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# Monetary and Exchange Rate Policies for the Perfect Storm: The Case of The Bahamas, Barbados, Guyana, Haiti, Jamaica, Suriname, and Trinidad & Tobago

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**Abstract**

This study provides a set of tools to analyze the monetary and exchange rate policy issues in the seven countries of the Inter-American Development Bank's Caribbean region (The Bahamas, Barbados, Jamaica, Haiti, Guyana, Suriname, and Trinidad and Tobago). It then applies some of them to the analysis of the impact of the global turmoil on these economies in the last quarter of 2008. The paper also discusses, in light of both recent theoretical developments and key aspects of these economies, the monetary and exchange policy responses to the initial phase of the global turmoil.

**JEL Classifications:** F33, E52
**Keywords:** Caribbean countries, Global crisis, Monetary policy

## 1. Introduction

The Caribbean's small, open economies are particularly vulnerable to severe external shocks, including terms of trade and financing shocks, as well as frequent natural disasters. This has been most evident recently as several hurricanes, oil shocks and food price shocks have hit the region, while the US financial crisis and the global economic downturn are also threatening to affect capital inflows, remittances, exports and tourism revenues.

A well-functioning and suitable monetary policy regime is an important tool to help preserve macroeconomic stability and absorb external shocks. A desirable monetary policy framework is one that keeps inflation expectations well-anchored and minimizes unnecessary fluctuations of economic activity around its trend path in response to shocks.

The choice of appropriate monetary and exchange rate regime is controversial in the best of times. Traditional theory in this area suggests that fixed exchange rate regimes with free capital flows may reduce the economy's volatility stemming from monetary (or nominal) shocks, but exacerbate those stemming from real shocks (such as terms of trade fluctuations). Yet, fixed exchange rate regimes may enhance monetary policy credibility if the commitment to the peg is perceived as credible. Alternatively, more flexible regimes may not only help to buffer real shocks but also, if coupled with a credible monetary or inflation target, have little in the way of costs in terms of reducing or maintaining low inflation. Flexibility has also been advocated as a way to push de-dollarization by ensuring that investing in dollar assets does not represent a one-way bet, whereas dollarization has been identified as a major threat if economies are faced with the potential of a sudden stop in capital flows. In addition, even within each broad policy regime there is plenty of scope for alternative policies as the precise choice of instruments and objectives may differ depending on each country's characteristics and experiences. Nonetheless, the current context is even challenging the frequently claimed supremacy of inflation targeting, as inflation before July 2008 was lying above targets in many countries that have adopted that system, while economies are now slowing dramatically in response to the global financial turmoil.

In short, this remains an area where one size does not fit all. For the small open economies of the Inter-American Development Bank's Caribbean region, the picture is even more complicated by frequent natural disasters. So it is perhaps not surprising that the seven

countries this paper focuses on have all adopted somewhat different monetary strategies to respond to these challenges.

An additional pressing issue for some of these countries was that of strong capital inflows until July 2008. This, coupled with the falling US dollar, had led to strong appreciation pressures on the local currencies, which was resisted vigorously in order to maintain competitiveness. In some countries this resistance took the form of capital controls, and in others the form of reserve management and the strong sterilization of capital inflows. In addition, in other countries there was inflationary pressure stemming from commodity prices increases. As a result, inflation in these countries rose and real appreciation occurred through a different channel, while sterilization increased the possibility of quasi-fiscal deficits, also putting upward pressure on local interest rates that in turn fed into more capital inflows. This dilemma is common to many other emerging market countries, and there remains a lack of clarity regarding appropriate policies.

More recently, commodity prices have plunged, capital flows have reverted, and domestic currencies have depreciated with the global crisis. External credit lines have dried up, and economic activity in developed economies has collapsed. Large losses of confidence have affected agents' decisions all over the world, and the prospects for growth in emerging market economies have worsened significantly as well.

This paper provides a set of tools to analyze the monetary and exchange rate policy issues in the seven countries of the IDB's Caribbean region (The Bahamas, Barbados, Jamaica, Haiti, Guyana, Suriname, and Trinidad and Tobago). It then applies some of them to the analysis of the initial impact of the global crisis on these economies. The paper also describes and discusses the initial monetary and exchange policy responses to the impact of the global crisis on these countries in light of recent theoretical developments as well as the key aspects of these economies.

The paper is organized as follows. The paper commences (in Section 2) with a description of the countries considered and their monetary regimes for the purpose of identifying major constraint on monetary and exchange rate policy in responding to external shocks.[1] In Section 3, the paper deals with methodological issues. In particular, it briefly describes the

[1] Reviewing the current experience within the Caribbean sub-region (Barbados in particular) and elsewhere with capital controls is beyond the scope of this paper and could be an area of future work.

construction of quarterly proxies for the GDP and the choice of monetary policy indicators for all the countries considered. Section 4 presents estimation results of Phillips and IS curves for the seven countries considered. Section 5 quantifies the impact of the recent reversal in external macroeconomic conditions associated with the global turmoil, using the estimated Phillips and IS curves equations. Section 6 reviews the policy responses to the external shocks associated with the global turmoil, focusing on developments through December 2008. Section 7 concludes. All methodological contributions of the paper are reported in the appendices.

## 2. The Monetary Policy Framework in The Bahamas, Barbados, Guyana, Haiti, Jamaica, Suriname, Trinidad and Tobago

This section briefly describes the main characteristics of the seven economies considered. This helps to evaluate the pattern of these countries' responses to external shocks and provides important information for the estimation of Phillips and IS curves. The section then summarizes the main features of the monetary and exchange rate regime of each of these economies.

### *2.1 Country Characteristics*

The Caribbean countries considered have some characteristics in common, such as their small size and the low level of production diversification and consequently high dependence on imports. Nevertheless, they are very different in many other dimensions. Summary Table 1 in Appendix 1 compares them along all dimensions considered. Below is a summary of the main similarities and differences.

*Similarities:*

- Small size;
- High degree of openness;
- Exports are the main GDP driver for most of the countries;
- Exports are based on tourism or commodities;
- Manufacturing sector is usually under-developed or concentrated on export goods;
- Weather conditions are very important for most of the countries;
- High dependence on the US economy for most of the countries;

- Import basket is very broad (high dependence on imports);
- Fiscal outcomes: tendency to deficit;
- Public debt: tendency to be high;
- Trade balance tends to be in deficit for most of the countries, compensated only partially by tourism or remittances (not enough to avoid current account deficits).

*Differences:*

- Levels of GDP per capita and social indicators;
- Economic performance, in terms of GDP growth and inflation rates;
- The role of agriculture varies across countries;
- External debt level varies significantly across countries (some countries can finance public debt domestically);
- Level of development of the financial system varies significantly too;
- Remittances are important for half of the countries;
- Official loans and grants are important for some of the countries;
- Degree of dollarization is high for half of the countries.

### *2.2 Monetary and Exchange Rate Regimes*

The Caribbean countries considered in this paper have different de facto monetary and exchange rate regimes, which are described in Summary Table 2 of Appendix 1. While most have fixed or pegged exchange rate regimes, two float to a different degree. The associated monetary policy frameworks also differ significantly. In terms of monetary policy instrument, they range from standard open market operations to nonmarket instruments. The intermediate target of monetary policy also differs widely across countries.

The main features of the monetary and exchange rate regimes are the following:

- The Bahamas and Barbados have a hard peg with a fixed nominal exchange rate since the 1970s;
- Guyana, Suriname and Trinidad and Tobago have a soft peg with periodic step-adjustments;

- Haiti and Jamaica have managed floats with no predetermined level or path for the exchange rate, although Jamaica floats more freely than Haiti.[2]

Thus, the presence of limited exchange rate flexibility in most countries implies that while there are limited inflation risks associated with movement in the nominal exchange rate in response to external shocks, there is also no chance to absorb the impact of these shocks on economic activity through quick changes in the real exchange rate and other relative prices.

The main monetary policy instrument differs across countries, with many of them using open market operations, but others using nonmarket instruments (such as credit restrictions, minimum deposit rates, etc.). In addition, for half of the countries, there is no clear monetary policy stance indicator, while the level of development of open-market operations is generally low.

The intermediate target of monetary policy differs across countries and is often unclear: it may involve maintaining the exchange rate peg or the real exchange rate or a monetary aggregate target. Reference to or use of monetary aggregate targets remains very common.

## 3. Data

For a sound discussion of monetary and exchange rate policy there needs to be an adequate data base, whose foundation is a high-frequency measure of real economic activity. An important contribution of this paper is the construction of a quarterly GDP series for most of the countries considered. This section also discusses the identification of a monetary policy indicator.[3]

### *3.1 GDP*

Quarterly GDP series are available only for Jamaica (since 1996) and Trinidad and Tobago (since 2000). For The Bahamas, Barbados, Guyana, Haiti, Suriname, and Trinidad and Tobago (for this country, before 2000), a quarterly GDP series was calculated using a distribution method applied to annual GDP data, based on Chow and Lin (1971). In short, annual GDP is regressed on annual indicators of economic activity that are also available at a quarterly frequency (electricity consumption, tourist arrivals, etc.). Then the estimated coefficients are

[2] This classification follows IMF's classification, which we consider consistent with the analyzed data.
[3] The data used in the paper are mostly from the IFS of the IMF, central banks' websites and national statistics institutes. A full description of the data used for each country is reported in Appendix 2.

used to distribute the annual GDP across quarters.[4] Further details on the methodology and the estimations for each country are presented in Appendix 3. The main caveat is that the resulting series are often very volatile.

### *3.2 Monetary Policy Indicator*

Identifying a good monetary policy indicator (MPI) is always a difficult task.[5] As we noted above, this is particularly challenging for the Caribbean countries considered in this paper because the monetary policy framework is not clearly articulated in most of them. Appendix 4 provides information on alternative indicators that describe the monetary policy stance. Table 1 below summarizes the variable proposed as a MPI based on this information. The variable proposed is typically consistent with anecdotal evidence from these countries' central banks reports on their monetary policy instruments, the objectives of monetary policy and the exchange rate arrangements (evidence not reported but available on request from the authors).

In the first column, we report the suggested main *instrument* of monetary policy. However, this variable is not necessarily used as an *indicator* of the monetary policy stance. The second column reports this variable, which in practice is used as the MPI in this paper. The MPI may differ from the policy instrument because of several reasons: the policy variable may be essentially constant (e.g, The Bahamas), or there may be data availability issues (e.g., Trinidad and Tobago). In the case of Suriname, it is unclear what the main policy instrument is.

[4] For The Bahamas, Barbados, Guyana, Haiti, and Suriname we have included in the estimation the projection of the GDP quarterly series for 2008Q1-2008Q2. However, the caveat here is that this quarterly figure is not based on a distribution of the annual GDP series.

[5] A simple framework for the choice of the optimal monetary policy instrument is presented in Appendix 6.

Table 1
Monetary policy indicator based on the interest rate

| Country | Main monetary policy instrument | Monetary policy indicator |
|---|---|---|
| The Bahamas | Discount rate | T-bill rate |
| Barbados | Minimum deposit rate | T-bill rate, Deposit rate |
| Guyana | T-bill rate | T-bill rate |
| Haiti | T-bill rate (91-day BRH bond rate) | T-bill rate (91-day BRH bond rate) |
| Jamaica | Repo rate | Repo rate |
| Suriname | | Deposit and lending rates |
| Trinidad and Tobago | Repo rate | T-bill rate |

## 4. Modeling Inflation and Output Gap Behavior in Individual Economies

In this section, a Phillips curve (the aggregate supply) and an IS curve (the aggregate demand) are estimated for each country. For all countries, the set of variables considered include domestic and US output gap, domestic and US inflation, the exchange rate (nominal or real), the interest rate (policy rate, bond rates and banking rates), and proxies for the terms of trade. The output gap is estimated using the HP filter. Real exchange rate series were taken from the IFS or estimated by using domestic and US CPI inflation. Terms of trade were defined as the ratio of export to import prices, but, because of data availability, they are sometime proxied by other variables. For the interest rate, we have used not only the MPI listed in the previous section, but also other interest rate series, when available, such as banking lending rate and banking deposit rate. The sample period starts in the early 1990s or later because of data availability. Importantly, the estimation uses quarterly data.

Table 2
Synthesis of the variables that entered statistically signficant in the Phillips curve
Dependent variable: Quarterly inflation

| Regressors | The Bahamas | Barbados | Guyana | Haiti | Jamaica | Suriname | Trinidad and Tobago |
|---|---|---|---|---|---|---|---|
| Past inflation | X | X | X | X | X | | X |
| Output gap | X | X | | | X | X | |
| Imported goods inflation | X | X | X | X | X | X | X |

Table 3
Synthesis of the variables that entered statistically signficant in the IS curve
Dependent variable: Output gap

| Regressors | The Bahamas | Barbados | Guyana | Haiti | Jamaica | Suriname | Trinidad and Tobago |
|---|---|---|---|---|---|---|---|
| Past output gap | | X | X | X | | X | X |
| US output gap | X | X | | X | | | |
| Terms of trade | | | X | | X | X | X |
| Interest rate | | X | | X | | | |
| Real exchange rate | | X | | X | X | X | |

Tables 2 and 3 summarize the variables that entered significantly the respective estimated equation. In general, the results appear consistent with countries' characteristics described above. The output gap in the Bahamas and the Barbados is highly dependent on the US economy, reflecting their high dependence on tourism and their exchange rate regime. The terms of trade are important for Guyana, Jamaica, Suriname and Trinidad and Tobago, as a result of the important role played by exports in these economies, and the dependence on commodities. Interest rates (considering all different series available) were statistically significant in the IS estimations only in a few cases (i.e., for Barbados and Haiti). This could reflect several factors, such as low development of monetary markets or the ambiguities in the monetary policy framework highlighted above, the high degree of the economy's specialization, and the high incidence of external factors for GDP dynamics.

In the Phillips curve, for all countries, domestic inflation depends on the inflation of the imported good basket (via the US CPI, the US PPI or the real exchange rate). For some of the countries, inflation also depends on the output gap (The Bahamas, Barbados, Jamaica, and Suriname). Pure backward-looking and hybrid specifications (with both backward- and forward-looking inflation terms) were estimated and tested. In general, pure backward-looking specifications fit the data better, and they are more suitable for partial equilibrium analyses.

The results for The Bahamas and Barbados are consistent with their specific country and monetary characteristics: a very small open economy with a hard peg and highly dependent on tourism. According to the estimated equations, inflation depends highly on external inflation (US CPI or real exchange rate), in addition to the output gap. The output gap, in turn, depends on US output. In the case of Barbados, the output gap depends on the interest rate and the real exchange rate as well.

The results for Guyana are puzzling: no driving force for inflation could be found. The most significant variable, in the case of inflation, is the exchange rate with a 0.13 p-value. It should be stressed, however, that the sample period starts only in 1998Q1 because of data availability. For the output gap, though, terms of trade were statistically significant.[6]

The results for Haiti were mixed. For the Phillips curve, the only driving force found is the exchange rate change (specified as contemporaneous nominal change) and external inflation, with a relatively high pass-through coefficient. This result is consistent with the floating exchange rate system, high ratio of imports to GDP, and higher levels of inflation. The estimated IS curve, in turn, is standard: real interest rate, real exchange rate and US output were statistically significant. The inclusion of the interest rate is not very robust, though.

The results for Jamaica are consistent with the economy's managed-float exchange rate system. The estimated equations show inflation depending on exchange rate changes and output gap. According to the IS equation, output gap depends positively on the real exchange rate (gap) and on terms of trade (proxied by the ratio of non-fuel commodity prices to the US PPI).

For Suriname, the results are also clearly interpretable. According to the estimated Phillips curve, the driving forces of inflation are output gap and change in the nominal exchange rate, with a very high pass-through. The result for the pass-through is consistent with a country

[6] The numerator of the proxy for terms of trade was constructed as an implicit index, based on export value series (using National Accounts and the exchange rate) and export volume series (both available in the IFS), and the denominator was the US PPI.

having relatively high levels of inflation, very open and with a de facto fixed peg, but with some large adjustments (so when exchange rate changes take place, they are considered as permanent). The estimated equation for the output gap, in turn, indicates the role played by the terms of trade (proxied by the ratio of nonfuel commodity prices to US PPI) and the real exchange rate.

For Trinidad and Tobago, the results were mixed and more difficult to interpret, although they confirm the important role played by oil in that economy. In the Phillips curve, output gap is not statistically significant, and the exchange rate change enters significantly, but the result is not very robust. In the IS equation, the only driver is the terms of trade (proxied by the ratio of oil prices to US PPI).

## 5. Estimating the GDP and Inflation Impact of the Global Turmoil

In this section we use the estimated Phillips and IS curves discussed in the previous section to analyze the impact of the recent reversal in external economic conditions on the group of countries considered. The approach is partial equilibrium, and we see this as the first step toward the building of a model-based framework for monetary policy analysis in the region, possibly including simple dynamic general equilibrium models. In the first subsection, we characterize the external shock processes we focus on and their realizations in the period considered. In the following subsection, we then use the estimated equations to simulate the impact of these shocks on inflation and GDP of these economies.[7]

### *5.1 Modeling External Shocks*

The shocks considered try to capture the main aspects in the global economic crisis: the global economic slowdown, reduction in commodity prices, and deterioration of global financial conditions. In particular, we consider shocks to the following variables:

- US output gap, as a proxy for global growth, which we interpret as a demand shock;
- Country-specific terms of trade, which we interpret as a cost-push shock for importers and an income shock for exporter;

[7] In principle, the estimations results in the previous section may be used for other exercises, which could also involve additional equations such as a policy reaction function.

- Country-external financing costs, which we interpret as a global financial shock affecting country-specific financing conditions;
- For Haiti and Jamaica, since the exchange rate is floating (although managed), we also estimate shocks to the exchange rate. In the other countries, the nominal exchange rate has remained stable so far, so we do not consider this shock.

The size of the shock we consider is the following (and the path is reported in Figure 1.a.):

- The US output gap falls by 1.1 percent;
- Terms of trade measures decrease in a range that goes from 8 percent to 50 percent;
- The external financing costs increase by 300 basis points; and
- The nominal exchange rate depreciates by 3 percent or 7 percent.

The shocks are set using the following methodology. We assume the variables above follow simple AR(1) processes. For US output, we use the forecasted values for the next few quarters (using a Fed survey) and then estimate the output gap applying the HP filter to the extended series. To obtain a smoother value, we use the average of the output gap over 2008Q4-2009Q3. For the US CPI, we also use the forecasted values for the next few quarters, and then estimate the inflation gap applying the HP filter to the extended series. We use the estimated value for 2008Q4. For the US PPI, which is used as the denominator in the estimated terms of trade, we use the actual values up to November 2008 as the values for 2008Q4.

For the numerator in the terms of trade, we do not have updated values for the series used in the estimation. However, we use recent data from CRB to estimate the change in commodity prices. For each country where terms of trade enters in the estimation, we estimate specific change in commodity prices using the main commodity export products (using traded volumes in the CRB). For Guyana, we use the change in the price of sugar and grains (proxy for rice); for Jamaica, aluminum and sugar; for Suriname, aluminum and gold; and for Trinidad and Tobago, oil and gas prices. We use the average value of the first half of December 2008 for 2008Q4. We apply the estimated change over the original IFS series, combine with the PPI value and run the HP filter. We then use the gap found for 2008Q4 as the shock value. In practice, the HP-filtered value is close to the change in the prices from 2008Q2 to 2008Q4.

For the external financial conditions, we combine EMBI with the T-bill rates to have a proxy for external credit costs. We then assume that domestic interest rates move by the same value. This applies only to the countries that have interest rate in the estimated IS equation, i.e., Barbados and Haiti. We take the difference between the average of the Latin American EMBI over the first half of December and the value in 2008Q2. Similar procedure is conducted for the exchange rate in Haiti and Jamaica. We compare the values in 2008Q4 with those in 2008Q2.

For most of the variables, we use estimated autoregressive parameters. The exceptions are the US CPI and the exchange rate. Estimated autoregressive coefficients for the US CPI are negative, so it would not capture the current shock process. We then use 0.4, which generates a CPI path similar to the path forecasted by professionals. For the nominal exchange rate, we use 0.95 to capture the probably high degree of persistence in the current shock.

### *5.2 Impact of the Recent External Economic Condition Reversal*

We then apply the estimated shocks to the Phillips curves and IS curves estimated in the previous section. We are assuming zero initial values because we are not conducting a forecasting exercise, but simulating the effects of a set of shocks. So the values represent deviations from an HP-filtered trend. The results are presented in Figures 1a-1h. Figure 1a summarizes the shocks, and the following figures (b through h) depict each country's relevant shocks and responses. Both, the nominal and the real exchange rates are expressed as domestic currency units per foreign currency units.

The most striking results are the fall in the output gap as a result of the US economic slowdown (affecting The Bahamas, Barbados, and Haiti), and the terms of trade deterioration (affecting Guyana, Jamaica, Suriname and Trinidad and Tobago). For Barbados and Haiti, the result is aggravated by the increase in the interest rate. For most of the countries, the peak of output gap reduction ranges from –0.8 to –1.7 percent, with Barbados reaching –4.7 percent. Note importantly that the countries with less output reduction are Jamaica and Haiti, the only countries with floating exchange rate regimes. The real depreciation of the domestic currency works as a stimulus for the economy, reducing the effects of the other variables.

A flexible exchange rate response has several benefits in addition to leaving more room for other uses of scarce international reserves. First, it can prevent the loss of market share in a context in which downward pressure on nominal exchange rate is global. Second, it may help

contain the deflationary impact of commodity price decline in those cases in which deflation pressure were to emerge (Catão and Chang, 2008). Nonetheless, in contrast to episodes of country-specific external shocks registered by the estimated equations in the previous section, a flexible exchange rate response to a global external shock leaves the economy in need of an additional policy instrument to help contain the output gap opened by such shock. The common nature of a global external shocks means that depreciations cannot have significant expansionary effects even in the absence of adverse balance sheet effects.

Except for Jamaica and Haiti, all countries present a deflation response (using actual values this would amount to a reduction in inflation). This is a result of negative output gaps (The Bahamas, Barbados, Jamaica, and Suriname) and decrease in imported goods prices (all seven countries). The deflationary range varies significantly, from –0.1 percent to –7.6 percent (four-quarter change).

In the case of Jamaica, the depreciation of the nominal exchange rate outweighs the effects of the negative output gap in the first quarters, generating an inflation rate of about 1 percent (four-quarter change). As this initial effect fades away, the exchange rate appreciates and the output gap is negative, the inflation rate reaches –2.4 percent. In the case of Haiti, since the nominal exchange rate depreciation is smaller, the resulting inflation is 0.3 percent, turning into deflation of –0.2 percent in the fifth quarter.

## 6. Policy Responses to the Global Crisis

In this section, we describe and discuss the policy responses to the initial phase of the global turmoil during 2008Q4. We do so against an eclectic normative benchmark grounded in both theory and experience in other LAC countries.

### *6.1 A Normative Benchmark*

The scope for monetary and exchange rate policy response to the global turmoil was limited but well defined. The first strategic objective of policy was to circuit-break the negative feedback loop from the real sector to the financial sector of the economy. The second strategic objective was to smooth adjustment to a new medium-term macroeconomic equilibrium. The monetary and exchange rate policy responses to the crisis also had to be coordinated at the regional level to the extent possible in the sense of not being detrimental to other economies---avoiding

competitive devaluations, exchange controls, or other measure that may further depress international trade.

Both theory (e.g., Benigno et al., 2009) and new evidence (Ortiz et al., 2008), in particular, show that the ability to pursue expansionary monetary policies in periods of financial turmoil can reduce the size of output contractions. For fixed exchange rate regime countries, such a cushion has to be provided through other policy instruments, including direct use of the central bank balance sheet in a quasi-fiscal manner (discussed further below).[8]

For floating exchange rate regime countries, the temptation to use reserves to defend any particular level of the nominal exchange rate should be resisted. A key lesson from the crises of the late 1990s is that countries should not shy away from allowing exchange rate flexibility and waste precious foreign liquidity to defend the level of the nominal exchange rate when conditions allow it—i.e., unless the exchange rate has to be defended because of balance sheet exposure or outright dollarization.

If monetary policy is freer of exchange rate constraints, could it then be used to circuit-break the negative feedback loop from the real to the financial sector in addition to guiding the economy to a new macroeconomic equilibrium? Monetary policy can certainly play an important role, but it cannot insulate the economy from the shock altogether, and there are important limits and risks to its effectiveness. The nature of the shock imposes a first important constraint. The global nature of the shock faced was such that domestic financial systems were an autonomous source of instability—albeit to a lesser extent than in the economies in the eye of the global financial storm or in the previous crises in emerging markets—and not only a channel of transmission of the external shock. As a result, policies that work through the transmission of price signals via the financial system may be less effective in responding to the current crisis than they usually are. Specifically, with the balance sheet of financial institutions and investors under strain because of tight liquidity conditions and global lending aversion, the transmission mechanism of monetary policy may not be functioning properly.[9] So it is unlikely that an aggressive loosening of monetary conditions could completely preserve domestic credit growth

[8] See Fernández-Arias, Powell and Rebucci (2009) for a discussion of the role of multilateral financial support to the policy response to the global crisis in emerging market economies.

[9] Monetary policy lags may be shorter in emerging markets than in advanced economies, hence making it more effective (Catão, Pagán and Laxton, 2008). The shorter duration of financial contracts, possibly underpinning this stylized fact, however, makes these economies more vulnerable to sudden increases in risk premia, thus suggesting that financial friction may result in tougher constraints in this context.

or keep the economy at the pre-shock levels of economic activity. Similarly, while reduction in reserve requirements frees up bank liquidity, this is likely to be hoarded rather than lent to households and firms. Importantly, as the shock faced has a permanent component, a monetary policy response that aims at preserving the pre-shock equilibrium would not be desirable either. Nonetheless, lowering benchmark interest rates can support valuations of riskier assets and also lower the total cost of borrowing for households and firms, and hence ultimately contain the likelihood of generalized insolvency (Mishkin, 2009). Through this channel, monetary policy can contribute effectively toward containing the negative spillovers from the real sector to the financial sector.

A second limit is imposed by the risk of losing credibility through attempting to use directly the central bank balance sheet in domestic currency to respond to the shock, which affects floaters and fixers alike.[10] A powerful additional instrument through which central banks in advanced economies have responded to the crisis is the direct use of their balance sheet to substitute for markets and intermediaries that are impaired, so-called quantitative easing. This means lending directly in domestic currency, and in a potentially unlimited manner, to the private sector, as opposed to loosening the funding conditions of the core domestic financial system through price signals to implement a more accommodative monetary stance (see also discussion in the banking section). A key challenge in implementing such a policy is how to prevent inflation expectations from spiraling out of control, and the risks of de-anchoring inflation expectations is much higher in emerging markets because of weaker policy institutions and their past histories of monetary instability. In emerging markets, therefore, aggressive quantitative easing in domestic currency could set off inflationary expectations, which would thus jeopardize recently hard-won inflation fighting credibility.

In emerging markets, quantitative easing (or more conventionally called, lending of last resort) must therefore be conducted in hard currency, using either own or borrowed reserves (Calvo, 2006). As there are competing demands on limited stocks of foreign reserves or lines of credit in hard currency, the issue arises of how to prioritize them. Obviously, official reserves are needed to lean against the wind and smooth changes in the equilibrium real exchange rate. They must also be used to repay public sector debt coming due in foreign currency (and possibly in domestic currency, when monetizing the debt poses significant inflationary risks). Additional

[10] A procedure to quantify monetary policy credibility in emerging markets is presented in Appendix 7.

potential claims on reserves include the provision of foreign currency liquidity to the banking sector if it is under stress from the deposit side of the balance sheet (as in Uruguay in 2002) or from the pulling back of foreign lines of credit. Finally, foreign currency liquidity may be needed to provide credit to the private sector previously provided by private foreign and domestic residents, or to facilitate the rollover of private sector liabilities in case the shock were to be very protracted. In past episodes of sudden stops, for instance, it has proven to be crucial to support trade credits (as in the case of Brazil in 2002).[11] In the current environment, protecting domestic credit growth to small and medium enterprises that are likely to be rationed out of the market may be equally important.

Implementing quantitative easing in either domestic of foreign currency when domestic capital markets are not functioning adequately poses other challenges as well. Allocating foreign liquidity through anonymous markets when they are disrupted runs the risk that international reserves end up financing capital flights. An alternative solution successfully implemented by Brazil in 2002 is to channel hard currency directly where it is most needed (Garcia, forthcoming). Such a drastic shift away from non-market-based ways of conducting monetary and exchange rate policies, ideally, however, should be accompanied by well-defined escape clauses to make sure that a gradual return to normal monetary policy procedures is guaranteed. Finally, while capital controls and other protectionist measures are additional ways to affect directly the allocation of foreign currency, they would be detrimental to the global equilibrium in a context in which world trade is collapsing, and they should be avoided.

### *6.2 The Policy Response to the Global Crisis*

To describe policy responses, we look at the behavior of the nominal exchange rate and the monetary policy instrument in 2008. For the purpose of the description and the analysis, the period is divided in two phases. The first corresponds to the first half of the year, which represents the last period of global "bonanza," associated with increasing commodity prices and loose financing conditions. The second half of the year, in turn, is the period marked by the deepening of the global crisis and its strong spillover effects on the emerging market economies, with sharp fall in commodity prices, tightening of external credit conditions and great

[11] Protecting trade credits was vital during sudden stops as their disappearance further constrains the availability of foreign currency in the domestic market.

uncertainty. This subsection is a descriptive analysis of monetary and exchange rate policy responses to this second phase.

In all five countries that follow a fixed or a pegged exchange rate regime (The Bahamas, Barbados, Guyana, Suriname, and Trinidad and Tobago), the nominal exchange rate remained stable throughout 2008. In the case of Haiti, the nominal depreciation was relatively small (8 percent through the end of the year), with most of it taking place before the deepening of the global crisis in September 2008. In fact, with an annual domestic inflation rate around 18 percent, the real exchange rate actually appreciated in 2008. In Jamaica, the depreciation was more pronounced (10 percent), and took place after mid-September, implying a depreciation of the real exchange rate.

After September 2008, many central banks used their international reserves to respond to the crisis, even in countries with more flexible exchange rates such as Haiti and Jamaica. From April to November 2008, Haiti sold net USD 65 million (reserves stood at USD 482 million in March 2008), whereas The Bank of Jamaica also sold foreign currency in the market to contain exchange rate pressures, with reserves falling from USD 2,251 million in September to USD 1,803 million in October, or about 20 percent). In The Bahamas, international reserves fell from USD 669 million to USD 590 million between September and November, and in Barbados they decreased by USD 129 million during 2008Q3.

The monetary policy reaction was much more mixed. By the end of the year, only Barbados had implemented monetary policy easing measures. Barbados, in contrast, pursued an active countercyclical monetary policy. The discount rate was reduced from 12 percent (value in place since March 2006) to 10 percent at the end of 2008. Actually, the easing cycle started at the end of 2007, with a reduction in the minimum interest payable on deposits from 5.25 percent to 4.75 percent in November 2007. The easing cycle continued in 2008 with two further reductions in the minimum deposit rate, to 4.5 percent in March and to 4.0 percent in October. The T-bill rate, which somewhat follows the minimum deposit rate, has also decreased, reflecting higher demand for liquidity (from 4.84 percent at the end of December 2007 to 3.48 percent in September 2008).

Guyana, Haiti, Jamaica and Trinidad and Tobago—were in a tightening cycle when hit by the global shock in September. And Guyana and Trinidad and Tobago even took additional restrictive measures after that month. The Central Bank of the Bahamas has kept the discount

rate fixed at 5.25 percent (the same value since 2005). In Guyana, the discount window rate was increased from 6.50 percent, in place since February 2007, to 6.75 percent in October 2008. The three-month Treasury Bill rate also increased, from 3.94 percent in September to 4.19 percent in October 2008.

The Banque de la République d'Haïti (BRH) has kept the three-month T-Bill rate unchanged at 8.0 percent, after the tightening moves of March and April 2008, when the rate was raised twice, from 4.0 percent to 7.0 percent, and then to 8.0 percent.

Similar response was implemented in Jamaica. Against a background of increasing inflation in the first half of 2008, the Bank of Jamaica raised the reverse repo rate three times in that period, from 11.65 percent to 14.0 percent (thirty-day), a figure in place since June. The Treasury Bill rate followed this movement, rising from 12.51 in December 2007 to 14.03 percent in September 2008. Inflation has started to fall since August, but the pass-through from the exchange rate, even though it was moderate because of the fall in commodity prices, it remained a concern.

In order to curb increasing inflationary pressures, the Central Bank of Trinidad and Tobago raised the repo rate three times in 2008, from 8.0 percent to 8.75 percent, a figure in place since September. The cash reserve requirement applicable to commercial banks was also increased on three occasions as well, from 11 percent to 17 percent in November 2008.

The main leading indicators of GDP for these economies were already showing strong signs of slackness by the end of 2008. According to the simulations conducted in the previous section, these economies were about to enter a significant economic slowdown at the end of 2008. Tourism and a fall in the terms of trade, in particular, affected negatively most countries.[12] However, the effects on inflation were more mixed. This is because most countries were hit by the global crisis at a time of raising inflation, which explains the initial lack of monetary response to the global shock. In some countries with strong inflationary pressures in the pipeline—resulting from earlier food price increases and brisk economic growth—inflation continued to be an issue through the end of 2008, whereas in other countries inflation was clearly receding because of the global turmoil by year-end. In The Bahamas, Barbados, and Guyana, inflation figures were still a source of concern by end-2008. On the other hand, Haiti recorded

[12] It is interesting to note that, according to the simulation exercises, the reduction in output in Barbados is significantly more pronounced that in the other countries. This results from the larger estimated sensitivity of Barbados GDP to US GDP and the impact of changes in the interest and real exchange rates.

CPI deflation in October as well as Jamaica did in November. In Trinidad and Tobago, inflation was also already falling by November 2008.

### *6.3 A Discussion*

In most of countries considered, the reaction to the global turmoil has been to wait and see before taking some action on the main monetary policy instrument. This seemingly hesitant reaction was predicated by two factors: (i) most of these economies were already facing important inflationary pressures when the global turmoil deepened in the second half of 2008; and (ii) there was great uncertainty as to likely duration of the global crisis. Most central banks thus prudently waited to see inflationary pressure receding before venturing into accommodative territory. In the case of Jamaica, in which the exchange rate depreciated in real terms, in addition, there was additional concern with possible pas-through from of the devaluation. Looking forward, however, inflationary pressures were receding in many cases by the end of the year, and a more proactive easing of monetary policy could be called for.

A second important complication in the response to the global shock documented above is the presence of a rigid exchange rate regime in most of the countries considered. While the resilience of the exchange rate regime in the face of such a large shock is commendable, it is important to note that what was observed through the end of 2008 was only the initial impact of the crisis. While many countries were able to meet the shock with significant international reserve declines, further reductions in the face of a protracted external crisis could be constrained by the limited availability of foreign currency liquidity.

## 7. Conclusions

This paper has described the diverse monetary and exchange rate regimes of seven Caribbean countries, the effects of the recent external shocks on these economies, as well as the initial monetary and policy reaction to those events. As a by-product, the study also provides several contributions that stand on their own, including (I) a comparison of these countries in regard to several macroeconomic aspects; (ii) a proxy for a quarterly GDP measure for most of the countries and an identification of their monetary policy instruments and indicators as well as a simple framework to analyze the trade-off involved in choosing among alternative instruments; and finally (iii) estimations of Phillips and IS curves for all countries, which shed light on

countries' characteristics and may be used for different purposes; as well as frameworks to quantify monetary or exchange rate regime credibility and the deliverability of alternative monetary policy instruments.

The comparison between countries illuminates the commonalities as well as the differences that may help define the relevant trade-offs involved in the monetary policy responses to a particular set of external shocks. Against the background of an exceptionally large external shock of uncertain duration and persistence, the weak initial position in term of inflation and the inherent rigidity of fixed exchange regimes with limited official reserves in most countries stood out as the most difficult policy challenge in responding to the global crisis.

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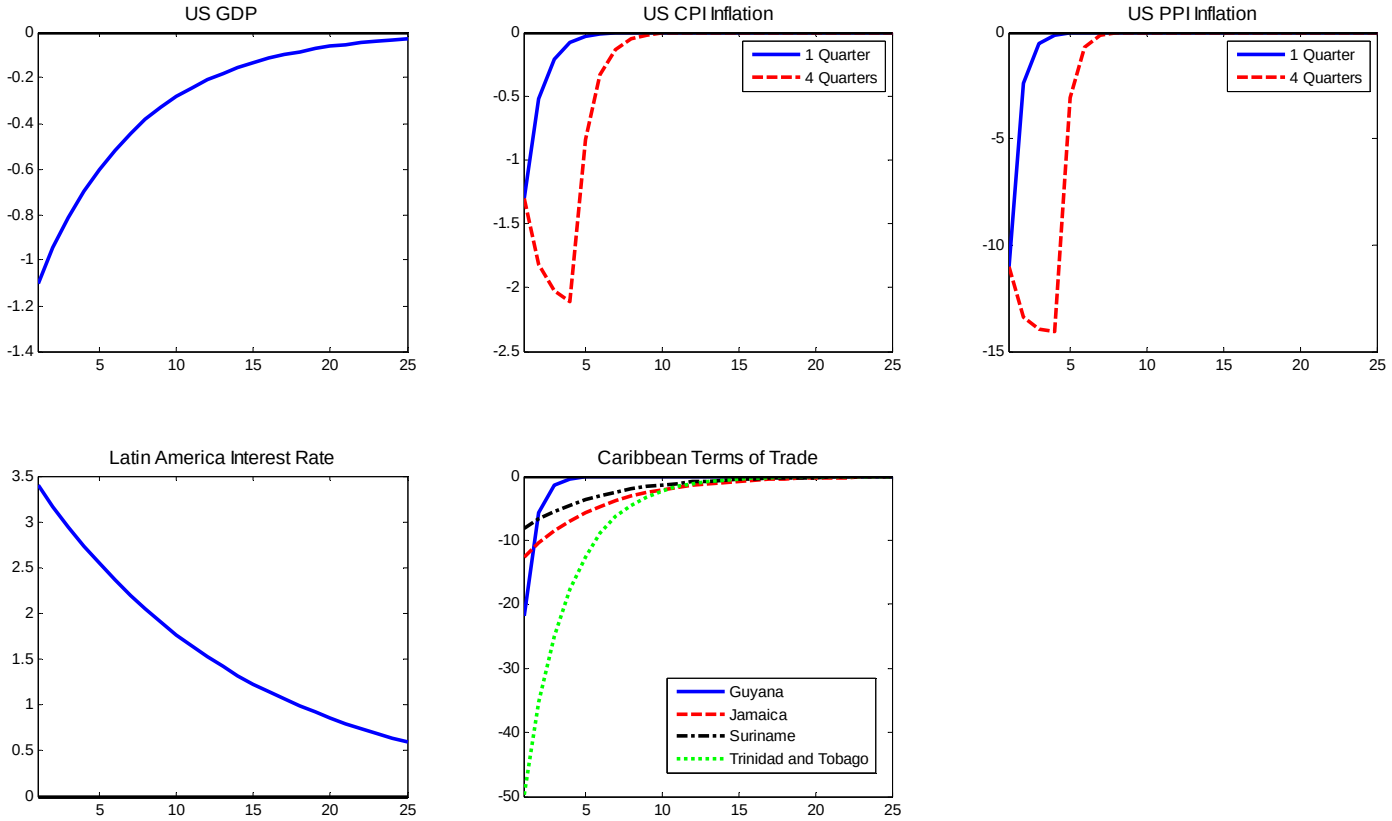
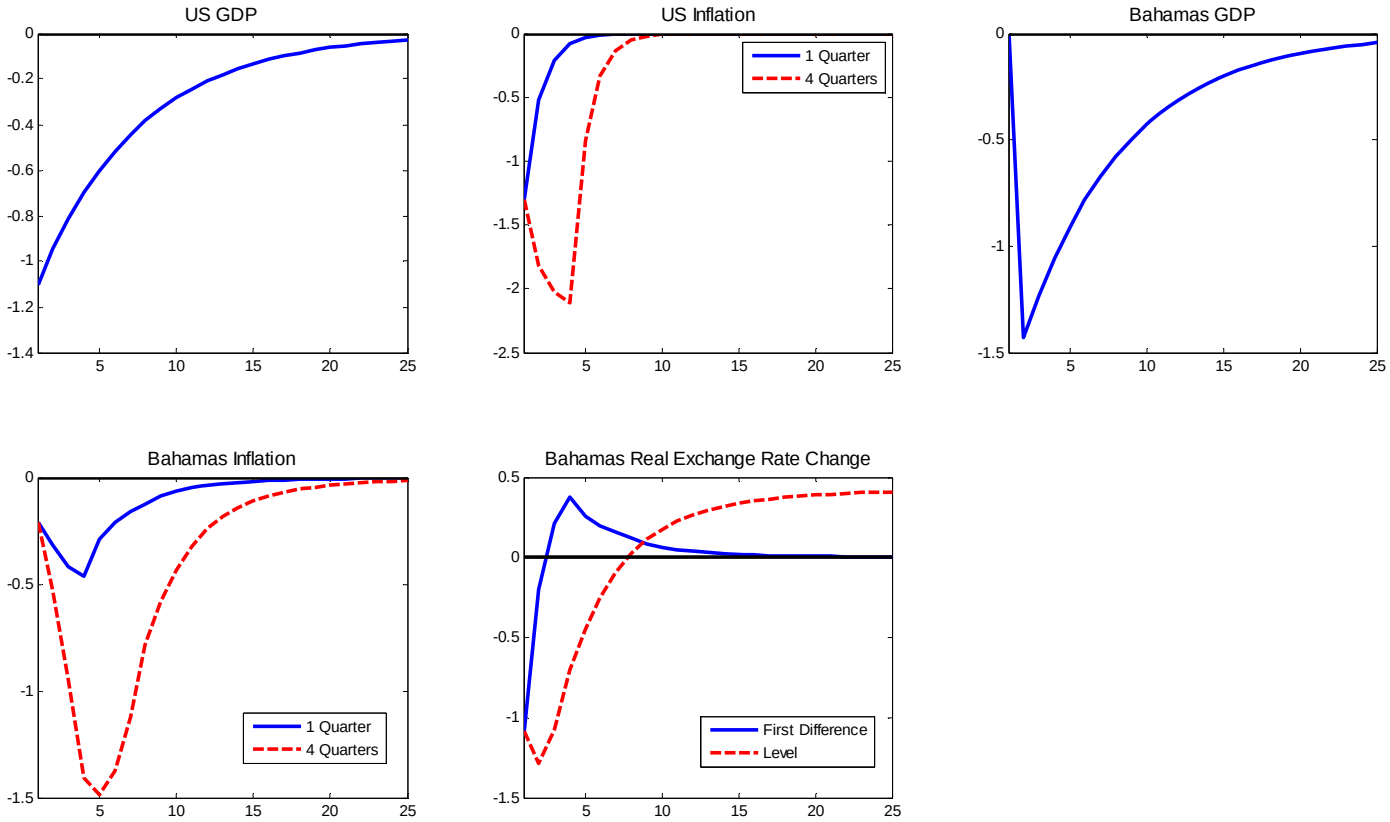
## Figure 1. Responses to the Set of Shocks

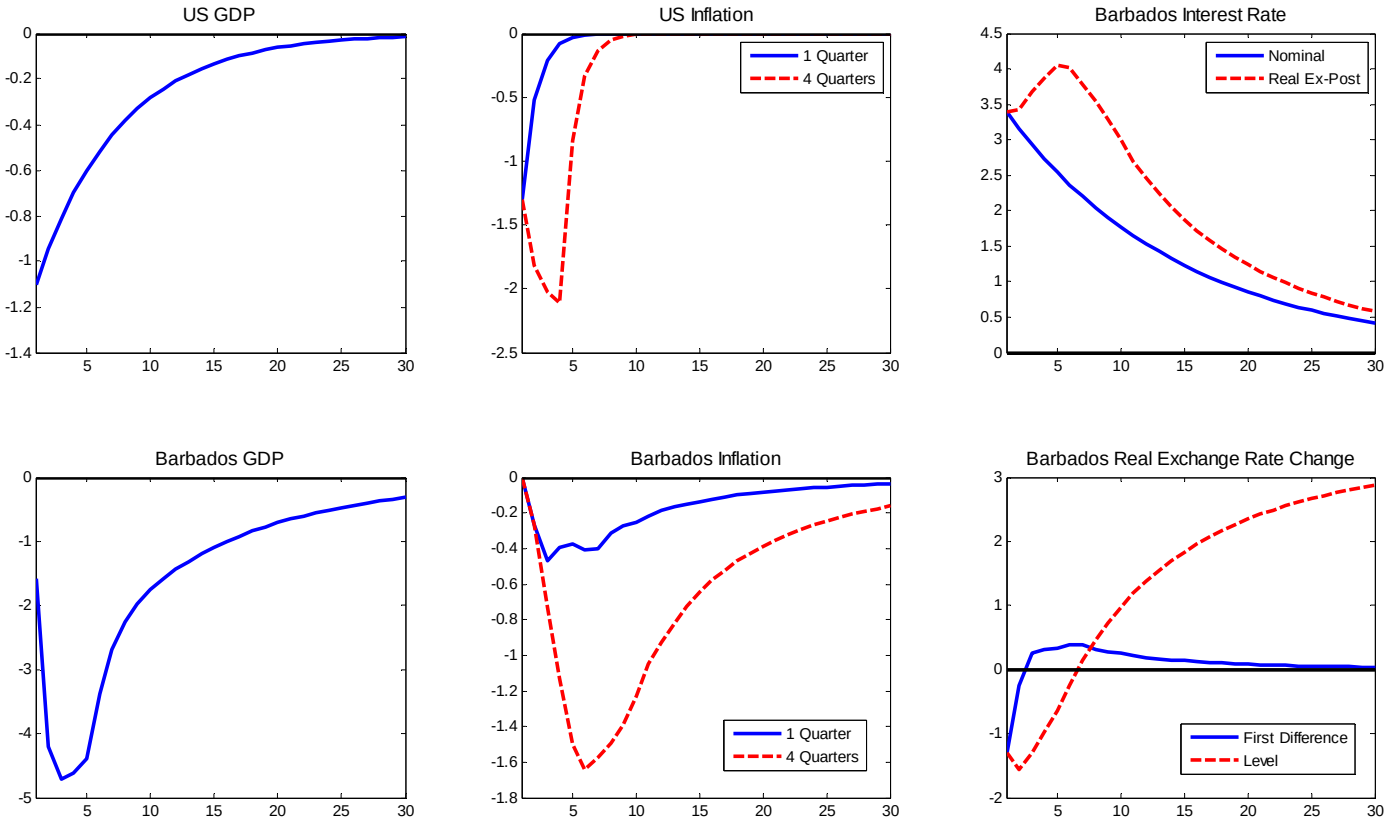
### Figure 1.a. Set of Shocks



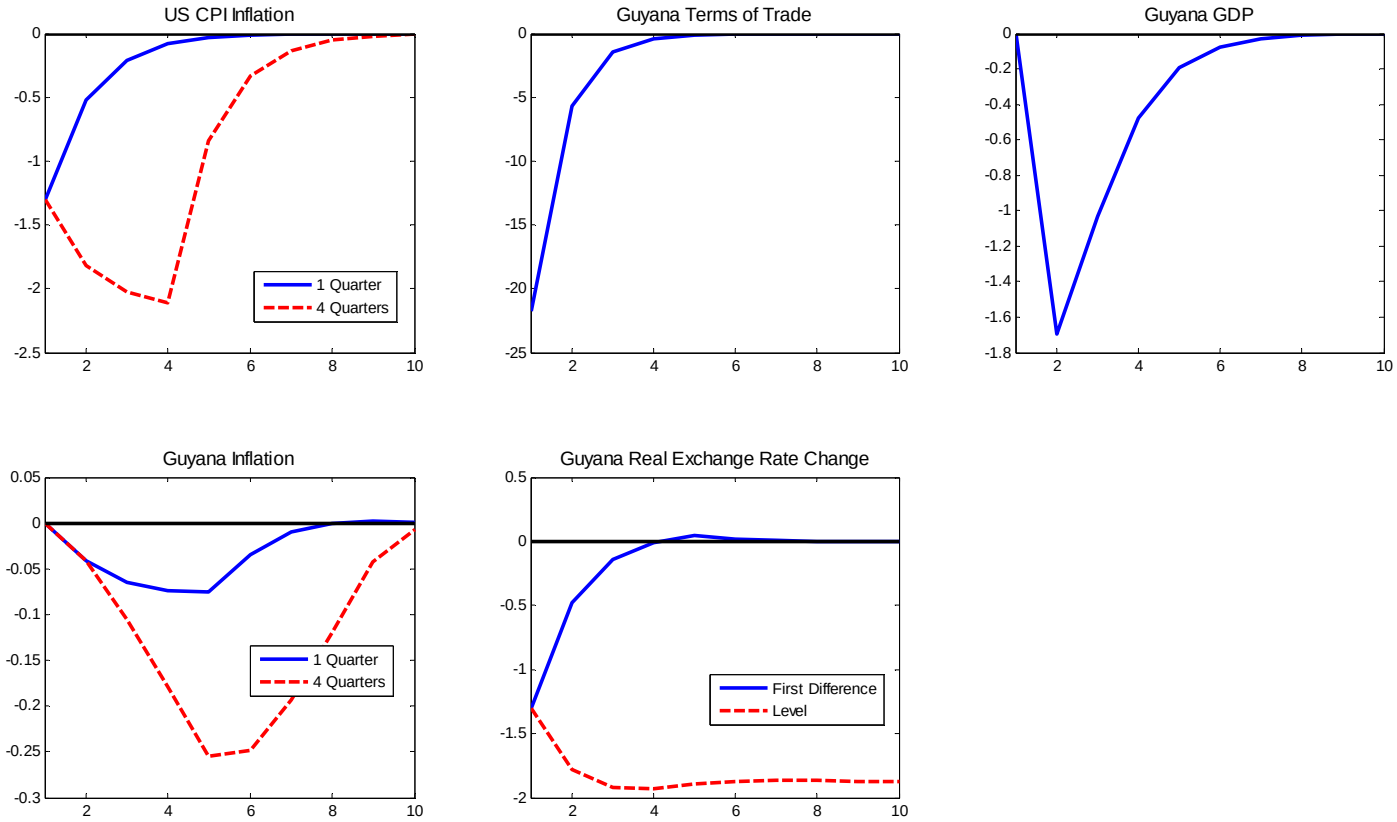
## Figure 1.b. The Bahamas' Responses



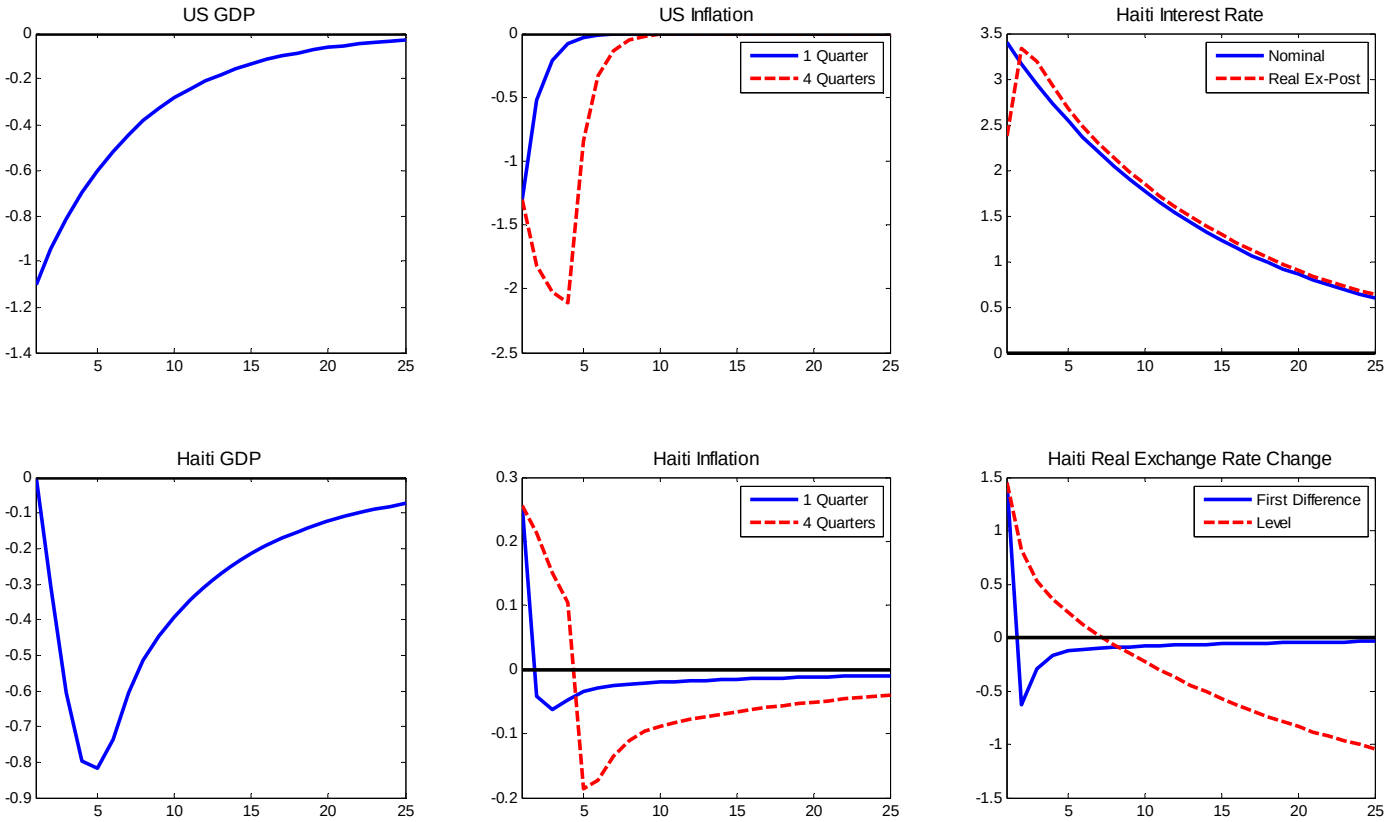
## Figure 1.c. Barbados' Responses



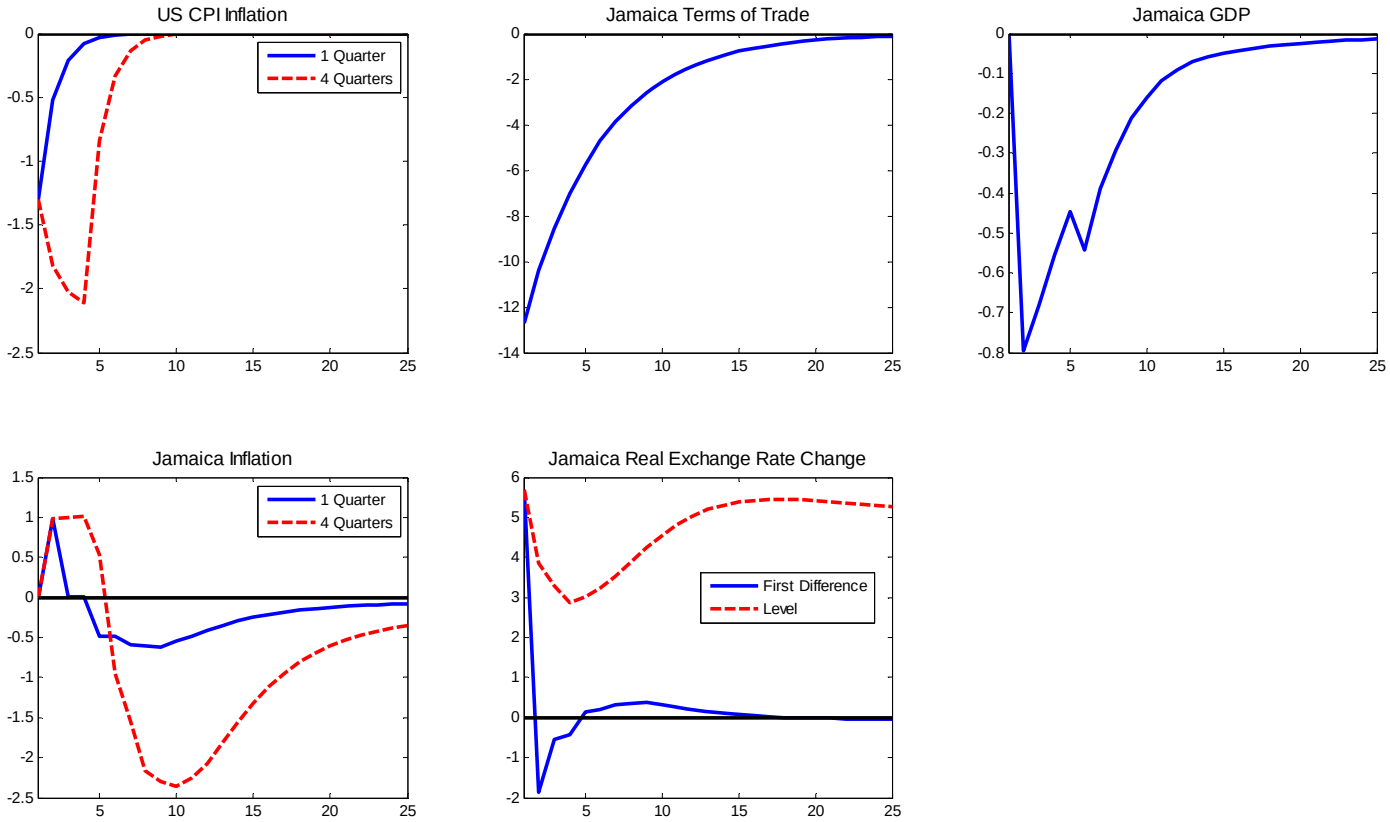
## Figure 1.d. Guyana's Responses



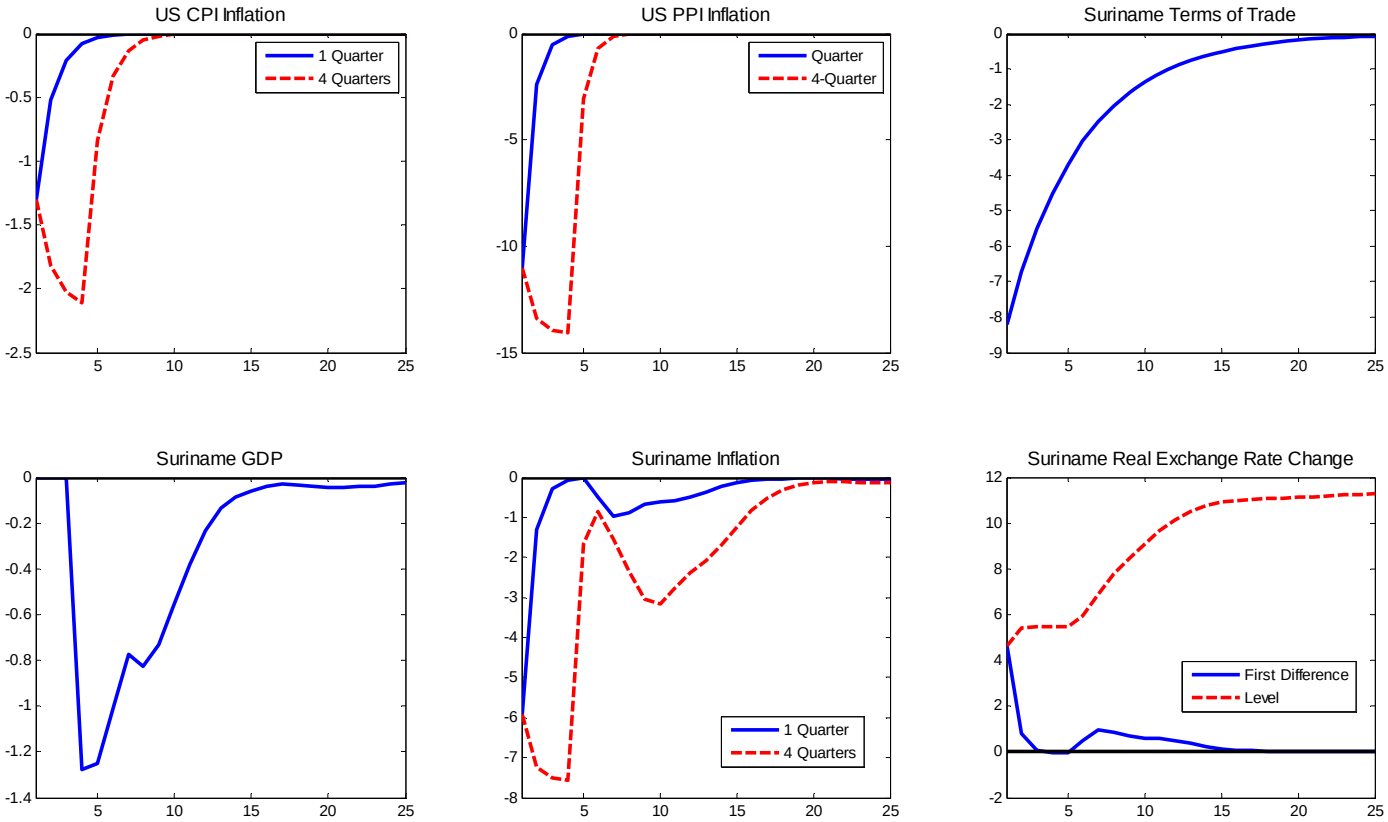
## Figure 1.e. Haiti's Responses



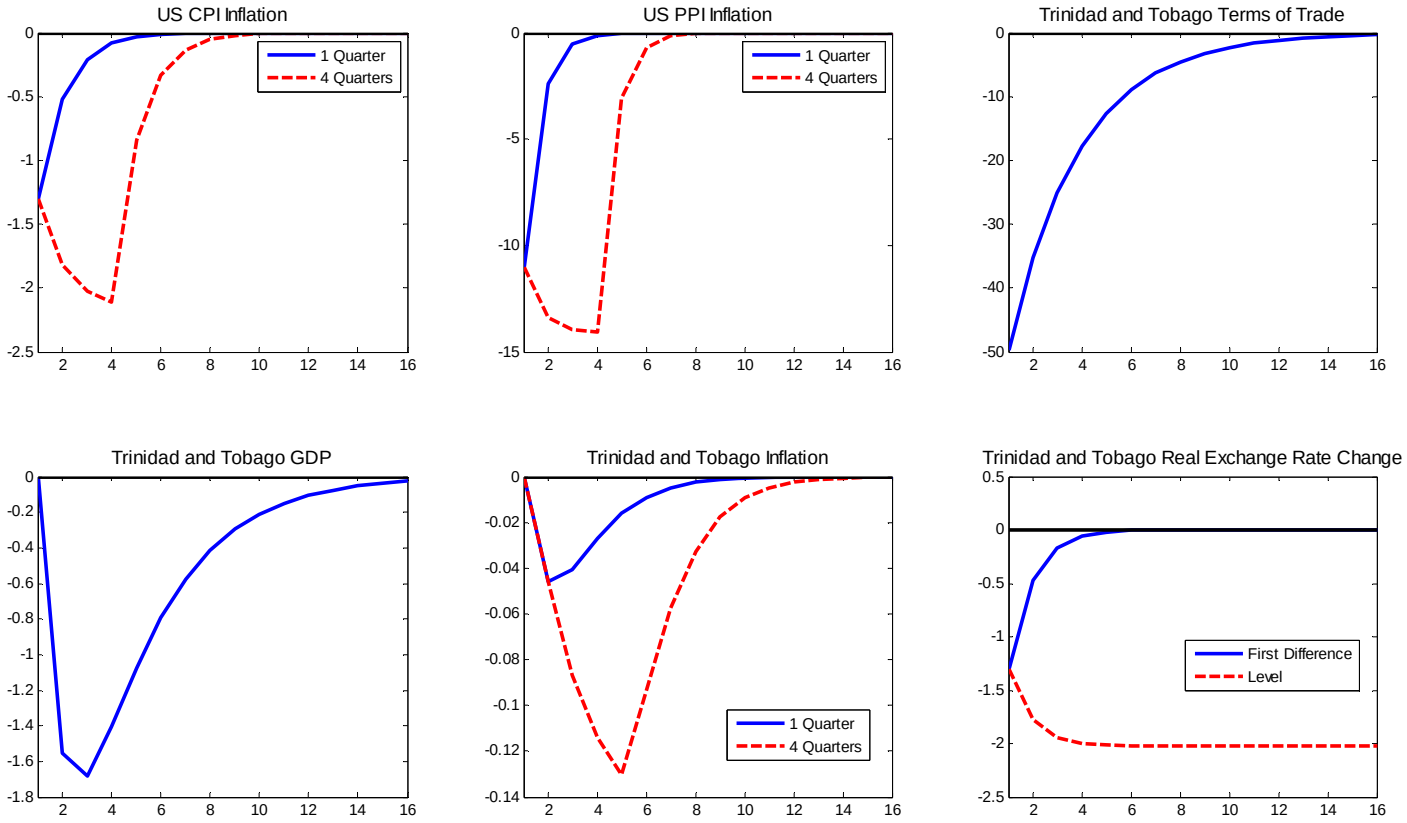
## Figure 1.f. Jamaica's responses



## Figure 1.g. Suriname's Responses



## Figure 1.h. Trinidad and Tobago's responses



## Appendix 1.

**Summary Table 1. Country Characteristics**

| Features | | The Bahamas | Barbados | Guyana | Haiti | Jamaica | Suriname | Trinidad and Tobago |
|---|---|---|---|---|---|---|---|---|
| Economic and Social Indicators | GDP (US$ bi, 2007) | 7.1 | 3.4 | 1.0 | 6.2 | 10.7 | 2.2 | 20.0 |
| | GDP per capita (US thous.) | 21.3 | 11.7 | 1.4 | 0.6 | 4.0 | 4.9 | 15.0 |
| | Population (thous.) | 331.1 | 293.9 | 738.5 (high net emigration) | 9,611.6 (high density, large emigration) | 2,667.2 (emigration) | 457.7 | 1,333 |
| | Social indicators | High | High | Medium-Low | Low | Medium-Low | Medium-Low | Medium |
| | Political backdrop | | | Ethnic tensions | Instability; violence | | Democracy since 1991; Ethnic tensions | |
| GDP Dynamics | GDP growth | High | High | Low (higher recently); volatile | Long stagnation | Low | Stagnation in the past; high recently | High (this decade) |
| | Main GDP driver | Tourism (from USA) | Tourism (UK, USA) | Agriculture (sugar, rice) and mining (gold, bauxite) | Agriculture (traditional/subsistence); | Tourism (USA) (and weather) | Mining (alumina, bauxite, gold) | Oil, gas - 43% of GDP |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Other GDP drivers | Tourism-related: construction; Financial services | Tourism-related: construction; Financial services | Forestry; fishing | Export assembly sector | Export goods: alumina, bauxite, sugar and manufactured goods | Oil; agriculture (rice, banana); fishing; forestry | Refining, petrochemicals; manufacturing, construction, Financial services |
| | Manufacturing sector | Underdeveloped | Some development | Negligible | Low (export assembly sector); for domestic consumption: stagnating | Some development (Competition from Central Am.; currency appreciation) | Important, bauxite processing and food processing | Oil refining and petrochemicals; excl. those: some development |
| | Agriculture role | Negligible | Negligible | High | High | Low; high for employment | Medium; high for employment | Negligible |
| | Role of weather | Medium(?) | | High | | High | Medium (flooding) | (Outside the main hurricane belt) |
| | Dependence on US econ. | High | High | Medium | High | High (but low correlations) | Low | As an export destination |
| | Main vulnerabilities | Dependence on tourism and US economy | Dependence on tourism and US economy | Dependence on commodities (low-value added form) and weather conditions; deficient infrastructure | External shocks; Political instabilities; poor infrastructure and technology | Dependence on commodities and tourism; emigrants remittances; large public debt | Dependence on commodities | Dependence on oil and gas prices |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Inflation | Inflation Level | Low<br>Around 2% | Low<br>Around 3% (recently 5%) higher than US | Medium<br>Around 6% | High, volatile<br>Average: 15% | High, volatile<br>Average: 10% | High, volatile<br>Av.: 28%; 10% (last 5 years) | Medium<br>Av. 5%; 7% (last 5 years - increasing) |
| | Inflation dynamics | US inflation | | | Exchange rate (high pass-through); international prices; stable relationship with monetary aggregates | Exchange rate; international prices; weather | Currency depreciations (changes in the pegged rate) (high pass-trough); international prices; USD depreciations; fiscal policies; spiral price-wage? | spiral price-wage? Credit expansion? Recently: food prices (gasoline prices constant), int. indexation |

| Features | | Bahamas | Barbados | Guyana | Haiti | Jamaica | Suriname | Trinidad and Tobago |
|---|---|---|---|---|---|---|---|---|
| Balance of Payments | Openness degree (X+M)/GDP 2007 | High 113.4% | High 110.6%$_{2004}$ | High 161.8% | High 56.9%$_{2006}$ Asymmetric: X:14%;M:43% | High 102.0%$_{2005}$ X:41%;M:61% | High 46.2%$_{2006}$ X:24%;M:22% | High 108.1%$_{2006}$ X:69%;M:39% |
| | Main export good | Crawfish | Manufactured goods | Agriculture (sugar); Mining (gold, bauxite) | Garment assembly products | Alumina | Alumina | Oil, gas |
| | Other exports | | | Rice, timber, seafood | Agriculture (mango,cocoa, essential oils, coffee) | Bauxite; sugar | Gold, oil | Chemicals |
| | Main export destination* | USA | Caricom, USA | Canada, USA | USA | USA, Canada, China, UK | Norway, Canada, USA | USA |
| | Main export good or service | Tourism (USA) | Tourism (UK,USA) | The same (tourism is not important) | | Tourism | The same (tourism is underdeveloped) | The same (tourism is not important) |
| | Importance of emigrants remittances | Negligible | Medium or Low | High-Medium | Very high | Very high, rising | Low? | Low |
| | Import products | All (high dependence) | All (high dependence) | All (high dependence) | | In part, related to tourism and remittances | All (high dependence) | All (high dependence) |
| | Main import origin | USA | Caricom, USA | T&T, USA | USA | USA, T&T | USA, Netherlands, T&T | USA, Venezuela, Brazil |
| | Trade balance | High deficit | High deficit | High deficit | Enormous deficit | High deficit, increasing | Surplus | Surplus (exc. 1997-8) |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | CA balance | High deficit | High deficit | High deficit | Medium-Low deficit increasing (remittances compensate trade def., grants balance CA deficit) | High deficit (tourism and remittances are important, but there is income deficit) | Cyclical behavior; Negative ->positive recently | Surplus (exc. 1997-8), but smaller than the trade balance |
| | Capital and Financial Account | Able to finance CA deficit; FDI | Able to finance CA deficit; FDI | Able to finance CA deficit; FDI; multilateral borrowing; PetroCaribe loans | Official loans; little FDI | FDI; Volatile capital flows; | FDI? | FDI into energy sector |
| | Importance of official loans and grants | Low or Nil? | Low or Nil? | Medium (increasing) | High (suspended in 1991-4,2001-4) | Low? | High, but volatile | Low or Nil? |
| | External debt | Negligible | Low | High | High | High | Medium, decreasing | Low, declining |
| | Reserves | Comfortable, but falling | Stable? | Stable | Rebuilding | Volatile | Volatile, increasing recently | Large increase; oil revenue stabilization fund |
| Financial | General assessment | Sound | | Increasing development | Low developed | Crisis in the mid-1990s; inv. schemes | Moderate developed | Deep and diversified |
| | Degree of dollarization | Low | | | High | High | High | |

*It includes both goods and services. A question mark (?) means that the information used did not allow a more conclusive assessment.

**Appendix 1.**

**Summary Table 2. Country Monetary Regimes**

| | | **The Bahamas** | **Barbados** | **Guyana** | **Haiti** | **Jamaica** | **Suriname** | **Trinidad and Tobago** |
|---|---|---|---|---|---|---|---|---|
| Exchange Rate | Exchange rate regime Start date | Fixed peg (to the USD: 1:1 s. 1970s) | Fixed peg (to the USD: 2:1 s. 1970s) | De facto: fixed peg, since 2004 (De jure: managed float); Before: managed float [or crawling peg?] | De facto: managed floating with no predetermined path for the e.r. since 1990-1; before: fixed peg | De facto: managed floating with no predetermined path for the e.r. since 1990?; peg before? | De facto: fixed peg, with some adjustments (hard peg until 1991Q3) (last important adj. 2004Q1) ; crawling peg for some periods?; De jure: managed float; dual system | De facto: fixed peg; De jure: managed float. e.r. very stable s. 1998 (and s. 1993Q2 low variation); before 1993: fixed peg with a few but large adjustments. |
| | Real exchange rate: domestic currency | Has depreciated | Has depreciated | Has appreciated | Has appreciated | Has appreciated | Volatile (stable recently); nominal effective has depreciated | Has appreciated (inflation rate differential) |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Assessment of exchange rate regime | IMF: appropriate | IMF: appropriate | IMF recommends more flexibility | Role of political backdrop | Use of reserves to support price stability | IMF recommends more flexibility | |
| Monetary Policy | Intermediate target of monetary pol. | Maintain the e.r. peg | Maintain the e.r. peg | Monetary aggregate target (banking reserves) | Monetary aggregate target | Maintenance of the real e.r.? EAER: mon. aggr. target (?) | Maintenance of the real e.r.? EAER: mon. aggr. target (?) | Maintainance of the e.r. peg? |
| | Main instruments | Credit restrictions ; moral suasion; discount rate | Minimum deposit rate; reserve requirements | T-bills; (secondary: reserve requirements) | Limited policy tools; Issuance of BRH bonds | Reverse repo | | Repo rate; (secondary: reserve requirements ) |
| | Degree of dev. open-market operations | Low | | Low | No bond secondary market | | | |
| | Monetary operational framework | | | Low developed | Low developed | | | |
| | Main indicators stance monetary policy | T-bill rate | Minimum deposit rate; T-bill rate | Monetary aggregates growth; T-bill rate | 91-day BRH bond rate | Reverse repo rate | Deposit and lending rates | T-bill rate |
| | Interest rates | Very stable | Follow US rates closely | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Assessment of monetary pol. | | | | Mixed framework | High public debt constraining mon. pol.? | Incomplete sterilization of reserve accumulation; credit expansion | |
| Fiscal Policy | Fiscal results | Some deficit | Deficit | Deficit | Deficit (excluding grants) | Burden of int. payments;primary surplus; revenues vulnerable to external shocks | History of fiscal imbalances; recently surplus (boosted by commodities) | Surplus; Revenues dependent on oil; Heritage and Stabilization Fund |
| | Public debt | High; has increased (40% of GDP) | Very High; increasing (95% of GDP) | | Medium (33% of GDP) | Very high (134% of GDP), although decreasing; around half external or dollar linked | High, decreasing sharply | Medium; declining |
| | Assessment of fiscal policy | | Worrisome | Improving | Improving | Improving | Improving | |
| | Member of Caricom? | Yes | Yes | Yes | Yes (recently) | Yes (2nd largest economy) | Yes | Yes |

A question mark (?) means that the information used did not allow a more conclusive assessment.

**Appendix 1.**

**Summary Table 3. Data Availability, Frequency, and Starting Date (since the 1970s)**

| Series | **Bahamas** | **Barbados** | **Guyana** | **Haiti** | **Jamaica** | **Suriname** | **Trinidad and Tobago** |
|---|---|---|---|---|---|---|---|
| GDP volume | A – 1989? | A - 1970 | A - 1970 | A - 1970 | A – 1970; Q - 1996 | A – 1973 | A – 1970 |
| CPI | M - 1970 | M - 1970 | M – 1970 | M - 1970 | M - 1970 | M – 1970 | M – 1970 |
| Nominal exchange rate | M - 1970 | M - 1970 | M - 1970 | M - 1970 | M - 1970 | M - 1970 | M – 1970 |
| Real exchange rate | M - 1980 | | M - 1980 | | | | M - 1975 |
| Interest rates | M –1970; 1976; 1985 | M – 1970; 1977; 1981 | M – 1970; 1972; 1981 | M – 1994Q4; | M – 1970; 1976; 1998 | Q – 1991; M – 2001; 2005 | M – 1970; 1982; 1989 |
| Indicator stance mon. pol. | M – 1971 T-bill rate | M –1981 Dep. Rates; M – 1970 T-bill rate | M – 1972 T-bill rate | M – 1997 BRH bond rate | M – 1998 repo rate | Q – 1990 deposit and lending rate (M – 2001) | M – 1970 T-bill rate |
| Unemployment rate | A (with na) | Q - 1992 | No | | Q - 2002 | | Q - 1993 |
| Tourism indicator | M - 1970 | A – 1977, M - 1987 | Not applicable | Not applicable | See CB | | Not applicable |
| Industrial production | | M - 1970 | No | Q – 1999 or 1986? | Q 1986 | | Q – 1978 (manufacturing) |
| Weather-related outlier | | | 2005: flooding=>GDP↓ | | Hurricane Aug. 2007 | | |
| Other outliers | | | 2007M1: intr. VAT=>prices↑ | Embargo (1991-94/95) | Removal of price and exchange controls (early 1990s); change in price index 2007 | Inflation 1993-95 | |
| GDP-AD components | A – 1973 | A - 1974 | A - 1970 | A - 1970 | A - 1970 | A - 1970 | A – 1970 |
| Export volume | | | | | M - 1970 | | |
| CA (and components) | Q - 1976 | A – 1970; | A – 1992 | A – 1971; Q - 2006 | A - 1976 | Q - 1977 | A - 1975 |

| Series | **The Bahamas** | **Barbados** | **Guyana** | **Haiti** | **Jamaica** | **Suriname** | **Trinidad and Tobago** |
|---|---|---|---|---|---|---|---|
| Candidates for quarterly economic activity indicator | Tourism arrivals | Tourist arrivals; industrial production | Export volume; constructed commodity export index | Ind. Production; electric energy consumption and production; construction; retail sales | GDPQ | Constructed export volume | Oil production ; unemployment rate; manufacturing production; constructed exported volume; GDPQ (2000Q1) |
| Starting dates of the regressions | 1989 | 1990 | 1998 | 1997 | 1996 | 1995 | 1990 |

**Data sources (in addition to the IFS)**

**Bahamas**
Central Bank of the Bahamas: www.centralbankbahamas.com
Department of Statistics: www.bahamas.gov.bs/statistics

**Barbados**
Central Bank of Barbados: www.centralbank.org.bb
Barbados Statistical Service: www.barstats.gov.bb/
Ministry of Tourism: www.barmot.gov.bb

**Guyana**
Bank of Guyana: www.bankofguyana.org.gy
Bureau of Statistics: www.statisticsguyana.gov.gy

**Haiti**
Banque de la République d'Haïti (BRH): www.brh.net
Institut Haïtien de Statistique et d'Informatique (IHSI): www.ihsi.ht

**Jamaica**
Bank of Jamaica: www.boj.org.jm

**Suriname**
Centrale Bank van Suriname: www.cbvs.sr
Algemeen Bureau voor de Statistiek: www.statistics-suriname.org/
Ministry of Finance: www.minfin.sr
Ministry of Planning: www.plos.sr
www.tct.sr

**Trinidad and Tobago**
Central Bank of Trinidad and Tobago**:** www.central-bank.org.tt
Central Statistical Office: www.cso.gov.tt

www.caricomstats.org/

## Appendix 2. Data Description

This appendix describes the main data series used in the estimation of IS and Phillips curves for the following seven Caribbean countries: The Bahamas, Barbados, Guyana, Haiti, Jamaica, Suriname, and Trinidad & Tobago. The data for each country can be grouped into four categories

- Monetary and financial indicators (e.g., interest rates)
- Economic activity indicators (e.g., GDP)
- Supply side indicators (e.g., inflation)
- Rest-of-the-world indicators (e.g., US GDP)

It is important to note that a much larger dataset (and sample period) was collected and analyzed than the one described here. To conserve space, only the variables that are used in the estimation results are reported here.

All the economic activity indicators are in real terms and seasonally adjusted. The interest and inflation rates are expressed in percentage points per quarter, unless otherwise denoted. All variables are expressed in natural log. The main data sources are: IMF's IFS, central banks and bureau of statistics (also listed in Appendix 1).

The text tables in this section list the data series used for each country. US data series used in the estimation of IS and Phillips curve for some countries are also reported at the end of the section.

## Table 1. Bahamas

| Series | Sources | Frequency | Sample Used | Unit | Adjustment/Treatment |
|---|---|---|---|---|---|
| Tbill rate | IFS | quarterly | 1989Q1-2008Q2 | % p.q. | None |
| Inflation rate (CPI) | IFS | monthly | 1989Q1-2008Q2 | % p.q. | cumulated in the quarter |
| Real exchange rate | IFS | quarterly | 1989Q1-2008Q2 | 2000 = 100 | inverse of the original series |
| Tourist arrivals | IFS | quarterly | 1989Q1-2008Q2 | 2000 = 100 | seasonally adjusted |
| GDP | Bahamas Department of Statistics | yearly | 1989-2007 | 2000 = 100 | none |
| GDP | Our calculation | quarterly | 1989Q1-2008Q2 | 2000 = 100 | See Appendix 3 |
| Output gap | Our calculation | quarterly | 1989Q1-2008Q2 | percent | HP deviations from trend of the GDP series |

## Table 2. Barbados

| Series | Sources | Frequency | Sample Used | Unit | Adjustment/Treatment |
|---|---|---|---|---|---|
| Prime lending rate | IFS | quarterly | 1987Q1-2008Q2 | % p.q. | none |
| Inflation rate (CPI) | IFS | monthly | 1987Q1-2008Q2 | % p.q. | cumulated in the quarter |
| Real exchange rate (CPI-based) | IFS, our calculation | monthly | 1987Q1-2008Q2 | 2000 = 100 | calculated using NER (Bd$/US$) and US CPI/BDCPI ratio, quarterly average |
| Tourist arrivals | IFS, Barbados Ministry of Tourism | quarterly | 1987Q1-2008Q2 | 2000 = 100 | seasonally adjusted |
| GDP | IFS and IDB's country reports | yearly | 1987-2007 | 2000 = 100 | none |
| GDP | Our calculation | quarterly | 1987Q1-2008Q2 | 2000 = 100 | see Appendix 3 |
| Output gap | Our calculation | quarterly | 1987Q1-2008Q2 | percent | HP deviations from trend of the GDP series |

## Table 3. Guyana

| Series | Sources | Frequency | Sample Used | Unit | Adjustment/Treatment |
|---|---|---|---|---|---|
| Inflation rate (CPI) | Global Financial Data | monthly | 1992Q1-2008Q2 | % p.q. | cumulated in the quarter |
| Real exchange rate | IFS | quarterly | 1992Q1-2008Q2 | 2000 = 100 | inverse of the original series |
| Exports volume | IFS | quarterly | 1977Q1-2008Q2 | 2000 = 100 | seasonally adjusted |
| Commodity index | Central Bank of Guyana and our calculation | quarterly | 1998Q1-2008Q2 | 2000 = 100 | seasonally adjusted |
| GDP | Guyana Bureau of Statistics | yearly | 1977-2007 | 2000 = 100 | none |
| GDP 1 | Our calculation | quarterly | 1977Q1-2008Q2 | 2000 = 100 | see Appendix 3 |
| GDP 2 | Our calculation | quarterly | 1998Q1-2008Q2 | 2000 = 100 | see Appendix 3 |
| Output gap 1 | Our calculation | quarterly | 1977Q1-2008Q2 | percent | HP deviations from trend of the GDP series |
| Output gap 2 | Our calculation | quarterly | 1998Q1-2008Q2 | percent | HP deviations from trend of the GDP series |

## Table 4. Haiti

| Series | Sources | Frequency | Sample Used | Unit | Adjustment/Treatment |
|---|---|---|---|---|---|
| Bank interest rate | IFS | quarterly | 1997Q1-2008Q2 | % p.q. | none |
| Inflation rate (CPI) | IFS | monthly | 1997Q1-2008Q2 | % p.q. | cumulated in the quarter |
| Real exchange rate (CPI-based) | IFS, our calculation | monthly | 1997Q1-2008Q2 | 2000 = 100 | calculated using NER (Bd$/US$) and US CPI/HA CPI ratio, quarterly average |
| Construction index | Statistical bureau (IHSI) | quarterly | 1997Q1-2008Q2 | 2000 = 100 | seasonally adjusted |
| GDP | IFS and IDB's country reports | yearly | 1997-2007 | 2000 = 100 | none |
| GDP | Our calculation | quarterly | 1997Q1-2008Q2 | 2000 = 100 | see Appendix 3 |
| Output gap | Our calculation | quarterly | 1997Q1-2008Q2 | percent | HP deviations from trend of the GDP series |

## Table 5. Jamaica

| Series | Sources | Frequency | Sample Used | Unit | Adjustment/Treatment |
|---|---|---|---|---|---|
| Repo interest rate | Bank of Jamaica | monthly | 1994Q2-2008Q2 | % p.q. | quarterly average |
| Inflation rate (CPI) | IFS | monthly | 1996Q1-2008Q2 | % p.q. | cumulated in the quarter |
| Nominal exch. rate | IFS | monthly | 1996Q1-2008Q2 | G$/US$ | quarterly average |
| Real exchange rate (CPI-based) | IFS, our calculation | monthly | 1996Q1-2008Q2 | 2000 = 100 | calculated using NER (Bd$/US$) and US CPI/JA CPI ratio, quarterly average |
| Terms of trade | IFS, Fred, our calculation | quarterly | 1996Q1-2008Q2 | 2000 = 100 | ratio of non-fuel commodity price to US PPI |
| GDP | IFS | quarterly | 1996Q1-2008Q2 | 2000 = 100 | seasonally adjusted |
| Output gap | Our calculation | quarterly | 1996Q1-2008Q2 | percent | HP deviations from trend of the GDP series |

## Table 6. Suriname

| Series | Sources | Frequency | Sample Used | Unit | Adjustment/Treatment |
|---|---|---|---|---|---|
| Inflation rate (CPI) | IFS | monthly | 1977Q1-2008Q2 | % p.q. | cumulated in the quarter |
| Real exchange rate (CPI-based) | IFS, our calculation | monthly | 1977Q1-2008Q2 | 2000 = 100 | calculated using NER (Sr$/US$), US CPI/SU CPI ratio, quarterly average |
| Exports volume | IFS, our calculation | quarterly | 1977Q1-2008Q2 | 2000 = 100 | calculated using nominal exports, NER and SU CPI |
| GDP | IFS | yearly | 1977-2007 | 2000 = 100 | none |
| GDP | Our calculation | quarterly | 1977Q1-2008Q1 | 2000 = 100 | see Appendix 3 |
| Output gap | Our calculation | quarterly | 1977Q1-2008Q1 | percent | HP deviations from trend of the GDP series |

## Table 7. Trinidad and Tobago

| Series | Sources | Frequency | Sample Used | Unit | Adjustment/Treatment |
|---|---|---|---|---|---|
| Tbill rate | IFS | quarterly | 1990Q1-2008Q2 | % p.q. | None |
| Inflation rate (CPI) | IFS | monthly | 1990Q1-2008Q2 | % p.q. | cumulated in the quarter |
| Real exchange rate (CPI-based) | IFS | quarterly | 1990Q1-2008Q2 | 2000 = 100 | inverse of the original series |
| Terms of trade | IFS, our calculation | quarterly | 1990Q1-2008Q2 | 2000 = 100 | ratio of oil (Texas) spot price index and US PPI |
| Industrial production | IFS | quarterly | 1980Q1-2008Q1 | 2000 = 100 | seasonally adjusted |
| Oil production | IFS | quarterly | 1980Q1-2008Q1 | 2000 = 100 | seasonally adjusted |
| Exports volume | IFS | quarterly | 1980Q1-2007Q4 | 2000 = 100 | seasonally adjusted |
| GDP | IFS | yearly | 1980-2007 | 2000 = 100 | none |
| GDP | Central Bank of TT | quarterly | 2000Q1-2008Q1 | 2000 = 100 | seasonally adjusted |
| GDP | Our calculation | quarterly | 1980Q1-1999Q4 | 2000 = 100 | see Appendix 3 |
| Output gap | Our calculation | quarterly | 1980Q1-2008Q2 | percent | HP deviations from trend of the GDP series |

## Table 8. US Data

| Series | Sources | Frequency | Sample Used | Unit | Adjustment/Treatment |
|---|---|---|---|---|---|
| Fed funds rate | IFS | quarterly | 1977Q1-2008Q2 | % p.q. | none |
| Inflation rate (CPI) | IFS | monthly | 1977Q1-2008Q2 | % p.q. | cumulated in the quarter |
| GDP | IFS | quarterly | 1977Q1-2008Q1 | 2000 = 100 | seasonally adjusted |
| Output gap | Our calculation | quarterly | 1977Q1-2008Q2 | percent | HP deviations from trend of the GDP series |

## Appendix 3. Estimation of Quarterly GDP Series

### *1. Introduction*

This appendix describes in detail how GDP series at quarterly frequency were obtained by distributing annual data for six Caribbean countries: The Bahamas, Barbados, Guyana, Haiti, Suriname, and Trinidad and Tobago. In Section 2 we present a brief overview of the alternative methods available. In Section 3 we discuss the method we apply to the Caribbean countries we consider. In Section 4 we present the results.

### *2. Alternative Methods*

The methods for obtaining high-frequency estimates based on low-frequency data can be grouped into two main categories: (i) interpolation without using additional information other than the own series to be interpolated, which we call "mathematical interpolation", and (ii) *interpolation* and *distribution* using related times series, which we call "statistical interpolation." We focus on the second method and abstracts from related topics such as data extrapolation.[13]

Some of the most popular mathematical interpolation methods are the linear interpolation, the interpolation with known data functions, and the polynomial interpolation. The first method is the simplest way for obtaining the missing values of a given time series *Y*. This method works well if the plot of *Y* against time resembles a straight line and if there is no clear pattern of cycle or seasonality in the missing quarters. In practice, linear interpolation is very limited because most economic time series (except maybe for population growth) do not behave this way. Interpolation with known data functions may, in part, reduce the potential error in linear interpolation. For instance, if *Y* cycles within a year, then a cosine function may be used to infer its missing values. Likewise, if there is information available about the seasonality pattern, this could be used to infer the missing values for each quarter. Finally, polynomial interpolation using high-order polynomials is a more robust method for interpolating time series. However, unless we know or calibrate the parameters of the polynomial function, it requires some sort of estimation, so this type of interpolation is also a statistical interpolation. Judd (1988) surveys many interpolation methods using polynomials. He highlights that piecewise polynomial interpolation using cubic splines (a smooth function of order 4 that is piecewise polynomial and

[13] For a detailed treatment of the three problems, see Chow and Lin (1971).

also smooth where the polynomial pieces connect) is very powerful. This method is used by many bureaus of statistics around the world (e.g., the Statistics Bureau of UK).

Statistical interpolation and distribution are more appropriate when it is more efficient to use additional economic information to infer the missing values of the unknown series. To simplify the discussion, suppose we want to interpolate *Y*, available at a given low frequency. Also suppose that there is a time series *X*, available at higher frequency (*X* is called "related series"). Without loss of generality, suppose we observe *Y* at yearly frequency and observe *X* at quarterly frequency. Hence, if we have *T* observations of *Y* (known as "benchmarks"), we will have 4*T* observations of *X*. The main goal of interpolation is to estimate the 3*T* missing values of *Y*. The problem of distribution is to obtain the 3*T* missing values of *Y* such that the sum of the three quarterly estimates for each year must equal the observed value for the year.

Even in developing countries there may be one (or more) time series (say, *X*) that is readily available at higher frequencies and highly correlated with *Y*. For instance, if *Y* is GDP, we may have information on many economic indicators that are coincident or leading indicators of GDP, such as industrial production, retail sales, energy consumption, etc. Therefore, we may estimate the missing values of *Y* more efficiently by looking at these related time series. Obviously, the related time series must satisfy some pre-conditions in order to yield good interpolation and distribution: (i) it must have an economic meaning ; (ii) it must be correlated with *Y* at low and high frequencies; and (iii) it must have small measurement error.

A nice example of a good related series is the series of commodity output used by Kuznets to produce the US GNP data for the period prior World War I. As Romer (1989) points out, the series of commodity output is the combined output of manufacturing, agriculture and mining at producer prices (this combination truly has economic meaning), representing about 44 percent of US GNP in 1910 (high correlation with GNP) and was constructed by combining census data, state reports and industry publications (small measurement error).

There are two main statistical interpolation/distribution methods, which differ with respect to the estimation procedure: *state space models with Kalman filter* and *multivariate OLS regressions*. This appendix focuses on the latter. Friedman (1962) is a pioneer work on data interpolation using related time series and OLS regressions. He focuses on the special case of a bivariate regression of *Y* on *X*, and only one missing value of *Y* between its benchmark values.

### *3. Chow and Lin (1971) Method*

Chow and Lin (1971) generalize Friedman's discussion for extrapolation and distribution and propose a statistical procedure for obtaining unbiased interpolated values[14]. Because Chow and Lin's method has been largely used in the literature, we describe it in detail for the univariate case. Suppose there is a linear relationship between $Y$ and $X$ for the entire sample period of $4T$ quarters:

$$Y = \beta X + u \tag{1}$$

where $Y$ and $X$ are both $4T$ x 1 vectors and $u$ is a $4T$ x 1 vector of errors, with mean zero and covariance matrix $V$, whose dimension is $4T$ x $4T$. The authors assume that $X$ is a fixed regressor (more on this below). Let $C$ be the $T$ x $4T$ matrix that converts $4T$ quarterly observations into $T$ annual observations:

$$C = \begin{pmatrix} 1 & 0 & 0 & 0 & 0 & \dots & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & \dots & 0 & 0 & 0 & 0 \\ & & & & & \dots & & & & \\ 0 & 0 & 0 & 0 & 0 & \dots & 1 & 0 & 0 & 0 \end{pmatrix}$$

If we want to distribute the benchmark value so that the quarterly values add to the annual observation, $C$ must be modified to:

$$C = \frac{1}{4}\begin{pmatrix} 1 & 1 & 1 & 1 & 0 & 0 & 0 & 0 & \dots 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 1 & 1 & 1 & \dots 0 & 0 & 0 & 0 \\ & & & & & & & & \dots & & & \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & \dots 1 & 1 & 1 & 1 \end{pmatrix}$$

The vector $Y_a$ of $T$ annual observations satisfies:

$$Y_a = CY = CX\beta + Cu = X_a\beta + u_a, \quad \text{with } Eu_a u_a' = CVC' \equiv V_a. \tag{2}$$

The authors show that the interpolation/distribution problem consists of estimating a $4T$ x 1 vector of linear unbiased estimator $\hat{Y}$ that satisfies, for a given $4T$ x $T$ matrix $A$:

$$\hat{Y} = AY_a = A(X_a\beta + u_a) \tag{3}$$

[14] Their method yields unbiased estimates of the missing values of $Y$ and not necessarily of the underlying coefficients of the regression model.

$$E(\hat{Y}-Y)=E[A(X_a\beta+u_a)-(X\beta+u)]=(AX_a-X)\beta=0\Leftrightarrow AX_a-X=0\Rightarrow\hat{Y}-Y=Au_a-u \quad (4)$$

$$A=X(X'_aV_a^{-1}X_a)^{-1}X'_aV_a^{-1}+VC'V_a^{-1}[I-X_a(X'_aV_a^{-1}X_a)^{-1}X'_aV_a^{-1}] \quad (5)$$

$$\hat{Y}=AY_a=X\hat{\beta}+VC'V_a^{-1}\hat{u}_a \quad (6)$$

$$\hat{\beta}=(X'_aV_a^{-1}X_a)^{-1}X'_aV_a^{-1}Y_a \quad (7)$$

$$\hat{u}_a=Y_a-X_a\hat{\beta} \quad (8)$$

Therefore, $\hat{u}_a$ in (8) is simply the vector of residuals in the regression using annual data, $\hat{\beta}$ in (7) is the OLS estimator of $\beta$ in the annual regression, and the unbiased estimator $\hat{Y}$ in (6) is a combination of the predicted values of *Y* (first term) and the residuals from the OLS regression (second term). Notice that (7) resembles the familiar formula in the GLS regression. It is clear that the above results depend on *V*, which has three possible candidates. First, if quarterly residuals are uncorrelated and homoskedastic, then

$$V=I_{4T}\sigma_u^2 \quad (9)$$

Second, if quarterly residuals display first-order serial correlation and constant variance, $u_t=\rho u_{t-1}+\varepsilon_t$, with $\varepsilon\sim(0,\sigma_\varepsilon)$, then

$$V=\frac{\sigma_\varepsilon^2}{1-\rho^2}\begin{pmatrix}1 & \rho & \rho^2 & \dots & \rho^{4T-1}\\ \rho & 1 & \rho & \dots & \rho^{4T-2}\\ \rho^2 & \rho & 1 & \dots & \rho^{4T-3}\\ & & & \dots & \\ \rho^{4T-1} & \rho^{4T-2} & \rho^{4T-3} & \dots & 1\end{pmatrix} \quad (10)$$

Finally, if quarterly residuals are uncorrelated and heteroskedastic, then *V* is a diagonal matrix as follows

$$V=\begin{pmatrix}\sigma_1^2 & 0 & \dots & 0\\ 0 & \sigma_2^2 & \dots & 0\\ 0 & 0 & \dots & 0\\ 0 & 0 & \dots & \sigma_{4T}^2\end{pmatrix} \quad (11)$$

In practice, the implementation of Chow and Lin's approach is very simple and involves the following steps:

- Step 1: chose a meaningful set of related economic series;
- Step 2: estimate (7) by GLS using low-frequency (annual) data;
- Step 3: use (8) to compute the annual residuals;
- Step 4: obtain the quarterly estimates using (6).

However, it is important to recognize that there are some shortcomings with Chow and Lin's approach. First, the researcher must be confident that the related series is reliable, and that this series does not display movements that are inconsistent with the benchmark series. Second, there are two technical constraints to the implementation of their method. First, the authors assume that *X* is non-stochastic, which is hardly verified in the case of economic time series. To circumvent this limitation and obtain a consistent estimator of $\beta$, we must assume that *X* and *u* are orthogonal. Second, we need to know the structure of *V*, which will likely resemble (10) in the case of most economic time series.

In fact, Abeysinghe and Lee (1998) apply Chow and Lin's procedure to the Malaysian data, assuming that quarterly residuals follow an AR(1) process. They use 20 years of annual data (1973 to 1993) for GDP and quarterly data for three related series (real output of manufacturing, agriculture and services) in order to estimate quarterly figures for the Malaysian GDP. They compare the interpolated values with actual quarterly GDP data, reported from 1987 onwards by the Malaysian Department of Statistics, and find that their estimates fit the actual data very well. Based on Chow and Lin, the authors also provide the formula for computing the quarterly correlation coefficient $\rho$ based on its annual counterpart $\rho_a$. They argue that under the assumption that both $\rho$ and $\rho_a$ are positive the quarterly coefficient is the unique positive real solution to the following polynomial equation:

$$\rho^7 + 2\rho^6 + 3\rho^5 + 4\rho^4 + (3 - 2\hat{\rho}_a)\rho^3 + (2 - 4\hat{\rho}_a)\rho^2 + (1 - 6\hat{\rho}_a)\rho - 4\hat{\rho}_a = 0 \qquad (12)$$

where $\hat{\rho}_a$ is the estimated autocorrelation coefficient from the OLS annual residuals.

Hayes and Turner (2003) also use Chow and Lin's method to generate quarterly GDP data for the UK for the period 1920Q1 to 1938Q4, also assuming that quarterly residuals display

first-order serial correlation. They also suggest an algorithm for estimating $\beta$ and $\rho$. Based on their suggestion, we propose the following algorithm:

(i) For some initial estimate of $\rho_a$, construct the matrix $V_a$ and estimate (7) by GLS;

(ii) Generate the residuals from step (i) using (8);

(iii) Estimate $\rho_a$ using the residuals generated in (ii) and the regression $u_t = \rho u_{t-1} + \varepsilon_t$;

(iv) Estimate $\rho$ using (12);

(v) Estimate $V$ and $V_a$ using the quarterly correlation coefficient estimated in (iv);

(vi) Generate quarterly values of $Y$ using the covariance matrix in (v) and (6).

Hayes and Turner obtain good estimates of quarterly GDP using only industrial production as related series. They also find that the estimated GDP series cointegrates with observed employment for the UK.

Bernanke et al. (1997) estimate a series of monthly GDP for the United States based on many related series. They also follow Chow and Lin's approach, but allow a more general treatment of the serial correlation in the residuals, and estimate the regression model by maximum likelihood. They use several related series to obtain monthly estimates of each component of aggregate demand, except private consumption, which is directly observed. For government consumption they use public construction, industrial production of defense and space equipment, and federal budget net outlay. For investment, they use industrial production of construction supplies, manufacturing shipments/construction materials/supplies, construction of private residential/industrial/commercial building, and housing starts. Finally, for exports and imports, they use US trade data on actual exports and imports, with adjustments.

Serju (2004) estimates quarterly GDP for Jamaica using both regression methods and state space models (with Kalman filter). He does not follow Chow and Lin's approach exactly, but his procedure has many similarities. First, he generates series of quarterly consumption, investment, exports and imports, using appropriate indicators (related series) for each of these components of aggregate demand, as in Bernanke et al. For private consumption, he uses

consumption tax, imports of goods and services, and a production composite index. For government consumption, he uses government expenditure, as well as spending on programs and wages. For exports and imports, he uses BoP statistics. Next, he feeds these data into the regression model and into the state space model in order to obtain the quarterly GDP estimates. He finds that the data generated by Kalman filter is too smooth and less consistent with the cyclical properties of the Jamaican data than the data generated by his regression model.

## 4. Quarterly GDP for Six Caribbean Countries

We now apply Chow and Lin's methodology to obtain GDP series for the six Caribbean countries we mentioned in the Introduction. For each country, we selected related series according to data availability, economic relevance and correlation with the annual GDP series. We tested for cointegration between the annual GDP series and the related series. Since in most cases we could reject the null hypothesis of no cointegrating relationship, we work with data in levels (after taking their natural log) for running the regressions. Additionally, we apply the distribution procedure rather than interpolation because we want the quarterly estimated values to add up to the total annual value.

### *4.1. Bahamas*

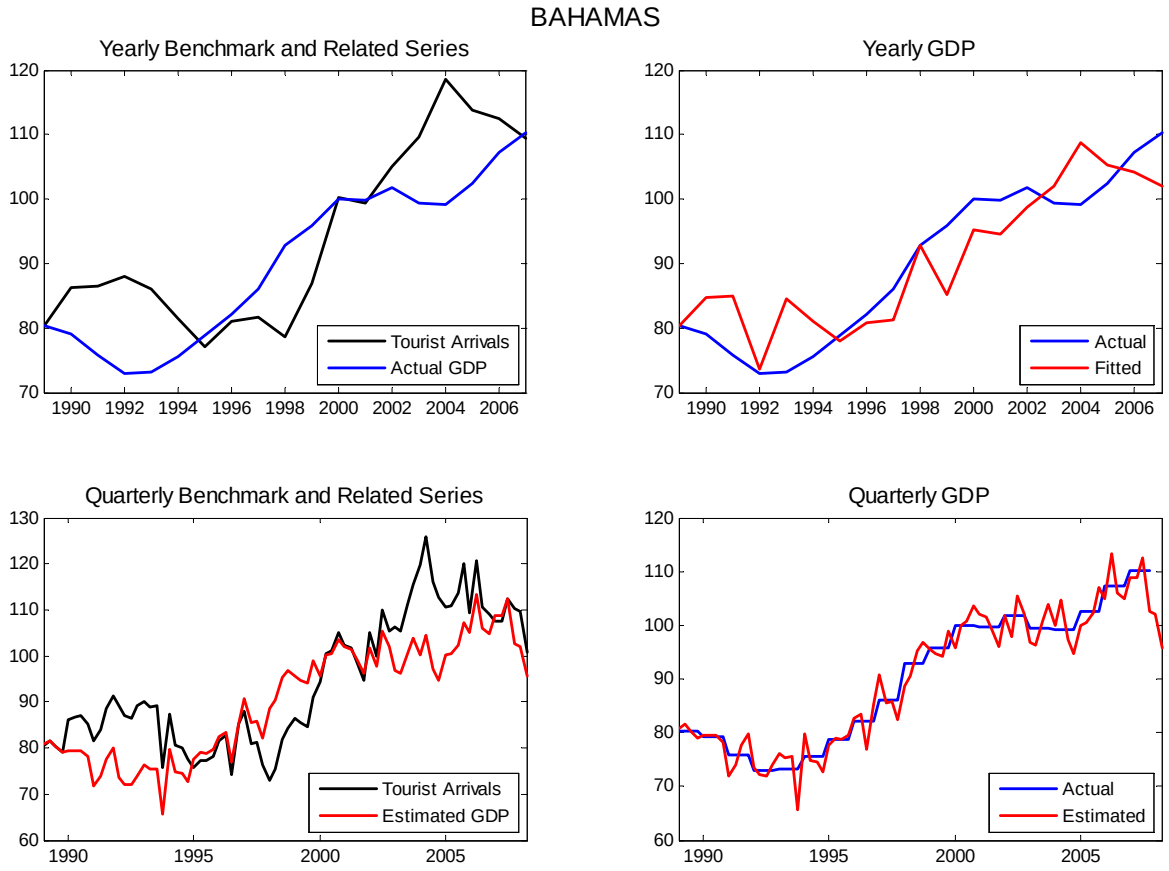
- Benchmark series: GDP index ($Y^{BA}$), at 2006 prices, 2000=100, 1989-2007
- Related series: Tourist Arrivals index ($TOUR^{BD}$), seasonally adjusted, 2000=100, 1989Q1-2008Q2
- Regression (standard deviations in parenthesis):

$$Y_t^{BA} = \underset{(5.949)}{20.61} - \underset{(3.470)}{12.50}\, d_{1992} - \underset{(3.587)}{13.68}\, d_{1998} + \underset{(0.061)}{0.74}\, TOUR_t^{BA}$$

$R^2 = 0.76; \quad \hat{\rho} = 0.71; \quad \hat{\rho}_a = 0.42$ Method: FGLS

The figure below shows the actual and estimated series, at both annual and quarterly frequencies. The top left panel depicts the annual series of GDP and Tourist Arrivals. This related series is a key driver of economic dynamics in Bahamas, accounting for about a third of The Bahamas' GDP (see Apendix 1). The top right panel compares the actual annual GDP with the fitted annual GDP. The fitted values behave well, except at the end of the sample, when the

estimated GDP declined (due to the large decline in TOUR) whereas the actual GDP kept its upward trend. The lower left panel depicts the quarterly estimated GDP and TOUR. This graph only reinforces the fact that TOUR is an important determinant of GDP dynamics in Bahamas. Finally, the lower right panel compares the estimated quarterly GDP with the annual observations for the same series.[15] As expected, the estimated series track the annual GDP very closely.




### *4.2. Barbados*

- Benchmark series: GDP index ($Y^{BD}$), at 2006 prices, 2000=100, 1987-2007
- Related series: Tourist Arrivals index ($TOUR^{BD}$), seasonally adjusted, 2000=100, 1987Q1-2008Q2

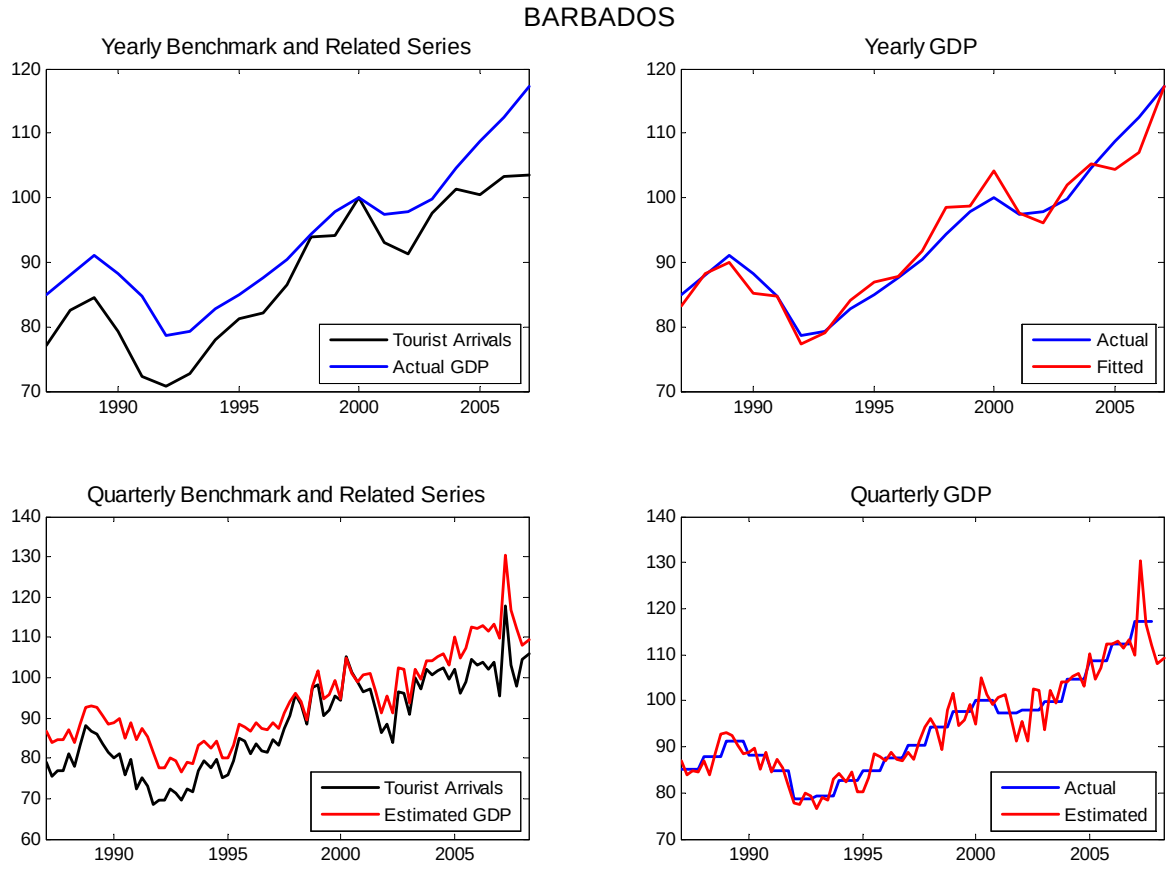
[15] We also estimated the GDP for the first half of 2008 by projecting the 2007Q4 value using the regression above. Notice in the last panel that we have replicated the annual GDP values in all quarters of each year, in order to better compare with the estimated quarterly series.

- Regression (standard deviations in parenthesis):

$$Y_t^{BD} = \underset{(2.716)}{12.73} + \underset{(1.407)}{5.84}\, d_{1991} + \underset{(1.399)}{9.90}\, d_{2007} + \underset{(0.0310)}{0.91}\, TOUR_t^{BD}$$

$$R^2 = 0.95; \quad \hat{\rho} = 0.64; \quad \hat{\rho}_a = 0.34 \qquad \text{Method: FGLS}$$

As we did for Bahamas, we also chose Tourist Arrivals as the related series for Barbados. Tourism is a key GDP driver in Barbados and is maybe the single most important economic activity in this country (see Apendix 1). We also tried industrial production, but it yielded worse results that TOUR. The figure below depicts the same variables we showed for Bahamas. Notice that both the correlation between the two annual series and the fitted values are slightly better than those of The Bahamas. The only relevant caveat affecting the estimated series is the large peak in 2007, which we could not fully address even using a time dummy for that year.



### *4.3. Guyana*

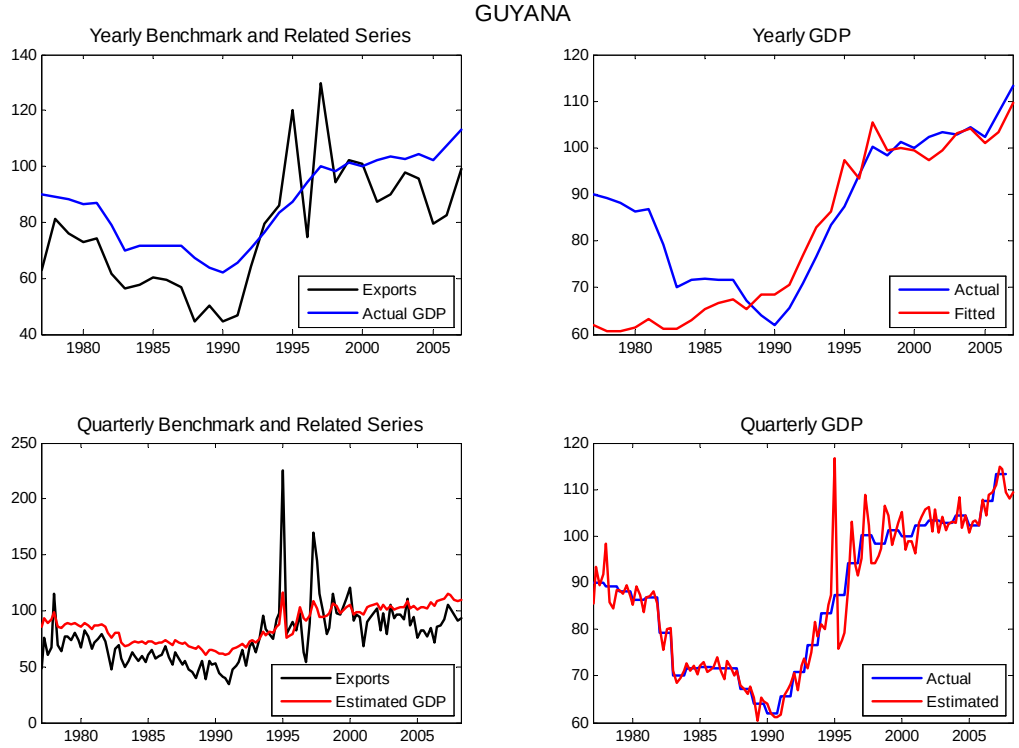
We run two regressions for Guyana. Initially, we used the series below and obtained the regression results that we report next.

- Benchmark series: GDP index ($Y^{GU}$), 2000=100, 1977-2007
- Related series: Exports index ($EXP^{GU}$), seasonally adjusted, 2000=100, 1977Q1-2008Q2
- Regression (standard deviations in parenthesis):

$$Y_t^{GU} = \underset{(7.300)}{35.29} + \underset{(0.074)}{0.38}\,Trend_t + \underset{(6.270)}{7.84}\,d_{1977} + \underset{(8.936)}{9.74}\,d_{1995} + \underset{(9.001)}{6.39}\,d_{1997} + \underset{(0.080)}{0.28}\,EXP_t^{GU}$$

$$R^2 = 0.34; \quad \hat{\rho} = 0.94; \quad \hat{\rho}_a = 0.85 \qquad \text{Method: FGLS}$$

We selected EXP as related series because Guyana is a highly open economy, with an export-to-GDP ratio of about two thirds (see Apendix 1). Despite the time dummies to control for outliers, the regression above produced a very volatile GDP series, as we can see in the next figure.



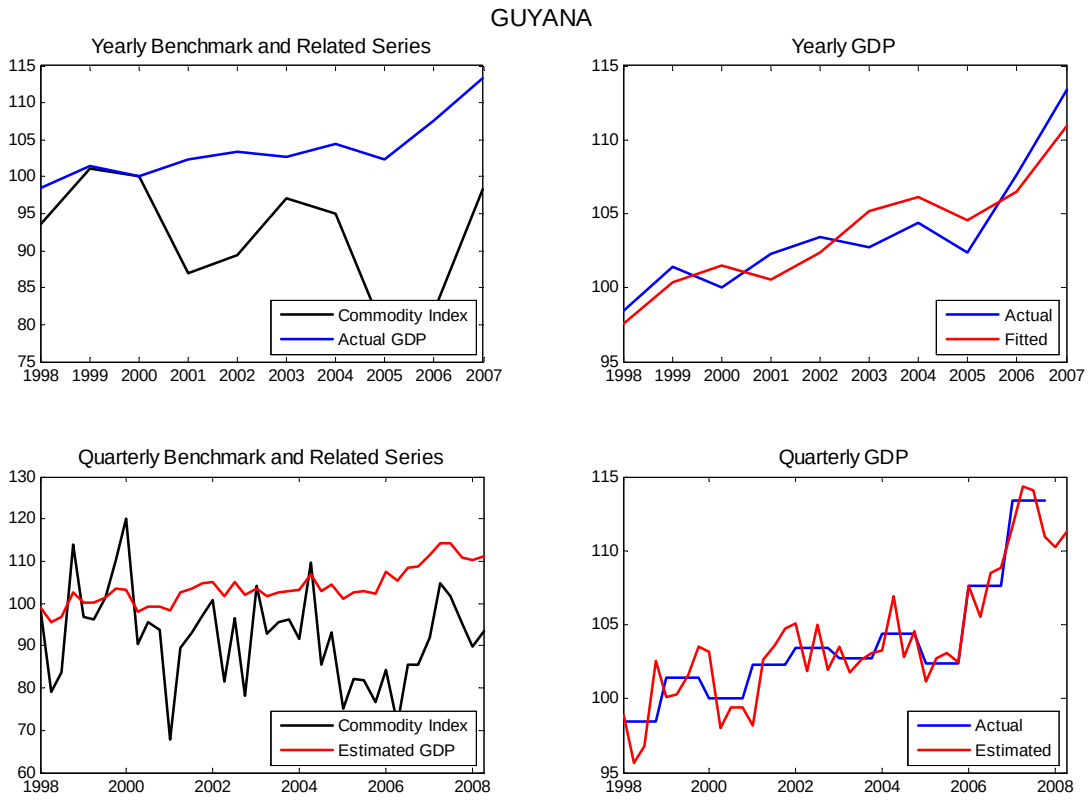
Alternatively, in order to reduce the volatility of the estimated series, we used a shorter sample, starting in 1998, and a different related series. The series we use is a weighted average of the volumes of sugar, rice and bauxite, the main commodities produced by Guyana. The production of these three commodities accounts for about a third of Guyana GDP. Below we report the regression results.

- Benchmark series: GDP index ($Y^{GU}$), 2000=100, 1998-2007
- Related series: Commodity index ($COM^{GU}$), seasonally adjusted, 2000=100, 1998Q1-2008Q2
- Regression (standard deviations in parenthesis):

$$Y_t^{GU} = \underset{(4.779)}{79.39} + \underset{(0.032)}{0.34}\,Trend_t + \underset{(0.048)}{0.18}\,COM_t^{GU}$$

$R^2 = 0.82; \quad \hat{\rho} = 0.40; \quad \hat{\rho}_a = 0.15$ Method: FGLS

As we can see, the goodness of the fit improved and the serial correlation in the residuals reduced considerably. Moreover, the figure below shows that the estimated series is much less volatile than the previous one. The caveat is a smaller sample.



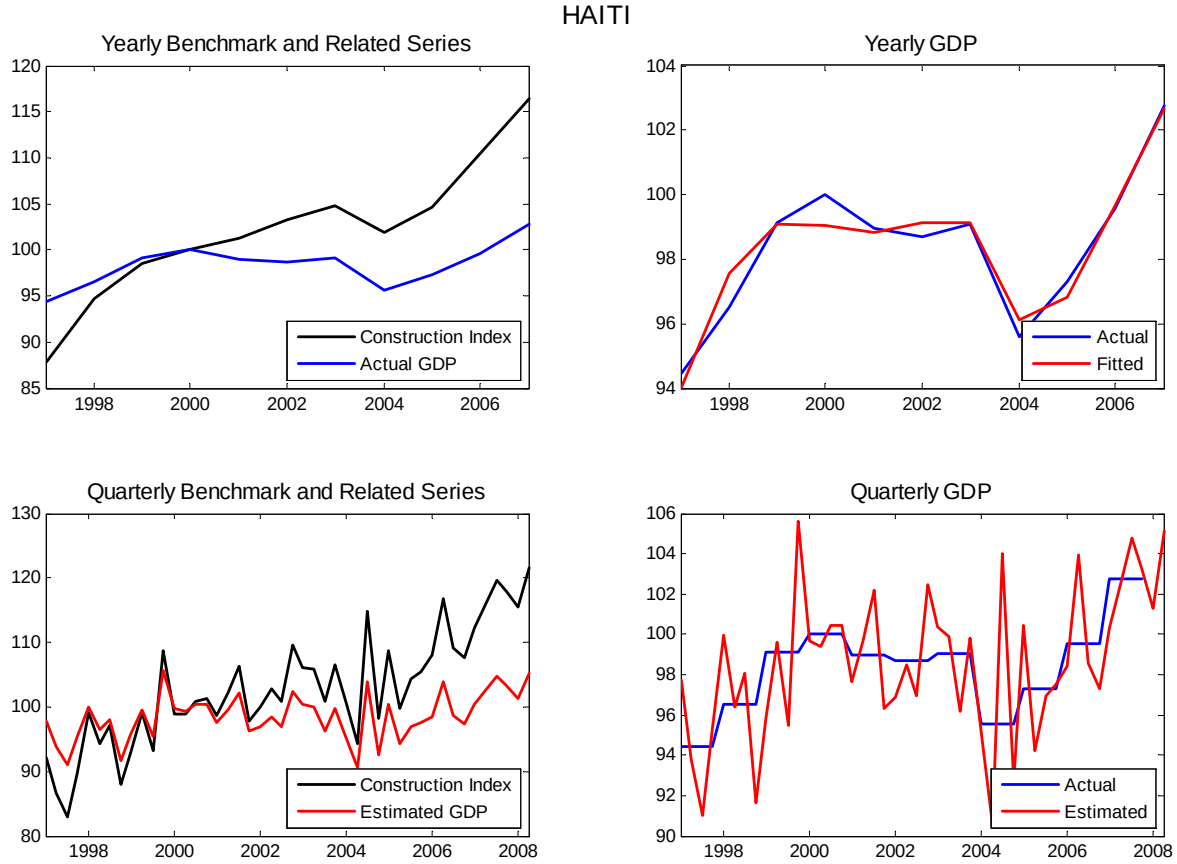

### *4.4. Haiti*

- Benchmark series: GDP index ($Y^{HA}$), 2000=100, 1997-2007
- Related series: Construction Activity index ($CON^{HA}$), seasonally adjusted, 2000=100, 1997Q1-2008Q2
- Regression (standard deviations in parenthesis):

$$Y_t^{HA} = \underset{(3.079)}{35.84} - \underset{(0.019)}{0.26}\,Trend_t + \underset{(0.034)}{0.67}\,CON_t^{HA}$$

$R^2 = 0.94$; Method: OLS

Even though construction is not the main economic activity in Haiti we chose it because, as the figure below shows, we obtained a quite high goodness of the fit and the estimated series is well behaved. We have also tried alternative related series (e.g., exports, industrial production, energy consumption and domestic retail sales) but they performed worse than the construction index.



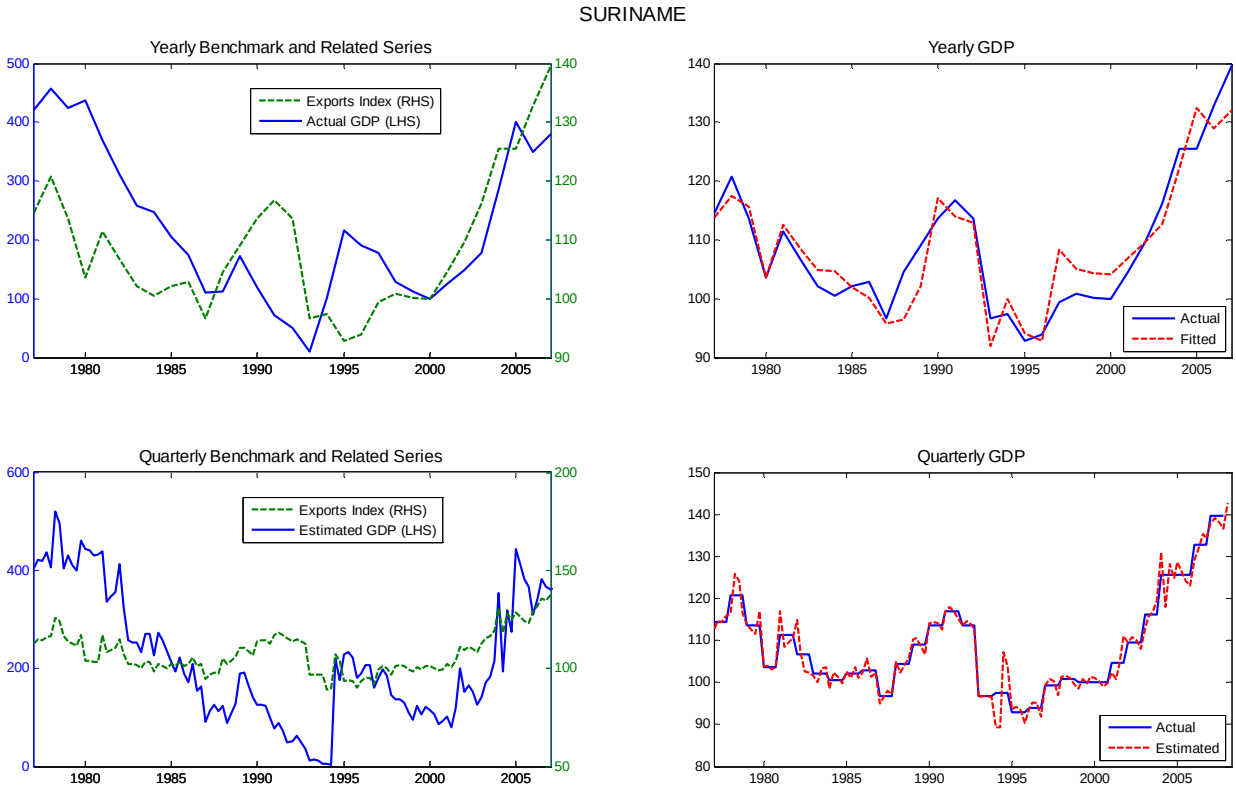

### *4.5. Suriname*

- Benchmark series: GDP index ($Y^{SU}$), 2000=100, 1977-2007
- Related series: Exports index ($EXP^{SU}$), seasonally adjusted, 2000=100, 1977Q1-2008Q2
- Regression (standard deviations in parenthesis):

$$Y_t^{SU} = \underset{}{79.04} + \underset{(1.378)}{0.18}\,Trend_t - \underset{(0.012)}{13.60}\,d_{1980} + \underset{(2.443)}{18.65}\,d_{1990-92} - \underset{(1.481)}{16.00}\,d_{1995-96} + \underset{(1.646)}{0.08}\,EXP_t^{SU}$$
$$(0.004)$$

$R^2 = 0.87; \quad \hat{\rho} = 0.49; \quad \hat{\rho}_a = 0.21$ Method: FGLS

The most important economic activities in Suriname are manufacturing, agriculture and mining. However, due to data availability we chose exports as the main related series. Exports account for about a quarter of Suriname GDP and, as we can see in the next figure, we managed to obtain high goodness of the fit. Additionally, the estimated series is well behaved, tracking the annual GDP series very closely.



### *4.6. Trinidad and Tobago*

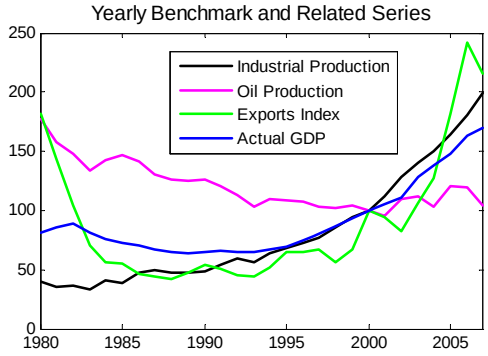
- Benchmark series: GDP index ($Y^{TT}$), 2000=100, 1980-2007
- Related series: Industrial Production index ($IP^{TT}$), Oil Production index ($OIL^{TT}$), Exports index ($EXP^{TT}$), both seasonally adjusted, 2000=100, 1980Q1-2007Q4
- Regression (standard deviations in parenthesis):

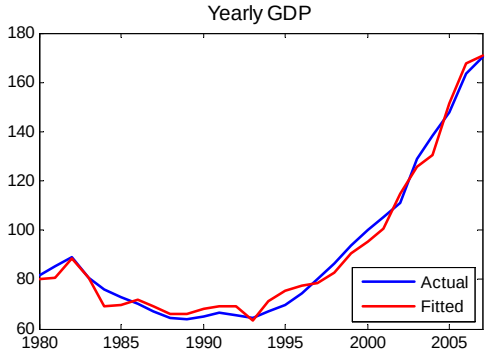
$$Y_t^{TT} = \underset{}{-12.89} \underset{(5.683)}{-14.09}\, d_{1980} \underset{(3.435)}{+15.15}\, d_{1982} \underset{(2.417)}{+17.88}\, d_{1983} \underset{(2.297)}{+0.62}\, IP_t^{TT} \underset{(0.027)}{+0.36}\, OIL_t^{TT} \underset{(0.043)}{+0.11}\, EXP_t^{TT} \underset{(0.020)}{}$$

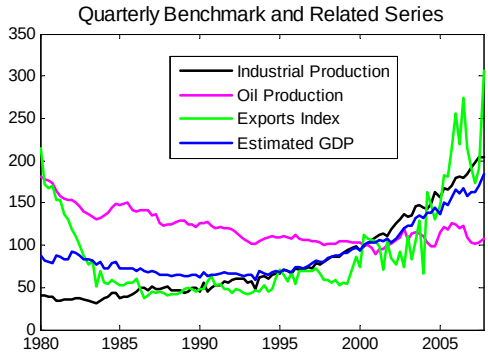
$R^2 = 0.98; \quad \hat{\rho} = 0.64; \quad \hat{\rho}_a = 0.34$ Method: FGLS

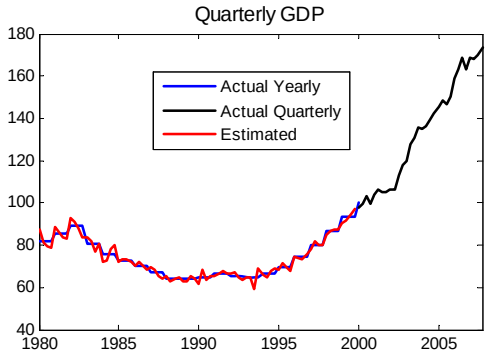
Data availability for Trinidad and Tobago is a much less severe problem than for the five previous countries. The three related series capture very well the GDP dynamics in Trinidad and Tobago, as well as the bulk of the economic activity in this country. For instance, manufacturing accounts for about 10 percent of the GDP, the energy sector (including oil production) represents 43 percent of the GDP, and the export-to-GDP ratio is about 69 percent (see Apendix 1). Moreover, we did not have to estimate the quarterly GDP for the entire sample period because the country reports a quarterly GDP series from 2000 onwards. Hence, our GDP series for the entire sample period combines the estimated values according to the above regression (for the period 1980-1999) and the actual values from 2000 onwards. The last panel of the next figure shows the two series combined. We ensured that the combination is robust to discontinuities in the trend and in the level of the two series.

TRINIDAD AND TOBAGO



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## Appendix 4. Alternative Monetary Policy Indicators

***The Bahamas***

In the case of The Bahamas, there is no clear monetary policy instrument. According to the Bank of Bahamas website: "The main instruments of monetary policy in The Bahamas are reserve requirements, changes in the Bank discount rate and selective credit controls, supplemented by moral suasion."

Reserve requirements change very seldom. Credit controls are difficult to use in the time series dimension, except perhaps using a dummy variable for periods of higher utilization, such as from Sept. 2001 through Aug. 2004. The discount rate is a clearer indicator. The main limitation is that it was also changed infrequently. For example, in the last nine years, there were only one change and hence two different values.

For the discount rate, the series used is the following:

IFS 31360...ZF... CENTRAL BANK RATE

First data point: 1970Q1 (or before)
Last data point: 2008Q2

Another possibility is to use the T-bill rate, despite the under-development of the market. The T-bill rate is highly correlated with the discount rate (0.86 for 1980Q1-2008Q2 sample, and 0.84 for 1990q1-2008q2 sample), but is more volatile. It is interesting to note that they both rose after the introduction of credit restrictions in Sept. 2001 (although they fell in 2003). In this case, the series would be the following:

IFS 31360C..ZF... TREASURY BILL RATE

First data point: 1971Q2
Last data point: 2008Q2

A third possibility is to use deposit or lending rates. They are highly correlated with the T-bill rate and the discount rate.

In the case of deposit rate:

IFS 31360L..ZF... WEIGHTED AVG. DEPOSIT RATE

For lending rate, we would have to use data from the Central Bank because the IFS contains only a prime rate, which is less variable than the average lending rate.

Series used in the estimations: TREASURY BILL RATE

***Barbados***

The main monetary policy instrument is the minimum deposit rate. The average deposit rate is available at the IFS:

IFS 31660L..ZF... AVERAGE DEPOSIT RATE

First data point: 1980Q1
Last data point: 2008Q2.

An alternative is to use the 3-month T-bill rate to be consistent with other countries. In fact, this rate is highly correlated with the average deposit rate. See, for example, figure on page 8 of the 2006 Annual Report of the Bank of Barbados.

IFS 31660C..ZF... TREASURY BILL RATE

First data point: 1970Q1 (or before)
Last data point: 2008Q2.

During the period 1990q1 2008q2, the correlation coefficient between average deposit rate and T-bill rate was 0.88.

Series used in the estimations: TREASURY BILL RATE, AVERAGE DEPOSIT RATE, and PRIME LENDING RATE. The latter was the only significant in the IS curve.

IFS and GFD 31660P..ZF... PRIME LENDING RATE

***Guyana***

IFS 33660C..ZF... TREASURY BILL RATE

First data point: 1972Q1
Last data point: 2008Q2

It is equivalent to the 91-day Treasury Bill Discount rate published by www.bankofguyana.org.gy (on the homepage the first data point is 2001Q1). The IFS figure seemingly represents the average of the monthly data published by the Central Bank. The Bank of Guyana also publishes the "Bank rate", which is the discount window rate.

Series used in the estimations: TREASURY BILL RATE

***Haiti***

The policy rate is the interest rate on 91-day BRH bonds. This series is available at www.brh.net and also in the IFS:

| | | |
|---|---|---|
| IFS | 26360A..ZF... | CENTRAL BANK BOND RATE |

Starting date: 1996Q4
Last date point: 2008Q2

The series available at the central bank (from which we calculated the quarterly average) has 0.96 correlation with the IFS series.

Series used in the estimations: CENTRAL BANK BOND RATE

***Jamaica***

The main policy instruments are the reverse repo rate and the monetary base.

Two options of interest rate series are available:

1.

| | | |
|---|---|---|
| IFS | 34360C..ZF... | TREASURY BILL RATE |

Is starts on 1970Q1 (or before) (This series is 0.99 correlated with the t-bill series published by the Bank of Jamaica)

2. Repo rate, published by the Bank of Jamaica, which starts on 1998Q1. The correlation between the series is 0.75

Series used in the estimations: repo rate, published by the Bank of Jamaica

***Suriname***

Series available only for lending and deposit rates:

| | | |
|---|---|---|
| IFS | 36660L..ZF... | DEPOSIT RATE |
| IFS | 36660P..ZF... | LENDING RATE |

Series used in the estimations: DEPOSIT RATE and LENDING RATE

***Trinidad and Tobago:***

IFS 36960C..ZF... TREASURY BILL RATE

It is widely used in the Monetary Policy Report. It seems highly correlated with the repo rate, which is the main monetary policy instrument.

Other possibilities are:

1. Interbank rate: not available at IFS (highly correlated with the treasury bill rate – at least for 2005-2008)

2. Repo rate: not available at IFS. They publish, however, the average discount rate, which seems to be equal to the repo rate.

Series used in the estimations: TREASURY BILL RATE, and LENDING RATE

IFS/GFD 36960P..ZF... LENDING RATE

## Appendix 5. Detailed Estimation Results

This appendix presents details on the estimation used in the simulations reported in the main text of the paper.

### *5.1. The Bahamas*

#### *5.1.1 Phillips Curve*

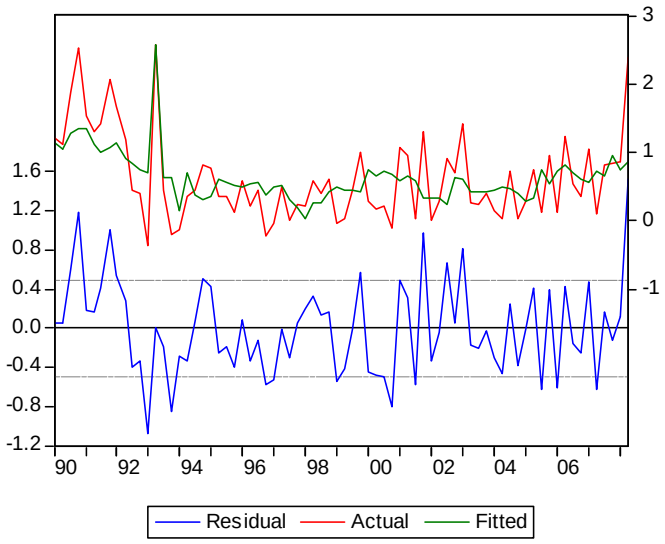
eq_pc_ben4

Dependent Variable: LBA_PIE_1Q_SA
Method: Least Squares
Date: 12/05/08 Time: 20:38
Sample: 1990Q1 2008Q2
Included observations: 74
LBA_PIE_1Q_SA = C(1) + C(2)*@MOVAV(LUS_PIE_1Q,4) + C(3)
*BA_Y_GAP(-1) + (1-C(2))*@MOVAV(LBA_PIE_1Q_SA(-1),4)+C(4)
*DUM_93Q2

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C(1) | -0.079820 | 0.060393 | -1.321675 | 0.1906 |
| C(2) | 0.656226 | 0.143662 | 4.567839 | 0.0000 |
| C(3) | 0.027448 | 0.015122 | 1.815141 | 0.0738 |
| C(4) | 1.985188 | 0.503276 | 3.944531 | 0.0002 |

| | | | |
|---|---|---|---|
| R-squared | 0.428891 | Mean dependent var | 0.635095 |
| Adjusted R-squared | 0.404415 | S.D. dependent var | 0.645951 |
| S.E. of regression | 0.498507 | Akaike info criterion | 1.498139 |
| Sum squared resid | 17.39563 | Schwarz criterion | 1.622683 |
| Log likelihood | -51.43115 | Hannan-Quinn criter. | 1.547821 |
| F-statistic | 17.52288 | Durbin-Watson stat | 1.671870 |
| Prob(F-statistic) | 0.000000 | | |

| | |
|---|---|
| LBA_PIE_1Q_SA – | Bahamas Inflation (one quarter, seasonally adjusted by the authors) |
| LUS_PIE_1Q – | US inflation (one quarter) |
| BA_Y_GAP - | Bahamas output gap |
| @MOVAV(variable,n) - | indicates moving average of n quarters |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*5.1.2 IS curve*

eq_is_ben_nw

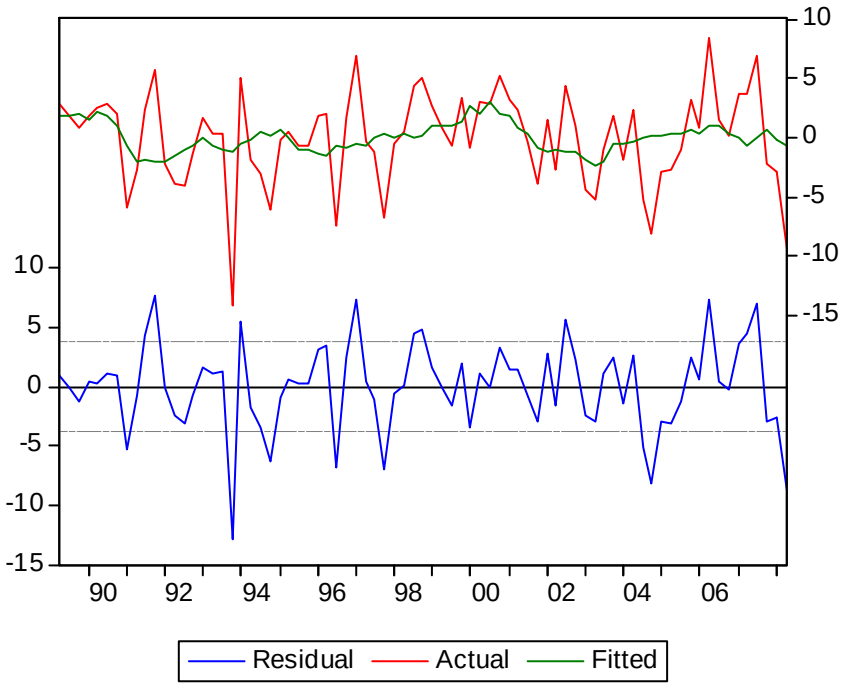
Dependent Variable: BA_Y_GAP
Method: Least Squares
Date: 12/02/08 Time: 09:11
Sample (adjusted): 1989Q2 2008Q2
Included observations: 77 after adjustments
Newey-West HAC Standard Errors & Covariance (lag truncation=3)

| | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | -0.014658 | 0.432521 | -0.033890 | 0.9731 |
| LUS_GDP_GAP_HP(-1) | 1.301443 | 0.363043 | 3.584818 | 0.0006 |

| | | | |
|---|---|---|---|
| R-squared | 0.093911 | Mean dependent var | -0.018198 |
| Adjusted R-squared | 0.081829 | S.D. dependent var | 3.963377 |
| S.E. of regression | 3.797756 | Akaike info criterion | 5.532329 |
| Sum squared resid | 1081.722 | Schwarz criterion | 5.593207 |
| Log likelihood | -210.9947 | Hannan-Quinn criter. | 5.556679 |
| F-statistic | 7.773284 | Durbin-Watson stat | 1.709594 |
| Prob(F-statistic) | 0.006715 | | |

With Newey-West standard errors – some evidence of the presence of heteroskedacity

BA_Y_GAP - Bahamas output gap
LUS_GDP_GAP_HP - US GDP gap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## *5.2 Barbados*

### *5.2.1 Phillips curve*

eq_pc_ben

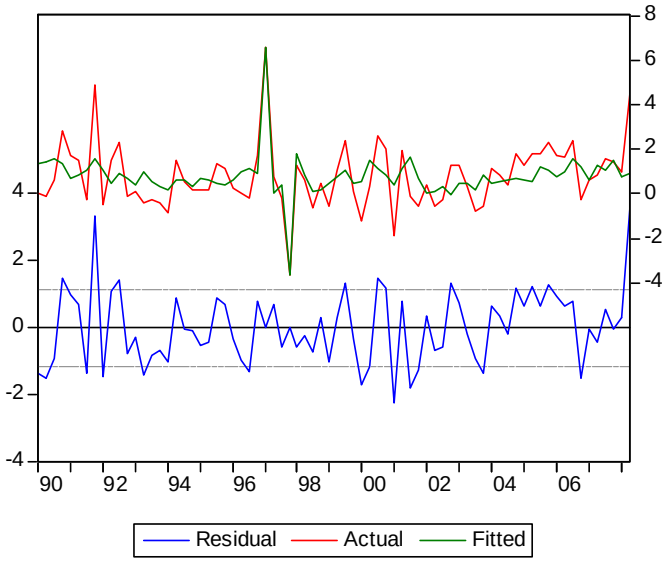
Dependent Variable: LBD_PIE_1Q_SA
Method: Least Squares
Date: 12/06/08 Time: 11:41
Sample: 1990Q1 2008Q2
Included observations: 74

| | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 0.314804 | 0.230260 | 1.367164 | 0.1761 |
| @MOVAV(LBD_PIE_1Q_SA(-1),4) | 0.630789 | 0.256771 | 2.456617 | 0.0166 |
| BD_Y_GAP(-2) | 0.066503 | 0.035005 | 1.899775 | 0.0617 |
| @MOVAV(LBD_RER_FD(-1),2) | 0.411282 | 0.168081 | 2.446931 | 0.0170 |
| DUM_97Q1 | 6.033641 | 1.162298 | 5.191133 | 0.0000 |
| DUM_97Q4 | -5.154933 | 1.224703 | -4.209127 | 0.0001 |

| | | | |
|---|---|---|---|
| R-squared | 0.421533 | Mean dependent var | 0.795540 |
| Adjusted R-squared | 0.378999 | S.D. dependent var | 1.460089 |
| S.E. of regression | 1.150603 | Akaike info criterion | 3.196054 |
| Sum squared resid | 90.02432 | Schwarz criterion | 3.382870 |
| Log likelihood | -112.2540 | Hannan-Quinn criter. | 3.270577 |
| F-statistic | 9.910431 | Durbin-Watson stat | 1.863314 |
| Prob(F-statistic) | 0.000000 | | |

Residuals: OK (serial correlation and heteroskedacity tests)

| | |
|---|---|
| LBD_PIE_1Q_SA - | Barbados Inflation (one quarter, seasonally adjusted by the authors) |
| BD_Y_GAP - | Barbados output gap |
| LBD_RER_FD - | Barbados real Exchange rate change (first log-difference) |
| @MOVAV(variable,n) - | indicates moving average of n quarters |
| DUM_97Q1 - | Impulse dummy for 1997Q1 |
| DUM_97Q4 - | Impulse dummy for 1997Q4 |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### 5.2.2 *IS curve*

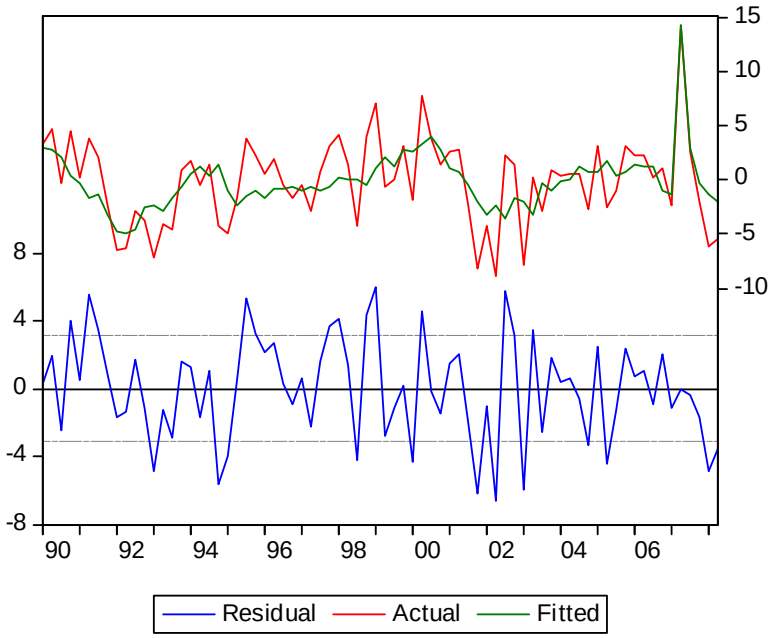
eq_is_ben

Dependent Variable: BD_Y_GAP
Method: Least Squares
Date: 12/06/08 Time: 12:43
Sample: 1990Q1 2008Q2
Included observations: 74

| | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 3.257712 | 2.090063 | 1.558667 | 0.1237 |
| LBD_PRIME_RATE(-1)-LBD_PIE_4Q(-1) | -0.521662 | 0.311673 | -1.673747 | 0.0988 |
| LUS_GDP_GAP_HP | 1.443436 | 0.437339 | 3.300493 | 0.0015 |
| LBD_RER_4QD(-1) | 0.566014 | 0.290740 | 1.946807 | 0.0557 |
| DUM_07Q2 | 15.41906 | 3.176794 | 4.853653 | 0.0000 |
| BD_Y_GAP(-1) | 0.204468 | 0.099507 | 2.054809 | 0.0437 |

| | | | |
|---|---|---|---|
| R-squared | 0.420812 | Mean dependent var | -0.127761 |
| Adjusted R-squared | 0.378225 | S.D. dependent var | 3.975211 |
| S.E. of regression | 3.134562 | Akaike info criterion | 5.200461 |
| Sum squared resid | 668.1325 | Schwarz criterion | 5.387277 |
| Log likelihood | -186.4170 | Hannan-Quinn criter. | 5.274984 |
| F-statistic | 9.881158 | Durbin-Watson stat | 1.943479 |
| Prob(F-statistic) | 0.000000 | | |

BD_Y_GAP - Barbados output gap
LBD_PRIME_RATE(-1)-LBD_PIE_4Q(-1) – Difference between prime lending rate and four-quarter cumulative inflation.
LUS_GDP_GAP_HP - US GDP gap
LBD_RER_4QD - Barbados real Exchange rate change (four-quarter log-difference)
DUM_07Q2 - Impulse dummy for 2007Q2




### *5.3. Guyana*

#### *5.3.1 Phillips Curve*

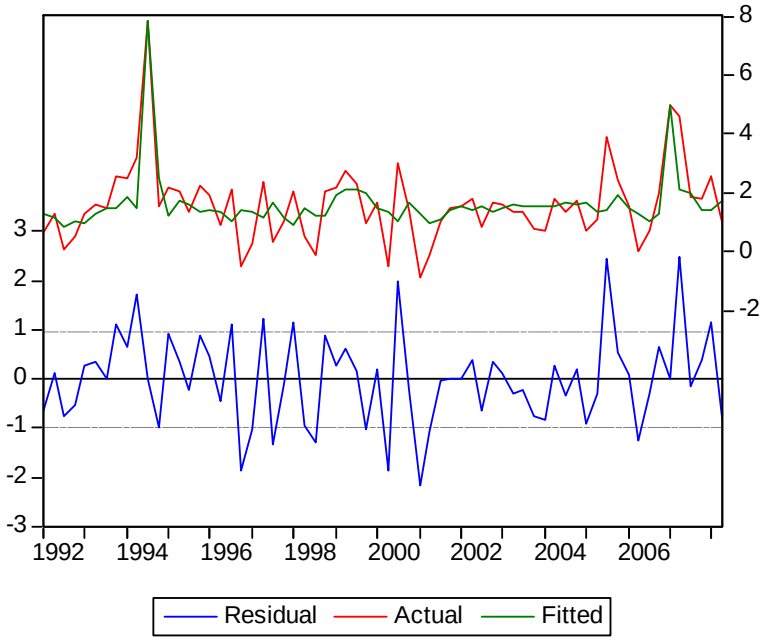
eq_pc_ben

Dependent Variable: LGU_PIE_1Q_SA
Method: Least Squares
Date: 12/06/08 Time: 16:38
Sample: 1992Q1 2008Q2
Included observations: 66

| | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 1.194080 | 0.189628 | 6.296954 | 0.0000 |
| LGU_PIE_1Q_SA(-1) | 0.203759 | 0.091162 | 2.235124 | 0.0291 |
| @MOVAV(LGU_RER_FD(-1),4) | 0.125801 | 0.081857 | 1.536842 | 0.1295 |
| DUM_94Q3 | 6.206041 | 0.996688 | 6.226662 | 0.0000 |
| DUM_07Q1 | 3.310279 | 0.983862 | 3.364577 | 0.0013 |

| | | | |
|---|---|---|---|
| R-squared | 0.501245 | Mean dependent var | 1.624246 |
| Adjusted R-squared | 0.468540 | S.D. dependent var | 1.333510 |
| S.E. of regression | 0.972146 | Akaike info criterion | 2.854113 |
| Sum squared resid | 57.64915 | Schwarz criterion | 3.019996 |
| Log likelihood | -89.18573 | Hannan-Quinn criter. | 2.919661 |
| F-statistic | 15.32614 | Durbin-Watson stat | 2.144736 |
| Prob(F-statistic) | 0.000000 | | |

| | |
|---|---|
| LGU_PIE_1Q_SA – | Guyana Inflation (one quarter, seasonally adjusted by the authors) |
| LGU_RER_FD - | Guyana real exchange rate change (one-quarter log-difference) |
| @MOVAV(variable,n) - | indicates moving average of n quarters |



*5.3.2 IS curve*

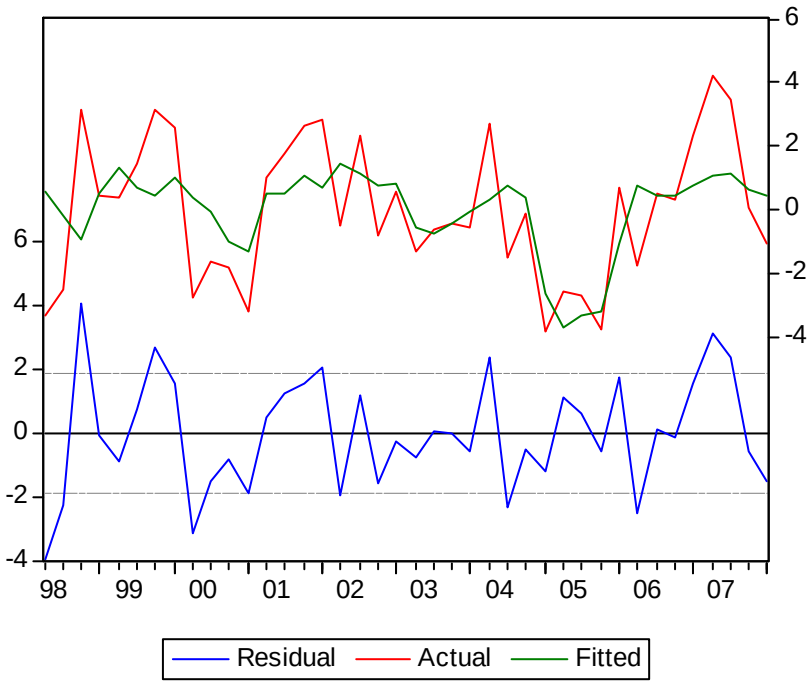
eq_is_new_ben

Dependent Variable: GU_Y_GAP_NEW
Method: Least Squares
Date: 12/22/08 Time: 10:12
Sample (adjusted): 1998Q2 2008Q1
Included observations: 40 after adjustments

| | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 0.341555 | 0.315548 | 1.082419 | 0.2863 |
| GU_Y_GAP_NEW(-1) | 0.348474 | 0.164511 | 2.118242 | 0.0411 |
| LGU_TOT_GAP(-1) | 0.077799 | 0.045890 | 1.695354 | 0.0986 |
| DUM_05Q1Q2Q3Q4 | -3.241924 | 1.065331 | -3.043115 | 0.0044 |

| | | | |
|---|---|---|---|
| R-squared | 0.335624 | Mean dependent var | 0.010953 |
| Adjusted R-squared | 0.280259 | S.D. dependent var | 2.203463 |
| S.E. of regression | 1.869364 | Akaike info criterion | 4.183713 |
| Sum squared resid | 125.8027 | Schwarz criterion | 4.352601 |
| Log likelihood | -79.67425 | Hannan-Quinn criter. | 4.244777 |
| F-statistic | 6.062061 | Durbin-Watson stat | 1.781460 |
| Prob(F-statistic) | 0.001890 | | |

GU_Y_GAP_NEW – Guyana output gap
LGU_TOT_GAP(-1) - Guyana terms of trade gap (Constructed as an implicit index, based on export value series (using National Accounts and the exchange rate) and export volume series (both available in the IFS)). Estimated using an HP filter. Note that an increase in that variable means better terms of trade.
DUM_05Q1Q2Q3Q4 - Dummy variable for 2005 (variable = 1 for Q1Q2Q3Q4) due to the flooding at the beginning of 2005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## *5.4 Haiti*

### *5.4.1 Phillips Curve*

eq_pc_ben

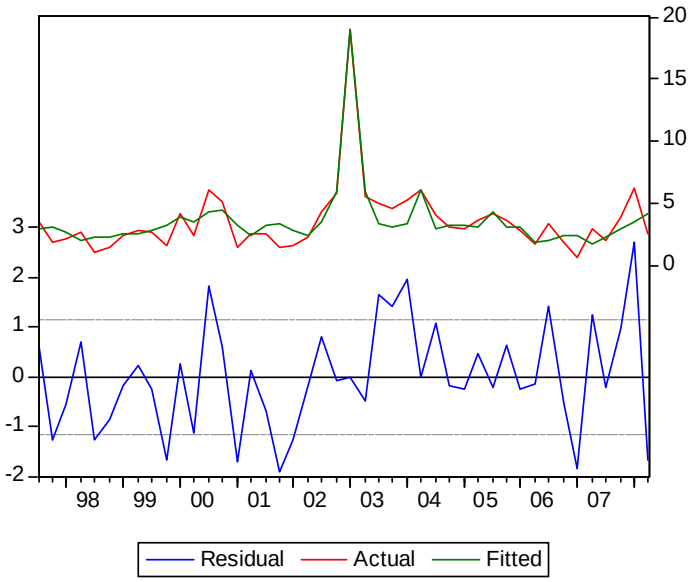
Dependent Variable: LHA_PIE_1Q_SA
Method: Two-Stage Least Squares
Date: 12/25/08 Time: 16:01
Sample: 1997Q3 2008Q2
Included observations: 44
LHA_PIE_1Q_SA = C(1) + C(2)*LHA_PIE_1Q_SA(-1) + C(3)
*(LHA_NER_FD+LUS_PIE_1Q)+ C(4)*DUM_03Q1+C(5)*DUM_04Q2
Instrument list: C LHA_PIE_1Q_SA(-1) LHA_NER_FD(-1) LUS_PIE_1Q
LHA_BANK_RATE(-1) LHA_BANK_RATE(-2) LHA_PIE_1Q(-1)
LHA_NER_4QD(-1) DUM_03Q1 DUM_04Q2

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C(1) | 1.963172 | 0.346272 | 5.669457 | 0.0000 |
| C(2) | 0.228132 | 0.063862 | 3.572277 | 0.0010 |
| C(3) | 0.150232 | 0.066778 | 2.249735 | 0.0302 |
| C(4) | 12.33241 | 1.798533 | 6.856924 | 0.0000 |
| C(5) | 4.732434 | 1.519610 | 3.114243 | 0.0034 |

| | | | |
|---|---|---|---|
| R-squared | 0.847778 | Mean dependent var | 3.567761 |
| Adjusted R-squared | 0.832166 | S.D. dependent var | 2.804531 |
| S.E. of regression | 1.148948 | Sum squared resid | 51.48320 |
| F-statistic | 51.84356 | Durbin-Watson stat | 1.943736 |
| Prob(F-statistic) | 0.000000 | Second-Stage SSR | 64.46105 |

No presence of serial correlation or heteroskedacity.

LHA_PIE_1Q_SA – Haiti Inflation (one quarter, seasonally adjusted by the authors)
LHA_NER_FD - Haiti nominal Exchange rate change (first log-difference)
LUS_PIE_1Q - US inflation (first log-difference)
DUM_03Q1 - Impulse dummy variable for 2003Q1
DUM_04Q2 - Impulse dummy variable for 2004Q2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*5.4.2 IS curve*

eq_is_ben

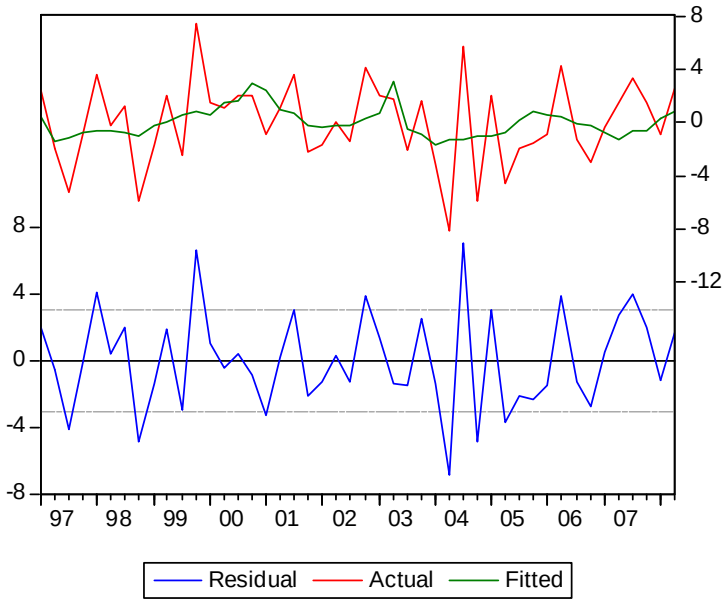
Dependent Variable: HA_Y_GAP
Method: Least Squares
Date: 12/22/08 Time: 11:10
Sample: 1997Q1 2008Q2
Included observations: 46
Newey-West HAC Standard Errors & Covariance (lag truncation=3)

| | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 0.222279 | 0.304344 | 0.730353 | 0.4692 |
| @MOVAV(LUS_GDP_GAP_HP(-1),4) | 0.903644 | 0.417856 | 2.162575 | 0.0363 |
| LHA_RER_4QD(-1) | 0.052515 | 0.019702 | 2.665481 | 0.0109 |
| LHA_BANK_RATE(-1)-4*LHA_PIE_1Q_SA(-1) | -0.055663 | 0.024550 | -2.267329 | 0.0286 |

| | | | |
|---|---|---|---|
| R-squared | 0.119522 | Mean dependent var | 9.02E-12 |
| Adjusted R-squared | 0.056631 | S.D. dependent var | 3.160629 |
| S.E. of regression | 3.069830 | Akaike info criterion | 5.164063 |
| Sum squared resid | 395.8020 | Schwarz criterion | 5.323075 |
| Log likelihood | -114.7734 | Hannan-Quinn criter. | 5.223630 |
| F-statistic | 1.900454 | Durbin-Watson stat | 2.511665 |
| Prob(F-statistic) | 0.144212 | | |

Presence of serial correlation and possibly heteroskedacity.

| | |
|---|---|
| HA_Y_GAP - | Haiti output gap |
| LHA_PIE_1Q_SA – | Haiti Inflation (one quarter, seasonally adjusted by the authors) |
| LHA_RER_4QD - | Haiti real Exchange rate change (four-quarter log-difference) |
| @MOVAV(variable,n) - | indicates moving average of n quarters |
| LHA_BANK_RATE - | 91-day BRH bond rate – policy instrument |
| LUS_GDP_GAP_HP - | US GDP gap |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Actual
Fitted

## *5.5 Jamaica*

### *5.5.1 Phillips Curve*

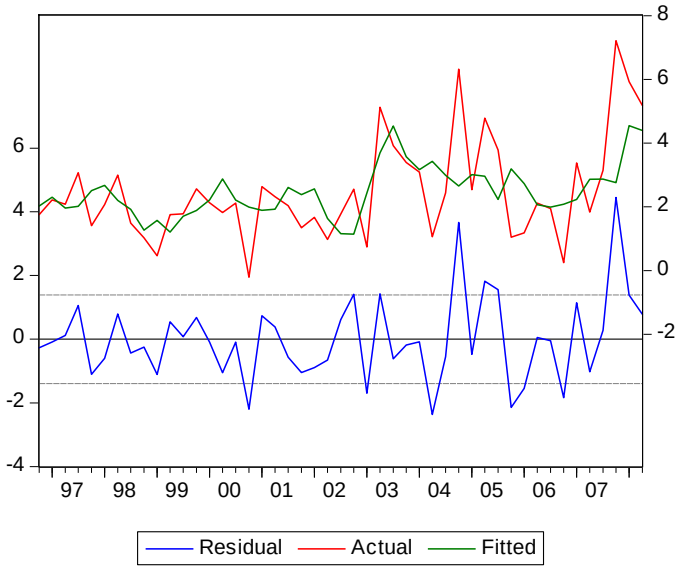
eq_pc_ben

Dependent Variable: LJA_PIE_1Q_SA
Method: Least Squares
Date: 12/09/08 Time: 08:33
Sample (adjusted): 1996Q4 2008Q2
Included observations: 47 after adjustments

| | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 0.920922 | 0.498497 | 1.847396 | 0.0716 |
| @MOVAV(LJA_PIE_1Q_SA(-1),2) | 0.683486 | 0.199039 | 3.433932 | 0.0013 |
| @MOVAV(JA_Y_GAP(-2),2) | 0.576742 | 0.271608 | 2.123438 | 0.0395 |
| LJA_RER_FD(-1) | 0.172455 | 0.083058 | 2.076324 | 0.0439 |

| | | | |
|---|---|---|---|
| R-squared | 0.266679 | Mean dependent var | 2.473616 |
| Adjusted R-squared | 0.215517 | S.D. dependent var | 1.569468 |
| S.E. of regression | 1.390094 | Akaike info criterion | 3.577886 |
| Sum squared resid | 83.09160 | Schwarz criterion | 3.735345 |
| Log likelihood | -80.08032 | Hannan-Quinn criter. | 3.637139 |
| F-statistic | 5.212449 | Durbin-Watson stat | 2.013913 |
| Prob(F-statistic) | 0.003694 | | |

LJA_PIE_1Q_SA – Jamaica Inflation (one quarter, seasonally adjusted by the authors)
JA_Y_GAP - Jamaica output gap
LHA_RER_FD - Jamaica real exchange rate change (first log-difference)
@MOVAV(variable,n) - indicates moving average of n quarters



### *5.5.2 IS curve*

eq_is_ben

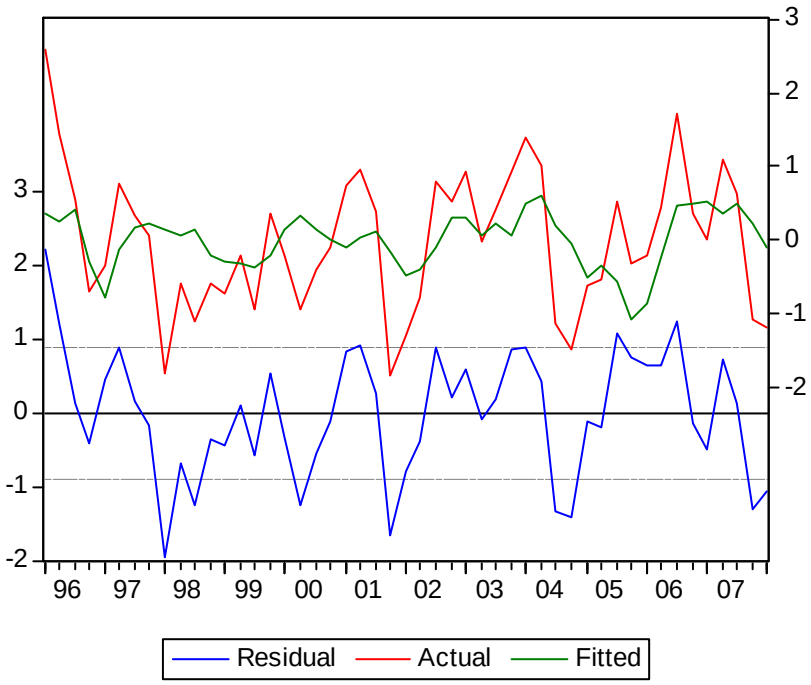
Dependent Variable: JA_Y_GAP
Method: Least Squares
Date: 12/25/08 Time: 19:31
Sample (adjusted): 1996Q1 2008Q1
Included observations: 49 after adjustments
Newey-West HAC Standard Errors & Covariance (lag truncation=3)

| | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 0.054614 | 0.156728 | 0.348464 | 0.7291 |
| LJA_RER_4QD(-1) | 0.034820 | 0.016492 | 2.111359 | 0.0402 |
| LTOT_NF_PPI_GAP(-1) | 0.078222 | 0.029036 | 2.693947 | 0.0098 |

| | | | |
|---|---|---|---|
| R-squared | 0.159949 | Mean dependent var | 2.89E-11 |
| Adjusted R-squared | 0.123425 | S.D. dependent var | 0.945097 |
| S.E. of regression | 0.884852 | Akaike info criterion | 2.652478 |
| Sum squared resid | 36.01632 | Schwarz criterion | 2.768304 |
| Log likelihood | -61.98571 | Hannan-Quinn criter. | 2.696422 |
| F-statistic | 4.379290 | Durbin-Watson stat | 1.015480 |
| Prob(F-statistic) | 0.018156 | | |

Presence of serial correlation in the residuals.

JA_Y_GAP - Jamaica output gap
LJA_RER_4QD - Real exchange rate change (four-quarter logdifference)
LTOT_NF_PPI_GAP Gap (estimated using an HP filter) of the proxy for the terms of trade – estimated as the ratio of non fuel commodity prices to US PPI. Note that an increase in that variable means better terms of trade.




### *5.6 Suriname*

#### *5.6.1 Phillips Curve*

eq_pc_ben1

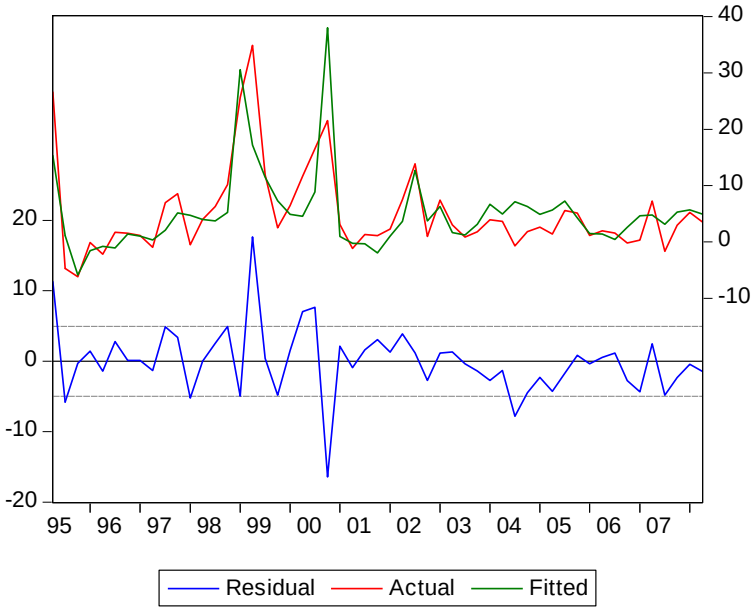
Dependent Variable: LSU_PIE_1Q_SA
Method: Two-Stage Least Squares
Date: 12/10/08 Time: 15:54
Sample (adjusted): 1995Q2 2008Q2
Included observations: 53 after adjustments
Newey-West HAC Standard Errors & Covariance (lag truncation=3)
Instrument list: C LSU_PIE_1Q_SA(-1) @MOVAV(SU_Y_GAP(-2),2) LSU_NER_FD(-1) LUS_PPI_1Q LSU_NER_FD(-2) LSU_PIE_4Q(-1) LSU_NER_FD(-3) LSU_NER_FD(-4)

| | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 2.760036 | 0.868962 | 3.176247 | 0.0026 |
| @MOVAV(SU_Y_GAP(-2),2) | 0.770312 | 0.369245 | 2.086182 | 0.0421 |
| LSU_NER_FD+LUS_PPI_1Q | 0.538547 | 0.173199 | 3.109414 | 0.0031 |

| | | | |
|---|---|---|---|
| R-squared | 0.607415 | Mean dependent var | 5.117346 |
| Adjusted R-squared | 0.591712 | S.D. dependent var | 7.789857 |
| S.E. of regression | 4.977519 | Sum squared resid | 1238.785 |
| F-statistic | 22.46698 | Durbin-Watson stat | 2.196015 |
| Prob(F-statistic) | 0.000000 | Second-Stage SSR | 2042.187 |

No serial correlation. Presence of heteroskedacity.

| | |
|---|---|
| LSU_PIE_1Q_SA – | Suriname Inflation (one quarter, seasonally adjusted by the authors) |
| SU_Y_GAP - | Suriname output gap |
| LSU_NER_FD - | Suriname real exchange rate change (first log-difference) |
| LUS_PPI_1Q - | US PPI (first log-difference) |
| @MOVAV(variable,n) - | indicates moving average of n quarters |
| LSU_PIE_4Q - | Suriname four-quarter cumulative inflation |



*5.6.2 IS curve*

eq_is_ben

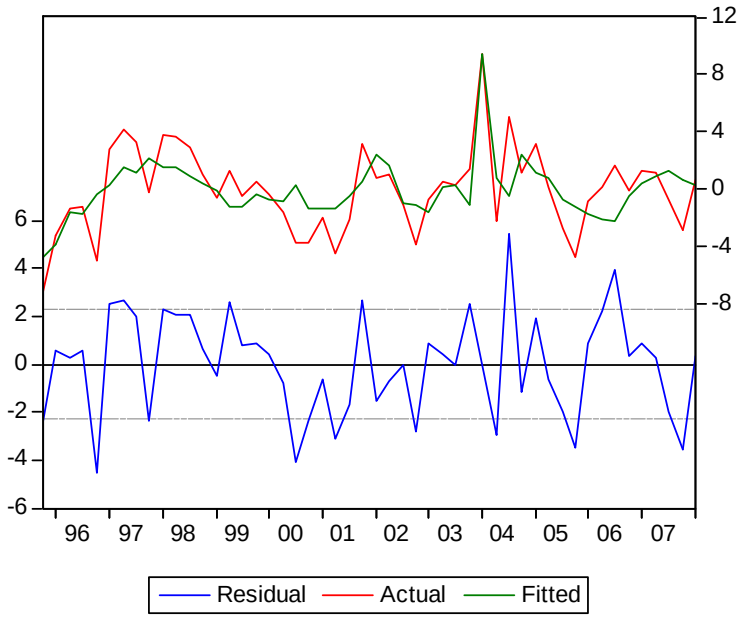
Dependent Variable: SU_Y_GAP
Method: Least Squares
Date: 12/25/08 Time: 16:59
Sample (adjusted): 1995Q4 2008Q1
Included observations: 50 after adjustments

| | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 0.085094 | 0.343582 | 0.247667 | 0.8055 |
| SU_Y_GAP(-1) | 0.227966 | 0.113303 | 2.011995 | 0.0502 |
| LTOT_NF_PPI_GAP(-3) | 0.187475 | 0.074628 | 2.512137 | 0.0157 |
| LSU_RER_4QD(-3) | 0.055931 | 0.018038 | 3.100700 | 0.0033 |
| DUM_04Q1 | 10.10276 | 2.330672 | 4.334699 | 0.0001 |

| | | | |
|---|---|---|---|
| R-squared | 0.456316 | Mean dependent var | -0.022483 |
| Adjusted R-squared | 0.407988 | S.D. dependent var | 2.955943 |
| S.E. of regression | 2.274371 | Akaike info criterion | 4.575923 |
| Sum squared resid | 232.7743 | Schwarz criterion | 4.767125 |
| Log likelihood | -109.3981 | Hannan-Quinn criter. | 4.648734 |
| F-statistic | 9.442151 | Durbin-Watson stat | 1.918565 |
| Prob(F-statistic) | 0.000013 | | |

No serial correlation or heteroskedacity.

SU_Y_GAP - Suriname output gap
LTOT_NF_PPI_GAP - Gap (estimated using an HP filter) of the proxy for the terms of trade – estimated as the ratio of nonfuel commodity prices to US PPI. Note that an increase in that variable means better terms of trade.
LSU_RER_4QD - Suriname real exchange rate change (four-quarter log-dfference)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Residual
Actual
Fitted

### *5.7.1 Trinidad and Tobago*

*5.7.1 Phillips Curve*

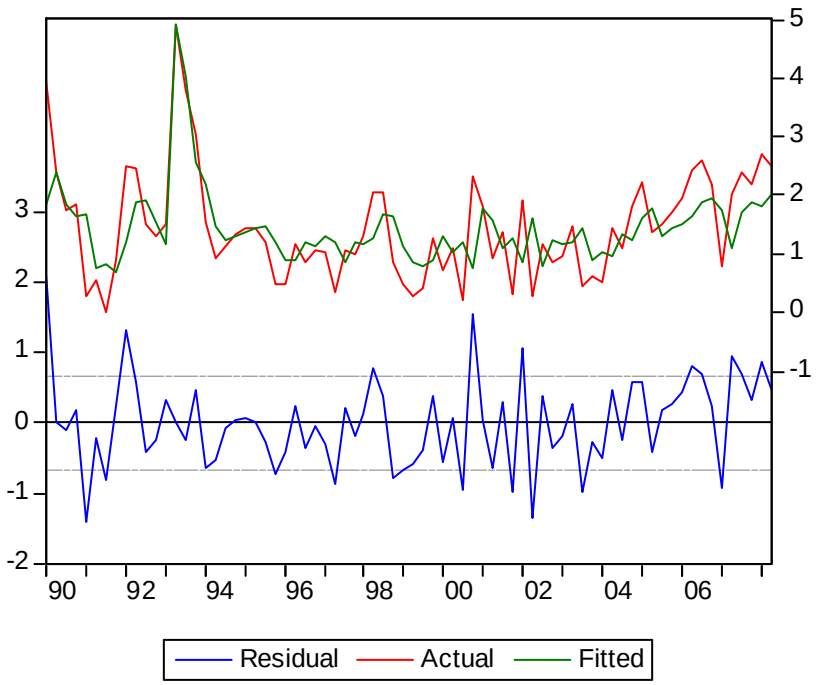
eq_pc_ben

Dependent Variable: LTT_PIE_1Q_SA
Method: Least Squares
Date: 12/07/08 Time: 18:42
Sample: 1990Q1 2008Q2
Included observations: 74

| | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 0.656483 | 0.146696 | 4.475122 | 0.0000 |
| LTT_PIE_1Q_SA(-1) | 0.520684 | 0.085448 | 6.093607 | 0.0000 |
| LTT_RER_FD(-1) | 0.035483 | 0.024186 | 1.467112 | 0.1468 |
| DUM_93Q2 | 3.574944 | 0.667229 | 5.357896 | 0.0000 |

| | | | |
|---|---|---|---|
| R-squared | 0.502857 | Mean dependent var | 1.454898 |
| Adjusted R-squared | 0.481551 | S.D. dependent var | 0.916208 |
| S.E. of regression | 0.659701 | Akaike info criterion | 2.058477 |
| Sum squared resid | 30.46434 | Schwarz criterion | 2.183021 |
| Log likelihood | -72.16365 | Hannan-Quinn criter. | 2.108159 |
| F-statistic | 23.60155 | Durbin-Watson stat | 1.965496 |
| Prob(F-statistic) | 0.000000 | | |

| | |
|---|---|
| LTT_PIE_1Q_SA – | T&T Inflation (one quarter, seasonally adjusted by the authors) |
| LTT_RER_FD - | T&T real exchange rate change (first log-difference) |
| @MOVAV(variable,n) - | indicates moving average of n quarters |
| DUM_93Q2 - | Impulse dummy variable for 1993Q2 |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*5.7.2 IS curve*

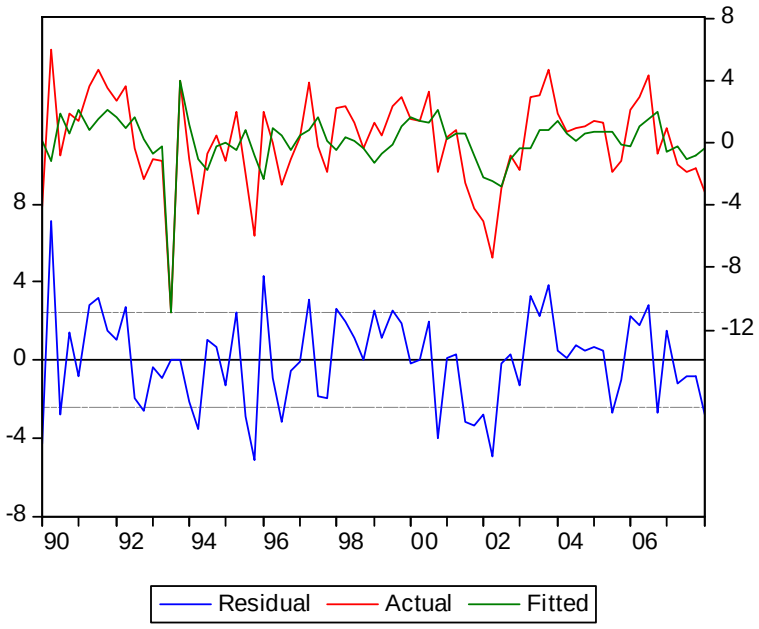
eq_is_ben

Dependent Variable: TT_Y_GAP
Method: Least Squares
Date: 12/09/08 Time: 11:28
Sample (adjusted): 1990Q1 2008Q1
Included observations: 73 after adjustments

| | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 0.062677 | 0.294290 | 0.212978 | 0.8320 |
| TT_Y_GAP(-1) | 0.370514 | 0.110114 | 3.364827 | 0.0013 |
| TOT_COM_OIL_PPI_GAP(-1) | 0.031261 | 0.019115 | 1.635449 | 0.1066 |
| DUM_93Q3 | -10.58444 | 2.482135 | -4.264247 | 0.0001 |
| DUM_93Q4 | 8.166591 | 2.765702 | 2.952809 | 0.0043 |

| | | | |
|---|---|---|---|
| R-squared | 0.354623 | Mean dependent var | 0.106989 |
| Adjusted R-squared | 0.316660 | S.D. dependent var | 2.975160 |
| S.E. of regression | 2.459398 | Akaike info criterion | 4.703745 |
| Sum squared resid | 411.3074 | Schwarz criterion | 4.860626 |
| Log likelihood | -166.6867 | Hannan-Quinn criter. | 4.766265 |
| F-statistic | 9.341203 | Durbin-Watson stat | 1.946329 |
| Prob(F-statistic) | 0.000004 | | |

TT_Y_GAP - T&T output gap
TOT_COM_OIL_PPI_GAP – Gap (estimated using an HP filter) of the proxy for the terms of trade – estimated as the ratio of oil (Texas) prices to US PPI. Note that an increase in that variable means better terms of trade.
DUM_93Q3 - Impulse dummy variable for 1993Q3
DUM_93Q4 - Impulse dummy variable for 1993Q4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## Appendix 6. Poole's Classical Analysis of the Monetary Policy Instrument Choice Problem

Poole's (1970) analysis of the choice of an interest rate or a monetary aggregate as the instrument of monetary policy is particularly informative in the case of a dollarized economy. In a dollarized economy, the demand for real money balances is very sensitive to domestic inflation (Obstfeld and Rogoff, 1996). Traditional concerns for the instability of monetary aggregates due to financial development and innovation are thus compounded by the higher inflation elasticity of money demand.[16] Under these circumstances, Poole's (1970) classical analysis suggests adopting a short-term interest rate as the instrument of monetary policy.

The logic of Poole's analysis is simple and compelling. Poole considered an economy in which the monetary policy instrument must be set before observing the current realization of the possible disturbances to the economy, a shock to money demand or a shock to real output. This is the realistic situation of a central bank that needs to set its instrument before observing the current value of inflation and output, which typically become available with some lag. He also assumed prices were fixed in the short term (the aggregate supply is elastic), and thus minimizing output volatility was the objective of monetary policy.

A simple example can illustrate the main point of Poole's analysis.[17] The example economy consists of an investment-saving equilibrium relation (IS curve), a money demand equation (MD), a money supply equation (MS), and an operating procedure to create money supply (OP). The operating procedure is such that, if the parameter $\mu = -1$ , the money supply is always zero ($m=0$). If $\mu$ is arbitrarily large, say infinity, the interest rate is always zero ($i=0$).
Thus, the following equations describe the example economy:

$$y = -i + u \quad \text{(IS)};$$
$$m = y - i + v \quad \text{(MD)};$$

[16] Monetary targeting was abandoned in most advanced countries at the beginning of the 1980s based on the traditional concerns for the effect of financial innovation on the stability of monetary aggregates. The interest rate targeting procedures earlier abandoned in advanced economies in the run up to the high inflation of the 1970s involved keeping a nominal interest rate constant for a protracted period of time. Unlike a typical Taylor rule under an inflation targeting regime, the interest rate targeting procedures of the 1970s were not responding systematically and appropriately to the state of the economy.

[17] The analysis can easily generalized to include shocks to the money multiplier, to the case of an economy with positive inflation, or the case of a small open economy (see Walsh, 2003, Chapter 9). The simple model above can be easily coded in DYNARE and appended to a standard New Keynesian model such as for instance the one used by Berg, Karam and Laxton (2006a and b).

$$m = b + i \qquad \text{(MS)};$$
$$b = \mu * i \qquad \text{(OP)}.$$

where b is monetary base.

The relative performance of the two alternative procedures depends on which shock dominates in the economy, or on the relative variance of the shocks if both nominal (v) and real (u) shocks are present. If nominal shocks dominate, as one would expect in a dollarized economy that is in a gradual disinflation process, then the interest rate-based procedure is superior. A procedure based on an interest rate instrument can accommodate money demand shocks, leaving output unchanged in this simple example, and hence would be more desirable (if u=0 and v=1, with $\mu = \infty$, i=0, y=0, m=1 and b=1). For the same shock configuration, a money-based procedure cannot accommodate money demand shocks, the interest rate must respond to such shocks to clear the money market, and as a consequence output fluctuates (for instance, if u=0 and v=1, with $\mu = -1$, m=0, i=y+1, and y = -0.5). If instead real shocks were to dominate, a money-based procedure would minimize output variability in this simple example. For instance, if u=1 and v=0, with b=-i, m=0, i=y, and y = 0.5; while with i=0, y=1, m=1, b=1.

## References


Berg, A., P. Karam, and D. Laxton. 2006a. "A Practical Model-Based Approach to Monetary Policy Analysis: Overview." IMF Working Paper 06/80. Washington, DC, United States: International Monetary Fund.

----. 2006b. "Practical Model-Based Approach to Monetary Policy Analysis: A How-to Guide." IMF Working Paper 06/81. Washington, DC, United States: International Monetary Fund.

Obstfeld, M., and K. Rogoff. 1996. *Foundations of International Economics*. Princeton, United States: Princeton University Press.

Poole, W. 1970. "Optimal Choice of Monetary Policy Instrument in a Simple Stochastic Macro Model." *Quarterly Journal of Economics* 84(2): 197–216.

Walsh, C. 2003. *Monetary Policy and Theory.* Second edition. Cambridge, United States: MIT Press.

## Appendix 7. Measuring Credibility

Credibility can be broadly defined and measured as the public's degree of confidence or uncertainty regarding the government's true policy objectives. Monetary or exchange rate policy credibility can thus be measured as the statistical or probabilistic distance between the policy outturns and the publicly announced policy targets.

A possible methodology to quantify such a definition of monetary or exchange rate policy credibility is proposed by Rebucci and Rossi (2006).[18] Focusing on inflation, the measure they propose is the difference between expected inflation and the inflation, normalized by the variance of expected inflation appropriately scaled. Thus, credibility = $(E\pi_t - T\pi_t)/ (SV\pi_t \text{ ^0.5})$, where $T\pi_t$ is the inflation target, $E\pi_t$ is the expected (unconditional) mean inflation at time t, $V\pi_t$^0.5 is the standard deviation of (unconditional) mean inflation.

The numerator of the ratio above quantifies the distance between expected inflation and the inflation target (i.e., it provides a signal on the direction and magnitude of the deviation of expectations from target). The denominator quantifies the uncertainty regarding such deviations (the noise surrounding the signal). For instance, a big deviation of expectations from the inflation target associated with high uncertainty may result in the same credibility level than a relatively smaller deviation with lower uncertainty. The measure is theoretically "perfect", when expected inflation is equal inflation target, at zero, and increases monotonically in the deviation of inflation expectations from the target. If desirable, the measure can be normalized to be an index approximately bounded between -1 and +1 (or bounded in absolute value between 0 and 1) by multiplying $V\pi_t$^0.5 by the appropriate integer scale S.

The procedure to compute $E\pi_t$ and $V\pi_t$ assumes that a representative agent "learns" in a Bayesian manner, knowing the econometric model of the inflation process, but with only beliefs (i.e., prior probability distributions) about its parameters. The agent updates these beliefs on the basis of realizations of the inflation process, to form posterior distributions of inflation and its characteristics. By manipulating these posterior distributions, a statistical or probabilistic measure of the distance between actual and target inflation, after each realization of the inflation process, can be computed.

[18] Rebucci, A., and M. Rossi, 2006, "Measuring Disinflation Credibility in Emerging Markets: A Bayesian Approach with an Application to Turkey's IMF-Supported Program," *Economics Bulletin* 6(11): 1-8. The RATS code is available on request from the authors.

To implement this procedure, three objects are needed: first, an inflation or exchange rate target; second, an econometric model of the disinflation process; and third, an estimation procedure to implement econometrically Bayesian learning about the inflation process and its characteristics. Given an inflation target range, it is assumed that inflation follows a simple AR(1) process: $\pi_t = \alpha + \beta\, \pi_{t-1} + e_t$, $e_t \sim N(0, \sigma^2)$, where $\alpha$ is the conditional mean of inflation, $\beta$ is the conditional persistence of temporary deviations from this mean, and $\sigma^2$ is the conditional volatility of the shocks producing these deviations. A different inflation process can obviously be considered.

The procedure focuses on the unconditional mean of inflation, given by $\pi = (\alpha/(1-\beta))$. The Theil's mixed estimator is used to update the posterior distributions of $\alpha$ and $\beta$, after each realization of the inflation process, thus providing for a very simple estimation procedure (see Rebucci and Rossi, 2006 for more details). For instance, given agents' prior on the model parameters at time T-1, say $\alpha(T-1)$ and $\beta(T-1)$, where T-1 is the month before the inflation target announcement, mixed estimation of the equation above over the sample period from T-S to T, where S is the fixed-length of the estimation window (24 months in our application), provides a posterior distribution of $\alpha(T)$ and $\beta(T)$. These posterior distributions can then be used as prior for T+1, and the posterior at time T+1 as prior at T+2, and so on. Given a sequence of posterior distributions, which are approximately normal if computed based on mixed estimation of the equation above, the approximate expected value and standard deviation of $(\alpha(T)/(1-\beta(T)))$ can then be easily computed, and hence our credibility measure described above.

Specifically, it can be shown that, for a given joint distribution of $(\alpha,\beta)$, the mean and the standard deviation of $\pi = g(\alpha,\beta) = (\alpha/(1-\beta))$, can be approximated as follows:

$$E\pi = E[g(\alpha,\beta)] \approx g(E\alpha,E\beta) + 0.5 \cdot V[\alpha] \cdot \partial^2 g(E\alpha,E\beta)/\partial\alpha^2 + 0.5 \cdot V[\beta] \cdot \partial^2 g(E\alpha,E\beta)/\partial\beta^2 + Cov[\alpha,\beta] \cdot \partial^2 g(E\alpha,E\beta)/\partial\alpha\partial\beta$$

$$V\pi = Var[(\alpha,\beta)] \approx V[\alpha] \cdot \{\partial g(E\alpha,E\beta)/\partial\alpha\}^2 + V[\beta] \cdot \{\partial g(E\alpha,E\beta)/\partial\beta\}^2 + 2Cov[\alpha,\beta] \cdot \{\partial g(E\alpha,E\beta)/\partial\alpha \cdot \partial g(E\alpha,E\beta)/\partial\beta\}$$

where $E\alpha$, $E\beta$, $V[\alpha]$, $V[\beta]$, and $Cov[\alpha,\beta]$ are the moments of the joint distribution of $(\alpha,\beta)$.