impact of inflation and its variability in the Caribbean. The use of this framework permits testing for the number of inflation regimes and to estimate the threshold levels and the marginal impact of inflation. Nautz and Scharff (2006) and Bick and Nautz (2008) used a similar approach for the Euro Area and American cities, respectively. In the first of these papers in which expected inflation and core inflation are also incorporated, Nautz and Scharff (2006) found that the impact of expected inflation on VRP was hump shaped. Thus, expected inflation increased VRP if core inflation is either very low ( $<-1.38\%$ ) or very high ( $>5.94\%$ ). They found that between these thresholds expected inflation does not affect the economy by way of its impact on VRP.



## II. The Determinants of inflation in the Caribbean

Tackling inflation and designing appropriate policies to manage inflation requires an understanding of the factors that determine inflation in the Caribbean. According to economic literature, there are two main views regarding the drivers of inflation. The first view holds that inflation is caused by non-monetary factors such as oil and commodity price shocks, while the second view holds that inflation is caused by monetary variables such as exchange rates and excessive money supply creation.

Several studies have examined the inflationary process in the Caribbean. Greenidge and DaCosta (2009) found that changes in the price of oil was a major determining factor of inflation during the period 1970-2006 for the four Caribbean<sup>3</sup> countries in their study. Exchange rate fluctuations, increases in the money supply, changes in the interest rate, unemployment and the output gap were also identified as major drivers of inflation among the countries.

The institutional framework also plays a critical role in determining the level of inflation in the Caribbean. Boyd and Smith (2004) found that the institutional framework within which monetary and fiscal policies were developed provided varying degrees of constraints, which in turn affected the level of inflation. They attributed low inflation and exchange rate stability in the Eastern Caribbean Currency Union (ECCU)<sup>4</sup> to the currency union which enforced monetary discipline. In the case of the Bahamas, Barbados and Belize, monetary stability was an important goal of their central banks. On the other hand, the poor monetary performance of Guyana, Jamaica and Trinidad and Tobago resulted from discretionary policy choices based on accommodating central government debts.

During the period 2002-2010 the inflation rates in the Caribbean varied considerably among countries. In the most developed countries (MDCs)<sup>5</sup> the inflation rates were much higher than those of the ECCU (see figure 1). Different factors accounted for this variation among the countries of which the exchange rate regimes is the most prominent. Of the MDCs, the inflation rates in the Bahamas, Barbados and Belize were comparable to that of the ECCU. These countries all have fixed exchange rate regimes in which the domestic currencies are pegged to the United States dollar. As a result, exchange rate stability has served as a buffer against international price increases.

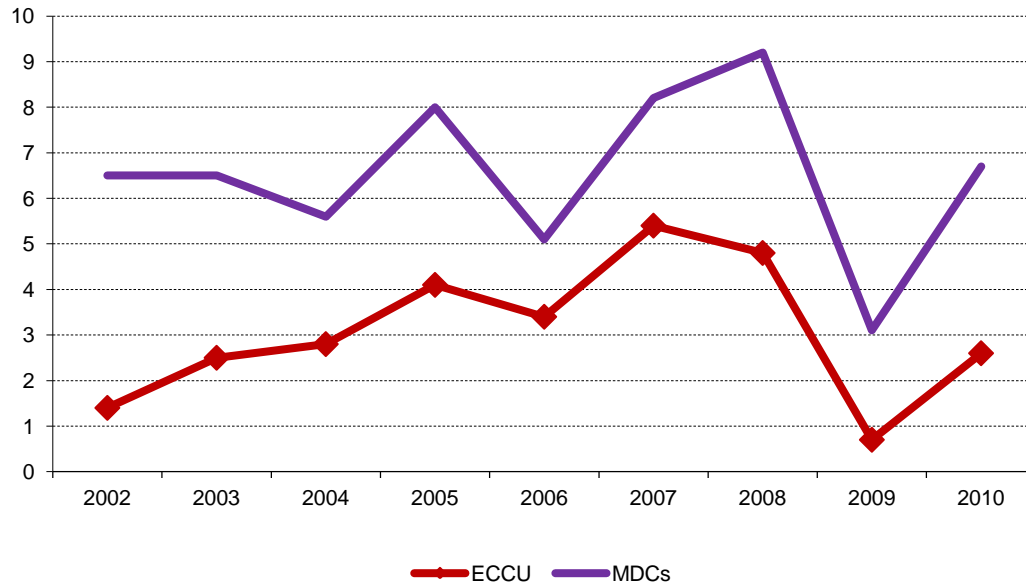
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<sup>3</sup> These countries were Barbados, Guyana, Jamaica and Trinidad and Tobago.

<sup>4</sup> Anguilla, Antigua and Barbuda, Dominica, Grenada, Montserrat, Saint Kitts and Nevis, Saint Lucia and Saint Vincent and the Grenadines.

<sup>5</sup> The Bahamas, Barbados, Belize, Jamaica, Guyana, Trinidad and Tobago and Suriname.

**FIGURE 1**  
**INFLATION RATES IN THE CARIBBEAN (15 COUNTRIES), 2002 -2010**  
*(Percentages)*



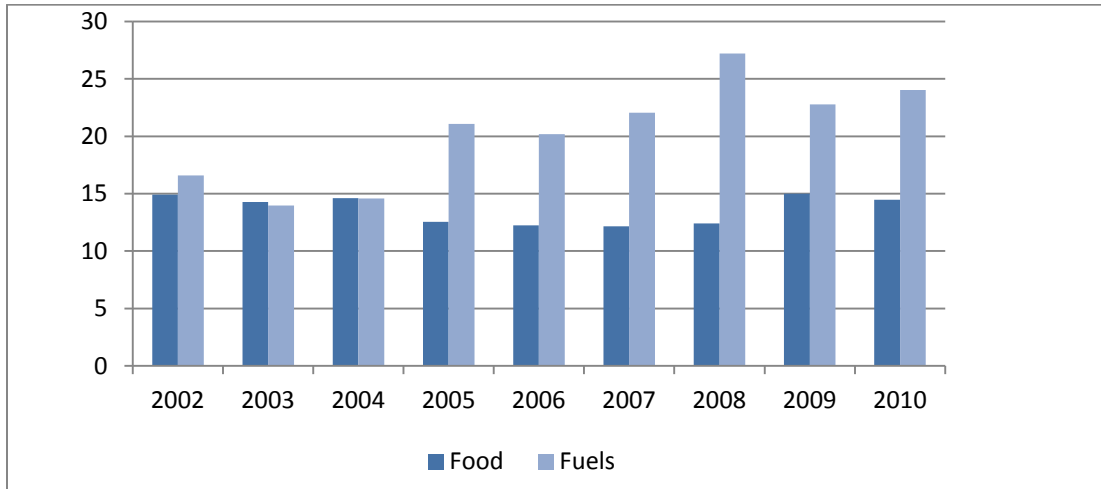
Source: Economic Commission for Latin America and the Caribbean (ECLAC), on the basis of official data.

On the other hand, countries with managed floats<sup>6</sup> or flexible exchange rate regimes, such as Jamaica, Guyana, Trinidad and Tobago and Suriname recorded higher levels of inflation, in some instances reaching double digits.

In addition, to differing exchange rate regimes, most Caribbean countries are net importers of food and oil, therefore, changes in these commodities on the international market directly affected domestic inflation rates. Figure 2 reports the average food and fuel imports for the Caribbean over the period 2002-2010. Food imports exceed 10% of total imports while fuel imports reached as high as 27% of total imports in 2008.

<sup>6</sup> Central bank sells and buys foreign exchange to influence the daily fluctuation of the exchange rate.

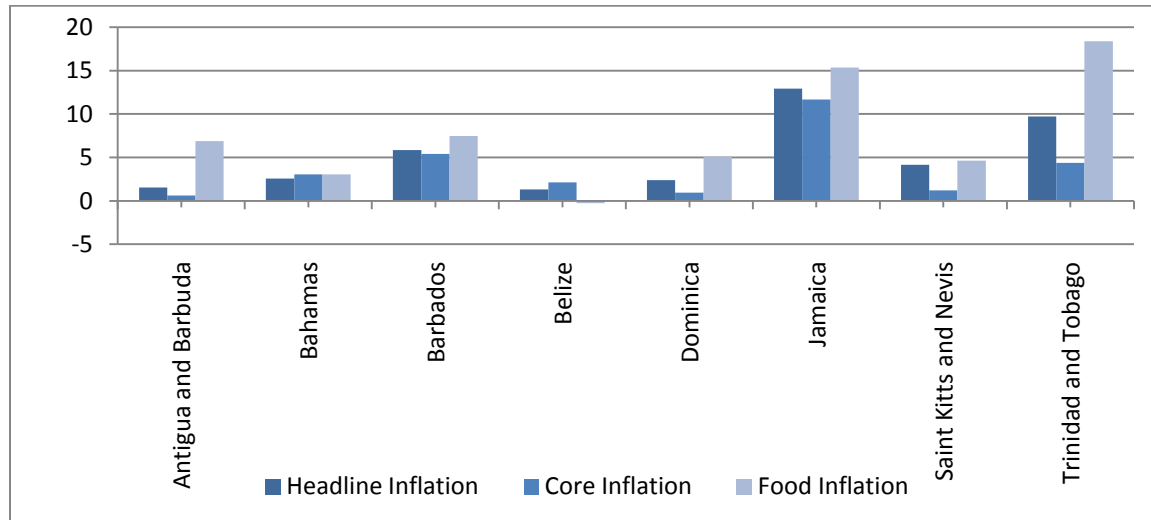
**FIGURE 2**  
**FOOD AND FUEL IMPORTS, CARIBBEAN (15 COUNTRIES)**  
**AVERAGE FOR THE PERIOD 2002-2010**  
*(Percentages of total merchandise imports)*



Source: United Nations Conference on Trade and Development (UNCTAD), UNCTADSTAT, (database), <<http://unctadstat.unctad.org>> [October 2011].

Disaggregating the inflation rates for selected countries into headline, core<sup>7</sup> and food inflation also provides relevant information over the period 2008-2010 (see figure 3). With the exception of Belize, food inflation surpassed headline inflation in all countries. The most significant difference between food and headline inflation was observed in Antigua and Barbuda, Dominica, Jamaica and Trinidad and Tobago.

**FIGURE 3**  
**HEADLINE, CORE AND FOOD INFLATION, AVERAGE 2008-2010**  
*(Percentages)*

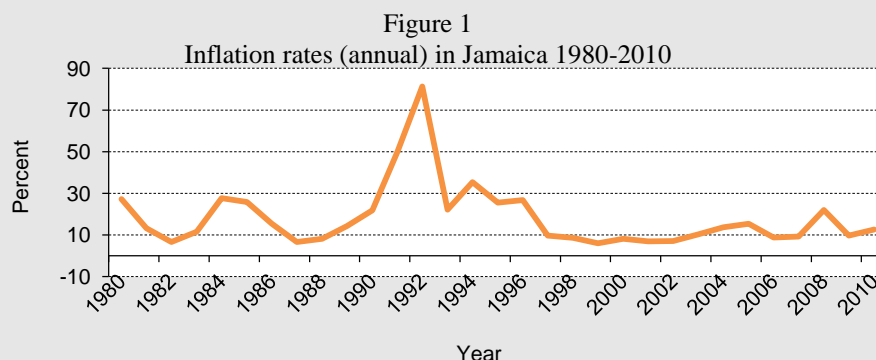


Source: Economic Commission for Latin America and the Caribbean (ECLAC) on the basis of official data.

<sup>7</sup> Headline inflation is a measure of total inflation. Core inflation is a measure of inflation that excludes price movements of food and fuel.

### BOX 1 INFLATION IN JAMAICA, 1980 - 2010

Jamaica is a small, open economy traditionally based on the production of bauxite, sugar and manufactured goods and the provision of services, particularly tourism. Inflation has generally been a major policy challenge for the authorities as high inflation rates discourage investments and private sector activity and often is a signal of poor economic management. During the period 1980-2010, the inflation rate in Jamaica was frequently high (double digits, see figure 1). This was attributed to several factors, which included devaluation or depreciation of the exchange rate, increases in import prices and to a lesser extent increases in the money supply.



Source: Economic Commission for Latin America and the Caribbean (ECLAC), on the basis of official data.

Jamaica recorded its highest inflation rate of 80.2% in 1991, tapering to 40.2% in 1992. This escalation in the inflation rate in 1991 was primarily due to transformation of the Jamaican economy through a number of structural reforms aimed at macroeconomic stability. Two major components of this reform were the liberalization of the foreign exchange market in 1990 and the capital account in 1991, which led a substantial depreciation of the currency. Because of the large import content of domestic production the depreciation in the exchange rate translated into higher domestic prices.

To curb the high levels of inflation, the Bank of Jamaica implemented a number of tight monetary policy measures. These included the maintenance of high interest rates, the increasing use of open market operations (base money targeting) to control liquidity and augmenting the supply of foreign exchange. Other indirect instruments included reverse purchase agreements and the development of an active secondary market for trading securities. These measures and particularly that of base money targeting caused the inflation rate to decline to single digit at 7.3% in 2002.

However, high inflation continued to be a major challenge as inflation once again trended up to double digits in 2003-2006 and peaked in 2008. This time this was on account of a widening fiscal deficit and concerns about the sustainability of the public debt burden which led to exchange-rate pressures. This trend was exacerbated by subsequent increases in utilities tariffs and transport fares, shortages arising from hurricane activity and higher food and fuel prices which resulted in a rate of inflation of 16.9% in 2008.

Controlling inflation remains a central focus in Jamaica's economic policy especially given the country's exposure to commodity price shocks and high dependence on imports. The Bank of Jamaica continues to employ open market operations and reserve requirement to manage the money supply.

Source: Shirene A. Bailey, "Investigating the link between financial dollarization and inflation: Evidence from Jamaica", Bank of Jamaica, 2005. Steve H. Hanke and Kurt Schuler, "Alternative monetary policy regimes for Jamaica", The John Hopkins University, 1995. Inter-American Development Bank (IDB), "Productivity and Competitiveness in the Jamaican Economy", *Economic and Sector Study Series*, Region 3, Jamaica, 2003.

### III. Description of the data

The inflation data were computed for eight countries: Antigua and Barbuda, Bahamas, Barbados, Dominica, Grenada, Jamaica, Saint Kitts and Nevis and Saint Vincent and the Grenadines using the consumer price index (CPI) for the respective countries. In addition, price data of eight major CPI subcategories<sup>8</sup> were used to compute the VRP for the period January 2002 to January 2010 (see annex 2).

Following Jamarillo (1999) and Mizen (2000), the VRP changes for country  $i$  in period  $t$ , ( $VRP_{it}$ ) was defined as the square root of the weighted sum of squared deviation of subcategory inflation  $\pi_{ijt}$  around the average inflation for each individual country which was defined as  $\pi_{it}$ . This can be written as

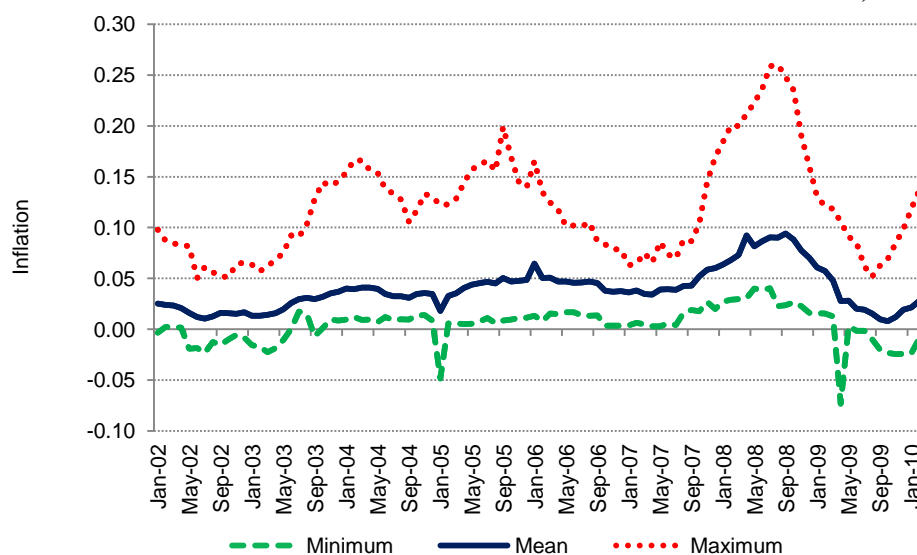
$$(1) \quad VRP_{it} = \sqrt{\sum_{j=1}^8 z_{ijt} (\pi_{ijt} - \pi_{it})^2}$$

Where  $\pi_{ijt} = \Delta \ln P_{ijt}$  and  $P_{ijt}$  is the price index of the  $j$ th subcategory of the index in the particular country  $i$  in period  $t$ . The variable  $z_{ijt}$  is the country specific weight of the  $j$ th subcategory in the aggregate index such that  $P_{it} = \sum_{j=1}^8 z_{ijt} P_{ijt}$  gives the aggregate price level in individual countries. The country specific weights tend to be time invariant based on the CPI. In addition, the inflation rate  $\pi_{it}$  is defined as  $\Delta \ln P_{it}$ .

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<sup>8</sup> The 8 subcategories were food and beverages, alcohol and tobacco, housing and utilities, clothing and footwear, furniture and household equipment, transportation, health and education.

**FIGURE 4**  
**INFLATION RATES ACROSS SELECTED CARIBBEAN COUNTRIES, 2002-2010**

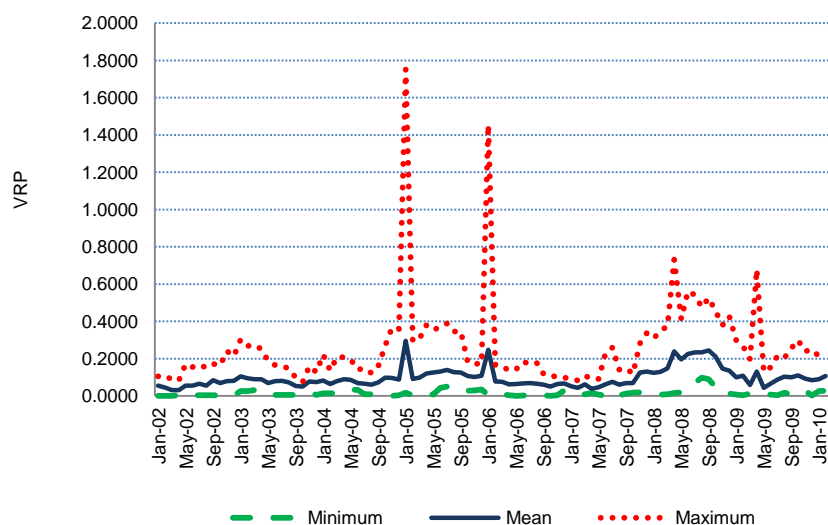


Source: Economic Commission for Latin America and the Caribbean (ECLAC), on the basis of official figures.

Figure 4 shows the behaviour of inflation rates in the eight Caribbean countries over the period January 2002 to January 2010. The evolution of mean inflation reflected three distinct periods: two periods of relatively low inflation (2002-2005 and 2009) and one period of high inflation (2006-2008). During 2002-2005, the average inflation rate ranged between 2%-4% in tandem with the general trend in global inflation in which commodity prices were contained. In 2006-2008, the average inflation rate spiked to as high as nearly 10%. This was mainly due to sharp increases in oil and food prices and the depreciation of the United States dollar against major currencies. Oil prices peaked at the highest level ever recorded to US\$ 148 per barrel in July 2008. The Food and Agricultural Organization of the United Nations general food index recorded a staggering 77% nominal inflation. This was mainly due the cereal sub-index which rose by 136.7%, driven by higher prices of wheat and rice which are the main staples of the region. Given that most Caribbean countries are net food and fuel importers, the spike in commodity prices had substantial effects on inflation in the region. For instance, in the first half of 2008, food inflation was 11.6% in Antigua and Barbuda, 6.1% in Barbados, 14.3% in Jamaica, and 10.1% in Saint Vincent and the Grenadines. During the period from July 2006 to June 2009, food inflation contributed 66.1%, 55.3% and 80.2% to headline inflation in Barbados, Jamaica and Saint Vincent and the Grenadines, respectively (ECLAC, 2008).

The minimum and maximum series highlighted country specific inflation rates. While there were negative and zero inflation rates in countries such as Antigua and Barbuda, Barbados and Dominica, Jamaica experienced double digit inflation rates that were as high as 26%. The difference between the minimum and maximum series pointed to the fact that there were different factors at play in determining the levels of inflation. The differences ranged from 6% to 24%, with the highest variation recorded in 2005 and 2008-2009. With the exception of Jamaica, which has a managed float, all the other countries in this study have fixed or quasi fixed exchange rates in which the domestic currency was pegged to the United States dollar. In the ECCU, Sun and Duttgupta (2008) found that price indexes (both tradable and non-tradable) moved closely with the United States of America price index and this may have helped to create price stability as the average annual rate of inflation was about 3% during 1990-2006 in these countries. Jamaica on the other hand has had a history of high inflation rates, with an average annual rate of inflation of 20% during 1990-2006. In the early 1990s the liberalization of the capital accounts, the movement away from fixed exchange rates, currency controls and the introduction of a value added tax, in a high inflation environment, helped to fuel inflation (see box 1).

**FIGURE 5**  
**VRP ACROSS SELECTED CARIBBEAN COUNTRIES, 2002-2010**



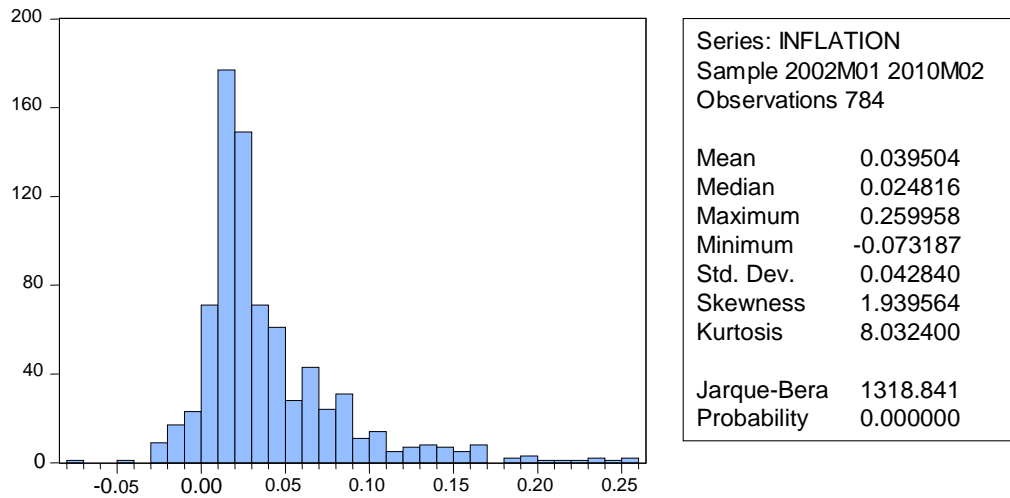
Source: Economic Commission for Latin America and the Caribbean (ECLAC), on the basis of official data.  
 Note: Generated from the Consumer Price Index for the selected countries.

Figure 5 shows the evolution of the VRP. The minimum values the VRP showed little movement around values of 1% while the maximum series spiked in 2005 and 2008 due to global commodity price shocks. The lowest VRP values were observed in Antigua and Barbuda and Barbados while the highest values were observed in Jamaica and Saint Vincent and the Grenadines (see annex 2).

The histogram of inflation rates (see figure 6) indicated that 25% of the observations are below an inflation rate of 1.6% and above an inflation rate of 5.2%. More than half of the inflation rates are in excess of 2%. This is important since central banks often tend to target an inflation rate of 2%. The histogram of the relative price volatility (see figure 7) indicates that 25% of the observations are below 3.1% and above 12.2% while more than half of the relative price volatility exceeds 6%.

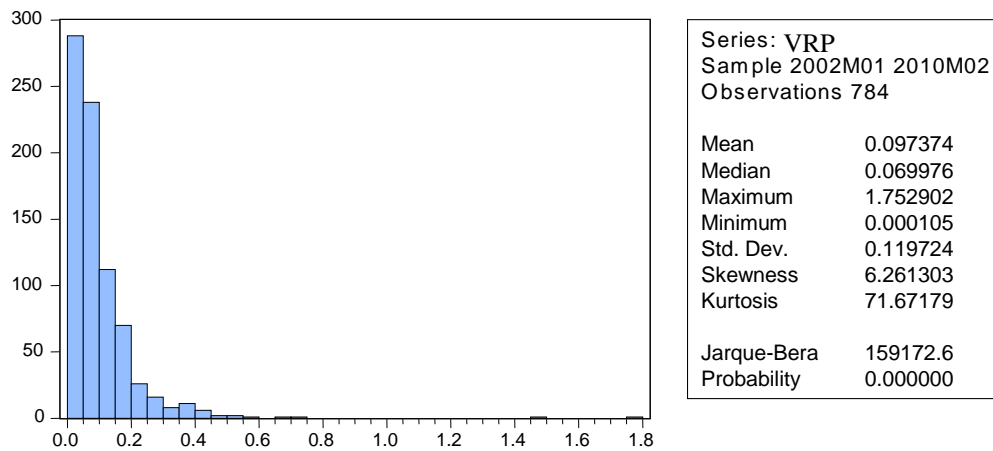
Looking more closely at the histograms of both series it appears that they were both skewed to the right with the VRP showing a much greater deviation from normality relative to the inflation series. For example the kurtosis for the inflation series was 8.03 but it was 71.67 for the VRP series. In addition, the Jarque-Bera test for normality shows greater departure from normality in the VRP series. This confirms that there was considerable variation among inflation rates in the region. As expected the skewness coefficient is greater for the VRP series relative to the inflation series.

**FIGURE 6**  
**FREQUENCY DISTRIBUTION OF COUNTRY INFLATION RATES, 2002-2010**



Source: Economic Commission for Latin America and the Caribbean (ECLAC), on the basis of official data.  
Note: Generated from Eviews 6.

**FIGURE 7**  
**FREQUENCY DISTRIBUTION OF VRP, 2002-2010**



Source: Economic Commission for Latin America and the Caribbean (ECLAC), on the basis of official data.  
Note: Generated from Eviews 6.



## IV. Estimation and results

Before doing the threshold analysis the relationship between inflation and relative price variability was estimated in a linear panel regression framework over the period January 2002 to February 2010. In addition, the absolute value of the inflation rate  $|\pi_{it}|$  was also employed as an explanatory variable since it could make a difference when inflation rates were very low. These formulations are as follows:

$$(1) \quad \text{VRP}_{it} = \alpha_i + \beta \pi_{it} + \varepsilon_{it}$$

$$(2) \quad \text{VRP}_{it} = \alpha_i + \beta |\pi_{it}| + \varepsilon_{it}$$

The result of this exercise suggested that no statistically significant linear relationship existed between inflation and its variability.

$$(3) \quad \text{VRP}_{it} = .094 + .294\pi_{it}$$

(.010) (.824)

$$(4) \quad \text{VRP}_{it} = .094 + .014|\pi_{it}|$$

(2.31) (17.7)

The results were in line with those of Bick and Nautz (2008) in which they found no relationship between the variability in relative prices and the rate of inflation. On the other hand there was a statistically significant relationship when the absolute value of the inflation rate was used in equation (4).

The double threshold model was estimated for the eight countries. Table 1 reported the tests for determining the statistical significance of the various threshold values including their confidence intervals. Following Nautz and Scharff (2006) in order to determine the number of thresholds, the

values of the threshold variable for inflation<sup>9</sup> was sorted with the sample restricted to having no less than 5% of the observations in each regime in one scenario and with the samples having no less than 10% of the observations in another which are referred to as the 5% and 10% rule. The likelihood statistics are reported as F1, F2 and F3 together with the asymptotic bootstrap<sup>10</sup> probability values.

TABLE 1  
TEST PROCEDURE FOR THE NUMBER OF THRESHOLDS

	5% RULE	10% RULE
Ho: no threshold (K=0)		
F1	352.18	311.42
p-value	0.00	0.00
Critical values (10%, 5%, 1%)	(13.00, 15.65, 22.57)	(11.20, 12.99, 22.27)
Ho: at most one threshold (K=1)		
F2	18.82	11.32
p-value	0.03	0.11
Critical values (10%, 5%, 1%)	(13.74, 16.32, 25.28)	(11.69, 14.24, 20.21)
Ho: at most two threshold (K=2)		
F3	12.51	5.79
p-value	0.122	0.56
Critical values (10%, 5%, 1%)	(13.65, 17.26, 26.69)	(11.55, 13.90, 20.56)

Source: Economic Commission for Latin America and the Caribbean (ECLAC), on the basis of official data.

The test for no threshold ( $K = 0$ ) was rejected at all three levels of significance (5%, 10% and 1%) for both the 5% and 10% rules. Under the null of a double threshold ( $K = 1$ ) the hypothesis was accepted at the 1% level under the 5% rule, but rejected for all levels under the 10% rule which suggested that the results for both strategies were not consistent for this null.

In the case of more than two thresholds ( $K = 2$ ), the likelihood ratio tests for the 5% and 10% rules rejected this comprehensively at all levels of significance with a correspondingly large probability value. Thus, there appears to be only two thresholds.

In light of the results that there may be two inflation thresholds, the double threshold model was estimated. The model was as follows:

$$(5) \quad \text{VRP}_{it} = \alpha_i + (\delta_1 + \beta_1 \pi_{it}) \mathbb{I}(\pi_{it} \leq \lambda_1) + (\delta_2 + \beta_2 \pi_{it}) \mathbb{I}(\lambda_1 < \pi_{it} \leq \lambda_2) + \beta_3 \pi_{it} \mathbb{I}(\lambda_2 < \pi_{it}) + u_t$$

In equation (5)  $\alpha_i$  is an overall intercept while  $\delta_1 + \beta_1$  is the intercept and slope respectively for regime one while  $\delta_2 + \beta_2$  is the intercept and slope in regime two. The variables  $\lambda_1$  and  $\lambda_2$  are the limits of the threshold values. When the regimes were estimated, the observations were sorted in relation to the threshold values for the 5% and 10% rules respectively (see table 2). The results

<sup>9</sup> Some authors hold the view that in the relationship between inflation and its variability, the inflation variables may not be homogenous and therefore core inflation was a better measure to use since it exhibited less correlation with inflation variability. This issue was not pursued here.

<sup>10</sup> Some 1000 bootstraps were done for each threshold draw.

suggested that only 5% of the observations fell in the low regime for the 5% rule while 87% fell in the middle regime. A similar pattern was obtained for the 10% rule which suggests that inflation rates were moderate. Of those countries having observations in the low regime, observations from Saint Vincent and the Grenadines were more frequent while Antigua and Barbuda, the Bahamas and Jamaica were never in that regime under the 5% rule. A few countries had observations in the high regime with the most frequent being Jamaica. A number of countries, however, had no observations in the high regime under any of the observation rules. Among these were Antigua and Barbuda, the Bahamas, Dominica and Grenada. This is an important result since three of these countries are part of the currency arrangement under the Eastern Caribbean Central Bank (ECCB).

**TABLE 2**  
**FREQUENCY OF INFLATION REGIMES IN SELECTED CARIBBEAN COUNTRIES**  
**UNDER THE 5% RULE WITH THE 10% RULE IN BRACKETS.**

	Low Inflation Regime	Medium Inflation Regime	High Inflation Regime
Antigua and Barbuda	0 (8)	98 (90)	0 (0)
Bahamas	0 (0)	98 (98)	0 (0)
Barbados	8 (13)	86 (74)	4 (11)
Dominica	9 (23)	89 (75)	0 (0)
Grenada	5 (13)	93 (85)	0 (0)
Jamaica	0 (0)	40 (28)	58 (70)
Saint Kitts and Nevis	3 (4)	95(79)	0 (15)
Saint Vincent and the Grenadines	13 (22)	81 (59)	4 (17)
Total	38 (83)	680(588)	66 (113)

Source: Economic Commission for Latin America and the Caribbean (ECLAC), on the basis of official data.

Note: The table shows how often a country appears in the various inflation regimes estimated for the inflation-VRP linkage under the 5 percent rule and 10 percent rule. The observations for the 10% rule are in brackets.

Turning now to the estimation results, the coefficients were estimated under the 5% and 10% rules. The estimated thresholds plus the 95% confidence intervals are reported in the upper part of table 3. Under the 5% rule, the point estimates of the two threshold values for monthly inflation are -0.64 and 10.1 respectively. The first of these values are the lower bound of the threshold value and the confidence intervals are fairly wide as they range between -0.62% and -0.24% for the first threshold and 0.7 and 10.8 for the second threshold value. Note also that the threshold value is closer to the upper bound of the confidence interval. Under the 10% rule, the values for the thresholds are 0.49 and 7.8. In light of the conclusions of the tests done before, greater confidence should be placed in the 5% relative to the 10% rule.

It is important to examine the estimates for the coefficients which capture the marginal impact of inflation in the three regimes. The coefficients were all highly statistically significant with the magnitude and sign of the coefficients depending on the level of inflation. In the low inflation regime that is when inflation is below -0.64% the marginal impact of inflation on VRP was negative with a value of -16.3%. This suggested a large decline in variability when inflation rates were negative. A number of writers, including Akerlof et al, (1996) and Jamarillo, (1999), have explained this as due to nominal wage rigidities. On the other hand when inflation was in the regime  $-0.64 < \lambda \leq 10.8$ , the coefficient was positive which suggested that inflation volatility rose sharply to 1.54 under the 5% rule and 2.01 under the 10% rule. When inflation was above the threshold value of 10.1% the VRP coefficient increased to 2.08 and 2.68, and was also highly significant suggesting that inflation variability rose above this threshold. The recent resurgence in food and oil prices raised considerable

issues again about the impact of inflation variability on prices. The results have clear implications for inflation targeting by central bankers for they suggest that there were threshold effects at which point inflation variability can be contained, however, beyond this threshold the inflation variability impact rises steeply.

**TABLE 3**  
**DOUBLE THRESHOLD MODEL SHOWING THE RELATIONSHIP**  
**BETWEEN VRP AND INFLATION**

		5% Rule	10% Rule
<b>Threshold estimate</b>			
$\hat{\lambda}_1$		-0.64	0.49
	95% confidence interval	(-0.64, -0.24)	(0.4, 0.5)
$\hat{\lambda}_2$		10.1	7.8
	95% confidence interval	(0.7, 10.8)	(1.8, 9.1)
<b>Regime dependent inflation coefficients</b>			
$\hat{\beta}_1$		-16.33	-11.12
	t- statistic	-2.2	-2.66
$\hat{\beta}_2$		1.54	2.01
	t- statistic	-8.1	-11.16
$\hat{\beta}_3$		2.08	2.68
	t- statistic	-6.5	-6.87
<b>Regime dependent intercepts</b>			
$\hat{\delta}_1$		-0.15	8.5
	t- statistic	-1.36	-2.12
$\hat{\delta}_2$		-0.01	0.08
	t- statistic	-0.25	-2.66
$R^2$		0.416	0.38

Source: Economic Commission for Latin America and the Caribbean (ECLAC), on the basis of official data.

## V. Conclusion

This paper examined the impact of VRP on the rate of inflation utilizing both traditional approaches and a threshold effects response function following Hansen (1999). The results suggested that the non-linear relationship has important implications for price variability especially given recent concerns about inflation. The paper rejected the linear relationship between inflation and its variability in preference of a non-linear relationship in which there were both negative and positive relationships in relation to each threshold. When inflation was below its threshold value of -0.64 %, which is very small, inflation variability is negative and suggested a significant decline in variability of -16.3%. Thus at low levels of inflation, not surprisingly variability is very low. On the other hand the results showed increasing variability as inflation increased with an upper limit of 10%. This means that central bankers in the Caribbean have a wider range for inflation targeting beyond the usual 2% to 3% that is often suggested by the general literature. In countries with low inflation such as the Antigua and Barbuda and Bahamas, the inflation target should be lower than in countries with high inflation such as Jamaica. Therefore, given the considerable variation in inflation rates among countries, each country will have to be examined individually for inflation targeting purposes.



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## **Annexes**

## Annex 1

### The Threshold Inflation Model

The methodology employed in this analysis utilizes the balanced panel threshold model along the lines of Hansen (1999 and 2000). This methodology can be explained in the case of a single threshold model with a balanced panel. A balanced panel means that all countries in the sample are observed over the same time period. Consider the following model:

$$(1) \quad y = \alpha_1 + \beta_1' \pi_{it} I(p_{it} \leq \lambda) + \beta_2' \pi_{it} I(p_{it} > \lambda) + u_{it}$$

In this formulation  $i$  refers to each of the individual countries such that  $1 \leq i \leq M$  where  $M$  in this case is eight and  $t$  is time covering the period 2002-2010 on a monthly basis. The indicator variable  $I(\cdot)$  takes on values of one and zero depending on the regime and the error term is distributed such that

$$u_{it} = N(0, \sigma^2) \quad ^{11}$$

Following standard notation, the dependent variable is  $y_{it}$  and the threshold variable  $p_{it}$  are scalars, while the regressor  $\pi_{it}$  is a vector of exogenous variables. The regimes also have intercepts in addition to an overall intercept.

When the threshold variable  $\pi_{it}$  is below a certain value in this case  $\lambda$ , it means that the variable of interest has a different impact on  $y_{it}$  which means that the two regimes are different. Within the Hansen (1999) framework the slope  $\beta$  can be estimated given some value for  $\lambda$  by ordinary least squares as a first strategy. In a second step the sum of squared errors is minimized such that  $\lambda = \text{argmin}_{\lambda} S_A(\lambda)$  leads to the estimate of the threshold  $\hat{\gamma}$  and the coefficient  $\hat{\beta} = \hat{\beta}(\hat{\gamma})$ . Having estimated the threshold it is possible to test for its statistical significance. An approach is to assume that there is no threshold effect in which case, the null is  $H_0: \beta_1 = \beta_2$ . The problem is that standard tests have non-standard distributions since the threshold is not available under the null. Hansen (1999) uses a bootstrap method to simulate the asymptotic distribution of the likelihood ratio test. The test procedure can also be used to construct confidence intervals.

In this example there are two threshold models in which case equation (1) can be modified as follows:

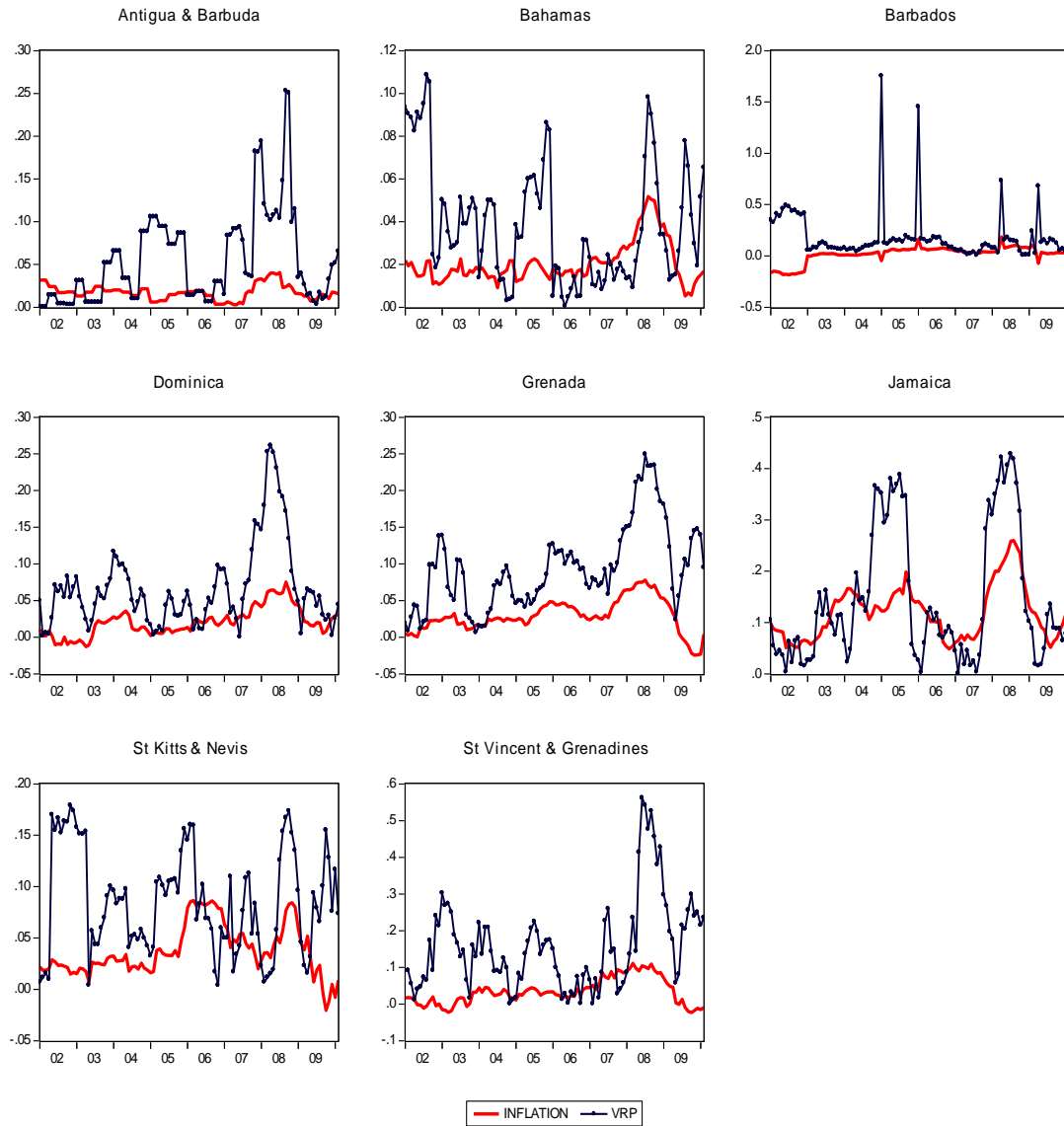
$$y_{it} = \alpha_i + \beta_1' \pi_{it} I(p_{it} \leq \lambda_1) + \beta_2' \pi_{it} I(\lambda_1 < p_{it} \leq \lambda_2) + \beta_3' \pi_{it} I(\lambda_2 < p_{it}) + u_{it} \quad \text{with the two } \lambda \text{ s differing from each other.}$$

As in the case of the single threshold model, the sum of squared residuals  $S(\lambda_1, \lambda_2)$  are calculated and the joint least squares estimates minimize  $S(\lambda_1, \lambda_2)$ . A sequential procedure can be employed to determine the significance of the thresholds within regimes. Thus, if the null of no thresholds is rejected, that is  $F_1$ , then the likelihood ratio statistic  $F_2$  discriminates between the first and second thresholds using the difference in the sum of squares from the two threshold models. Bai (1997) pointed out that the asymptotic distribution in the multiple threshold model is similar to the distribution in the single threshold model.

<sup>11</sup> The errors are assumed to be independent and identically distributed.

## Annex 2

### The evolution of Inflation and VRP, 2002-2010



Source: Economic Commission for Latin America and the Caribbean (ECLAC), on the basis of official data.