“Asymmetries in Exchange Rate Pass-through and Monetary Policy Principle: Some Caribbean Empirical Evidence.”

Abstract

The study finds that using linear models to examine the exchange rate pass-through to prices is generally fraught with serial correlation, heteroscedasticity and functional instability problems. As a solution to these problems, we employed nonlinear or asymmetric model to correct most of the problems for six non-members of Eastern Caribbean Currency Union (ECCU). Results show three threshold values for The Bahamas and Jamaica, and two threshold values for the rest of the countries. Previous month prices are found to be the threshold variable for all the countries, and they range from -5.2 percent in The Bahamas to 63.3 percent in Trinidad-Tobago during a low inflation/prices regime, and from -6.2 percent in The Bahamas to 61.2 percent in Trinidad-Tobago during high inflation/prices regime. Foreign prices drives most increase in prices in Jamaica and Guyana, and results in least increase in Belize. World oil prices result in least increase prices in Belize. Their effects on prices are insignificant in Guyana, Jamaica and Trinidad-Tobago, and rather decrease prices in The Bahamas. Depreciation in all the countries are caused by increase in prices, although the effect is strongest in The Bahamas, but occurs at nearly the same rate in Belize and Trinidad-Tobago. Depreciation drives up prices, while appreciation drives down prices in all the countries, with the exception of Belize where the latter is insignificant. The monetary policy principle (MPP) is ineffective in all the countries. Both TAR and M-TAR results show asymmetric cointegration adjustment in The Bahamas, and symmetric cointegration adjustment in Trinidad-Tobago. The rest of the countries exhibits different cointegration adjustment in the TAR and M-TAR results, with most of the countries showing symmetric cointegration adjustments in the TAR model, and asymmetric cointegration adjustment in the M-TAR model. Results of the MPP where 91-day Treasury Bills rates are used as the primary operating target have the right signs in most of the countries, but their effects are all insignificant. Thus, exchange rates are the most effective operating targets for central banks to control increase in prices/inflation in these countries.

Keywords: exchange rate pass-through, exchange rates, Treasury Bills rates, monetary policy principle, nonlinear models, asymmetry

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1: Introduction

Most central banks world-wide have stable prices as their overarching goal. This is because price stability creates a stable environment consistent with low inflation; and the resulting low inflation expectation reduces real interest rates -- the primary determinant of the cost of borrowing faced by most businesses and other market participants. The low interest rate encourages and promotes high investment in capital stocks and spending on consumer durables to drive economic growth. Thus, stable prices and attending low interest rates reduce uncertainties in financial markets. Additionally, stable financial markets promote business and consumer confidences which are important spokes in the wheels of business finance and lending that drive investment, production and economic growth.

Price stability also ensures that the government eschews deficit financing. It is consistent with fiscal discipline which emanates from dissociating the central banks' authority to print money from the authority of the ruling government. This central banks' independence can be achieved by adhering to price stability as a long-run monetary policy goal. Furthermore, maintaining a long-run price stability goal frees monetary policy to be implemented over the short-term to even out business fluctuations, and ensures that the monetary policy is not subject to a time inconsistency problem.

A long-run price stability goal also infuses fiscal discipline which restrains unwarranted fiscal spending and its concomitant burgeoning national debt. It also relieves central banks' from employing monetary policy to accommodate fiscal policy. Rather, it enables central banks to adhere to a monetary policy principle, and to effectively maintain a long-run goal of stable prices by aligning fiscal policy to the national budget constraint to accommodate monetary policy.

Notwithstanding the significance of the role of the monetary policy principle in stabilizing prices and inflation as outlined above, it should be noted that the collapse of the fixed exchange rate regimes in 1973 which led most developing countries (DCs) to adopt flexible exchange rate or a version of managed float regimes to end the Bretton Woods system's fixed exchange rate, has now empowered monetary authorities (MAs) to assume complete control over their monetary policy. But the fact that changes in money supply cause exchange rate overshooting (Dornbusch, 1976), renders floating exchange rate policy questionable in DCs. Additionally, the J-curve effect which emanates from implementing monetary policy amplifies exchange rate volatility. As a result, using monetary policy to change exchange rate to improve trade balance in most developing countries are now questionable. It is further complicated by the size of exchange rate pass-through to (or the degree by which changes in exchange rate affect increase in) prices of imports and hence inflation in developing countries.

According to Mishkin (2008, p.4), countries where central banks have pursued independent monetary policy without acquiescing to political pressures and fiscal considerations tend to have a stable monetary policy environment, so their exchange rate pass-through to consumer prices tends to be low. John Taylor (2000) also observes that countries that have a strong nominal anchor also enjoy a low exchange rate pass-through to prices and inflation. In fact, in most of these countries their monetary authorities eschew monetizing fiscal spending and/or deficit financing.

Consequently, in a sound monetary policy environment where there is even a high degree of exchange rate pass-through to import prices, it does not translate into high prices and inflation. In fact, in 1992 when the United Kingdom (UK) and Sweden withdrew from the Exchange Rate Mechanism (ERM) of the European Monetary System, although the pound and krona depreciated by 15 percent and 9 percent, respectively, their inflation rates remained largely unaffected at 2 percent and 3 percent, respectively. This is because the inflation targeting regime of both countries provided a nominal anchor to quell their large depreciation from passing through to their national prices and inflation.

This raises the questions, (i) what is the size of the exchange rate pass-through to prices and inflation in the Caribbean region? (ii) Are Caribbean countries following the monetary policy principle -- a principle which instructs central banks to raise their real interest rates above their respective inflation rates -- to avert destabilizing inflation in their countries?

Although we cannot measure the degree of exchange rate pass-through to imports prices in the Caribbean economies because of the absence of adequate reliable data on the latter (Krugman, 1986; Dornbusch, 1987), we have estimated the size or degree of exchange rate pass-through to general prices and inflation in non-member countries of the Eastern Caribbean Currency Union (ECCU) (Magee, 1973; Branson, 1972) to answer the moot question. Thus, our findings will inform policymakers on the effect of depreciation on price increases and inflation in these non-member countries of the ECCU, and assist central banks in the region to determine the type of monetary policy they can implement to mitigate inflation and the unidirectional movement of depreciation in their countries.[1]

Considering that most studies in advanced developed countries (ADCs) indicate that the size of exchange rate pass-through to prices and inflation hovers around 20 percent, although it has fallen even further to about 5 percent after the early 1980s (Gagnon and Ihrig, 2004), and remains generally low for countries with stable monetary policy environment (Taylor, 2000; Mishkin, 2008)[2], finding a small exchange rate pass-through size comparable to ADCs will confirm to policymakers and the general public that central banks in the region are implementing a stabilizing and effective monetary policy. It will also confirm if they are following a monetary policy principle, and measure the effectiveness of their interest rates and/or exchange rates as optimal operating targets.

Exchange rate is an important policy instrument in the tool kits of monetary authorities in especially developing countries, where it is often used as a substitute for operating target instrument such as Treasury Bills rates during open market operations. It also provides information on how prices are set in international trade of goods and services. The elasticity of exports prices with respect to exchange rates, which measures pricing-to-market, is complete when it is unity, and partial when it is less than unity. Additionally, the elasticity of import prices with respect to exchange rates, which measures the extent of exchange rate pass-through to imports prices, is complete when it is unity, and partial when it is less than unity.

The size of exchange rate pass-through to imports prices and pricing-to-market are therefore important determinants in setting an optimal monetary policy, and in choosing optimal exchange rate regime to serve as a nominal anchor to tie down the long-run goal of stable prices and low inflation. Thus, exchange rate pass-through and pricing-to-market information also assist monetary authorities to conduct sound monetary policy, balance the current account and deal with capital inflow. In particular, exchange rate pass-through to imports prices also informs policymakers about the extent a country is vulnerable to import inflation from foreign countries during international trade. See Kreinin (1977), Baldwin (1988), Hooper and Mann (1989), Kim (1990), Clark (1999), Yang (1991), Menon (1993), Lee (1997), Campa and Goldberg (2005), and Ghartey (2016).

Unfortunately, there are no adequate and readily available time series data on disaggregated export and import prices for us to estimate the size of pricing-to-market (Krugman, 1986; Dornbusch, 1987) and/or exchange rate pass-through to import prices (Magee, 1973; Branson, 1972). Consequently, instead of estimating the size of pricing to market to inform policymakers on market structure of their countries, whether they face perfect competition or imperfect competition in their international trade, and/or estimating the size of exchange rate pass-through to import prices to inform how vulnerable these countries are in importing foreign inflation or deflation, in this study we have estimated the effect of exchange rate pass-through to domestic prices and inflation to inform policy in some Caribbean economies, namely: Barbados, Bahamas, Belize, Guyana, Jamaica and Trinidad and Tobago (see also Ghartey, 2015). We have also determined empirically

[1] Note that apart from Ghartey (2016) among a few, most of the previous studies on the subject have not actually estimated the size of short-term and long-run exchange rate pass-through.

[2] See also Ihrig et al. (2006), Bailliu and Fujii (2004), Sekine (2006), and McCarthy (1999).

(i) whether central banks in the region follow a monetary policy principle, (ii) the effectiveness of the monetary policy principle (MPP) being practiced by central banks in the region, and (iii) whether or not exchange rates (or Treasury Bills rates) is their optimal operating target/instrument.

Additionally, empirical studies of the exchange rates pass-through to changes in prices and inflation have often yielded results which suffer from serial correlation, heteroscedasticity and functional-form instabilities problems. Consequently, results of past studies often fail to observe cointegration among changes in the exchange rates, real interest rates, and prices and/or inflation. Since most past studies on the exchange rate pass-through are mostly specified in linear forms, and their adjustments from short-term to long-run equilibrium are also specified in linear forms by using the Engle and Granger's two stage approach, we have attempted to resolve the linearity bias in such studies, by using nonlinear regression analysis and nonlinear cointegration models to specify the relationship among exchange rate, real interest rate, price/inflation and other exogenous or predetermined variables in our study.

Thus, we have estimated a linear model, and a nonlinear regression model using threshold model. We have also employed linear cointegration in the form of Johansen, and resolved the nonlinearity problem by estimating threshold cointegration and asymmetric cointegration (see Engle and Granger, 1987; Enders and Siklos, 2002; Granger and Yoon, 2002). We have also used asymmetric adjustments to address the dynamics from the short-term to long-run equilibrium.

Following the introduction, the model is developed in Section 2. It is followed by discussions of empirical results in Section 3. The paper is concluded with a summary of the findings and policy recommendation in Section 4.

2: The Model

The threshold model and nonlinear adjustments for exchange rates pass-through to prices are developed in section 2.1, and the nonlinear asymmetric cointegration and adjustments for the MPP are developed in section 2.2.

2.1: Threshold Model

Estimated cointegration or long-run equilibrium relationship function is

$$p_t = b_1 rtbr_t + b_2 rxr_t + b_3 wop_t + b_4 fp_t + c + u_t \tag{1a}$$

Threshold regression equation:

$$\begin{aligned} p_t = {} & (\beta_1 rtbr_t + \beta_2 rxr_t + \beta_3 wop_t + \beta_4 fp_t)I(1)_t(p_{t-1}<k_1) + (\beta_1' rtbr_t + \beta_2' rxr_t + \beta_3' wop_t \\ & + \beta_4' fp_t)I(2)_t(k_1 \leq p_{t-1}< k_2) + (\beta_1'' rtbr_t + \beta_2'' rxr_t + \beta_3'' wop_t + \beta_3'' fp_t)I(3)_t(k_2 \leq p_{t-1}) \\ & + c + u_t' \end{aligned} \tag{1b}$$

Engle-Granger Two-Stage Approach (TSA):

$$\Delta p_t = b_1 \Delta rtbr_t + b_2 \Delta rxr_t + b_3 \Delta wop_t + b_4 \Delta fp_t - \lambda u_{t-1} \tag{2a}$$

where, p, rxr, rtbr, wop and fp are logarithmic form of domestic prices, real effective exchange rates, real Treasury Bills rates, world oil prices, and foreign prices, respectively; I is the indicator function, and the US consumer price index is used as a proxy for foreign prices. $\hat{u}_t$ is the estimated residual ($u_t = p_t - b_1 rtbr_t - b_2 rxr_t - b_3 wop_t - b_4 fp_t - c$) from equation 1a, and corresponding threshold residual is obtained from equation 1b. The lagged augmentations have been reduced to only unity because of the under-sized sample problem. The error-correction term in equation 2a is λ, and it is stable if $\lambda \in [-1, 0]$. There is instantaneous adjustment when λ is -1, and no adjustment when λ is zero. Significance of λ indicates that variables in equation 1a are cointegrated, and the size of λ measures the speed of adjustment.

Alternative expression for testing the Engle and Granger (1987) TSA error-correction model in equation 2a is to express the adjustment as follows:

$$\Delta u_t = \rho u_{t-1} + \varepsilon_t \tag{2b}$$

where, $\rho \in (-2, 0)$ and $\varepsilon_t \sim N(0, \sigma^2)$ and is iid or has white noise innovation. Thus, if $|\rho| < 1$ or $\rho \in (-2, 0)$ then the adjustment towards long-run equilibrium is stationary or linear and symmetrical or convergent.

In a three regime threshold autoregressive (TAR) model, where there are two threshold values such that $k_1 < k_2$, if indeed our leading TAR model follows equation 1b, then because we have three threshold regimes, our (a)symmetric adjustment of the TAR model will be expressed in error-correction form as

$$\Delta p_t = I(1)_t.\rho_1.u_{t-1} + I(2)_t.\rho_2.u_{t-1} + I(3)_t.\rho_3.u_{t-1} + \varepsilon_t \tag{3a}$$

where,

$$I(1)_t = 1 \text{ if } u_{t-1} < k_1 \text{ and 0 if otherwise}$$
$$I(2)_t = 1 \text{ if } k_1 \le u_{t-1} < k_2 \text{ and 0 if otherwise}$$
and $$I(3)_t = 1 \text{ if } u_{t-1} \ge k_2 \text{ and 0 if otherwise} \tag{3b}$$

Here, equation 3a is stationary when $-2 < (\rho_1, \rho_2, \rho_3) < 0$, random-walk when $\rho_1 = \rho_2 = \rho_3 = 0$, and reduces to equation 2b when $\rho_1 = \rho_2 = \rho_3 = \rho$. The Heaviside step or indicator functions I(1), I(2) and I(3) in equation 3a and 3b constitute the TAR equation.

The momentum-TAR (M-TAR) model of a three regimes threshold will comprise of equations 3c and 3d[3]. Its (a)symmetric adjustment is expressed in error-correction form as

$$\Delta p_t = M(1)_t.\rho_1.u_{t-1} + M(2)_t.\rho_2.u_{t-1} + M(3)_t.\rho_3.u_{t-1} + \varepsilon_t \tag{3c}$$

where, the Heaviside step functions are

$$M(1)_t = 1 \text{ if } \Delta u_{t-1} < k_1 \text{ and 0 if otherwise}$$
$$M(2)_t = 1 \text{ if } k_1 \le \Delta u_{t-1} < k_2 \text{ and 0 if otherwise}$$
and $$M(3)_t = 1 \text{ if } \Delta u_{t-1} \ge k_2 \text{ and 0 if otherwise} \tag{3d}$$

Equation 3c replaces 3a so the TAR model which comprises of equations 3c and 3d constitute an M-TAR model. In such a situation, the adjustment is asymmetrical to the extent that the series show more 'momentum' in one direction than the other. Thus, if $|\rho_1| < |\rho_2| < |\rho_3|$, then the M-TAR model exhibits less decay when Δu_{t-1} is above the threshold value k_1, and relatively more decay when Δu_{t-1} is below k_1. It also means that increase in Δu_{t-1} results in persistent adjustment, whereas a reduction in Δu_{t-1} results in the system reverting towards its long-run equilibrium or attractor. The M-TAR can be used to capture 'steepness' (see Sichel, 1993). According to Sichel (1993, p.225), steepness refers to the cycle in which contractions tend to be steeper than expansions, while 'deepness' refers to a cycle where troughs are further below trend line than peaks are above it.

A series of F-statistics tests are used to determine whether the adjustments are symmetrical or asymmetrical. In the case of two threshold values which means three regimes, we employ the Φ or

[3]. See also Enders and Granger (1998) or any time series econometrics textbook. Ghartey (2016) develops and employs both bivariate and trivariate models.

F-statistic to test H_0: $\rho_1 = \rho_2 = \rho_3 = 0$. If the null hypothesis (H_0) is not rejected, then the adjustment is random walk, but if it is rejected, then we accept the F-statistic for H_1: $\rho_1 = \rho_2 = \rho_3 \neq 0$, and there is threshold cointegration. We proceed to test whether the adjustment is symmetrical or asymmetrical by testing the F-statistic for H_0: $\rho_1 = \rho_2 = \rho_3$. If we fail to reject the null hypothesis, then the adjustment is symmetrical. If we reject the null hypothesis, which means that we accept the H_1: $\rho_1 \neq \rho_2 \neq \rho_3$, then the adjustment is asymmetrical.

In this study, we have first determined the threshold variable and its associated values, and from then on proceeded to determine whether the adjustment towards long-run equilibrium is symmetrical or asymmetrical. We have therefore established that a nonlinear or threshold model can exhibit a symmetrical adjustment towards a long-run equilibrium. According to Balke and Fomby (1997, p.628): "... the standard tests for detecting cointegration in linear time series are also capable of detecting threshold cointegration."

2.2: Nonlinear Asymmetric Cointegration

The long-run asymmetric regression equation for the MPP is

$$rtbr_t = \beta^+ p^+_t + \beta^- p^-_t + w_t \tag{4a}$$
$$\Delta p_t = v_t \tag{4b}$$

where, $rtbr_t$ and p_t are integrated of order unity I'(1) variables.

The variable p_t is decomposed as

$$p_t = p_0 + p^+_t + p^-_t$$

where, $p^+_t = \sum_{i=1}^{n} \Delta p^+_i = \sum_{i=1}^{n} \max(\Delta p_i, 0)$ and $p^-_t = \sum_{i=1}^{n} \Delta p^-_i = \sum_{i=1}^{n} \min(\Delta p_i, 0)$

$$rtbr^+_t = \sum_{i=1}^{n} \Delta rtbr^+_i = \sum_{i=1}^{n} \max(\Delta rtbr_i, 0) \text{ and } rtbr^-_t = \sum_{i=1}^{n} \Delta rtbr^-_i = \sum_{i=1}^{n} \min(\Delta rtbr_i, 0)$$

Thus, p^+_t ($rtbr^+_t$) is a partial sum of processes of positive changes, and p^-_t ($rtbr^-_t$) is a partial sum of processes of negative changes. See Schorderet (2001), Granger and Yoon (2002), and Shin et al. (2011). Variables $rtbr_t$ and p_t are 'asymmetrically cointegrated' if their partial sum components, z_t, is stationary or integrated at degree zero I(0), such that their linear combinations can be expressed as

$$z_t = \beta_0^+ rtbr^+_t + \beta_0^- rtbr^-_t + \beta_1^+ p^+_t + \beta_1^- p^-_t \tag{4c}$$

Equation (4c) with z_t as a regressand is linearly cointegrated if $\beta_0^+ = \beta_0^-$ and $\beta_1^+ = \beta_1^-$, under the assumption that z_t is a process with a zero mean and finite constant variance ($E(w_t) = 0$, and $V(w_t) = \sigma^2 < \infty$) which are identically and independently distributed (iid).

Equation 4a is expressed as a nonlinear autoregressive distributed lag (NARDL) model with orders p' and q' -- NARDL (p', q') model -- as follows:

$$rtbr_t = \sum_{i=0}^{p'} \alpha_i rtbr_{t-i} + \sum_{i=0}^{q'} \lambda_i^{+'} p^+_{t-i} + \sum_{i=0}^{q'} \lambda_i^{-'} p^-_{t-i} + \varepsilon_t \tag{5a}$$

where p_t is our exogenous variable defined above, α is the autoregressive parameter, λ_i^+ and λ_i^- are the asymmetric distributed lag parameters, and ε is the error term which exhibits iid process with zero mean and constant finite variance.

Although p can be decomposed around any estimated or calculated non-zero threshold value, we have decomposed it into p^+ and p^- around a threshold value of zero. Thus, expansion or increase in p (or inflation) is denoted by p^+ and contraction or decrease in p (or deflation) is denoted by p^-. Equation 5a can be re-written as

$$\Delta rtbr_t = \rho rtbr_{t-1} + \lambda^+ p^+_{t-1} + \lambda^- p^-_{t-1} + \sum_{i=1}^{p'-1} \partial_i \Delta rtbr_{t-i} + \sum_{i=0}^{q'-1} \lambda_i^{+'} \Delta p^+_{t-i} + \sum_{i=0}^{q'-1} \lambda_i^{-'} \Delta p^-_{t-i} + \varepsilon_t \qquad (5b)$$

Its nonlinear long-run equation is equation 4a, and its associated nonlinear error-correction term is

$$\xi_t = rtbr_t - \beta^+ p^+_t - \beta^- p^-_t$$

The nonlinear error-correction form of equation 5b is re-written as

$$\Delta rtbr_t = \rho \xi_{t-1} + \lambda^+ p^+_{t-1} + \lambda^- p^-_{t-1} + \sum_{i=1}^{p'-1} \partial_i \Delta rtbr_{t-i} + \sum_{i=0}^{q'-1} \lambda_i^{+'} \Delta p^+_{t-i} + \sum_{i=0}^{q'-1} \lambda_i^{-'} \Delta p^-_{t-i} + \varepsilon_t \qquad (5c)$$

where $\rho = \sum_{i=1}^{p'} \alpha_i - 1$, and $\partial_j = -\sum_{j=i+1}^{p'} \alpha_j \ \ \forall$ j = 1, … , p'-1, with $\beta^+ = -\frac{\lambda^+}{\rho}$ and $\beta^- = -\frac{\lambda^-}{\rho}$ as the corresponding long-run asymmetric parameters, and λ^+ and λ^- are the short-term asymmetric parameters.

In a large sample data, the optimal lag-length is chosen from AIC and SBC which is then used to generally correct serial correlation problem. However, because our study is faced with under-sized sample problem, we have imposed the unit lag as our optimal lag-length.

Additionally, misspecification originating from weak endogeneity associated with nonstationary regressors have been corrected by using the NARDL error-correction model (ECM) which is estimated by the standard ordinary least squares (OLS) estimator. We have used the fully modified Phillips and Hansen maximum likelihood estimator to correct serial correlation and heteroscedasticity problems. See Phillips and Hansen (1990), Pesaran and Shin (1999), and Pesaran et al. (2001).

In using the unit lag as the optimum lag-length in our NARDL model because of undersized sample problem, we have often arrived at it from a maximum lag-length of two. We have also employed long-run or reaction asymmetry, and short-term and/or impact asymmetry to study the dynamic effect of exchange rate pass-through to prices, and monetary policy principle in six Caribbean non-member ECCU countries in the region. See Borenstein et al. (1997), Apergis and Miller (2006), Shin et al. (2011), Schorderet (2001) and Granger and Yoon (2002).

We have employed secondary high frequency quarterly data spanning 1995Q1 to 2016Q2 in our study, and they are sourced from International Standard Organization Country Code Indicators, World Bank.

3: Discussion of Empirical Results

Least squares (LS) results of cointegration equation which captures the relationship among prices, real interest rates, real effective exchange rates, world prices of oil, foreign prices and intercept terms of six Caribbean non-members of the ECCU are reported in Table 1. It is clear that in all countries, results are faced with problems of serial correlation, heterscedasticity, and except Guyana, functional instability.

The results of threshold regression which is used to remedy the statistical problems of the LS results reported in Table 2, show that with the exception of Guyana, there are no serial correlation problems in the rest of the countries. Additionally, with the exception of Belize and Jamaica, there are no heteroscedasticity problem in results of the remaining countries. All the countries experience

Table 1: Least-squares estimates of linear models with prices as a regressand

Regressors	Bahamas	Barbados	Belize	Guyana	Jamaica	Trinidad-Tobago
$rtbr_t$	0.002(0.23)	0.022(0.02)	-0.008(0.10)	0.036(0.00)	-0.042(0.10)	-0.012(0.00)
rxr_t	-0.103(0.05)	0.785(0.00)	0.424(0.00)	0.060(0.36)	0.162(0.09)	0.890(0.00)
wop_t	-0.034(0.00)	0.058(0.02)	0.071(0.00)	0.018(0.15)	-0.075(0.00)	0.031(0.02)
fp_t	0.992(0.00)	1.300(0.00)	0.619(0.00)	2.353(0.00)	4.174(0.00)	1.127(0.00)
c	0.661(0.00)	-5.212(0.00)	-0.585(0.34)	-6.501(0.00)	-15.218(0.00)	-4.907(0.00)
$\overline{R}^2$	0.98	0.96	0.94	0.99	0.99	0.99
DW	0.23	0.22	0.40	0.70	0.38	0.56
BG $\chi^2_{SC}(1)$	61.922(0.00)	66.151(0.00)	54.344(0.00)	34.772(0.00)	56.852(0.00)	44.845(0.00)
BPG $\chi^2_H(k)^a$	26.891(0.00)	16.095(0.00)	36.482(0.00)	27.414(0.00)	12.707(0.01)	20.510(0.00)
AIC	-.353	-3.265	-4.189	-4.327	-2.766	-4.493
SBC	-5.208	-3.120	-4.045	-4.181	-2.623	-4.350
Stability	V. Unstable	V. Unstable	V. Unstable	F. Stable	V. Unstable	V. Unstable

Notes: p, rxr, rtbr, wop and fp are logarithmic form of domestic prices, real effective exchange rates, real Treasury Bills rates, world oil prices, and foreign prices, respectively, and c is a constant term. Fairly (F) stable describes stability by either the CUSUM or CUSUMSQ, Very (V) Stable describes stability by both CUSUM and CUSUMSQ. BG χ^2_{SC} is Breusch and Godfrey's (BG) serial correlation LM test, and BG χ^2_H is Breusch-Pagan-Godfrey's (BPG) heteroscedasticity test. P-values are reported in parentheses.

Table 2: Estimates of threshold models with prices as a regressand

	Bahamas	Barbados	Belize	Guyana	Jamaica	Trinidad-Tobago
Regressors	$p_{t-1}<4.42$	$p_{t-1}<4.18$	$p_{t-1}<4.34$	$p_{t-1}<4.44$	$p_{t-1}<3.75$	$p_{t-1}<3.91$
$rtbr_t$	0.004(0.13)	-0.058(0.00)	-0.056(0.00)	-0.002(0.84)	0.060(0.00)	0.027(0.44)
rxr_t	-0.052(0.04)	0.147(0.00)	0.380(0.00)	0.033(0.53)	0.424(0.00)	0.633(0.00)
	$4.42\leq p_{t-1}<4.57$	$4.18\leq p_{t-1}<4.29$	$4.34\leq p_{t-1}<4.55$	$4.44\leq p_{t-1}<4.69$	$3.75\leq p_{t-1}<4.44$	$3.91\leq p_{t-1}<4.48$
$rtbr_t$	0.004(0.00)	-0.007(0.01)	-0.503(0.00)	0.034(0.00)	0.025(0.44)	0.014(0.09)
rxr_t	-0.048(0.05)	0.168(0.00)	0.069(0.21)	0.073(0.17)	0.444(0.00)	0.614(0.00)
	$4.57\leq p_{t-1}<4.64$	$4.29\leq p_{t-1}$	$4.55\leq p_{t-1}$	$4.69\leq p_{t-1}$	$4.44\leq p_{t-1}<4.81$	$4.48\leq p_{t-1}$
$rtbr_t$	-0.025(0.00)	-0.046(0.00)	0.004(0.08)	-0.102(0.00)	0.015(0.33)	-0.008(0.00)
rxr_t	-0.062(0.01)	0.150(0.00)	0.452(0.00)	-0.059(0.25)	0.476(0.00)	0.612(0.00)
	$4.64\leq p_{t-1}$				$4.81\leq p_{t-1}$	
$rtbr_t$	0.002(0.24)				-0.034(0.62)	
rxr_t	-0.035(0.15)				0.459(0.00)	
Non-threshold Variables						
wop_t	-0.013(0.00)	0.052(0.00)	0.026(0.00)	-0.008(0.35)	-0.013(0.50)	0.006(0.48)
fp_t	0.695(0.00)		0.410(0.00)	2.137(0.00)	3.455(0.00)	1.722(0.00)
c	1.651(0.00)	0.048(0.75)	0.529(0.13)	-5.428(0.00)	-13.437(0.00)	-6.221(0.00)
p_{t-1}		0.759(0.00)				
$\overline{R}^2$	0.99	0.99	0.99	0.99	0.99	0.99
DW	1.74	1.98	1.70	1.57	1.61	1.64
BG $\chi^2_{SC}(1)$	1.138(0.29)	0.000(0.99)	1.881(0.17)	4.322(0.04)	1.704(0.19)	2.008(0.16)
BPG $\chi^2_H(k)^a$	7.661(0.66)	10.876(0.21)	34.090(0.00)	9.686(0.29)	26.322(0.00)	8.281(0.41)
AIC	-7.263	-6.198	-5.811	-5.172	-4.278	-5.569
SBC	-6.943	-5.935	-5.551	-4.908	-3.960	-5.308
Stability	Fairly Stable	Very Stable	Fairly Stable	Fairly Stable	Very Stable	Very Fairly Stable

Notes: K denotes degrees of freedom, and they are 10 for The Bahamas and Jamaica, and 8 for Barbados, Belize, Guyana, and Trinidad-Tobago. See also notes in Table 1.

Table 3: EG TSA, TAR and MTAR Cointegration Estimates and Tests of Asymmetric Adjustments

	Bahamas	Barbados	Belize	Guyana	Jamaica	Trinidad-Tobago
Regressors	EG TSA					
u_{t-1}	-0.717(0.00)	-0.999(0.00)	-0.854(0.00)	-0.786(0.00)	-0.863(0.00)	-0.846(0.00)
c	-0.000(0.74)					
DW	2.07	1.98	2.04	1.94	2.021	1.94
BG $\chi^2_{SC}(1)$	3.243(0.07)	2.843(0.09)	2.125(0.14)	1.457(0.23)	0.065(0.80)	0.415(0.52)
BPG $\chi^2_{H}(k)^a$	0.205(0.65)	0.612(0.43)	0.0180(0.89)	0.025(0.87)	0.775(0.38)	1.202(0.27)
AIC	-7.542	-6.382	-6.017	-5.402	-4.648	-5.809
SBC	-7.512	-6.353	-5.988	-5.373	-4.619	-5.779
Stability	F. Stable	V. Stable	F. Stable	V. Stable	V. Stable	V. Stable
	TAR					
ρ_{t-1}	-0.440(0.00)	-0.636(0.01)	-0.511(0.01)	-0.533(0.00)	-0.890(0.00)	-0.741(0.01)
ρ_{t-2}	-1.175(0.00)	-1.042(0.00)	-0.889(0.00)	-0.942(0.00)	-1.121(0.00)	-0.956(0.00)
ρ_{t-3}	-1.636(000)	-1.136(0.00)	-1.096(0.00)	-1.116(0.00)	-0.445(0.03)	-0.776(0.00)
ρ_{t-4}	-0.678(0.00)				-0.955(0.00)	
	Wald Test: $\rho_1 = \rho_2 = \rho_3 = \rho_4 = 0$					
Φ_u	107.273(0.00)	83.641(0.00)	32.196(0.00)	59.079(0.00)	79.257(0.00)	60.643(0.00)
	Wald Test: $\rho_1 = \rho_2 = \rho_3 = \rho_4 = \rho$					
Φ_u	23.403(0.00)	2.608(0.27)	4.448(0.11)	5.199(0.07)	6.136(0.10)	0.751(0.69)
DW	1.98	1.94	1.94	1.97	2.01	1.95
BG $\chi^2_{SC}(1)$	0.000(1.00)	0.280(0.59)	0.644(0.42)	0.143(0.70)	0.000(1.00)	0.354(0.5)
BPG $\chi^2_{H}(k)^a$	5.054(0.28)	7.212(0.06)	0.814(0.85)	3.175(0.36)	3.934(0.41)	3.132(0.37)
AIC	-7.731	-6.366	-6.041	-5.417	-4.650	-5.770
SBC	-7.613	-6.278	-5.953	-5.329	-4.534	-5.682
Stability	F. Stable	V. Stable	F. Stable	V. Stable	V. Stable	V. Stable
	M-TAR					
$\rho_{t-1'}$	-0.111(0.49)	0.027(0.89)	-0.181(0.28)	-0.142(0.18)	-0.354(0.00)	-0.106(0.55)
$\rho_{t-2'}$	-0.620(0.00)	-0.412(0.00)	-0.357(0.03)	-0.411(0.00)	-0.465(0.00)	-0.354(0.00)
$\rho_{t-3'}$	-0.783(0.00)	-0.469(0.00)	-0.673(0.00)	-0.327(0.00)	0.088(0.53)	-0.316(0.00)
$\rho_{t-4'}$	-0.306(0.03)				-0.199(0.16)	
c	-0.000(0.85)	0.000(0.98)	0.000(0.98)	-0.000(0.90)	-0.000(0.86)	-0.000(0.80)
	Wald Test: $\rho_1 = \rho_2 = \rho_3 = \rho_4 = 0$					
$\Phi_u(M)$	99.238(0.00)	61.848(0.00)	55.525(0.00)	30.345(0.00)	51.813(0.00)	28.954(0.00)
	Wald Test: $\rho_1 = \rho_2 = \rho_3 = \rho_4 = \rho$					
$\Phi_u(M)$	17.043(0.00)	5.596(0.06)	7.857(0.02)	3.757(0.15)	12.777(0.00)	1.553(0.46)
DW	2.25	2.19	2.23	2.24	2.13	2.17
BG $\chi^2_{SC}(1)$	6.600(0.01)*	6.298(0.01)*	4.360(0.04)*	11.574(0.00)*	8.180(0.00)*	6.128(0.01)*
BPG $\chi^2_{H}(k)^a$	3.566(0.47)	0.506(0.92)	2.137(0.54)	3.996(0.26)	2.144(0.71)	0.843(0.84)
AIC	-7.312	-5.830	-5.748	-4.956	-4.115	-5.321
SBC	-7.194	-5.741	-5.659	-4.867	-3.998	-5.233
Stability	F. Stable	V. Stable	F. Stable		V. Stable	V. Stable
Method	FMOLS	FMOLS	FMOLS	FMOLS	FMOLS	FMOLS

Notes: Φ_u is the F-statistics of the Wald test of the TAR model, and $\Phi_u(M)$ is the F-statistics of the Wald test of the MTAR model. FMOLS is the fully modified ordinary least squares of Philip and Hansen, and EG TSA is Engle and Granger two-stage approach.

Table 4: Estimates of the Monetary Policy Principle (MPP)

Bahamas

$rtbr^{+}_{t} = 17.950(0.01)p^{+}_{t} – 73.067(0.01)p^{-}_{t},$ (6a)
DW = 2.178, $BG\chi^{2}_{SC}(1) = 0.000(1.00)$, BPG $\chi^{2}_{H}(2) =2.018(0.36)$

$rxr^{+}_{t} = 1.201(0.00)p^{+}_{t} – 2.088(0.04)p^{-}_{t},$ (6b)
DW = 1.51, $BG\chi^{2}_{SC}(1) = 2.176(0.14)$, BPG $\chi^{2}_{H}(2) = 1.301(0.52)$

$rtbr^{+}_{t} = 6.366(0.02)rxr^{+}_{t} – 6.976(0.04)rxr^{-}_{t},$ (6c)
DW = 2.19, $BG\chi^{2}_{SC}(1) = 0.000(1.00)$, BPG $\chi^{2}_{H}(2) =0.372(0.83)$

$p^{+}_{t} = 0.171(0.00)rxr^{+}_{t} – 0.159(0.00)rxr^{-}_{t},$ (6d)
DW = 1.79, $BG\chi^{2}_{SC}(1) = 0.000(1.00)$, BPG $\chi^{2}_{H}(2) =3.648(0.16)$
$p^{+}_{t} = - 0.001(0.67)rtbr^{+}_{t} + 0.001(0.59)rtbr^{-}_{t},$ (6e)
DW = 1.99, $BG\chi^{2}_{SC}(1) = 0.001(0.98)$, BPG $\chi^{2}_{H}(2) = 0.605(0.74)$

$rxr^{+}_{t} = -0.001(0.87)rtbr^{+}_{t} + 0.005(0.33)rtbr^{-}_{t} + 0.011$ (6f)*
DW = 1.49, $BG\chi^{2}_{SC}(1) = 5.314(0.02)$, BPG $\chi^{2}_{H}(2) = 1.609(0.45)$, *FMOLS

Barbados

$rtbr^{+}_{t} = -0.539(0.82)p^{+}_{t} – 11.016(0.01)p^{-}_{t} + 0.056$ (7a)
DW = 1.67, $BG\chi^{2}_{SC}(1) = 2.103(0.15)$, BPG $\chi^{2}_{H}(2) = 0.438(0.80)$

$rxr^{+}_{t} = 0.716(0.00)p^{+}_{t} – 0.603(0.02)p^{-}_{t} + 0.001$ (7b)*
DW = 1.67, $BG\chi^{2}_{SC}(1) = 2.263(0.13)$, BPG $\chi^{2}_{H}(2) = 11.089(0.00)$, *FMOLS

$rtbr^{+}_{t} = 1.498(0.31)rxr^{+}_{t} – 5.192(0.01)rxr^{-}_{t},$ (7c)
DW = 1.78, $BG\chi^{2}_{SC}(1) = 0.436(0.51)$, BPG $\chi^{2}_{H}(2) =1.235(0.54)$

$p^{+}_{t} = 0.511(0.00)rxr^{+}_{t} – 0.191(0.04)rxr^{-}_{t},$ (7d)
DW = 1.52, $BG\chi^{2}_{SC}(1) = 0.000(1.00)$, BPG $\chi^{2}_{H}(2) = 5.080(0.08)$

$p^{+}_{t} = - 0.006(0.21)rtbr^{+}_{t} + 0.005(0.55)rtbr^{-}_{t} + 0.012$ (7e)
DW = 1.64, $BG\chi^{2}_{SC}(1) = 2.575(0.11)$, BPG $\chi^{2}_{H}(2) = 0.825(0.66)$

$rxr^{+}_{t} = -0.006(0.44)rtbr^{+}_{t} - 0.007(0.59)rtbr^{-}_{t} + 0.012$ (7f)*
DW = 1.50, $BG\chi^{2}_{SC}(1) = 5.003(0.02)$, BPG $\chi^{2}_{H}(2) = 0.291(0.86)$, *FMOLS

Belize

$rtbr^{+}_{t} = 0.063(0.87)p^{+}_{t} – 0.975(0.05)p^{-}_{t},$ (8a)
DW = 2.010, $BG\chi^{2}_{SC}(1) = 0.000(1.00)$, BPG $\chi^{2}_{H}(2) = 0.154(0.92)$

$rxr^{+}_{t} = 0.848(0.00)p^{+}_{t} – 0.071(0.62)p^{-}_{t} + 003$ (8b)*
DW = 1.31, $BG\chi^{2}_{SC}(1) = 10.936(0.00)$, BPG $\chi^{2}_{H}(2) = 1.312(0.52)$, *FMOLS

$rtbr^{+}_{t} = 0.040(0.89)rxr^{+}_{t} – 0.962(0.03)rxr^{-}_{t},$ (8c)
DW = 2.00, $BG\chi^{2}_{SC}(1) = 0.000(1.00)$, BPG $\chi^{2}_{H}(2) =1.311(0.52)$

$p^{+}_{t} = 0.569(0.00)rxr^{+}_{t} – 0.121(0.25)rxr^{-}_{t},$ (8d)*
DW = 1.39, $BG\chi^{2}_{SC}(1) = 7.870(0.00)$, BPG $\chi^{2}_{H}(2) = 58.660(0.00)$, *FMOLS

$p^{+}_{t} = - 0.014(0.63)rtbr^{+}_{t} + 0.002(0.86)rtbr^{-}_{t} + 0.007$ (8e)

DW = 1.87, BGχ^2_{SC}(1) = 0.380(0.54), BPG χ^2_H(2) = 0.146(0.93)

rxr^+_t = -0.015(0.66)$rtbr^+_t$ - 0.013(0.34)$rtbr^-_t$ + 0.008 (8f)
DW = 1.85, BGχ^2_{SC}(1) = 0.428(0.51), BPG χ^2_H(2) = 0.466(0.79),

Guyana

$rtbr^+_t$ = 0.577(0.00)p^+_t – 1.413(0.00)p^-_t, (9a)
DW = 1.59, BGχ^2_{SC}(1) = 2.087(0.15), BPG χ^2_H(2) =2.481(0.29)

rxr^+_t = 0.577(0.00)p^+_t – 1.413(0.00)p^-_t, (9b)
DW = 1.58, BGχ^2_{SC}(1) = 2.087(0.15), BPG χ^2_H(2) = 2.481(0.29)

$rtbr^+_t$ = 0.485(0.08)rxr^+_t – 0.752(0.03)rxr^-_t, (9c)
DW = 2.07, BGχ^2_{SC}(1) = 0.000(1.00), BPG χ^2_H(2) =0.8630.65)

p^+_t = 0.384(0.00)rxr^+_t – 0.501(0.00)rxr^-_t, (9d)
DW = 1.60, BGχ^2_{SC}(1) = 0.000(1.00), BPG χ^2_H(2) = 0.616(0.73)

p^+_t = - 0.016(0.59)$rtbr^+_t$ - 0.032(0.07)$rtbr^-_t$ + 0.011 (9e)
DW = 1.71, BGχ^2_{SC}(1) = 1.453(0.23), BPG χ^2_H(2) = 0.967(0.62)

rxr^+_t = -0.018(0.67)$rtbr^+_t$ + 0.014(0.58)$rtbr^-_t$ + 0.012 (9f)*
DW = 1.50, BGχ^2_{SC}(1) = 5.021(0.02), BPG χ^2_H(2) = 0.528(0.77), *FMOLS

Jamaica

$rtbr^+_t$ = 0.789(0.04)p^+_t – 11.554(0.06)p^-_t, (10a)
DW = 2.08, BGχ^2_{SC}(1) = 0.000(1.00), BPG χ^2_H(2) = 4.615(0.10)

rxr^+_t = 0.481(0.00)p^+_t – 0.733(0.55)p^-_t + 0.001 (10b)*
DW = 1.29, BGχ^2_{SC}(1) = 10.3397(0.00), BPG χ^2_H(2) = 3.657(0.16), *FMOLS

$rtbr^+_t$ = 0.184(0.66)rxr^+_t – 2.947(0.00)rxr^-_t + 0.006 (10c)*
DW = 2.35, BGχ^2_{SC}(1) = 2.748(0.10), BPG χ^2_H(2) = 18.795(0.00), *FMOLS

p^+_t = 0.722(0.00)rxr^+_t - 0.373(0.07)rxr^-_t, (10d)
DW = 1.08, BGχ^2_{SC}(1) = 0.325(0.57), BPG χ^2_H(2) = 0.395(0.82)

p^+_t = - 0.000(0.99)$rtbr^+_t$ + 0.025* (10e)
DW = 1.10, BGχ^2_{SC}(1) = 16.936(0.00), BPG χ^2_H(2) = 4.517(0.03), *FMOLS

rxr^+_t = -0.019(0.50)$rtbr^+_t$ - 0.065(0.03)$rtbr^-_t$ + 0.009 ** (10f)*
DW = 1.32, BGχ^2_{SC}(1) = 5.355(0.02), BPG χ^2_H(2) = 0.882(0.64), *FMOLS

Trinidad-Tobago

$rtbr^+_t$ = 3.072(0.11)p^+_t – 1.801(0.84)p^-_t, (11a)
DW = 2.00, BGχ^2_{SC}(1) = 0.000(1.00), BPG χ^2_H(2) = 0.171(0.92)

rxr^+_t = 0.854(0.00)p^+_t - 0.195(0.56)p^-_t, (11b)
DW = 1.62, BGχ^2_{SC}(1) = 2.577(0.11), BPG χ^2_H(2) =0.555(0.76)

$rtbr^+_t$ = 2.567(0.15)rxr^+_t – 4.883(0.19)rxr^-_t (11c)*
DW = 2.06, BGχ^2_{SC}(1) = 0.000(1.00), BPG χ^2_H(2) = 0.551(0.76), *FMOLS

$p^{+}_{t} = 0.514(0.00)rxr^{+}_{t} - 0.082(0.53)rxr^{-}_{t} + 0.009$ (11d)*
DW = 1.52, $BG\chi^{2}_{SC}(1) = 0.456(0.50)$, BPG $\chi^{2}_{H}(2) = 41.098(0.00)$, *FMOLS

$p^{+}_{t} = - 0.002(0.67)rtbr^{+}_{t} + 0.015$ (11e)
DW = 1.65, $BG\chi^{2}_{SC}(1) = 2.506(0.11)$, BPG $\chi^{2}_{H}(2) = 0.229(0.63)$

$rxr^{+}_{t} = 0.000(0.94)rtbr^{+}_{t} + 0.013$ (11f)*
DW = 1.47, $BG\chi^{2}_{SC}(1) = 5.640(0.02)$, BPG $\chi^{2}_{H}(2) = 0.052(0.82)$, *FMOLS

stable functional forms, with results of Barbados, Jamaica and Trinidad-Tobago being very strong, judging by the cumulative sum (CUSUM) and cumulative sum of squares (CUSUMSQ) of residuals[4]. The adjusted coefficient of determination ($\bar{R}^2$) was 99 percent in all of the countries which indicates that prices are well explained by the regressors.

The threshold results indicate that The Bahamas and Jamaica have three threshold values, whereas the remaining countries have two threshold values[5]. Thus, there are three price regimes for Barbados, Belize, Guyana and Trinidad-Tobago, and four price regimes in The Bahamas and Jamaica.

The effect of exchange rate pass-through to prices during a low price regime is negative for The Bahamas. This can be explained by the fact that the country practically pegs its currency to the US dollar. The exchange rates pass-through is insignificant in Guyana, but it is 14.7 percent in Barbados, 38 percent in Belize, 42.4 percent in Jamaica, and 63.3 percent in Trinidad-Tobago during low price regimes.

The real interest rate is significant in all the countries except Jamaica during the moderate price regime, and contributes to increase in prices in all the countries except Barbados and Belize where it reduces prices. Depreciation contributes to increase in prices in all the countries, except Belize and Guyana where it is insignificant, and The Bahamas, where appreciation drives prices.

In the high prices regime, increase in real interest rates decreases prices in all the countries, except Belize and Jamaica, although in the case of the latter, the result is insignificant. Depreciation increases prices in all the countries, except The Bahamas, where appreciation drives up prices, although it is insignificant in Guyana. In the highest price regimes observed in The Bahamas and Jamaica, depreciation is insignificant in both countries, although only Jamaica observes a highly significant unit change in depreciation driving up prices by 45.9 percent.

The effect of non-threshold variable such as world oil prices significantly drives up prices in Barbados and Belize, although it drives down prices in The Bahamas. Foreign prices drive up prices in all the countries, except Barbados, with the effect being most significant in Jamaica, followed by Guyana and then Trinidad-Tobago. Lagged prices drive up prices in only Barbados.

Cointegration results of EG TSA, TAR and M-TAR models are reported in Table 3 to determine whether the dynamics resulting from displacement from the long-run equilibrium is symmetric or asymmetric. Results of EG TSA show that only The Bahamas and Barbados show serial correlation problem at 0.10 significant levels. It is corrected by using the FMOLS estimator. Thus, neither of the results of the countries are affected by serial correlation and heterscedasticity problems. The error-correction term is significant for all the countries at 0.01 levels, and they are all very stable, except The Bahamas and Belize where they are fairly stable because only their CUSUMSQ graphs were unstable. Thus, all the countries have cointegrated results which exhibit symmetrical adjustments towards long-run equilibrium. The speed of adjustments ranges from 71.7 percent in the Bahamas to 99.9 percent in Barbados, with Belize, Jamaica and Trinidad-Tobago showing nearly the same results of about 85 percent.

Results of TAR show complete absence of both serial correlation and heteroscedasticity problems for all the countries, except Barados which exhibits heteroscedasticity problems, but even there, the problem is rejected at 0.10 significant levels. With the exception of The Bahamas and Belize where the stability result is fairly stable, the rest of the countries have very stable stability functions. Wald tests of zero restriction of the parameters are rejected at 0.01 significant levels for all the countries. Thus, none of the countries results follows a random walk. Furthermore, all of their parameters are stationary as they lie within (-2, 0).

Wald test result of the null hypothesis (H_0) of equal parameters is not rejected by Barbados, Belize and Trinidad-Tobago. This means that displacement from a long-run equilibrium adjust

[4] Results or Graphs of CUSUM and CUSUMSQ have not been reported to conserve space. They are can be received from the author upon request.
[5] See Ghartey (2017)

symmetrically back to equilibrium. However, The Bahamas Wald test results completely rejects the equal parameter restriction at 0.01 significant levels, whereas results of Guyana and Jamaica reject the H_0 of equal parameters at 0.10 significant levels. Thus, there is asymmetric cointegration adjustment of displacements in all three countries.

The M-TAR LS results show acute serial correlation problem for all the countries, even though there is no heteroscedasticity problem. Consequently, the Phillips and Hansen FMOLS is used to estimate the M-TAR model. Results show that the first parameter and intercept term in all of the countries are insignificant. The second and third parameters of all the countries except Jamaica are significant at 0.05 significant levels. In Jamaica, both the third and fourth parameters are insignificant. Magnitudes of the M-TAR parameters in all of the countries are less than unity and lie within (-2, 0). However, the magnitudes of $|\rho_1| < |\rho_2| < |\rho_3|$ in Barbados and Belize show that an increase in shocks leads to persistent adjustment, whereas a reduction in shocks reverts the system towards the long-run equilibrium.

Wald test results show a zero restriction imposed on the parameters is rejected at 0.01 significant levels which rules out random walk. However, restriction of equal parameters is rejected at 0.05 significant levels in The Bahamas, Belize and Jamaica, and at 0.10 significant levels in Barbados. Only Guyana and Trinidad-Tobago have Wald test results of equal parameters which cannot be rejected at even 0.10 significant levels. Their adjustments when displaced from long-run equilibrium are symmetrical. Thus, the rest of the countries adjust asymmetrically towards long-run equilibrium when displaced from it.

Results of the MPP are reported in Table 4. Although, an increase in the real Treasury Bills rates results in a decline in prices as expected for all the countries, none of them is significant. However, it is clear that appreciation drives down prices/inflation whereas depreciation drives up prices. Increase in prices/inflation drives up both the real interest rates and depreciation, while contraction in prices/deflation drives down interest rates and results in appreciation. Thus, the traditional MPP principle where an increase in real interest rates prevent destabilizing inflation is insignificant in all of the countries. Further, with the exception of The Bahamas, an increase in prices or inflation does not result in central banks in the region increasing their interest rates by more than the proportionate change in those prices/inflation.

4: Conclusion

The study finds that using linear models to examine the exchange rate pass-through to prices is generally fraught with serial correlation, heteroscedasticity and functional instability problems. As a solution to these problems, we employed nonlinear or asymmetric model to correct most of the problems in the study for six non-members of Eastern Caribbean Currency Union (ECCU). Results show three threshold values for The Bahamas and Jamaica, and two threshold values for the rest of the countries. Lagged/Previous month prices are found to be the threshold variable for all the countries, and they range from -5.2 percent in The Bahamas to 63.3 percent in Trinidad-Tobago during a low inflation/prices regime, and from -6.2 percent in The Bahamas to 61.2 percent in Trinidad-Tobago during high inflation/prices regime.

Of the non-threshold variables, foreign prices drive most increase in prices in Jamaica and Guyana, and least increase in prices in Belize. World oil prices result in least increase in prices in Belize. Their effects on prices are insignificant in Guyana, Jamaica and Trinidad-Tobago, and rather decrease prices in The Bahamas.

Both threshold regression and monetary policy estimates show that depreciation is caused by increase in prices in all the countries, although the effect is strongest in The Bahamas, but nearly the same in Belize and Trinidad-Tobago. On the other hand, depreciation drives up prices, while appreciation drives down prices in all the countries, with the exception of Belize where the latter is insignificant.

There is threshold cointegration in all the countries judging by the TAR and M-TAR results, as the Wald test of zero restriction is rejected at 0.01 significant levels. Wald test of equal parameters restriction shows asymmetric cointegration adjustment in The Bahamas, and symmetric cointegration adjustment in Trinidad-Tobago. The rest of the countries exhibit different cointegration adjustment in both TAR and M-TAR results, with most of the countries showing symmetric cointegration adjustments in the TAR model, and asymmetric cointegration adjustment in the M-TAR model.

The monetary policy principle (MPP) is ineffective in all the countries. Results of the MPP where 91-day Treasury Bills rates are used as the primary operating target have the right signs in most of the countries, but their effects are all insignificant. However, depreciation (appreciation) is caused by increase (decrease) in prices in all the countries, whereas it also causes increase (decrease) in prices/inflation in all the countries. Thus, exchange rates are the most effective operating targets for central banks to control increase in prices/inflation in all six nonmember ECCU countries.

Bibliography

Apergis, N. and Miller, S. (2006), “Consumption asymmetry and the stock market: Empirical Evidence.” Economics Letters, 93 (3), 337-342.

Bailliu, J. and E. Fujii (2004). “Exchange rate pass-through and the inflation environment in industrialized countries: An empirical investigation.” *Bank of Canada Working Paper*, No. 2004-2, (Ottawa: Bank of Canada).

Baldwin, R.E. (1988). “Hysteresis in import prices: the beachhead effect.” *American Economic Review*, 78, 773-785.

Balke, N. S. and T.B. Fomby (1997). “Threshold cointegration.” International Economic Review, 38 (3), 627-645.

Borenstein, S., Cameron, C. and Gilbert, R. (1997), “Do gasoline prices respond asymmetrically to crude oil price changes?” The Quarterly Journal of Economics, 112 (1), 305-339.

Branson, W.H. (1972). “The trade effects of the 1971 currency realignment.” *Brookings Papers on Economic Activity*, (1), 15-69.

Campa, J.M. and L.S. Goldberg (2005). “Exchange rate pass-through into import prices.” *Review of Economics and Statistics,* 87, 679-690.

Clark, L.J. (1999). “The exchange rate and the price level in a small open economy.” *Journal of Policy Modelling,* 13 (2), 309-315.

Dornbusch, R. (1987). “Exchange rates and prices.” *American Economic Review*, 77, 93-106.

Dornbusch, R. (1976). “Expectations and exchange rate dynamics.” *Journal of Political Economy*, 84, 1061-1076.

Ender, W. and C.W.J. Granger (1998). “Unit-roots tests and asymmetric adjustment with an example using the term structure of interest rates.” Journal of Business & Economic Statistics, 16 (3), 304-311.

Enders, W. and P.L.Siklos (2001). “Cointegration and threshold adjustment.” Journal of Business & Economic Statistics, 166-176.

Engle, R.F. and C.W.J. Granger (1987). “Cointegration and error-correction: Representation, Estimation and Testing.” Econometrica, 55, 251-276.

Granger, C.W.J. and Yoon, G. (2002). “Hidden Cointegration,” unpublished manuscript, University of California, San Diego.

Ghartey, E.E. (2017). “Empirical evidence of nonlinear effects of monetary policy reaction functions in a developing country,” African Finance and Economics Association, ASSA/AEA Annual Meeting, Chicago, Illinois, USA, January 8.

Ghartey, E.E. (2016). “Empirical evidence of exchange rate pass-through to prices and inflation in Ghana,” Annual Meeting of Allied Social Science Associations, ASSA/AEA Annual Meeting, San Francisco, California, USA, January 5.

Ghartey, E.E. (2015). “Empirical evidence of the role of financial development and economic growth in Caribbean Countries,” *Caribbean Center for Money and Finance Conference,* Bank of Guyana, Georgetown, November 18.

Hooper, P. and C.L. Mann (1989). “Exchange rate pass-through in the 1980s: the case of U.S. imports of manufactures.” *Brookings Papers on Economic Activity*, 1, 297-329.

Ihrig, J.E., M. Marazzi and A.D. Rothenberg (2006). “Exchange rate pass-through in the G-7 Countries.” *International Finance Discussion Papers,* No. 851, (Washington: Board of Governors of the Federal Reserve System).

Kim, Y. (1990). “Exchange rates and import prices in the US: a varying parameter estimation of exchange rate pass-through.” *Journal of Business and Economic Statistics*, 8 (3), 305-315.

Kreinin, M.E. (1977). “The effect of exchange rate changes on the prices and volume of foreign trade.” *IMF Staff Papers*, 47, 207-239.

Krugman, P. (1986). “Pricing to market when the exchange rate changes.” *NBER Working Pape*r, No. 1926, 1-43.

Lee, J. (1997). “The response of exchange rate pass-through to market concentration in a small economy: The evidence from Korea,” *Review of Economics and Statistics*, 2, 142-145.
Magee, S.P. (1973). “Currency contracts, pass-through and devaluation.” *Brookings Papers on Economic Activity*,” 1, 303-323.
McCarthy, J. (1999). “Pass-through of exchange rate and import prices to inflation in some industrialized economies.” *BIS Working Paper*, No. 79, (Basel: Bank of International Settlements).
Menon, J. (1993). “Exchange rate pass-through.” *Journal of Economic Surveys*, 9, (2), 197-231.
Mishkin, F.S. (2008). “Exchange rate pass-through and monetary policy.” *NBER Working Paper*, No. 13889.
Miishkin, F.S. (2016). *The Economics of Money, Banking, and Financial and Financial Markets*, (New York, Pearson).
Pesaran, M.H., Shin, Y. and Smith, R.J. (2001). “Bounds testing approaches to the analysis of level relationships.” *Journal of Applied Econometrics*, 16, 289-326.
Pesaran, M.H. and Shin, Y. (1999). “An autoregressive distributed lag modelling approach to cointegration analysis, in: S. Storm (Ed.) Econometric and Economic Theory in the 20th Century: The Ragnar Frisch Centenial Symposium (Cambridge: Cambridge University Press).
Phillips, Peter C. B. and Bruce E. Hansen (1990). “Statistical Inference in Instrumental Variables Regression with I(1) Processes,” Review of Economics Studies, 57, 99-125.
Schorderet, Y. (2001). “Revisiting Okun’s law: An hysteretic perspective,” unpublished manuscript, University of California, San Diego.
Sekine, T. (2006). “Time-varying exchange rate pass-through: Experiences of some industrial countries.” *BIS Working Paper*, No. 202, (Basel: Bank of International Settlements).
Shin, Y., Yu, B., and Greenwood-Nimmo, M. (2011). “Modelling asymmetric cointegration and dynamic multipliers in a nonlinear ARDL framework,” SSRN Electronic Journal.
Sichel, D.E. (1993). “Business cycle asymmetry: A deeper look.” Economic Inquiry, 31, 224-236.
Taylor, J.B. (2000). “Low inflation, pass-through, and the pricing power of firms.” *European Economic Review*, 44, 1389-1408.
Yang, Y.Y. (1991). “Structural change in the US import prices of manufactures.” *Welwirtschaftliches Archiv*, 127 (2), 323-342.