

An Assessment of Reserve Adequacy in Caribbean Economies

Skeeta Carasco

Summer Intern, Research and Economic Analysis Department
Central Bank of Barbados
and
Post-graduate Student, Department of Economics
The University of the West Indies, St. Augustine, Trinidad and Tobago
Email: scarasco@gmail.com

Roland Craigwell

Professor of Economics, Department of Economics
The University of the West Indies, Cave Hill Campus, Barbados
and
Research Associate, Research and Economic Analysis Department
Central Bank of Barbados
Email: roland.craigwell@cavehill.uwi.edu

Darrin Downes

Chief Research Economist, Research and Economic Analysis Department
Central Bank of Barbados
Email: darrin.downes@centralbank.org.bb

An Assessment of Reserve Adequacy in Caribbean Economies

Skeeta Carasco, Roland Craigwell and Darrin Downes

Abstract

Caribbean economies face a binding foreign exchange constraint that requires prudent management of foreign reserves for protection against external shocks and to engender market stability and confidence. This paper assesses the adequacy of foreign exchange reserves in the Caribbean over the period 1981-2011. It uses the informal method of ratio analysis, the combined factor measure of reserve adequacy for small islands proposed by Mwase (2012), compares actual and forecasted reserves from a reserve demand specification and applies the optimisation frameworks of Jeanne (2007), Jeanne and Rancier (2006) and Barnichon (2009). The findings were that while some countries held adequate reserves for most of the period under study, other nations were faced with periods of insufficient reserves. This suggests that the region economies need to exercise prudence in managing their holdings of foreign exchange reserves.

JEL Classification No: F31, O54

Keywords: Foreign Exchange Reserves, Country Studies

Introduction

Small open countries face a binding foreign exchange constraint that requires prudent management of foreign exchange reserves to mitigate against adverse economic challenges and to engender market confidence and stability. The build-up of adequate foreign reserves has become especially relevant given the prolonged and uncertain nature of the global economic environment. In general, countries accumulate foreign exchange reserves¹ primarily for precautionary and mercantile purposes. Precautionary motives reflect the need for protection against external shocks and to provide sufficient coverage for crisis prevention and management (Sehgal and Sharma, 2008). The accumulation of foreign exchange reserves for mercantile purposes is closely related to the pursuance of policies to promote exports and to attract foreign direct investment inflows. In the Caribbean, foreign exchange reserves arguably serve both purposes, with the predominance accorded to the precautionary purpose of reducing external vulnerability.

While the literature does not clearly define reserves adequacy², there is consensus on the various indicators, methods and factors that may be used to determine the adequacy or optimal holdings of foreign reserves. An important consideration in the debate is whether Caribbean countries are accumulating reserves beyond adequate or optimal levels, since large or excessive reserve holdings have costs. From a practical perspective, the approaches adopted by individual countries, which involves choosing relevant benchmarks and designing appropriate stress tests, should reflect country-specific economic circumstances. Previous studies on reserve adequacy have included Caribbean countries broadly under the rubric of small islands or emerging market economies and have applied a few of the benchmarks utilised to test reserve adequacy. For example, Mwase (2012) provides a disaggregated country assessment of foreign reserves for a number of Caribbean territories using a metric designed for small economies. Dehesa, Pineda and Samuel (2009), which assessed the optimality of reserves in the Eastern Caribbean States, which form the Eastern Caribbean Currency Union (ECCU), only applied the informal ratio analysis and the optimisation framework based on Jeanne (2007).

The main objective of this paper is to examine the adequacy of foreign exchange reserves for individual Caribbean countries over the period 1981 to 2011, using a combination of four methods. The countries investigated are The Bahamas, Barbados, Belize, Guyana, Haiti, Jamaica, Trinidad and Tobago, and the ECCU. The study extends the investigation by Dehesa,

¹ Foreign exchange reserves consist of external assets that are readily available to and controlled by the monetary authorities for direct financing of payments imbalances, indirectly regulating the magnitude of such imbalances through market intervention to affect the exchange rate and/or for other purposes (International Monetary Fund, 1993).

² Agarwal (1971) argues that an optimal level of foreign reserves is that amount which enables a developing country to finance, at a given fixed rate of exchange, its temporary and unanticipated balance of payments deficits, arising in a planning period and at the same time confers on the country a benefit equal to the opportunity cost of holding reserves.

Pineda and Samuel (2009) to the wider Caribbean by employing the methods of informal ratios, combined factor analysis, estimation and forecasting of reserve demand and the optimisation frameworks developed by Jeanne and Rancier (2006) and Barnichon (2009). It is in line with previous work for other developing or emerging market countries (see Davies (2012) for the Francophone Zone countries, Drummond, Mrema, Roudet and Saito (2009) for the East African Community nations, Gosselin and Parent (2005) and Park and Estrada (2010) for the Asian countries and Zeng (2012) for China).

The paper has six sections organised as follows: Section 2 reviews the literature on foreign exchange reserve adequacy. Section 3 presents some stylised facts on the evolution of foreign reserves in Caribbean economies over the past thirty years. The data and methodology utilised in this study are contained in section 4. Section five presents the results for the different methods of measuring reserve adequacy and section 6 offers the concluding remarks.

2. Literature Review

The evolution of the literature on foreign exchange reserve adequacy has been influenced by changing global monetary systems, past financial crises and the acceleration of reserve accumulation, particularly in the emerging market economies in South and East Asia. Triffin (1947) fuelled the debate on foreign reserve adequacy during the period after World War II and the establishment of the Bretton Woods System. During this period, countries adopted fixed exchange rate regimes and the focus was on sustaining adequate reserves to maintain the exchange rate. Following the collapse of the Bretton Woods System in 1973, academic interest in reserve adequacy waned, but there was a resurgence, particularly on measures related to the capital account after the Asian financial crisis (see Wijnholds and Kapteyn, 2001; Flood and Marion, 2002; Aizenman and Marion, 2003 and Edison, 2003).

2.1. Informal Methods

These methods have attracted much attention mainly because of their simplicity (Grubel (1971) asserts these methods are based on a theoretically limited foundation). The most widely used of these ratios is the share of non-gold reserves to imports, which provides a simple but useful indication of the number of months' worth of imports that can be purchased by a country if there is a 'sudden stop' of foreign exchange due to a payment shock (see Chan, 2007 and Kenan and Yudin, 1965). However, IMF (2001) points out that this benchmark is inherently arbitrary and does not take into account the unique economic circumstances of countries. Furthermore, it fails to address issues stemming from fluctuations in the financial and capital account balance.

The methods accounting for capital account transactions became quite topical in the wake of the Asian financial crisis. One such measure is the proportion of foreign exchange reserves to domestic money (usually M2), which is intended to capture the risk of capital flight by residents

when a country faces a capital account crisis (IMF, 2011). Chan (2007) posits the higher this ratio, the greater the confidence in the domestic currency, especially under a fixed exchange rate regime. This indicator is especially relevant if money demand is not stable and financial systems are weak (Sehgal and Sharma, 2008). The difficulties in measuring capital flight have resulted in a lack of consensus on the optimal reserve-to-M2 ratio. However, an upper limit of 20 percent is usually quoted (see IMF, 2011).

The ratio of foreign exchange reserves to short-term external debt (STED) is another capital account indicator of reserve adequacy. It reflects a country's ability to service external debt obligations within a year. Sehgal and Sharma (2008) also note that this measure provides a useful metric of the threshold at which investors lose confidence. The Greenspan-Guiotti rule³ suggests a 100% cover of short-term debt for one year (IMF, 2011). However, Wijnholds and Kapteyn (2001) criticised this benchmark for focusing entirely on the external drain on a country's reserves, as there is also an internal drain or capital flight by residents. In addition, this indicator may be more applicable to countries that have good access to international capital markets.

2.2 Combined Factors Measures

More studies are attempting to combine various factors in proposing benchmarks for reserve adequacy. Using end of year 1999 data for 21 emerging market economies, Wijnholds and Kapteyn (2001) suggests a rule of thumb of full coverage of short-term external debt and a risk-adjusted percentage of broad money. The main issue with this benchmark is its arbitrary selection without sufficient consideration of country-specific knowledge. Additionally, the index of country risk used to adjust the required percentage of the money supply may not have been the most reliable as it was produced by a popular journal.

IMF (2011) proposes a combination metric for emerging market countries that accounts for differences in exchange rate regimes and both external current and capital account flows. The IMF (2011) index was created in two stages. Firstly, a "risk-weighted liability stock" was derived by estimating the relative riskiness of different potential drains on reserves, dependent on observed distributions of outflows on each source during periods of exchange market pressure. Secondly, the desired proportion of the liability stock that should be held as liquid reserves was gauged based on past crisis experience. The resulting metric for fixed exchange rate economies was computed as 30% of short-term debt, 15% of other portfolio liabilities (i.e., debt and equity), 10% of broad money and 10% of exports of goods. For floating exchange rate countries, the measure comprises 30% of short term debt, 15% of other portfolio liabilities, 10% of broad

³ See Greenspan (1999).

money and 5% of exports of goods⁴. In general, coverage of between 100%–150% of this indicator is considered to be adequate for a typical country.

Recognising the limited applicability of the IMF (2011) measure to small islands, Mwase (2012) developed a more operationally relevant metric that incorporates services exports and assigns different weights to the various components. Specifically, the index was computed as 35% of exports of goods and services, 10% of broad money and 95% of short-term debt (fixed exchange rate countries). The index comprises 10% of exports of goods and services, 30% of broad money and 40% of short-term debt (for floating exchange rate countries) and 20% of exports of goods and services, 20% of broad money and 80% of short-term debt for the economies in a currency union. This metric requires countries to hold a higher level of reserves than any of the traditional approaches, with reserve adequacy proposed to be between 75% and 100% of the metric. Mwase (2012) found that reserve holdings were adequate in 37% of the sample countries, with 32% above and 42% below the range of adequacy. This measure, however, does not consider critical country-specific risk factors, such as the risk of natural disasters, and the inclusion of short-term debt is irrelevant for small countries without short-term market debt.

Zeng (2012) presents a multifactor measure, which is based on Wu (1998), that assumes the required level of foreign exchange reserves in China is driven by the foreign exchange required for imports, repaying total foreign debt and profits returned from foreign direct investment. While Wijnholds and Kapteyn (2001), IMF (2011) and Mwase (2012) suggested combination indicators that hinge on observed patterns of reserve losses during periods of pressure, this level of empirical rigor was not applied in the present case. Despite the absence of a concrete benchmark for reserve adequacy, Zeng (2012) concluded that Chinese foreign exchange reserves exceeded optimal reserves for the years 1996 to 2005.

2.3. Estimation and Forecasting the Demand for Foreign Reserves

Some studies have examined reserve adequacy by estimating an empirical reserve demand specification and making a forecast of the optimal level of reserves. Actual data on foreign reserves are compared to forecasted reserves to assess whether reserve levels are adequate or in line with their long-run macroeconomic determinants (i.e., whether there is a significant difference between actual reserves and the predicted reserves). The key explanatory factors of foreign reserve holdings are identified generally as economic size, current account vulnerability, capital account vulnerability, exchange rate flexibility and opportunity cost (Gosselin and Parent, 2005).

⁴ The percentage of exports is lower for floating exchange countries based on the general view that fixed exchange rate economies require higher levels of reserves than countries with a floating exchange rate.

Most studies have used panel data to test the importance of these regressors. Aizenman and Marion (2002), employing data on 125 developing countries for the period 1980-2002, showed that reserve holdings was the predictable outcome of the size of international transactions, volatility, the exchange rate arrangement and political considerations before the Asian crisis, whereas it under predicted reserve holdings after the crisis. Edison (2003) similarly estimated reserve demand as a function of economic size, current account vulnerability and exchange rate flexibility for a sample of 122 emerging countries for the period 1980-1996 and found that actual reserves were predictable by the model forecast before the Asian crisis but actual reserves exceeded forecasts after 2001. Based on Edison (2003), Park and Estrada (2011) tested whether reserve levels in developing Asia were excessive using data covering the period 1980-2004 for 130 emerging economies. They concluded that for the period 1990–2002, economic fundamentals could explain the bulk of developing Asia’s reserve accumulation but from 2003 onwards actual reserves exceeded predicted reserves, an indication that reserves had become excessive for the Asian region as a whole.

Recent studies on foreign exchange demand have employed non-stationary econometrics. Gosselin and Parent (2005) estimated a reserve demand function in a panel of eight emerging market countries for the period 1980 to 2003. They found that the ratio of imports to GDP, the ratio of broad money to GDP and the volatility of export receipts are significant explanatory factors of reserves in the long run and short run. Gosselin and Parent (2005) concluded that their model could not predict the strong pace of reserve accumulation for the years 2003 and 2004, an indication that reserves were not in line with their long-run determinants.

The main drawback of the above econometric and forecasting research is that the results are model dependent and accurate only within sample. The Korean experience during the 2008 global financial crisis shows the limitation of using such an approach. Despite the country being assessed as having excess reserves, both the Korean currency and stock market came under severe pressure during the third quarter of 2008, triggering fears of a repeat of the 1997-98 Asian financial crisis (Park and Estrada, 2011). These issues suggest a case can be made for a more contingency-based approach, possibly using stress tests, that takes into account severe negative shocks a country may face when assessing foreign exchange reserve adequacy.

2.4. Model of Rational Optimising Behaviour

Heller (1966) pioneered the cost-benefit approach to analysing reserves for developed countries. Optimal reserves were determined at the point where the marginal cost of holding reserves equaled the marginal benefit. Agarwal (1971) adjusted Heller’s model to account for the foreign exchange constraint faced by developing countries. This is of particular relevance since these countries are required to balance foreign exchange receipts and payments and to ensure limited the foreign exchange is channeled into the most productive uses. Clarks (1970) created a

stochastic version of the model and others have emphasised the role of capital flows in a balance of payments crisis. In this regard, the optimal reserve framework that possibly stood out is Jeanne and Rancier (2006). This model is based on the intertemporal optimisation problem of the government in a small open economy hit by “sudden stops” in capital flows and an associated fall in output. A closed-form solution for the optimal level of reserves was calibrated using data for a sample of 34 emerging market countries over the period 1980 to 2003. Among the findings were that many Asian economies held excessive reserves after the Asian crisis. While the Jeanne and Rancier (2006) model and its variants made a marked contribution to the literature, issues such as the role of default risk as a determinant of the cost of holding reserves, the preventative role of reserves in reducing the probability and severity of sudden stops and problems relating to the collective management of reserves were not addressed.

Many studies have used the Jeanne and Rancier (2006) framework for assessing reserve adequacy in terms of insurance against balance of payments shocks. Yang and Yan (2012) computed levels of optimal reserves for Taiwan and found this country held excessive reserves from 1981 to 2009. After adjusting the Jeanne and Rancier (2006) model to include 3 months’ worth of imports and the additional need for foreign reserves due to Taiwan’s political situation of not being a member of the IMF, the Taiwanese reserves were considered to be excessive. Barnichon (2009) extended the optimisation framework to include parameters to capture no access to the international capital market, susceptibility to natural disasters and terms of trade shocks. Using data for the period 1963 to 2007, the model was calibrated for low to middle-income economies of the Caribbean and the Sahel region in sub-Saharan Africa. The estimated lower bound of an optimal reserves-to-imports ratio of 1.5 months’ worth of imports for the Caribbean economies and 4.5 months of import cover for an average Sahel country were applied to the data. The framework was, however, limited, as it only accounts for reserves needed for self-insurance against a natural disaster or trade shock, without taking into consideration the reserves required for liquidity purposes, maintenance of an exchange rate peg and limiting exchange rate volatility.

Dehesa, Pineda and Samuel (2009) derived the optimal level of reserves for the ECCU using the Jeanne (2007) optimisation framework and traditional measures. The model was calibrated over the period 1996 to 2008. The results indicated that reserve levels were adequate for a variety of external current and capital account shocks. Importantly, these authors note that moderate to severe (domestic) deposit withdrawals in the context of an open capital account could be a challenge on existing reserves in the currency union.

Valencia (2010), like Jeanne and Rancier (2006), employed a precautionary savings model adapted to situations where there are borrowing constraints. The model computed the optimal levels of reserves for Bolivia as ranging between 29% and 37% of GDP which was assessed as being higher than the adequacy levels suggested by standard rule of thumb measures. Later

Tereanu (2010) applied Valencia (2010) and Barnichon (2009) frameworks to determine reserve adequacy for The Gambia, characterised as a small open economy with a significant import component and subject to external shocks. Tereanu (2010) suggested an optimal reserve cover of 4.5 to 7 months of imports would be adequate for The Gambia and concluded the country’s reserves were in line with its macroeconomic risks.

3. Evolution of Foreign Currency Reserves in Caribbean Economies over the Past Thirty Years

Caribbean countries have recorded fairly impressive growth in foreign exchange reserves, particularly during the last decade. Total foreign reserve holdings rose from US\$3.9 billion in 1981 to US\$18.4 billion in 2011 at average annual growth rate of \$US5.4 billion. An examination of Figure 1 reveals three distinct phases of performance. During the 1980s, the level of foreign reserves exhibited a general downward trend, declining on average by 10% or US\$2 billion. This was followed by a pick-up in reserve accumulation during the 1990s, which was characterised largely as an expansionary phase for the majority of Caribbean economies. In the immediate post-2001 period, there was a temporary shock resulting from the terrorists’ attacks in United States and reserves growth stagnated, mainly in the tourism-dependent economies. Thereafter, total reserve growth resumed uninterrupted, except in 2009 when the impact of the global economic and financial crisis took root, and continued to increase largely because of the strong expansion in foreign exchange reserves in Trinidad and Tobago.

Figure 1: Growth in Total Foreign Exchange Reserves for Caribbean Economies (US\$ Millions)

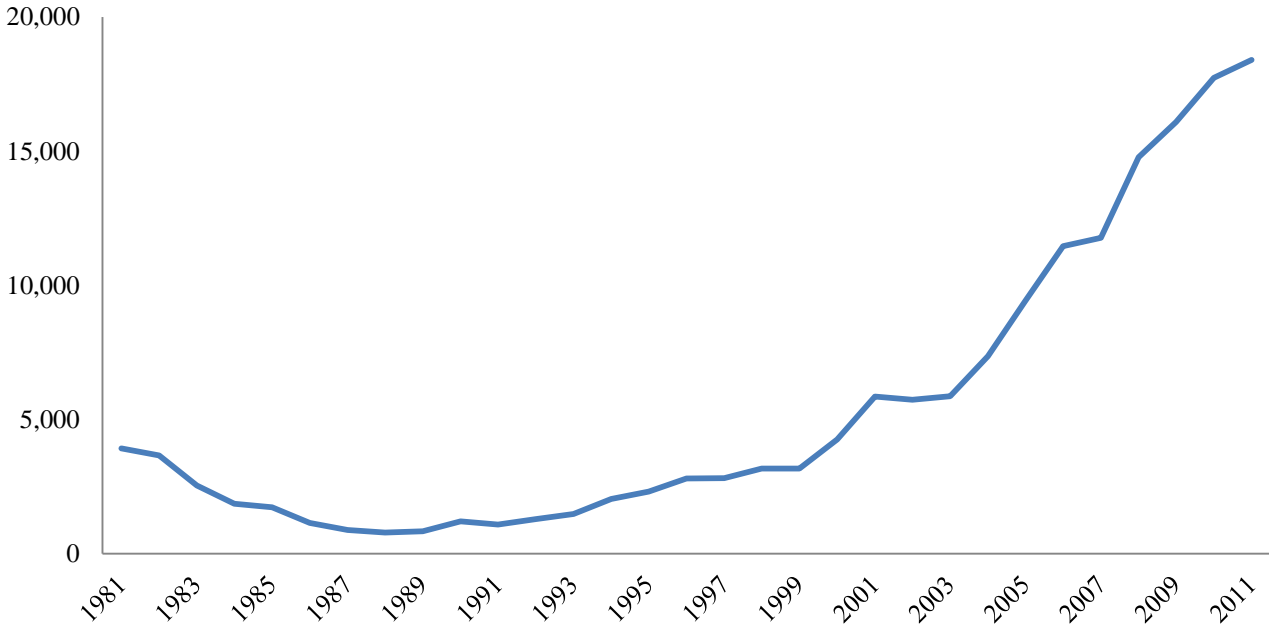


Figure 2 shows the contribution of the fixed and floating rate economies to total foreign reserves. Not surprisingly, the floating exchange rate economies account for the larger share of total reserves of approximately two-thirds, driven primarily by reserves holdings of Trinidad and Tobago⁵. Jamaica, whose individual share of total reserves expanded from the early 2000s also plays significant role in the general upward trend in reserve accumulation in the region. The economies of Barbados, Belize, The Bahamas and the ECCU countries together account for a share roughly one-third of total reserves.

Figure 2: Country Shares of Foreign Exchange, 1981-2011

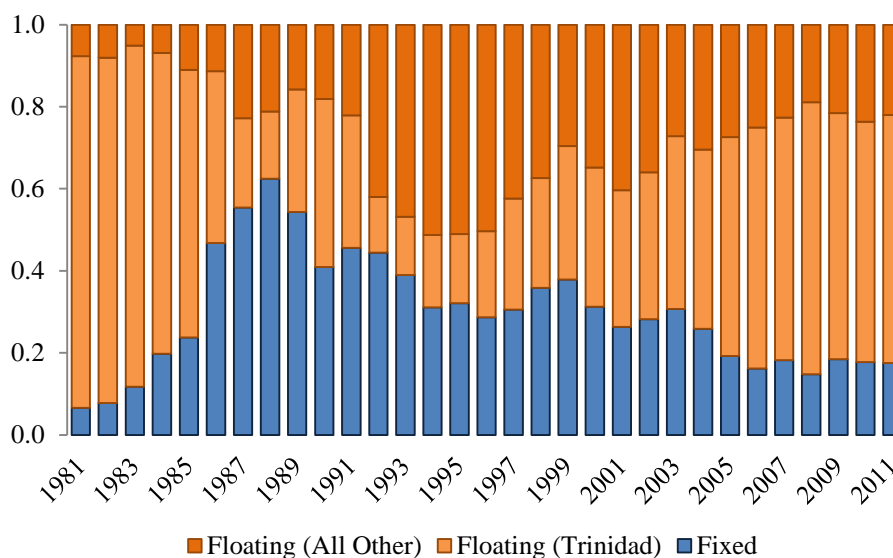


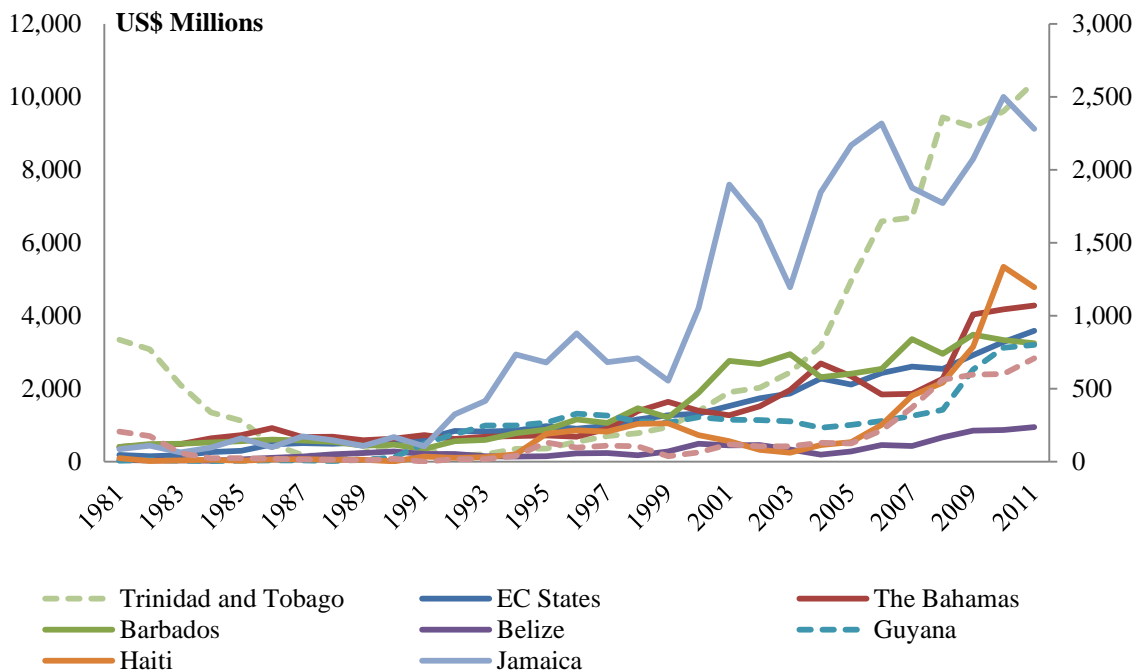
Figure 3 displays the trends in reserve growth for the sample Caribbean countries over the sample period. Most noticeably, Trinidad and Tobago, which registered a sharp decline in foreign reserves during the 1980s, experienced rapid reserve growth from the early 2000s until the end of the sample period, a reflection of the rising international oil prices and resultant current account surpluses. Notwithstanding fluctuations in reserve holdings during the past two decades, Jamaica has generally recorded moderate growth over the review period. Among the fixed exchange rate economies, Barbados, after suffering a dramatic decrease in foreign exchange reserves in 1991, exhibited a general upward trend in reserves for the mid-1990s to end of the sample period. The aftermath of this negative tourism shock in 2001 was a marked decline in foreign exchange reserves in most of the regional economies.

Of particular note was Haiti’s strong reserve growth during the period 2007-09, a reflection of its emergence from the political and economic crisis experienced earlier in the decade. That country’s foreign exchange reserves peaked in 2008 declining following the global economic

⁵ Since 2000, Trinidad and Tobago has held an average share of 80% of total foreign reserves.

crisis with recovery by 2010. The slump in reserve accumulation during the economic crisis was expected but reserve growth resumed in the subsequent years.

Figure 3: Caribbean Countries Foreign Exchange Reserves Growth, 1981-2011
(Trinidad and Tobago on LHS Axis and Other Countries on RHS Axis)



4. Data and Methodology

This study employs four methods to assess reserve adequacy for Caribbean economies⁶ over the period 1981 to 2011. These methods are ratio analysis, combined factor ratio analysis, estimation and forecasting of reserve demand and a rational optimising behaviour modelling approach. The sources of the data on foreign reserves, GDP and imports were obtained from the IMF International Financial Statistics (IFS) databases. The measure of foreign reserves used is total reserves excluding gold, and imports are imports of goods and services. Short-term external debt, defined as debt with an original maturity of one year or less, and monetary aggregate data were collected from the World Bank’s World Development Indicators Database (WB-WDID).

⁶ The foreign exchange reserves for the countries of The Eastern Caribbean, comprising Anguilla, Antigua and Barbuda, Dominica, Grenada, St. Kitts and Nevis, St. Lucia and St. Vincent and the Grenadines are aggregated, since these countries pool reserves as part of the ECCU.

4.1 Ratio Analysis

The derived ratios, foreign exchange reserves to imports (IMP), foreign exchange reserves to short-term external debt (STED) and foreign exchange reserves to broad money (M2), are compared to the specific benchmark levels of reserve adequacy proposed in the existing literature.

Import coverage ratio: The literature assumes three months' worth of imports to be adequate, which corresponds to an imports-reserves ratio of 0.25. The computed country ratios are compared with this benchmark to determine whether reserves were adequate.

Ratio of Reserves to Short-Term External Debt (STED): Applying the Greenspan- Guiotti (1999) rule of 100% coverage of short-term debt for one year means that a ratio of unity or above is adequate. However, given that only four of the sample countries held STED, this measure may not be the most suitable indicator for assessing reserve adequacy across Caribbean countries.

Ratio of Reserves to Broad Money (M2): This ratio has a conventionally accepted range of between 0.05 and 0.2, i.e., reserve holdings should be within the range of 5% and 20% of M2.

4.2 Combined Factor Analysis

The informal ratios may not capture the level of reserves required to cover the various motives for accumulating reserves. For instance, the import cover ratio only addresses balance of payments vulnerabilities that stem from the current account transactions, whereas the other two ratios (i.e., reserves to STED and reserves to M2) account for transactions related to the capital and financial account. Therefore, the combination metric of Mwase (2012), which was adapted from IMF (2011), was also applied to the Caribbean data.

Mwase (2012) Metric: This measure assumes that balance of payments shocks arise from both the external current and capital accounts. It is applicable to Caribbean countries, which experience vulnerabilities on the external current account, owing to relatively high import dependence, and export volatility, particularly with respect to tourism in the tourism-dependent economies and energy-based production in Trinidad and Tobago. Furthermore, capital account shocks are relevant, especially in light of capital account liberalisation in some Caribbean countries. More importantly, the measure includes exports of goods and services, which is more suitable to the service-oriented Caribbean economies and makes allowance for the assessment of reserve adequacy in a currency union. The metric is computed as follows: for the ECCU, the metric comprises 20% of exports of goods and services + 20% of broad money + 80% of short-term external debt. The components used in the computation for the fixed exchange rate countries (i.e., The Bahamas, Barbados and Belize) was 35% of exports of goods and services +

10% of broad money + 95% of short-term external debt. For Suriname, Guyana, Haiti, Jamaica and Trinidad and Tobago, which have floating exchange rate regimes, the measure was calculated by combining 10% of exports of goods and services +30% of broad money +40% of short-term external debt. The ratio of foreign exchange reserves to the computed Mwase metric for each country was deemed adequate if between 75% and 100%.

4.3 Estimation and Forecasting of Reserve Demand

Previous empirical studies estimating reserve demand include economic size, current account vulnerability, capital account vulnerability, exchange rate flexibility and opportunity cost of holding reserves as the main explanatory variables (Gosselin and Parent, 2005). For the Caribbean, the most recent study by Craigwell et al (2007) applied non-stationary econometrics, namely the Stock and Watson's (1993) dynamic OLS method.

Specification of the general long-run reserve demand equation is as follows:

$$lres = \beta' X_t + \sum_{j=-k}^k \lambda_j \Delta X_{t-j} + \varepsilon_t \quad (1)$$

where $lres$ is the dependent variable, log of reserves, X_t denotes the set of explanatory variables which capture economic size (GDP per capita), current account vulnerability (imports to GDP), export volatility (three-year moving standard deviation of the change in exports), capital account vulnerability (M2 to GDP), β the vector of long-run coefficients, X is the sub-set of I(1) explanatory variables of X . Lagged regressors are used to address serial correlation and lead or future values correct for endogeneity. A general-to-specific approach is utilised with j starting at 2 and then reduced to a statistically-adequate specification based on various diagnostic tests, including checks for normality, heteroscedasticity, misspecification and serial correlation.

It is expected *a priori* that reserve demand is positively related to real GDP per capita, imports to GDP, export volatility, and M2 to GDP. The demand for foreign reserves is expected to rise with an increase in income per person, which accords with the reality of Caribbean economies where spending is predominantly on imported goods. The high degree of trade openness of Caribbean economies suggests a positive sign is expected on the estimated coefficient of the imports to GDP variable. By extension, export volatility, particularly in the context of a large propensity to import, is expected to generate greater demand for foreign reserves to pay for imports. The ratio of M2 to GDP, which provides a proxy of potential foreign exchange losses resulting from resident-based capital flight, is likely to result in an increased level of foreign currency reserves.

The long run reserve demand equation is estimated for each country over the period 1981 to 2006. Out of sample forecasts are done for the period 2007 to 2011 to allow for comparisons of actual and forecasted reserves to determine whether reserve accumulation was consistent with the long-run factors that influence reserves. Where the level of reserves predicted by the model is significantly different from actual reserves, the reserves are considered to be inadequate or excessive as the case dictates.

4.4 *Rational Optimisation Methods*

This method is based on a cost-benefit analysis as developed by Heller (1966). Jeanne and Ranciere (2006) presents a framework to account for capital account crises by featuring a model of a small open economy vulnerable to sudden stops in capital flows. Jeanne (2007) also proposes an optimisation model in the context of a small open economy with a representative consumer where reserves are held to smooth consumption in the face of a currency crisis defined as a loss of access to external credit that results in a fall in output. This model was adapted to the ECCU by Dehesa et al (2009). Other studies such as Barnichon (2009) have used similar models to determine the optimal level of reserves based on balance of payment pressures, arising from terms of trade shocks or natural disasters. Given the Caribbean's susceptibility to current and capital account vulnerabilities, both types of frameworks are applied to the data.

4.4.1 *Jeanne and Rancier (2006) Model*

This model is applicable to Caribbean realities given the growing importance of the capital account flows to balance of payments dynamics. It uses an absorption approach with domestic absorption expressed as the sum of domestic output, the capital and financial account balance, income from abroad and reserve changes, *viz.*,

$$A_t = Y_t + KA_t + IT_t - \Delta R_t \quad (2)$$

This basic equation posits that, all other things equal, a sudden stop reduces domestic absorption. The extent of the contraction in domestic absorption is greater if the impact of the sudden stop is accompanied by lower domestic output. However, by drawing down existing foreign exchange reserves to meet external payment obligations tempers the effect of the negative shock to the capital account and by extension the size of the fall in domestic absorption. In other words, using available foreign exchange reserves avoids an external adjustment that involves reducing national income to reduce purchases of imports.

The model assumes that reserves accumulated for intertemporal consumption smoothing is necessitated by the possibility of a sudden stop in capital flows. The explicit formula postulated by Jeanne and Rancier (2006) for calculating optimal reserve to output holdings is as follows:

$$\rho = \lambda + \gamma - \frac{p^{\frac{1}{\sigma}} - 1}{1 + \left(p^{\frac{1}{\sigma}} - 1\right)(1 - \delta - \pi)} \left(1 - \frac{r - g}{1 + g} \lambda - (\delta + \pi)(\lambda + \gamma)\right) \quad (3)$$

where ρ is the optimal reserves-to-output ratio, λ denotes the ratio of short-term debt to GDP, γ represents the fraction of output loss below the long-run growth path, σ measures risk aversion, π is the probability of a sudden stop, p denotes the marginal rate of substitution between consumption in a sudden stop state and consumption in a non-sudden stop state, δ represents the risk premium, g is real output growth and r , the risk-free interest rate.

For the calibration of this model, the majority of the parameter values were adopted from Jeanne and Ranciere (2006) and Dehesa et al (2009). The output loss γ is set at 10% of GDP, the probability of a sudden stop, π , is assumed to be 10%, risk aversion $\sigma = 2$, the real output growth g is 0.033, risk free interest rate $r = 0.05$ and the risk premium $\delta = 0.015$. The average ratio of short-term debt to GDP over the sample period was computed for the sample countries holding this debt obligation.

4.4.2 Jeanne (2007) Model

This model assumes a representative consumer for a small open economy where the consumer's wealth is held either in the form of liquid international reserves (R) or a higher yielding but illiquid asset (I). The economy is vulnerable to a currency crisis with reserves used to smooth consumption and possibly reducing the probability of occurrence of a crisis by providing a buffer against external shocks. Holding reserves, however, comes at a cost (∂), i.e., the opportunity cost of holding liquid assets rather than illiquid assets with higher returns. Optimal reserves minimise the consumer's welfare loss function which is dependent on the sum of the expected welfare cost of a crisis $f(R)$ that occurs with probability $\pi(R)$ and the opportunity cost of holding reserves ∂R .

The closed-form solution for the optimal level of reserves for this model is given as:

$$R = L + \Delta Y - \left[1 - \left(1 + \frac{\partial}{\pi}\right)^{-\frac{1}{\sigma}}\right] \quad (4)$$

where L is capital flight, ΔY is the output cost of a crisis, and σ a relative consumer's risk aversion parameter. Equation 4 assumes that the optimal level of reserves is equal to the minimum level sufficient to maintain consumption at a desired level in a crisis less the opportunity cost of holding reserves.

Model calibrations for the Caribbean economies were done using the same parameters as Jeanne (2007) and Dehesa et al (2009). The parameters employed were as follows: size of the sudden

stop $L = 0.1$; output loss $(\Delta Y) = 0.1$; opportunity cost of reserves $\delta = 0.03$; probability of a sudden stop $\pi = 0.1$ and risk aversion, $\sigma = 2$.

The probability of a sudden stop and the growth rate are set at 0.1 and 3.3%, respectively⁷. With most Caribbean countries falling within this income category, these parameters are applicable to the region. The output loss of 10% of GDP, previously used for Caribbean countries by Dehesa et al (2009), is suggested by the literature on currency and banking crises. Dehesa et al (2009) also applied the standard growth and real business cycle risk aversion parameter of 2 to the Caribbean data. An opportunity cost of 3% computed by Jeanne (2007) as the historical average cost differential between issuing a 10 year U.S. Treasury bond and investing in liquid assets such as a 3 month U.S. Treasury bill is acceptable, especially given the paucity of consistent interest rate data. The parameter values for the risk-free interest rate of 5% and the term premium of 1.5% were similarly adopted from the literature.

4.4.3 Barnichon (2009) Model

This model assumes a representative consumer that maximises expected utility by consuming domestic and foreign goods subject to an aggregate resource and balance of payments constraint. They obtained an approximated closed-form solution for the reserves to imports ratio given:

$$\frac{R^*}{C_F} \approx \varepsilon \delta \left[\frac{\pi^{nd}}{\left(\frac{1+g}{\beta} - (1 - \pi^{nd}) \right) + (1 - \pi^{nd}) \frac{\delta}{1-\delta} \frac{r\theta}{1-\theta}} - \eta_\varepsilon \eta_X \eta_Y \right] \times \frac{1}{\varepsilon \delta + Tr} \quad (5)$$

where C_F is foreign or imported goods, R^* is the optimal reserve to output ratio, ε is the terms of trade, δ is an export fraction of output, π^{nd} is the probability of the occurrence of a natural disaster, $\frac{1+g}{\beta}$ is the discount rate, β is the discount factor, g is the growth rate of the economy, r is the opportunity cost of holding reserves, θ is the preference for home goods, Tr is the share of imports covered by foreign grants and loans, η_ε is the fraction of normal terms of trade during a disaster, η_X is the fraction of export capacity during a disaster and η_Y is the fraction of output production in a disaster state.

Equation 5 suggests that a higher shock probability or larger decline in the value of exports raises the optimal reserves to imports ratio. Conversely, a greater opportunity cost of holding reserves and a higher discount rate lowers the reserves-to-imports ratio. An increased level of the share of imports covered by foreign grants decreases the optimal reserves-to-imports ratio as transfers or loans are not sensitive to natural disasters. An inverse relationship exists between the size of the

⁷ See Jeanne and Ranciere (2006).

export sector and optimal reserve to output ratio. Given the concavity of the utility function, more foreign-exchange inflows make reserve accumulation easier and the optimal reserves-to-imports ratio increases. To obtain a numerical solution, a CES utility function is assumed. The model derived an optimal level of reserves to imports adequate to cover a hurricane or terms of trade shock in the Caribbean of 1.52 months of imports. This paper compares this suggested optimal import cover ratio with the actual reserve import ratios in the region over the sample period.

5. Results

5.1 *Informal Ratio Analysis*

The estimated import cover ratios for each country are shown in Figure 4. The figure reveals that the ratio for Trinidad and Tobago declined sharply from 16 months in 1981 to less than one month in 1988. The ratio fell below the benchmark in 1987 and remained thereabouts until 1999, indicating inadequate holdings of reserves. Reserve adequacy was restored for the remainder of the sample period, as the ratio rose rapidly to a high of 16.8 months in 2010. Guyana's holdings of reserves during the 1980s were below one month, considerably lower than the benchmark 3 months for reserve adequacy. This trend was reversed dramatically in the early 1990s, with the ratio reaching a peak of 6.6 months in 1996. There was a steady reduction in reserve adequacy levels during the subsequent years, as the import ratio fell to 2.5 months in 2008, before rising again to an average of 5.3 months between 2009-11. The estimated import cover ratio for Jamaica indicates that foreign reserve holdings were not adequate during the 1980-99 period. In the remaining years of the sample period, reserve adequacy improve as the ratio (except for 2008) was more or less greater than the benchmark. Reserve adequacy in Haiti was only observed for a few years of the sample period, i.e., in the mid-1990s and for the 2009 to 2011. In the case of Barbados, the stock of reserves was substantially below the three-month-imports benchmark during the 1980s to the mid-1990s. In particular, the ratio was estimated at a low of 1.3 months in 1991 when the country experienced a balance of payments crisis. Foreign reserves accumulation gradually improved from the late 1990s onwards, as foreign investment picked up and economic growth gained momentum. The calculated ratios for Belize, The Bahamas, the ECCU suggested that reserves were practically inadequate for a significant part of the sample period. In the case of Belize, this result is not surprising given Mwase (2012) observation that Belize's reserve holdings were consistently lower than can be attributed to economic fundamentals. The ratio for the ECCU, while hovering around the three-month benchmark in the early 2000s, indicated reserve adequacy only in 2004 and the period 2009 to 2011. Dehesa et al (2009) found that foreign reserves in terms of months of imports of goods and services were lower in the ECCU when compared with other small tourism-dependent economies in the Caribbean and Africa. The calculated import ratio suggests that The Bahamas only held adequate reserves in the latter years of the sample period (i.e., from 2008 to 2010).

Figure 5 presents comparatively different results than the import cover ratios, as the majority of countries were viewed as holding adequate reserves over the sample period. However, Jamaica's reserves were found to be below the lower bound of 20% for three years, and the reserve holdings of Haiti and Guyana were insufficient during the 1980s up to the early 1990s.

The estimated reserves to STED ratios are shown in Figure 6. For the four sample countries (i.e., Belize, ECCU countries, Jamaica and Guyana) that held short-term external debt, the calculated ratios indicated that the stock of reserves held were generally satisfactory to cover this debt obligation. Despite the sharp fall in the ratio from the mid-1980s, the ECCU reserves remained adequate over the entire period. Belize's foreign reserves were estimated to be inadequate for only a few years. Guyana's reserves were insufficient up to the early 1990s, but adequate during the later years. The estimated ratio for Jamaica indicated insufficient coverage between 1982 and 1992, followed by a sustained but fluctuating period of reserve adequacy for the remainder of the sample period.

Figure 4: Import Coverage in Months of Imports

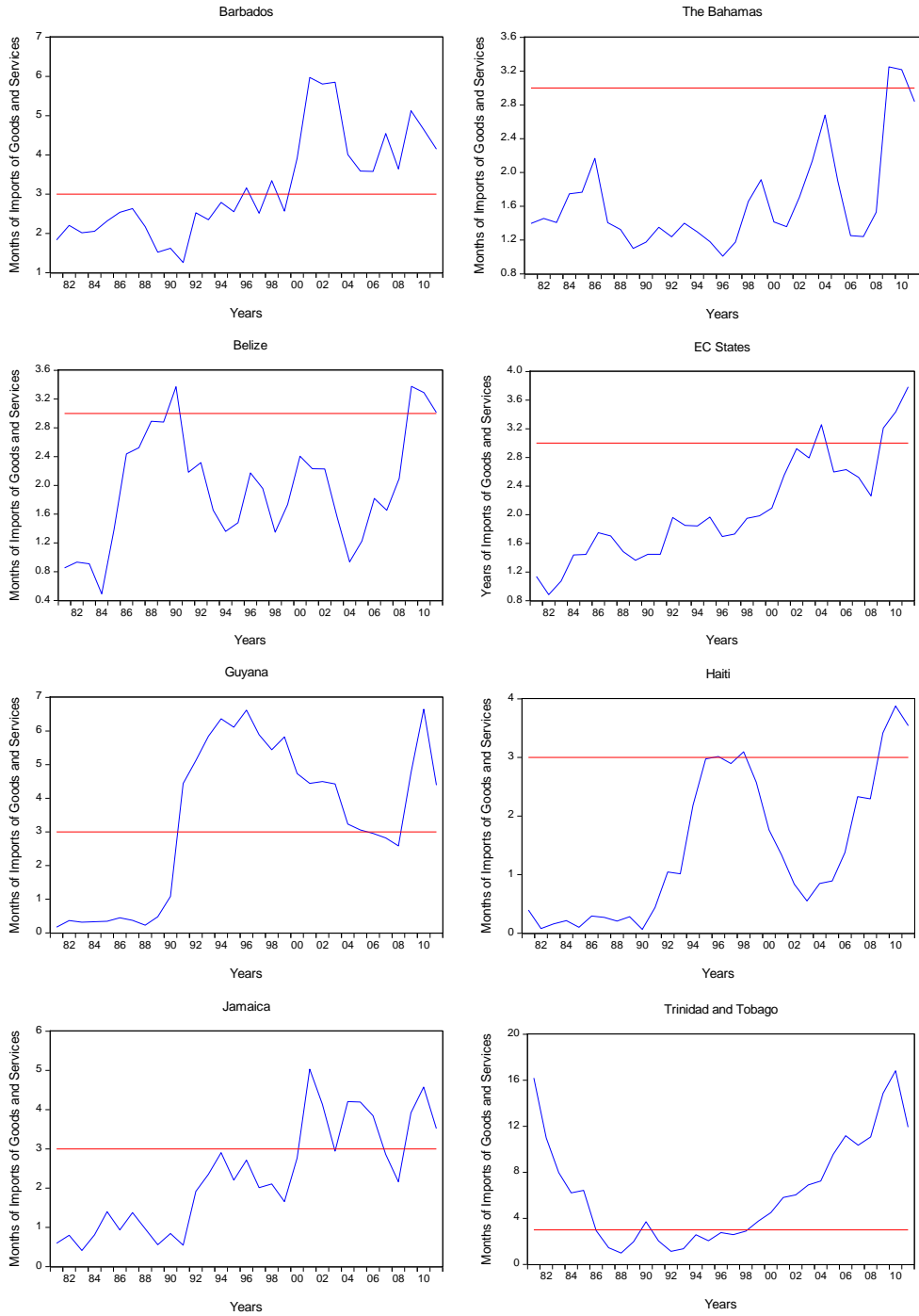


Figure 5: Reserves to M2 Ratios

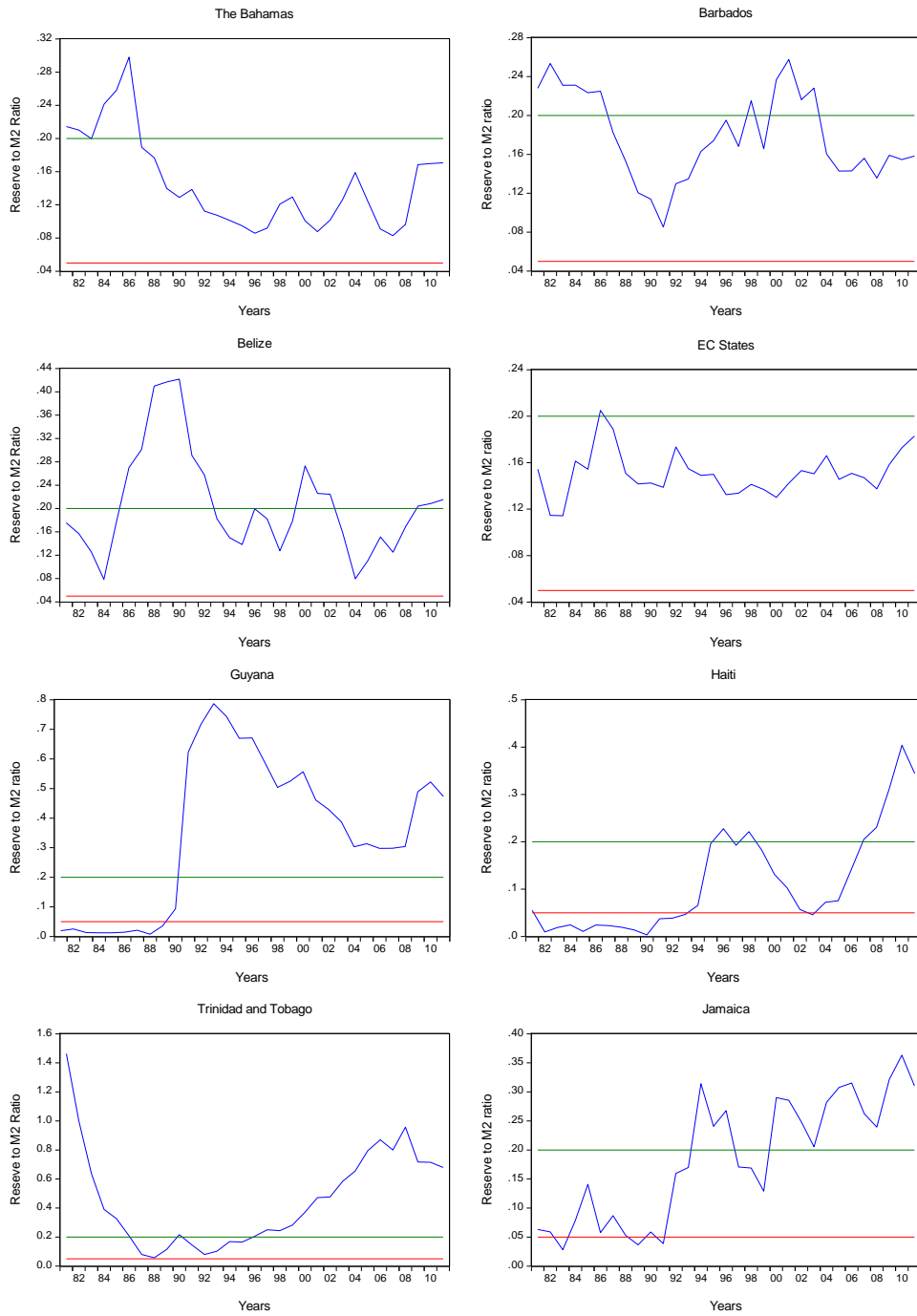
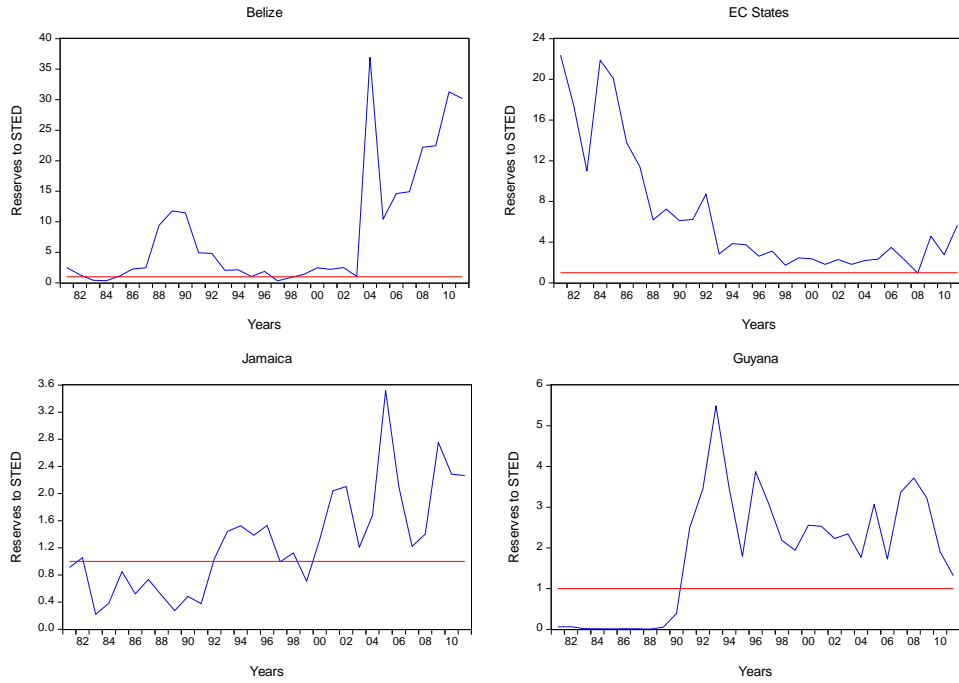


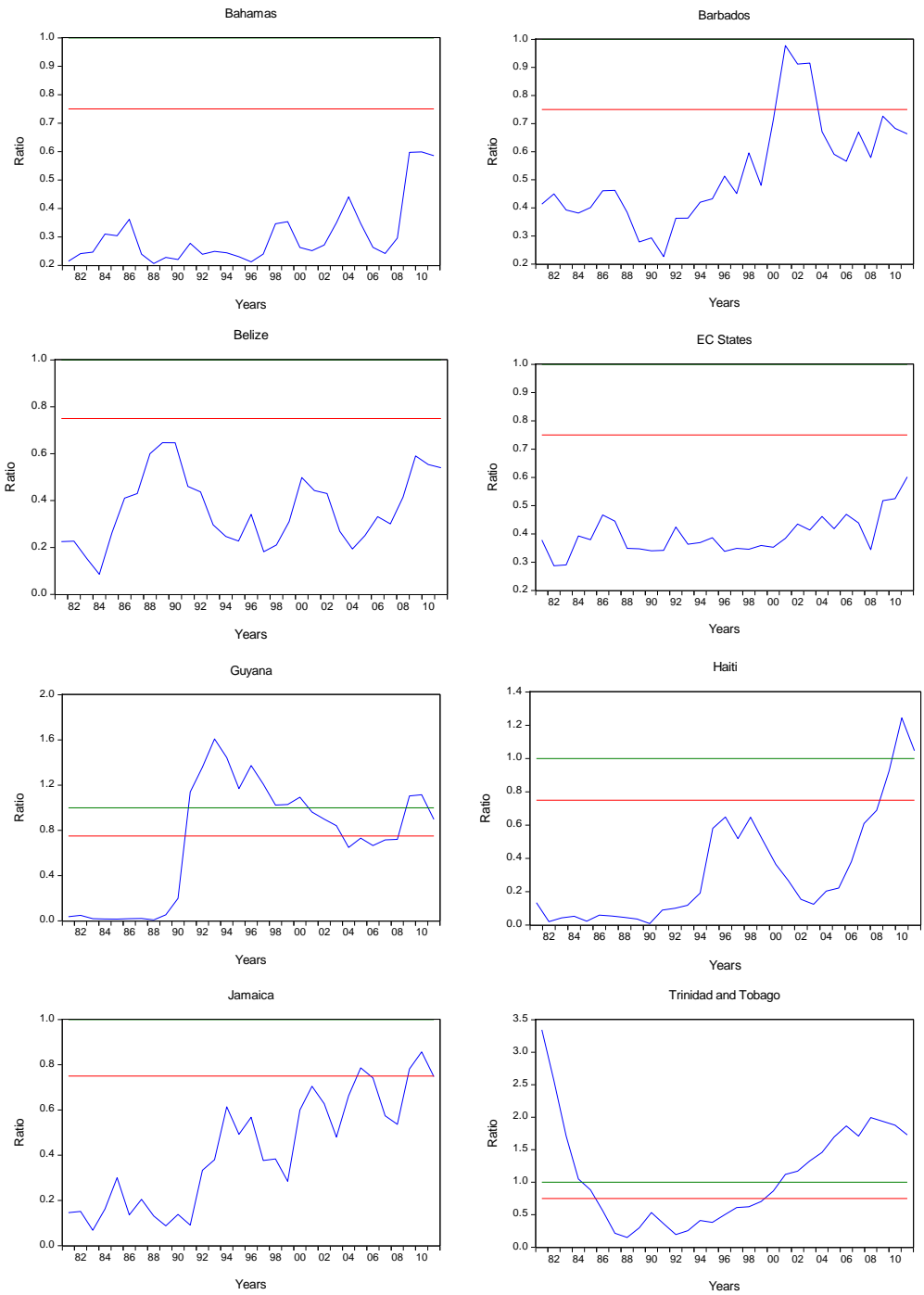
Figure 6: Reserves to Short Term External Debt



5.2 Combined Factor Analysis

Figure 7 shows the Mwase (2012) metric for the sample countries. According to this measure, most countries failed the reserve adequacy test over the sample period. For Barbados, the ratio of reserves to the metric was within the optimal band only between 2001 and 2003. The Bahamas, Belize and the ECCU did not achieve reserve adequacy according to this measure. In a similar vein, Jamaica and Haiti's reserves were deemed adequate by this measure for only a few of the latter years in the sample period. Guyana and Trinidad and Tobago were the most consistent in holding adequate reserves by this measure.

Figure 7: Reserves to Mwase (2012) Measure



5.3 Estimation and Comparison of Actual and Forecasted Reserves⁸

Table 1 presents the empirical results of estimating the reserves demand equations for each country over the sample period 1983-2006. Using a general to specific approach, the most parsimonious dynamic OLS models were obtained for forecasting purposes, with the final specifications generally passing tests of misspecification, normality, serial correlation and heteroscedasticity. The forecast evaluation criteria revealed that most of the estimated models were appropriate for assessing the adequacy of foreign reserve holdings in the sample countries. The results indicate that in general the estimated coefficients had the correct signs.

Table 1: DOLS Estimation Results, 1983-2006

	BAR	BAH	BZ	ECCU	GUY	JAM	TT
C	8.4254***	11.994***	13.04***	9.4754***	15.6851***	21.483***	19.862***
lgdppc	0.1802	1.633***	1.4728***	1.1231***	1.43248*	2.7447***	2.4819***
lexv	-0.395***			0.0249	-0.2321	0.435***	0.1021
limp_gdp	1.636***	0.1834	0.4582	-0.0514*	3.7633***	-0.4535	1.2499**
lm2_gdp	1.3417***	-0.660***	0.7826	0.2814	-1.5197*	0.3427	-0.8263
d(lgdppc)	1.0756	-1.2092**				-1.6279**	
d(lexv)	0.3395***					-0.3147**	
d(limp_gdp)	-1.373***			1.1513***			
d(lexv(-1))	0.1816***						
d(lgdppc(-1))			3.3919**				
d(limp_gdp(-1))				0.659**			
d(lgdppc(1))		2.2697***	5.1719***			2.0486***	
d(limp_gdp(1))	1.1134**	2.3252***			1.4791**		
Adj. R ²	0.96	0.93	0.79	0.98	0.80	0.91	0.85
F-Test	88.5***	42.6***	18.9***	205.1***	20.8***	40.4***	38.2***

Notes: ***, **, * denotes statistical significance at the 1, 5, and 10% levels, respectively. Leads and lags selected according to the AIC and SC. BAR = Barbados, BAH = The Bahamas, BZ = Belize, ECCU = Eastern Caribbean Currency Union, GUY = Guyana, JAM = Jamaica, Sur = Suriname, and TT = Trinidad and Tobago

Table 2: Actual and Forecasted Foreign Exchange Reserves, 2007-2010

Country	2007		2008		2009		2010	
	Actual	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast
Barbados	839.43	895.21	738.53	667.20	871.15	707.67	833.54	679.13
Bahamas	464.48	349.63	567.91	204.97	1,009.82	246.80	1,044.15	325.69
Belize	108.51	141.69	166.16	100.40	213.68	122.53	218.00	93.20
ECCU	651.43	656.68	635.39	692.26	731.43	595.51	819.67	645.87
Guyana	313.01	555.98	355.91	757.65	631.41	418.94	782.06	371.52
Jamaica	1,878.51	2,725.32	1,772.71	1,961.46	2,075.84	3,263.64	2,501.09	3,767.53
Trinidad	6,693.73	12,985.05	9,442.61	24,257.09	9,177.94	7,074.77	9,605.54	7,134.59

⁸ Estimation of reserve demand specifications for the individual Caribbean countries was done with the econometric software programme E-Views 7.0. The Augmented Dickey Fuller, Phillips-Perron and Kwiatkowski-Phillips-Schmidt-Shin unit root tests determined that most of the variables were integrated of order 1.

This reserve forecasts suggests that The Bahamas held ample foreign reserves, whereas the forecasts for Jamaica indicate that the reserves held were inadequate over the entire forecast period. The comparison of actual and forecasted reserves for Barbados and Belize indicate insufficient holdings of reserves only for the year 2007. The ECCU and Trinidad and Tobago, for the first two years of the forecast period, did not hold reserves which were in line with their long-run determinants. However, in the subsequent two years, the reserve holdings surpassed forecasted reserves, indicating reserve adequacy.

5.4 Rational Optimisation Method Results

5.4.1 Jeanne and Ranciere (2006) Optimisation Framework

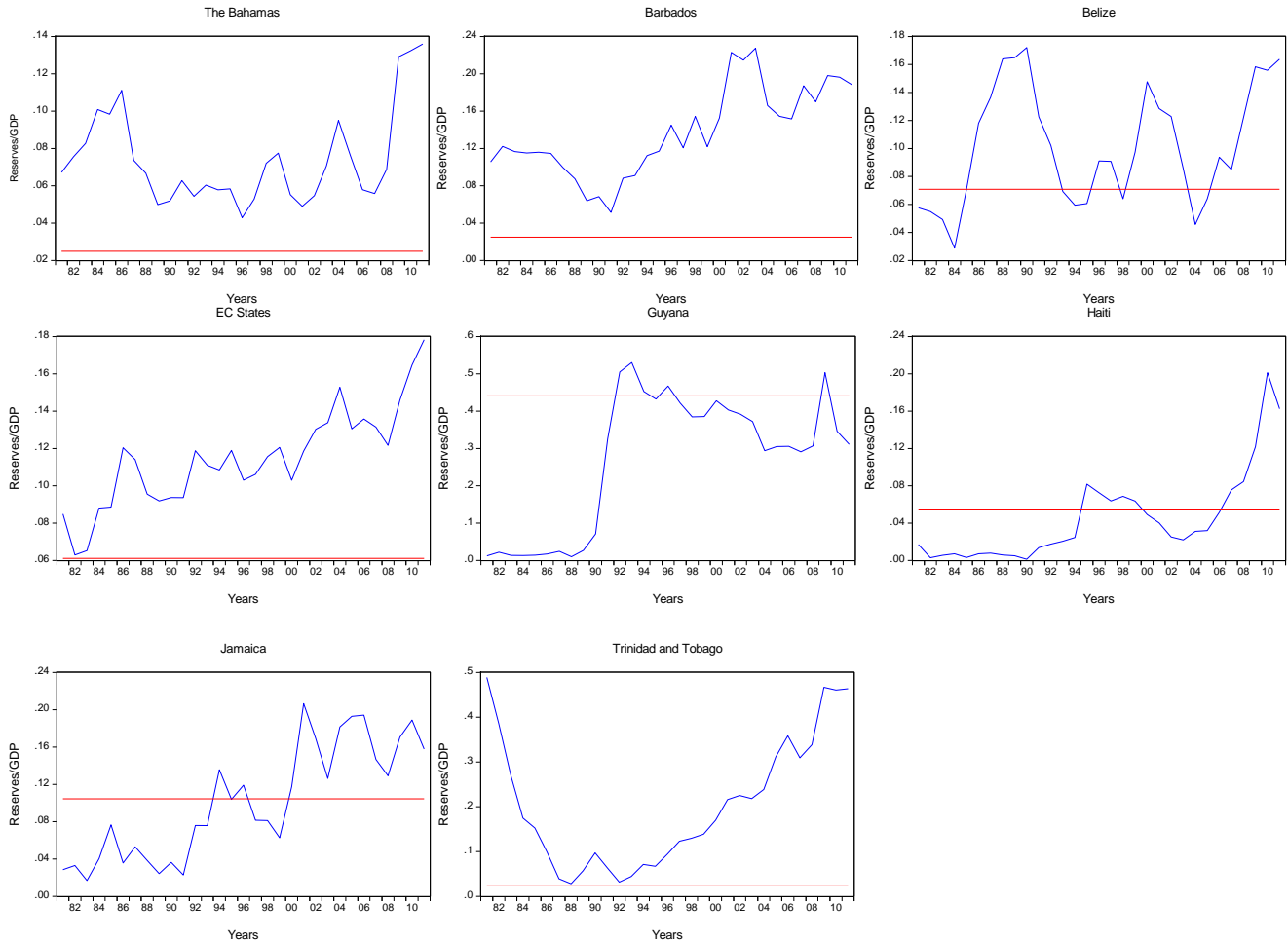
Using the average short-term debt to GDP ratio and the original Jeanne and Ranciere (2006) parameters, the optimal ratio of reserves to GDP for each country is given in Table 2 below.

Table 3: Optimal Reserves to GDP Ratios
(Jeanne and Ranciere (2006) Approach)

Country	Optimal Reserve to GDP Ratio
Barbados	0.025
ECCU	0.061
The Bahamas	0.025
Belize	0.071
Guyana	0.441
Haiti	0.054
Jamaica	0.104
Suriname	0.025
Trinidad and Tobago	0.025

Comparing the optimal reserve-to-GDP ratios with the actual ratios indicate that Barbados, The Bahamas, the ECCU, and Trinidad and Tobago held adequate reserves over the sample period. Similar to the results suggested by the previously-mentioned adequacy measures, reserves for Belize, Jamaica, Guyana and Haiti were below the benchmark levels, especially in the earlier years of the sample period (see Figure 8).

Figure 8: Optimal and Actual Reserves to GDP

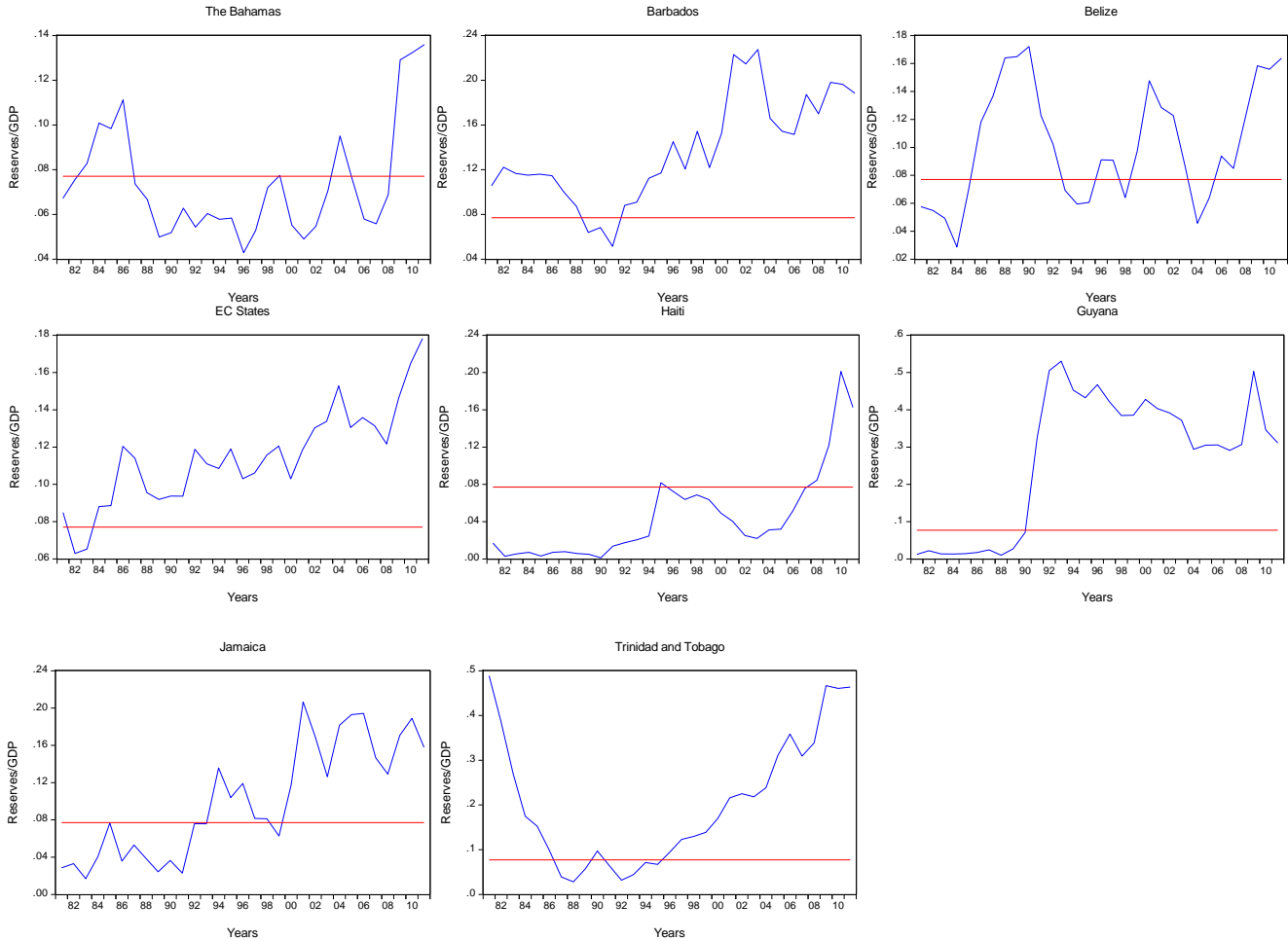


The optimal level of reserves computed using the Jeanne (2007) optimisation framework was estimated to be 7.7% of GDP. In Barbados and the ECCU actual reserves were beyond the optimal level suggested for most years, with the exception of 1989 to 1991 for Barbados and 1982 to 1983 for the ECCU. Trinidad and Tobago held adequate reserves for most of the period, with the years of inadequacy corresponding to the period during which the country experienced balance of payments difficulties. The Bahamas and Belize showed fluctuating periods of adequacy and insufficiency whereas Guyana's reserves were unsatisfactory for the first decade of the sample, but thereafter were enough. This measure like others highlighted Haiti as having the worst case of reserve adequacy in the region for most of the period (see Figure 9).

In some cases these results were similar to those obtained with the informal ratio analysis. Trinidad and Tobago, which held adequate reserves according to the informal ratio procedure, also carried sufficient reserves by this measure. For Belize and The Bahamas these findings were in line with that of the import cover ratio while different to the results derived with the reserves

to M2 ratio. Whereas the ECCU held inadequate reserves by the import cover measure, their reserves were sufficient under this optimisation framework.

Figure 9: Optimal verses Actual Reserves to GDP by Jeanne (2007)

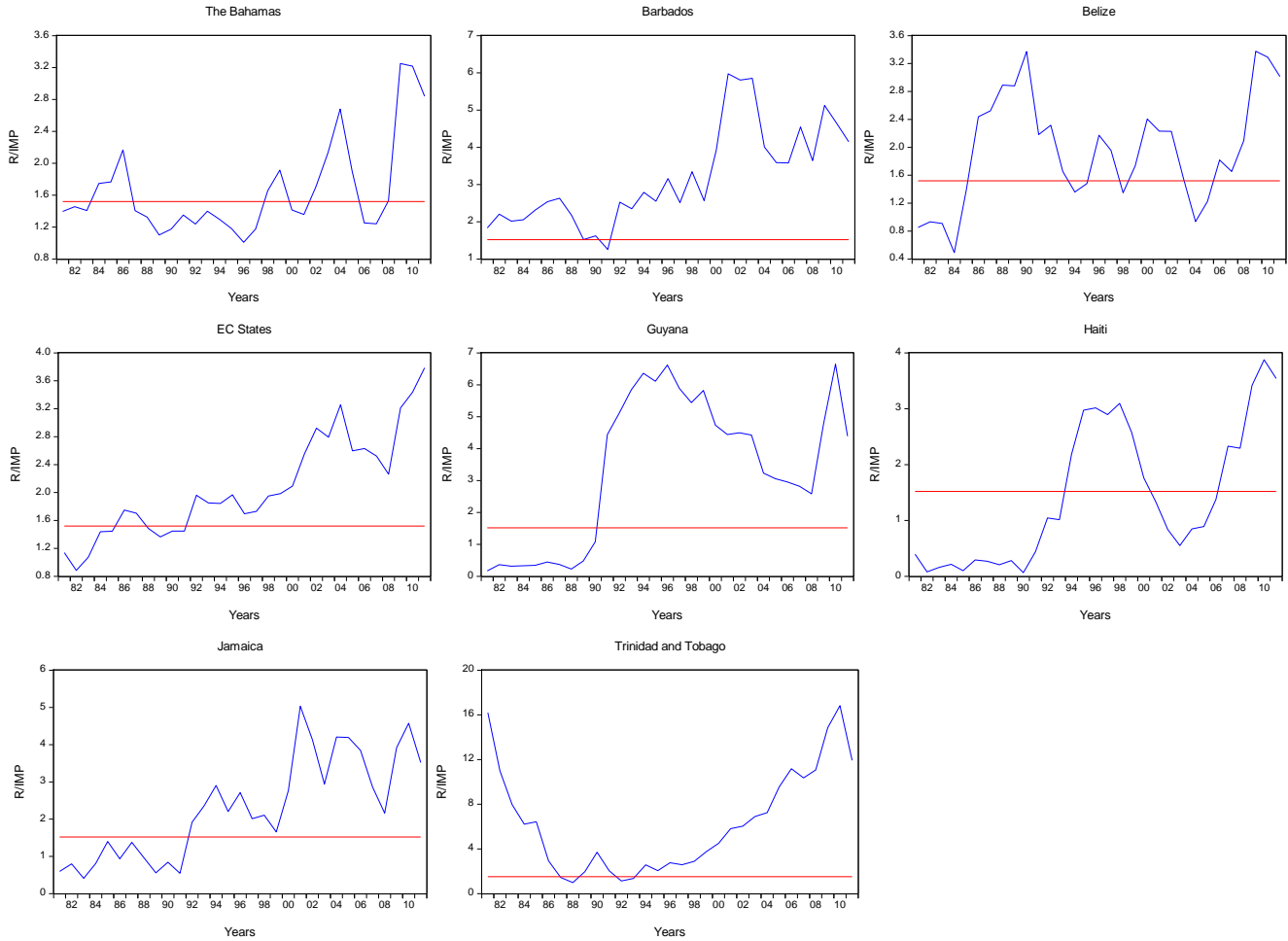


5.4.2 Barnichon (2009) Optimisation Framework

Using the optimal reserve import cover of 1.52 months, as suggested for Caribbean countries under this framework, the results suggest that Caribbean countries generally held adequate reserves to cover an external current account and natural disaster shock. Barbados and Trinidad and Tobago held insufficient reserves in the corresponding years of balance of payments difficulties. Belize and The Bahamas altered between having inadequate and ample reserves over the period. Whereas countries such as The ECCU, Guyana and Jamaica were reserve restraint in the first decade of the sample period, these countries recovered and held sufficient reserves for the remaining years. Haiti's reserves were unsatisfactory for most of the period but as with most of the other countries, it carried adequate reserves for the last five years under study. Haiti's

results are in line with previous methods and are no surprise given its poor economic performance for most of the sample period (see Figure 10)

Figure 10: Optimal versus actual reserves to imports by Barnichon (2009)



6. Conclusion

This study used four methods, namely informal ratio analysis, combined factor analysis, an estimation and forecasting procedure and cost benefit or rational optimising models, to assess foreign exchange reserve adequacy in the Caribbean. While country results varied across some measures, there were sufficiently consistent to allow for evaluation of reserve adequacy for each country.

Trinidad and Tobago by all measures held adequate reserves for most of the review period. That country's instances of inadequate reserves, as evaluated by the import coverage ratio, reserves to

M2 metric and Barnichon's optimisation framework, coincided with periods of shortfalls in energy exports and balance of payment deficits. In contrast, Guyana's reserves were below the benchmark level between the 1980s to early 1990s. This was reversed for the most part for the remainder of the sample period by three of the measures, except the reserve demand forecast. Jamaica, as indicated by most of the metrics, held reserve levels that were deemed inadequate in the earlier years under consideration. During the latter period, the metrics suggested foreign reserves holdings were adequate, except the forecast of reserve demand procedure and the Mwase (2012) indicator. Haiti, described as the poorest country in the Western Hemisphere, not surprisingly did not hold adequate reserves for the better part of the period under study. One of the few episodes during which Haiti's reserves were adequate were the latter years under consideration, an era which coincided with the country's post-earthquake relief efforts. Like Haiti, some other countries had better adequacy ratings in these latter years despite the ongoing economic crisis. This could possibly be attributed to the 2009 SDR allocations alongside Caribbean countries escalated debt reflected in their growing debt to GDP ratios. Belize's reserves varied between being adequate and inadequate for most indicators with reserves assessed to be adequate in the latter years under study. Of the tourism dependent economies, Barbados was the most consistent in holding adequate reserves, apart from the early 1990s period of insufficiency. The ECCU generally held ample reserves, although the import coverage ratio indicated a shortfall in the earlier period under study. The Bahamas held less than adequate reserves for significant period of time which may possibly be linked to de facto dollarisation in that country.

The overall findings suggest that Caribbean countries should pursue economic policies aimed at enhancing foreign exchange earning capacity needed to boost foreign reserves. This is imperative in light of significant slowdown in economic growth, particularly in the service-based Caribbean countries, stemming from the prolonged challenging economic circumstances gripping the region. The Caribbean, unlike developing Asia has not amassed unprecedented levels of reserves and should continue to exercise prudence in reserve management.

This study has attempted to address some of the limitations of assessing reserve adequacy by applying several methods that take into account multiple vulnerabilities. However, the deficiencies of the individual methods remain. The informal ratios narrowly focus on either current or capital account vulnerabilities, whereas Caribbean countries face vulnerabilities related to both accounts. While the Mwase (2012) measure seemed quite attractive as it addressed both current and capital account issues, it produced results which suggested that reserves were inadequate in most Caribbean countries. The suggested benchmark for this measure may possibly be too strict to be meaningful in a Caribbean context. The estimation and forecasting of reserve demand was not void of the challenges of performing econometric analysis in a region characterised with limited data availability. Moreover, the age-long argument of using econometric estimates of reserve demand based on past experience to predict optimal

reserves still has some merit. For the optimisation frameworks, results are very sensitive to the parameters used. With better data, alternative or more sample specific parameters could have been used in favor of the adoption of most of the parameters from the literature. This, as well as some scenario analysis, will be undertaken in future work.

References

- Aizenman, J. and Marion, N. (2003). The High Demand for International Reserves in the Far East: What is going on? *Journal of the Japanese and International Economics*, 17, 370-400.
- Agarwal, J.P. (1971). Optimal Monetary Reserve for Developing Countries. *Weltwirtschaft Lichs Archiv*, (CVII).
- Barnichon, R. (2009). The Optimal Level of Reserves for Low-Income Countries: Self – Insurance against External Shocks, *IMF Staff Papers*, 56, 852-875.
- Chan, S. S. (2007). The Basic Framework for International Reserves. Research and Statistics Department, Monetary Authority of Macao.
- Clark, P. B. (1970). Optimum International Reserves and the Speed of Adjustment, *Journal of Political Economy*, 78, 356-376.
- Craigwell, R., Downes, D. and Greenidge, K. (2007). The Demand for International Reserves in Barbados: Empirical Evidence for the Past Three Decades. in R. Craigwell, K. Greenidge and M. Williams (Editors), *Aspects of Financial Liberalization and Capital Market Development in the Caribbean*, Central Bank of Barbados, Barbados, 179-199.
- Davies, C. N. (2012). Optimal Reserves in the Franc Zone: An Empirical Analysis, *Africa Development Review*, 24, 1-17.
- Dehesa, M., Pineda, E. and Samuel, W. (2009). Optimal Reserves in the Eastern Caribbean Currency Union, *IMF Working Paper*, 09/77.
- Drummond, P., Mrema, A., Roudet, S. and Saito, M. (2009). Foreign Exchange Reserve Adequacy in East African Community Countries, *IMF, African Departmental Paper*, 09/1.
- Edison, H. (2003). Are Foreign Reserves in Asia too High? World Economic Outlook 2003 Update, Washington, D.C.: *International Monetary Fund*, October 2003.
- Grubel, G. H. (1971). The Demand for International reserves: A Critical Review of the Literature *Journal of Economic Literature*, 9, 1148-68.
- Gosselin, M. and Parent, N. (2005). An Empirical Analysis of Foreign Exchange Reserves in Emerging Asia, *Bank of Canada Working Paper*, 2005-38.
- Heller, R., (1966). Optimal International Reserves, *The Economic Journal*, 76, 296-311.
- IMF (2011). Assessing Reserve Adequacy, Monetary and Capital Markets, Research, and Strategy, Policy and Review Departments.
- IMF (2000). Debt and Reserve-Related Indicators of External Vulnerability, Policy Development and Review Department.
- Jeanne, O. and Ranciere R. (2006). The Optimal Level of International Reserves for Emerging Market Countries: Formulas and Applications, *IMF Working Paper*, 06/229.
- Jeanne, O. (2007). International Reserves in Emerging Market Countries: Too Much of a Good Thing? *Brookings Papers in Economic Activity*,1, 1-79

- Kim, J.S., Li J., Rajan, R. S., Sula, O. and Willett T.D. (2007). Reserve Adequacy in Asia Revisited: New Benchmarks Based on the Size and Composition of Capital Flows, *The Korean Economic Review*, 23, 131-158.
- Mwase, N. (2012). How Much Should I Hold? Reserve Adequacy in Emerging Markets and Small Islands, *IMF Working Paper*, 12/205.
- Park, D., and Estrada, G. E. B. (2010). Does Developing Asia Have Too Much Foreign Exchange Reserves? An Empirical Examination. *The Journal of the Korean Economy*, 11, 103-128.
- Sehgal, S. and Sharma, C. (2008). A Study of Adequacy, Cost and Determinants of International Reserves in India, *International Research Journal of Finance and Economics*, 20.
- Tereanu, E. (2010). International Reserve Adequacy in The Gambia, *IMF Working Paper*, 10/215.
- Triffin, R. (1947). National Central Banking and the International Economy. *Foreign Trade and Finance: Essays in International Economic Equilibrium and Adjustment*.
- Valencia, F. (2010). Precautionary Reserves: An Application to Bolivia, *IMF Working Paper*, 10/54
- Wijnholds, O. B., and Kapteyn, A. (2001). Reserve Adequacy in Emerging Market Economies. *IMF Working Paper*, 01/143
- Wu (1998). The Analysis and Affirmation of the China Foreign Exchange Reserves, *Economy Research Journal*, 6, 20-29
- Yang, C. and Yan, H. (2012). Assessing Reserve Holding Adequacy of Taiwan. *International Journal of Economics and Research*, 9, 369-399.
- Zeng, S. (2012). Study on Chinese Foreign Exchange Reserves, *Journal of Applied Finance and Banking*, 2, 1, 29-67.