CBB Working Paper No. WP/15/8

IS THERE A ROLE FOR INDEPENDENT MONETARY POLICY IN BARBADOS?

BY

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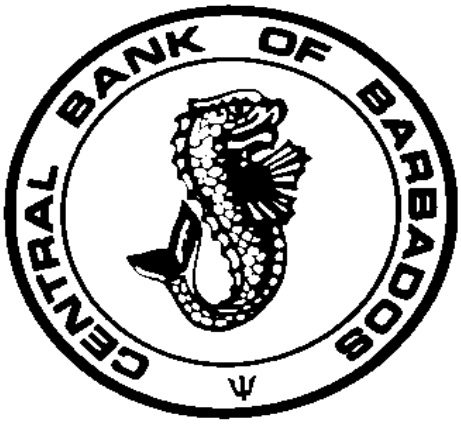

CENTRAL BANK OF BARBADOS

Is there a Role for Independent Monetary Policy in Barbados?

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July 2015

ABSTRACT

Conventional monetary theory holds that a country can only possess one nominal anchor in the long run. With an open capital account, the country must decide between an exchange rate target or independent monetary policy. The latter implies inflation targeting with a benchmark interest rate reacting to output gap, inflation gap and possibly a macro-prudential variable. This paper addresses this question in the context of Barbados by exploring a novel channel of the transmission mechanism. We argue that shocks to the foreign exchange constraint engender dynamic changes in bank assets, bank liquid assets, aggregate output and price level. Therefore, an examination of the transmission mechanism in small economies requires that the foreign exchange constraint be taken into account. There is tentative evidence that the Treasury bill rate in Barbados could serve as a benchmark reacting to shocks in the foreign exchange market. The Treasury bill rate could help to smooth the flow of foreign exchange through the Barbadian foreign exchange market. Seen in this light, the benchmark rate allows for a dual, but secondary anchor, in support of the primary exchange rate target. Once this interest rate is determined in the primary Treasury bill market, and not in a flexible yield secondary market, the monetary authority can minimize the domestic debt burden associated with the benchmark. Moreover, imperfectly competitive buyers of Treasury bills can purchase in bulk and still make profit at a lower interest rate, thereby reducing the debt burden.

1. INTRODUCTION

This paper explores how monetary policy works in Barbados. It observes that the central bank's accumulation of foreign exchange reserves over time is fundamental in determining liquidity levels in the banking system and has implications for an interest rate benchmark. Targeting the level of foreign exchange for maintaining credibility in the exchange rate anchor is at the centre of monetary management (Blackman 1998, Worrell 2012). Moreover, short-term domestic interest rate fine tuning could also be useful after the central bank accomplished its foreign exchange objective. This perspective is often down played given the dominance of the inflation

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targeting framework, which assumes only one nominal anchor. Inflation targeting implies the central bank has an interest rate instrument which it changes in anticipation of the inflation gap and output gap – the popular Taylor rule (Taylor 1993). Here the central bank adjusts the benchmark interest rate and uses open market operations to steer cash reserves in line with the target benchmark rate. In the inflation targeting approach, the central bank adjusts interest rate in line with market agents' expectation of inflation. In the exchange rate targeting framework, the central bank has to manage foreign exchange reserves consistent with expectations of market agents operating in the domestic or localized foreign exchange market. In the long-term the accumulation of foreign exchange reserves injects cash reserves into the domestic banking system.

Outside the United States – especially small open economies – countries experienced a different history regarding the evolution of the money market. Historically there has not been a large enough home-grown class of traders and speculators in securities[4]. Given the limited pool of private traders of securities, commercial banks assume the mantle to buy Treasury bills, and buy and sell foreign exchange. Other institutional investors and the central bank also purchase Treasury bills, as in the case of Barbados. With increasing concentration in commercial banking globally, it means the interest rate of financial assets – and even the bid-ask spread in the localized foreign exchange market – is determined in imperfectly competitive markets (Khemraj 2014). History and imperfect markets imply monetary policy is likely to operate differently in small emerging and developing economies.

The interest rate which seemingly operates as a benchmark rate works as part of a compensation mechanism in which the monetary authority buys Treasury bills from the central government and offloads them to commercial banks as in Guyana and Trinidad and Tobago. The transactions are often always one sided whereby the central bank almost always sells Treasury bills to commercial banks, hence a possible explanation for the excess liquidity phenomenon found in developing countries. In Barbados the central bank bids just like the commercial banks for the Treasury bills from central government, indirectly influencing the interest rate on the asset. In each example, the central bank can exercise considerable control over the formation of the Treasury bill interest rate. This interest rate acts as a rate of compensation for commercial

[4] This has never been a problem for the United States which had a large class of traders and financial speculators the Federal Reserve could turn to in 1913 to conduct money market interventions (Mehrling 2011).

banks and other institutional investors to hold domestic sovereign securities instead of foreign financial assets. Furthermore, what appear to be open market operations is likely a system of compensation of commercial banks because of the excess reserves injected into the banking system when the central bank accumulates foreign exchange reserves (Khemraj 2009). The persistent foreign exchange constraint requires the monetary authority to incentivize domestic investors to hold domestic assets.

This paper studies monetary policy in Barbados by looking at the issue from two directions. First, a series of predictability tests (often called causality tests) are conducted for the purpose to studying the dynamic feedback relationships among several variables, particularly the relationship between central bank's foreign reserves, broad money supply and asset allocation of commercial banks. Second, a vector autoregression model is used to examine how several endogenous variables respond over time given a shock to: (i) central bank's foreign reserves and (ii) compensation (interest rate shock). The compensation shock is identified using the Treasury bill interest rate. The compensation shock is interpreted as independent monetary policy shocks. We also study how aggregate demand and supply respond to these two shocks.

The paper is organized as follows. Section 2 briefly reviews pertinent literature. Section 3 gives the historical and institutional context of Barbados' monetary policy. Section 4 presents stylized facts that include predictability or causality tests. Section 5 presents a dynamic analysis of the two shocks. Section 6 presents a theoretical analysis to interpret the result of section 4. Section 7 concludes.

2. RELATED LITERATURE

Conventional wisdom has it that central banks utilize monetary policy to reduce fluctuations in aggregate output and prices. The task can be implemented by either targeting a monetary variable (Williams 2005) or through management of a benchmark interest rate target (Ceccheti 2000). Although indirect or market based monetary policy appears to be the holy grail, Worrell (1997) indicates several direct instruments such as moral suasion, changes in the discount rate, commercial bank reserve requirements, the setting of deposit and loan rates, credit limits and interventions in the Treasury bill auctions. Exactly how monetary policy impulses feed through to aggregate prices and output has been the study of a large literature on transmission

mechanisms. Mishkin (1995) summarizes the main transmission channels that are most pertinent to the advanced economies with well-developed flexible yield secondary markets.

A more recent comprehensive review of the literature on how monetary policy works in developing economies was done by Mishra and Montiel (2013). The latter authors found limited effectiveness of monetary policy in low income countries. They attribute this outcome to failure of studies to consider "facts on the ground" and methodological deficiencies. Excess bank liquidity is also proffered as a potential factor weakening monetary policy in developing economies (Saxegaard 2006). However, Khemraj (2014) notes that excess liquidity is a normal part of the transmission process if we view monetary policy as working through a compensation system that involves defending an exchange rate anchor. Khemraj also shows mathematically that excess liquidity can reduce the volatility of bank asset portfolios, while Moore (2007) shows empirically that excess liquidity reduce the severity of banking crises.

Exchange rate targets are often seen with a heavy dose of skepticism. For example, Obstfeld and Rogoff (1995) note that small economies will often face speculative attacks and the exchange rate anchor is just a mirage. Often an inflation target with flexible exchange rate is seen as the preferred policy stance. The idea of the trilemma notes that with capital mobility, a fixed exchange rate regime results in endogenous money supply. In other words, monetary policy is not independent as the central bank must exercise some control over interest rate or a monetary aggregate. Nevertheless, Caribbean economists have been preoccupied by this question. Moore and Williams (2008) note that even in fixed exchange rate economies independent monetary policy can be implemented once monetary impulses affect the financing cost of firms. These costs are hypothesized to feed through to wages and employment. Khemraj (2006) argues that minimum mark-up interest rates by commercial banks add a non-zero lower bound threshold to interest rate formation that is unrelated to a liquidity trap. This mark-up interest rate threshold prevents offsetting capital flows owing to monetary policy in exchange rate targeting economies with open capital accounts.

The management of foreign exchange reserves becomes central to the implementation of an exchange rate target. Ganga (2001) looks at the case of Guyana, while Worrell et al. (2011) do the same in the Barbadian case. Delivering her *Adlith Brown Memorial Lecture*, Williams (2005) underscores various dimensions of foreign exchange reserve management, including the need to intervene to smooth flows of foreign currencies and the opportunity costs of holding reserves.

She also discusses the political economy context of foreign exchange reserve management and the importance of foreign reserves as a signal of credibility in the pegged exchange rate. As a result, the establishment of operational guidelines is essential for foreign exchange management by the monetary authority as economies with a binding foreign exchange constraint must hold reliable levels of international reserves for seasonal and cyclical variations in foreign currencies in the market (Blackman 1981, Edwards 1988).

3. STYLIZED FACTS

This section analyses how central bank international reserves interact with several asset components of aggregate commercial bank balance sheet, broad money, price and GDP. Table 1 presents the findings of Granger causality tests that are obtained from bivariate autoregressive distributed lag models. The estimates are done with quarterly data from 1990:Q1 to 2014:Q4. Using standard unit root tests the variables were found to be I(1)[5]. Therefore, the ARDL models were estimated in first differences to make them stationary. The lag selection criteria suggest one lag model. One lag is used when interpreting the results of the predictability test at all levels of significance. These results are suggestive and intended as a first indicator for obtaining general patterns among the variables; hence, we call them stylized facts. The variables are define as RES = commercial banks reserves, LIQ = liquid assets held by commercial banks (typically Treasury bills), IR = Central Bank of Barbados foreign exchange reserves, GDP = real GDP, Price = the price level and CP = commercial bank credit to the private sector. The symbol Δ indicates the first difference operator.

One of the consistent findings is the unidirectional causality from IR to RES at 5% level of significance (row 1 of Table 1). This makes sense since when the central bank accumulates foreign exchange reserves it injects domestic currency reserves into the banking system. This mechanism, we argue, is at the centre of the excess liquidity phenomenon in developing economies. Excess liquidity reflect the foreign exchange constraint and the need for the central bank to hold sufficient foreign currency reserves to bring credibility to the peg. Broad money (M) and IR are surprisingly not related as the hypotheses of no causality cannot be rejected in both cases (row 2). This implies that the funds are held as excess reserves given the

[5] The variables were consistently stationary in first differences under all tests – Augmented Dickey Fuller, Phillips Perron and KPSS.

accumulation of foreign reserves. Therefore, the commercial banking system may possess a discernible liquidity preference function as was documented for other countries in Khemraj (2014, 2006).

The lack of any predictability between RES and credit to the private sector (CP) underscores this notion of a bank liquidity preference function. As the liquidity preference curve

Table 1 Causality or predictability tests

Row	Null Hypothesis	One lag F-Stat.	P-val.
1	Δ(RES) does not Granger Cause Δ(IR)	0.045	0.833
	Δ(IR) does not Granger Cause Δ(RES)	5.336	0.023**
2	Δ(M) does not Granger Cause Δ(IR)	1.426	0.236
	Δ(IR) does not Granger Cause Δ(M)	0.345	0.559
3	Δ(CP) does not Granger Cause Δ(IR)	0.043	0.836
	Δ(IR) does not Granger Cause Δ(CP)	0.385	0.536
4	Δ(PRICE) does not Granger Cause Δ(IR)	5.115	0.026**
	Δ(IR) does not Granger Cause Δ(PRICE)	0.960	0.330
5	Δ(GDP) does not Granger Cause Δ(IR)	1.924	0.169
	Δ(IR) does not Granger Cause Δ(GDP)	0.088	0.767
6	Δ(M) does not Granger Cause Δ(RES)	1.182	0.280
	Δ(RES) does not Granger Cause Δ(M)	0.154	0.696
7	Δ(CP) does not Granger Cause Δ(RES)	0.330	0.567
	Δ(RES) does not Granger Cause Δ(CP)	0.092	0.762
8	Δ(PRICE) does not Granger Cause Δ(RES)	1.404	0.239
	Δ(RES) does not Granger Cause Δ(PRICE)	3.400	0.068*
9	Δ(M) does not Granger Cause Δ(LIQ)	1.649	0.202
	Δ(LIQ) does not Granger Cause Δ(M)	0.026	0.873
10	Δ(CP) does not Granger Cause Δ(LIQ)	5.300	0.024**
	Δ(LIQ) does not Granger Cause Δ(CP)	2.534	0.115
11	Δ(PRICE) does not Granger Cause Δ(LIQ)	3.689	0.058*
	Δ(LIQ) does not Granger Cause Δ(PRICE)	1.939	0.167
12	Δ(GDP) does not Granger Cause D(LIQ)	6.669	0.011**
	Δ(LIQ) does not Granger Cause Δ(GDP)	9.791	0.002
13	Δ(CP) does not Granger Cause Δ(M)	0.280	0.598
	Δ(M) does not Granger Cause Δ(CP)	0.778	0.380
14	Δ(PRICE) does not Granger Cause Δ(M)	0.617	0.434
	Δ(M) does not Granger Cause Δ(PRICE)	0.100	0.753
15	Δ(GDP) does not Granger Cause Δ(M)	0.006	0.939
	Δ(M) does not Granger Cause Δ(GDP)	0.459	0.500
16	Δ(GDP) does not Granger Cause Δ(CP)	1.438	0.234
	Δ(CP) does not Granger Cause Δ(GDP)	1.542	0.217

Significance levels: ***- 1%, **- 5%, *-10%

becomes flat, the banks demand reserves elastically thereby not stimulating lending. The latter finding implies excess reserves do not result in loan creation (row 7). Moreover, this finding was observed previously by Worrell (1997) and Khemraj (2007) also found an insignificant response in private sector credit given a shock to excess bank reserves in the case of Guyana.

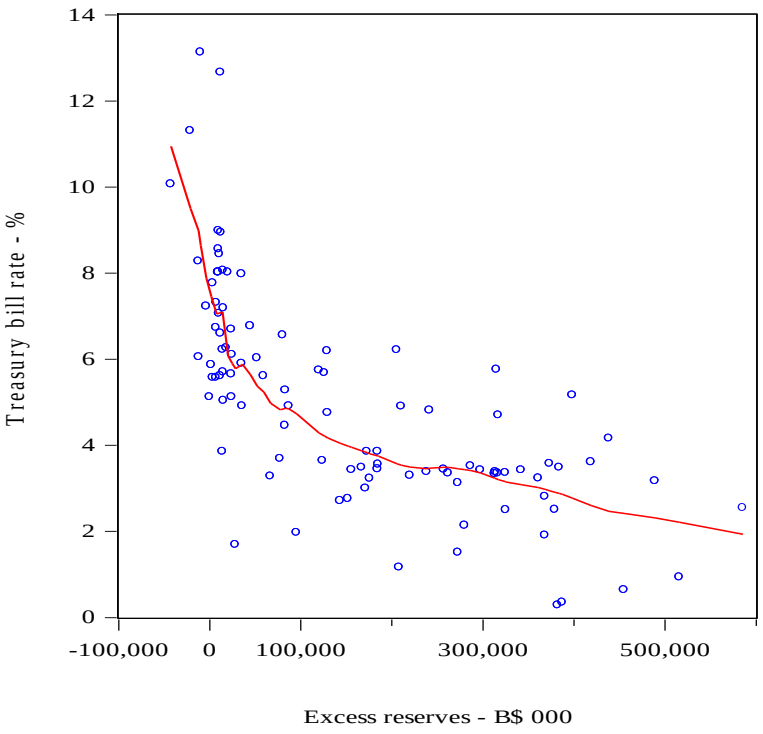
Interestingly, the existence of unidirectional causality from RES to PRICE (at 10% significance level, row 8) implies excess reserves are not working through the classic base money multiplier principle as outlined in money and banking textbooks. Excess reserves possibly work through third or fourth variables. There is no relationship between loans to private sector (CP) and bank deposits, the main component of broad money (row 13) when one lag is considered. A long standing tradition in Post Keynesian economics establishes there should be a stronger relationship between loans and deposits (see, for example, Pollin 1991). Further empirical work for the Caribbean is needed to test the money endogeneity hypothesis against the bifurcated loanable funds market thesis. Khemraj (2014) proposes the hypothesis that a bifurcated loanable funds market will involve high loan-deposit rate spread, excess liquidity and interest rate mark-up pricing.

There is little evidence indicting causality from LIQ to broad money (row 9). Regardless, we should keep a close eye at LIQ, the amount of sovereign liquid assets held by commercial banks. This asset and its rate of interest are central to the working of monetary policy in several small open developing economies. We have already observed that IR determines excess reserves. In that light, the liquid assets can be seen as a compensation system for introducing a new profit centre for commercial banks given that the central bank's accumulation of foreign reserves reduces the amount of foreign exchange the private sector has at its disposal. A unidirectional causality was observed between LIQ and CP (row 10) at 5% significance level. PRICE is statistically significant in predicting LIQ at the 10% level, thereby suggesting that inflation elicits a response on compensation through liquid assets held by the private sector. This relationship indicates some kind of a reaction of LIQ to inflation.

Two other stylized facts consistent with the idea that the stock of foreign exchange reserves is the leading variable in the Barbados economy is given by a simple single equation co-integration test between IR and GDP. The co-integration equation is estimated by fully modified OLS and the typical ADF unit root test is conducted on the residual of the long run equation, which is found to be GDP = 197,986 + 0.052IR. The t-statistics on both coefficients are in excess

of 9 for the slope and intercept, thus indicating strong statistical significance. The Engel-Granger tau static = -3.14 (p-value = 0.09) and the Engel-Granger Z-statistic = -32.64 (p-value = 0.002); therefore, providing some tentative evidence of a long run relationship between GDP and international reserves.

Figure 1 Bank liquidity preference curve



Evidence of a compensation mechanism should at least be consistent with a long-term or co-integrating relationship between RES and LIQ. As noted above, the central bank has to maintain a certain level foreign currency reserves. The co-integrating relationship above suggests a positive relationship between real GDP and IR. Since accumulating foreign reserves removes from the stock of foreign exchange that could be available to the private sector, the domestic government liquid assets serve as a replacement so that banks and private investors have another opportunity to invest instead of foreign currency assets. The following co-integrating equation estimated by fully modified OLS was found between RES and LIQ: RES = -150,080 + 0.27LIQ. The t-statistics on the intercept and slope coefficients, respectively, are -3.36 and 7.18. Both test statistics allow for rejecting the null hypothesis of no co-integration. The Engel-Granger tau-statistic = -4.22 (p-value = 0.005) and Engel-Granger Z-statistic = -111.67 (p-value = 0.000).

Therefore, we can conclude a long-term relationship exists between non-remunerated excess reserves and interest-earning liquid assets.

The accumulation of foreign reserves is a main channel through which cash reserves enter the banking sector. When the central bank buys foreign exchange cash reserves enter the system. On the occasions foreign reserves are depleted, excess reserves decline. These changes represent supply shifts along a relatively stable bank liquidity preference function in Treasury bill-excess reserves space (Figure 1). The bank liquidity preference curve is derived from a scatter plot using locally weighted least squares with a smoothing parameter of 0.3. At high interest rate the curve is steep indicating a greater willingness of banks to exchange reserves for the Treasury bills. However, at lower interest rates the trade-off becomes less active as the elasticity tends towards perfect elasticity, suggesting eventual perfect substitutability between excess reserves and liquid assets. Moreover, as the curve reaches an asymptote it indicates a minimum rate of interest at which compensation could realistically take occur. At rates above the minimum threshold, the curve suggests substitution from excess reserves to liquid assets.

4. INSTITUTIONAL AND HISTORICAL CONTEXT

This section examines several institutional and historical features of Barbados' monetary policy frameworks. Barbados heavily depends on direct interest rates to conduct their monetary policy with supporting instruments of moral suasion, commercial banks cash reserves and security requirements, credit controls and advances and rediscounts. The Central Bank of Barbados has an arsenal of policy options from which it can implement. The key function of the central bank's policy, apart from maintaining their fixed exchange rate, is to influence the interest rate and overall excess liquidity of the banking system. Over the period 1975 to 1993, the Central Bank of Barbados implemented credit controls through the establishment of legislation, credit ceilings on distributional and personal sectors, concessions and exemptions in order to manage credit demand in the economy. However, after 1993, credit controls became a dormant policy instrument and credit flows has been left to its own mechanisms to equilibrate. Other policy options like cash reserves, security requirements and interest rates play a more active role in Barbados' monetary policy stance.

Cash and security requirements, unlike credit controls, are still used by the monetary authority. At inception, the central bank required that commercial banks hold 1% Treasury bills

and 2% cash reserve ratio of their total deposit liabilities. Over the years the minimum limits required have been continually adjusted to achieve policy outcomes. In early 2001, the securities requirement converged into one single security ratio so that the distinction between Treasury bill or debenture holdings was rendered ineffective. At that time the stipulated government securities was 19% of domestic deposits, which was reduced to 10% in 2010.

The bank has used a combination of an interest rate ceiling on lending and minimum rate on savings deposit accounts. In addition, special rates to key productive sectors were instituted and the bank maintained a rediscount rate offered to commercial banks. The interest rate indicator used primarily by the central bank over the last decade was minimum savings deposit rate. Changes to the minimum savings rate communicated to the market the sentiments of the bank's policy direction. The rediscount rate also moved but more so, as a reflection of the consistency of the central bank's policy.

A major shift in the banks' interest rate policy tool occurred in April 2013, when the bank adopted the three month Treasury bill rate as the benchmark indicator. One rationale for the switch is to smooth the process of adjusting domestic interest rates in response to changes in foreign rates to minimize the potential losses in international reserves (Worrell et al. 2012). Historically, the Barbados Treasury bill rate correlates closely with the corresponding United States Treasury bill rate. Therefore, the central bank rationalizes the local T-bill rate should be in line with the US T-bill rate with a small margin to account for country risk and liquidity conditions. The spread between the Barbados and US Treasury Bill Rates which has been typically no more than 200 basis points widened to 300 basis points in the wake of the Global recession. The unusually high spread remained unaffected by the introduction in April 2013 of a new central bank policy of influencing interest rates through intervention in the Treasury bill market. However, recently the T-bills have declined marginally by 80 basis points. The central bank's intervention in the T-bill auction is intended to communicate incrementally to the market the central bank's sentiments on where short end interest rates should be. The market is expected to factor in this reality when pricing longer term instruments.

Participation in the Treasury bill market has drastically increased over the decades. Institutions such as the Commercial Banks have monopolized the treasuries market from the 1970's to present day, initially holding 17% in 1973, over 90% between 2001 and 2004 and 61% of Treasury bills by the second quarter of 2015. The Central Bank has been increasing its

holdings Treasury bills since their announcement with the intention of influencing interest rates in 2013. Their holdings have gradually increased from about 8% to 17% (see Figure 2). At the same time, commercial banks excess liquidity has grown significantly. By convention high liquidity leads to a downward pressure on the Treasury bill interest rate. Commercial banks were somewhat lower bounded because of its implicit cost of funds stipulated by the 2.5% minimum interest rate on the savings deposit.

Figure 2: Institutional holders of Barbados Treasury bills

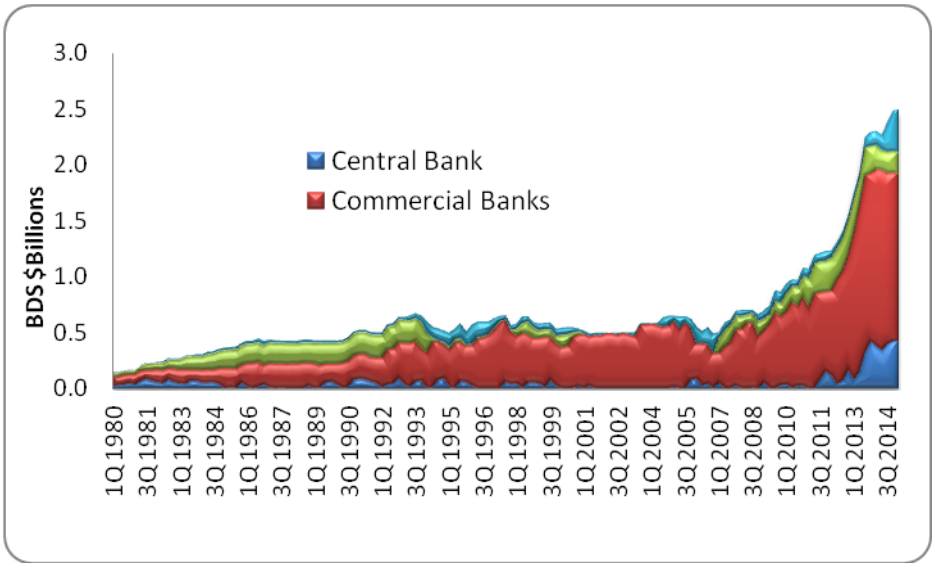
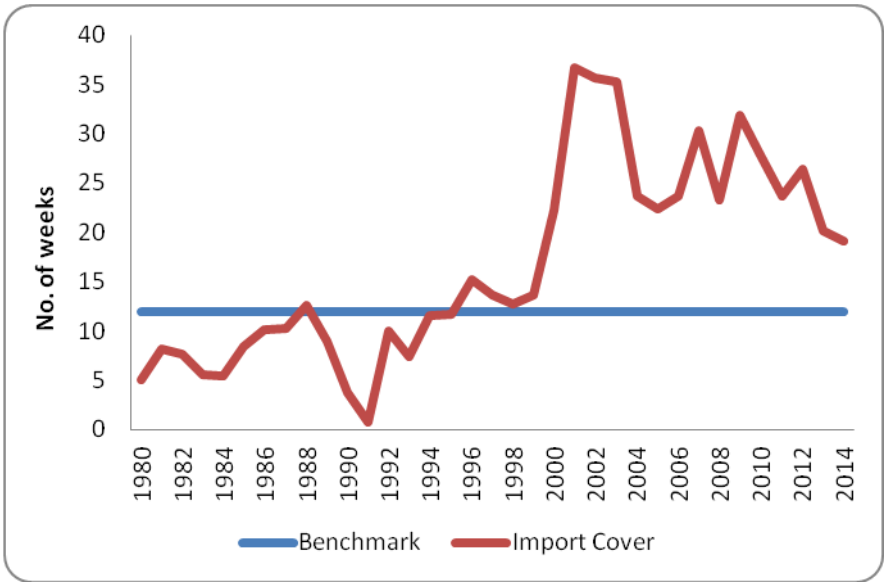


Figure 3: Barbados Import Cover



As a fixed exchange rate country, import cover is a primary indicator of the economy's health (Blackman 1981, Ganga 2001). The benchmark level of foreign reserves is twelve weeks of import cover. The accumulation of international reserves above the benchmark is essential for the maintenance of the anchor, as market players in a sense interpret this metric as the distance to devaluation. From Barbados' contemporary monetary history, we have seen the collapse of the import cover from 12.6 weeks in 1988 to less than one week by 1991. Significant expenditure cuts and other adjustments were made by the policy makers to avert the imminent devaluation. The foreign exchange constraint remains a binding constraint for the small open economy with an exchange rate peg. Policy implementation and analysis is therefore underpinned by this reality and must be carefully considered in the effective management of the economy. Figure 3 shows the evolution of import cover relative to the benchmark since 1980.

5. MULTIVARIATE ANALYSIS

The next stage in the analysis is to examine the dynamic effects on excess reserves, credit to private sector, broad money supply, GDP and price level given a one standard deviation shock to central bank foreign exchange reserves and compensation. The model can be written as

$$Y_t = \Theta_0 + \Theta_1 Y_{t-1} + e_t \qquad (1)$$

Where $Y_t = (IR, RES, TB, GDP, CP, PRICE, M)'$ is a (7 ×1) vector of endogenous variables, comprising central bank's stock of foreign reserves (*IR*), excess reserves held by commercial banks (*RES*), Treasury bill rate (*TB*), real gross domestic product (*GDP*), credit to private sector (*CP*), price level (*PRICE*) and broad money (*M*). Since the variables were found to be I(1) using standard unit root tests, each variable is entered into the VAR in first differences. Θ_0 is a (7 ×1) parameter vector, while Θ_1 is a (7 ×7) parameter matrix. e_t is a (7 ×1) vector of error terms.

There are seven structural shocks, which include international reserves shock (ε^{ir}), excess reserves shock (ε^{res}), compensation or monetary policy shock (ε^{tb}), aggregate demand shock (ε^{gdp}), credit shock (ε^{cp}), aggregate supply shock (ε^{price}) and broad money shock (ε^{cp}). Independent monetary policy is measured by the shock to the Treasury bill rate (*TB*). Conventional wisdom as enshrined in the idea of the trilemma says that a fixed exchange rate economy such as Barbados with open capital account cannot pursue an independent monetary policy. Therefore, it would be interesting to observe what the data finds. It is however likely that

the shocks to international reserves will dominate as Barbados is an economy operating within the confines of a foreign exchange constraint (Worrell et al. 2012).

The reduced form errors are related to the structural shocks through equation 2. We did not estimate a VECM because the multivariate Johansen-Juselius co-integration test did not uncover a co-integrating vector. Therefore, we are going to focus on short-term dynamic interaction among the variables.

$$e_t = B\varepsilon_t \qquad (2)$$

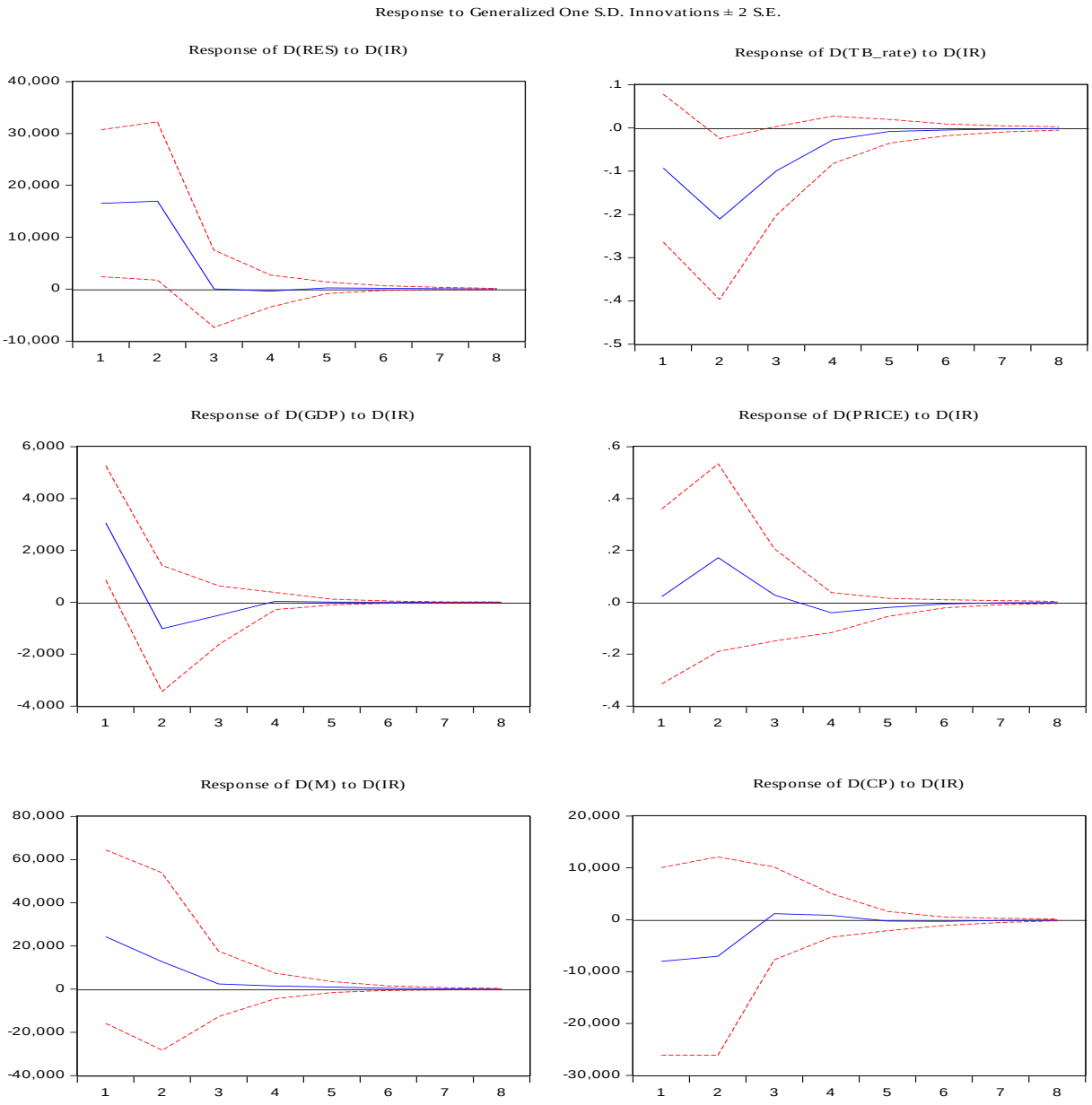
Where $\varepsilon_t = (\varepsilon^{ir}, \varepsilon^{res}, \varepsilon^{tb}, \varepsilon^{gdp}, \varepsilon^{cp}, \varepsilon^{price}, \varepsilon^{m})'$ and B is a (7×7) matrix whose elements are $B^{i,j}$ for $i \in \{IR, RES, TB, GDP, CP, PRICE, M\}$ and $j \in \{\varepsilon^{ir}, \varepsilon^{res}, \varepsilon^{tb}, \varepsilon^{gdp}, \varepsilon^{cp}, \varepsilon^{price}, \varepsilon^{m}\}$. The model could be identified by Choleski ordering as given, for example, by the ordering of the variables above. However, we will use the method of generalized impulses so as to remain agnostic with respect to restrictions to the contemporaneous coefficients (Pesaran and Shin 1996). The results below are robust over various institutionally relevant Choleski ordering. By institutional relevance we mean features consistent with the Barbadian economy. For example, *IR* always takes precedence in the contemporaneous coefficient restriction. This emphasizes the notion of a foreign exchange constraint and the necessity to manage same.

RES comes immediately after given that reserves are injected following the accumulation of foreign reserves. Monetary policy follows next. The impulse responses are robust in light of different ordering of *GDP*, *CP*, *PRICE* and *M*. Therefore, we feel the generalized impulse response functions are sufficient for studying the dynamics of shocks emanating from foreign reserves and monetary policy. The optimal lag length of the VAR appears to be two lags; nevertheless, the impulse response functions are stable over the lags 1, 2, 3 and 4 quarters. Because of the loss of degrees of freedom, we rely on a VAR with one lag. The Dickey-Fuller and Phillips-Perron unit root tests indicate that the variables are stationary in first difference; therefore, the VAR is estimated in first differences .The model was found to be stationary as indicated by the fact that the inverse characteristic roots lie inside the unit circle. The estimation is conducted using quarterly data from 1990:Q1 to 2014:Q4.

Figure 4 shows the response of *RES*, *TB* rate, *GDP*, price level, *CP* and *M* given a one standard deviation shock in central bank's stock of *IR*. The first point to observe is *RES* responds

positively to a positive shock in *IR*, a result consistent with expectation since cash reserves are injected when the central bank accumulates foreign currency reserves. The Treasury bill rate

Figure 4 Impulse response functions showing response to IR shock



responds negatively to the same shock confirming the classic liquidity effect – the negative relationship between reserves and interest rate – as shown by Figure 1. The result further suggests that the monetary authority can ease off on the compensation interest rate when

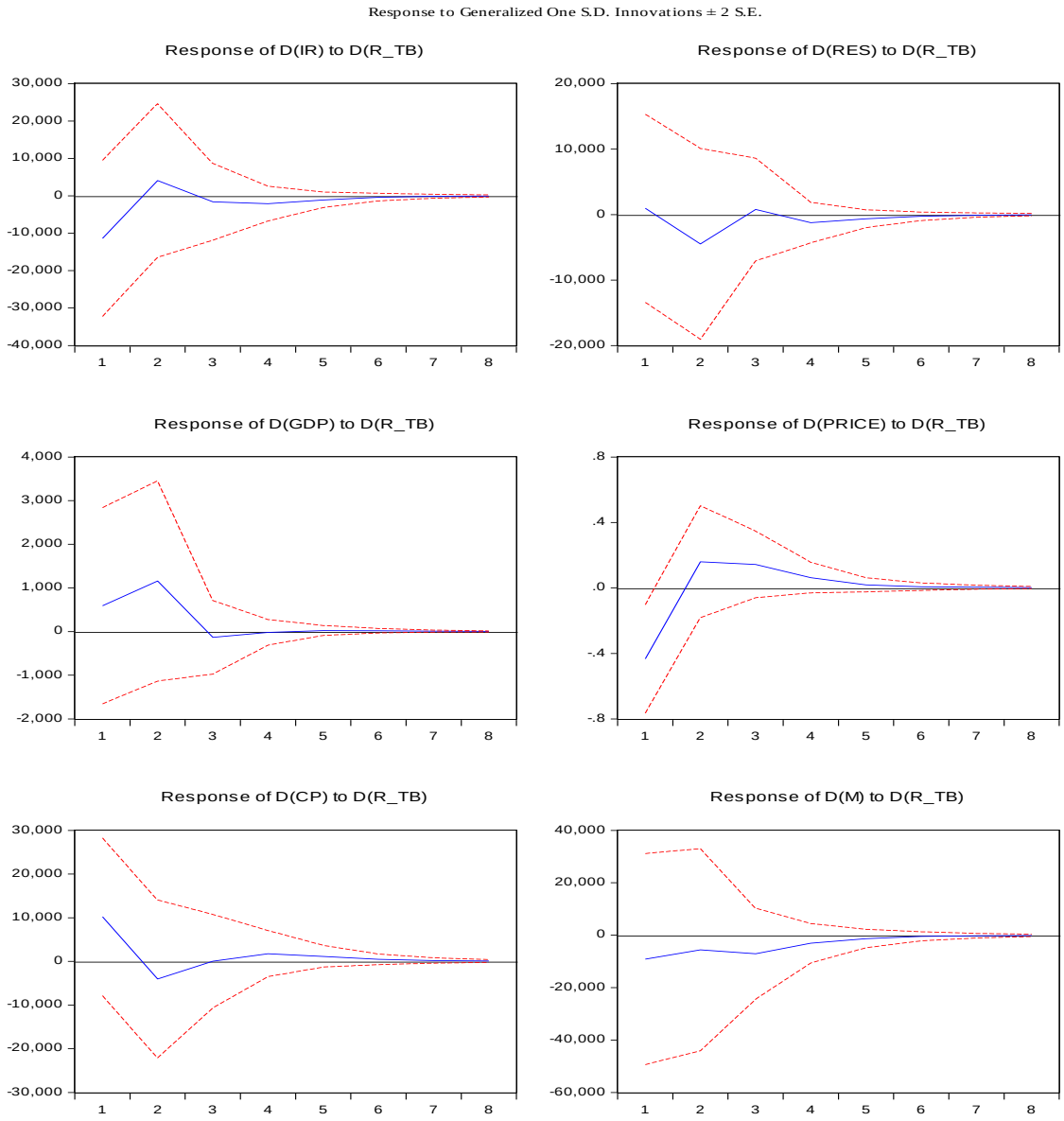
international reserves increase owing to a positive favourable shock. *GDP* responds positively to the *IR* shock and changes to negative after the second quarter. It moves back to equilibrium in four quarters. The same positive *IR* shock engenders a small positive increase in the price level that increases up to the second quarter and moves back towards equilibrium after three quarters.

Broad money increases and moves back towards equilibrium in three quarters. However, it is interesting to note that credit to the private sector (*CP*) responds negatively and reaches equilibrium in three quarters. Therefore, accumulation of foreign reserves essentially generates excess liquidity, suggesting that the liquid banking system is a function of the structural and institutional features of an open economy operating within the foreign exchange constraint. Volatility measures of uncertainty may determine excess liquidity in the short-term; however, excess liquidity is fundamentally a product of the structure of financial arrangements in a foreign exchange constrained economy.

The results given in Figure 5 require some interpretation of the dynamic patterns of *IR*, *RES, GDP, PRICE, CP* and *M*. One of the features is the anticipatory nature of the interest rate variable. In other words, there is tentative evidence that the domestic Treasury bill rate is beginning to serve as a form of benchmark rate. First, the positive shock of the rate (what we call the compensation shock) is associated not with an inflow of capital that would increase the level of *IR*, but is associated with a negative response of *IR*. This implies interest rate increase is associated with a decline in the foreign exchange reserves, hence the anticipatory nature of the interest rate policy. Second, the one standard deviation compensation shock is associated with a small positive then negative response in RES implying the liquidity effect Note also how this result corroborates the previous one. The decline in central bank's international reserves would reduce cash reserves in the banking system.

Third, higher interest rate results in a positive response of *GDP*, which goes back toward equilibrium after three quarters. On the surface this is counterintuitive since higher interest rate should reduce consumption and investment as the conventional wisdom has it. However, this is a compensating interest rate meant mainly for stabilizing the foreign exchange market and offering banks an alternative asset in which to invest instead of foreign assets, which would drain the market of foreign exchange. This rate is unlikely to have an impact on bank lending, thus consumption and investment. Therefore, the positive response in *GDP* could be indicating this alternative transmission channel of monetary policy that works through stability in the localized

Figure 5 Impulse response functions showing response to interest rate shock



foreign exchange market. Fourth, the price level responds negatively and moves back towards equilibrium after two quarters. Fifth, credit to the private sector responds positively given the positive shock to interest rate. This finding possibly corroborates with the positive response in *GDP* that increases the demand for credit. CP moves back towards equilibrium after two quarters. Finally, broad money responds negatively and moves back to equilibrium after five quarters. The negative result is consistent with a liquidity effect taking place at the broad level of money.

6. THEORETICAL ANALYSIS

The empirical analysis above suggests a connection among foreign exchange reserves of central bank, asset allocation of commercial banks and the real economy. This section presents a theoretical model connecting the foreign exchange market and reactive interest rate policy in light of shocks to the foreign exchange market. We assume that interest rate policy reacts to changes in the foreign exchange (FX) market, rather than lead outcomes in the said market. The FX market is at the centre of economic life in Barbados. A system of dealers buys and sells foreign currencies and the central bank only intervenes when there is need to stabilize the flow of foreign currencies consistent with the declared peg (Worrell et al. 2011).

Before we can present a model showing general equilibrium, it is useful to examine the foreign exchange market at the theoretical level. In this market expectation adjusts quickly. Essentially, we are making the assumption that participants in this market can access information and make necessary adjustments quickly before other members in the society. The idea of rapid expectation adjustments is illustrated by the vertical line along which expected exchange rate (e^E) is equal to the central bank's anchor or pegged rate (e^A). These features are indicated by Figure 6. The line is vertical at a level of foreign exchange that constrains the economy's long run capacity to grow. This quantity can be defined as

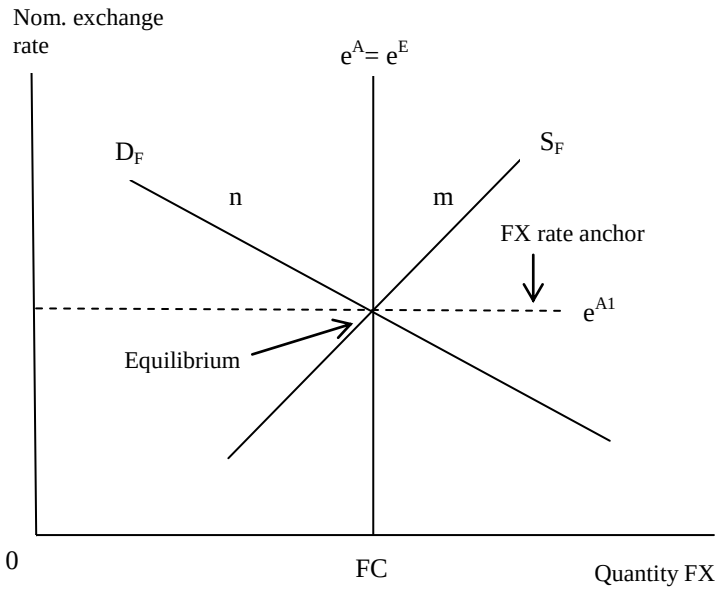
$$FC = FXR - ND \tag{3}$$

FC represents the stock of foreign exchange available to the economy that can be used for supporting imports of capital goods, intermediate goods and other forms of imports. A subset of this quantity is the central bank's stock of foreign reserves (*FXR*) and the market's net demand (*ND*). A positive net demand (a shortage) causes the constraint to tighten. A negative net demand (a surplus) causes the constraint to be less binding or to loosen. When the constraint loosens it shifts outward and in the process anchors a new set of supply and demand curves. The constraint, therefore, operates as the long-term anchor in the market. The supply and demand curves are short-term and they can shift around the constraint. On the other hand, when the constraint tightens it shifts inward and in the process anchors a new set of supply and demand curves. As usual, the supply of foreign exchange is upward sloping while the demand is downward sloping. The market is in equilibrium at the foreign exchange anchor e^{A1}.

A change in expectation causes the constraint to tighten or loosen. In other words, expectation determines adjustments in the FX market. For example, an outward shift in the

demand curve, say to point *m* on the supply curve (Figure 6), implies market expectation of a devaluation exceeds the central bank's target exchange rate ($e^E > e^A$), given that there is a positive *ND*. The central bank has to intervene to shift supply curve until it intersects with the anchor. When this intervention occurs, the *FC* line shifts inward because of the fall in *FXR* and the positive *ND*. An inward shift in the demand curve has exactly the opposite effect. Here market expectation of an appreciation grows ($e^E < e^A$). In other words, there is more confidence in the peg. Here the central bank is able to accumulate *FXR* and the net demand is now negative. An inward shift in the supply curve to, for example, point *n* on the demand curve will see expectation of devaluation take hold ($e^E > e^A$). This means the central bank will lose foreign reserves as it intervenes and there is positive net demand. The FC line will shift inward taking with it a new set of supply and demand curves. A positive shock to the supply curve has the opposite effect of shifting the FX constraint or frontier outward.

Figure 6 The FX market in equilibrium



Aggregate output (*Y*) is determined by the following production function

$$Y = AF(K,L) = AK^{\alpha}L^{\beta} \qquad (4)$$

As in the standard assumption, $\alpha + \beta = 1$. The stock of gross capital is assumed to be linearly related to the stock of the FX constraint. The parameter (θ) determines how efficiently the stock of foreign exchange is transformed into physical capital (*K*). A low θ could indicate more foreign

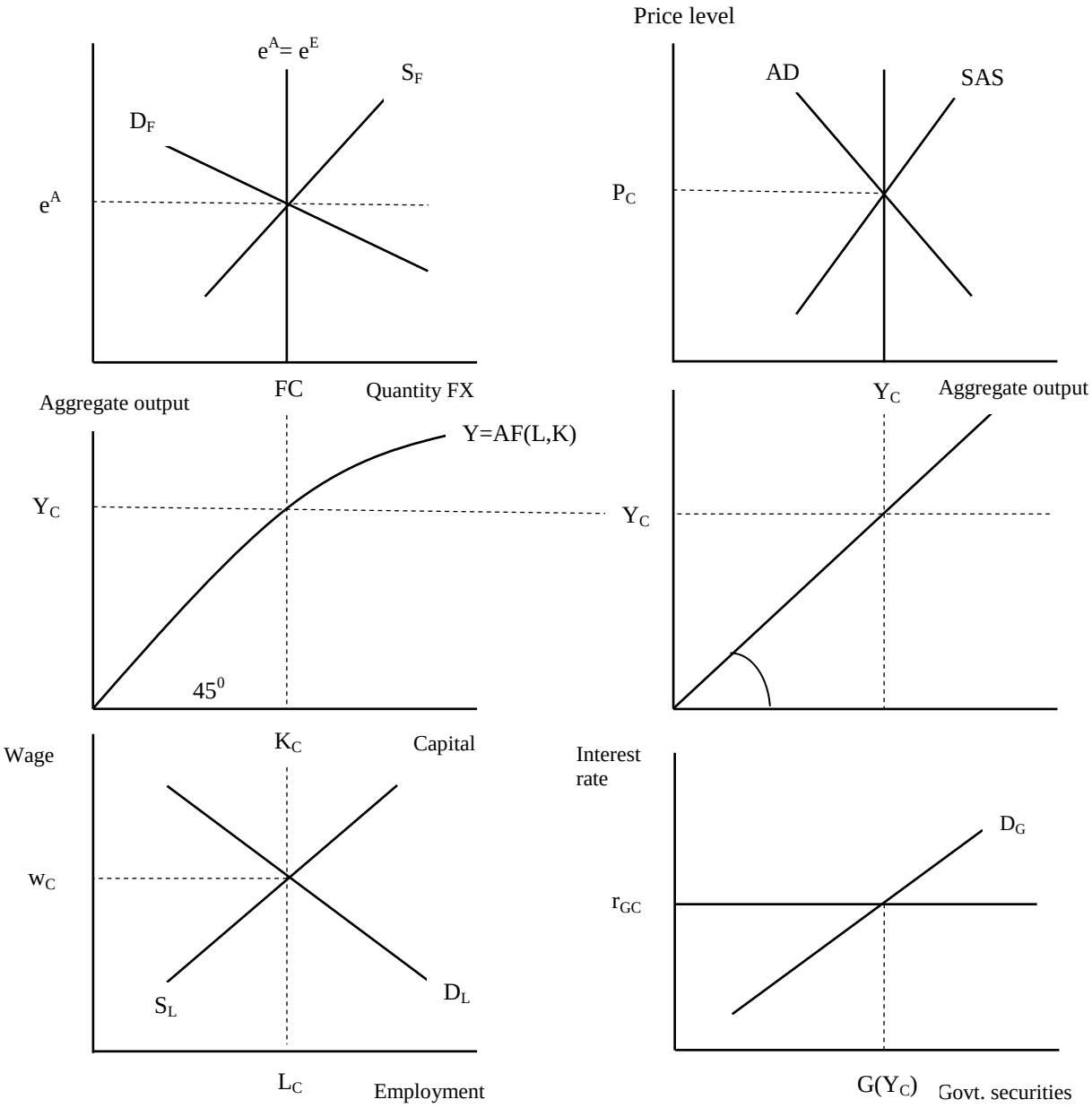
exchange goes into consumption, while a higher θ indicates a higher utilization for capital accumulation.

$$K = \theta FC \tag{5}$$

Figure 7 shows a simple general equilibrium model linking the foreign exchange market, labour market, aggregate output, price level and the level of interest rate used for compensation. The first panel shows the foreign exchange market in equilibrium. At equilibrium market expectation is in line with the central bank's target exchange rate and the foreign exchange constraint is in a state of rest. In equilibrium, K_C is the level of capital associated with FC as given by equation 5. This level of K_C produces Y_C aggregate output and allows for L_C number of workers to be employed at wage w_C (the second and third left panels, respectively). The wage bill is therefore $w_c L_c$ and the capitalists earn the triangle above the wage bill. The price level consistent with the FX constraint is P_C (top right panel). An upward sloping supply curve for labour is assumed. However, the model can be easily adjusted to consider surplus labour (a flat labour supply curve) as in Lewis (1954).

The bottom right panel shows the market for government securities. The rate of interest at which the authorities compensate is given by r_{GC}. The authorities have the power to sell bonds at said rate and therefore the effective supply curve is a horizontal line at r_{GC}. This rate can operate as a form of response function. The commercial banks and other institutional investors obtain government securities at the said rate. Their demand curve is represented by D_G. The quantity of securities consistent with the existing aggregate output – itself consistent with the existing FX constraint – is given by the expression $G(Y_C)$. Notice the way the Treasury bill market is written implies the market is purely competitive. However, this may not be the case. If any institutional buyer has monopsony power, the compensating interest rate will be lower. These ideas are explored theoretically by Khemraj (2014). At the level of intuition, a monopsony buyer can afford to purchase Treasury bills at a lower interest rate and still make a profit by large scale purchase. Therefore, r_{GC} could be a lower interest rate than the purely competitive rate, which is assumed for analytical tractability.

Figure 7 General equilibrium model for an FX constrained economy



The empirical analysis above tends to indicate that interest rate policy is reactive to conditions in the foreign exchange market. Therefore, a shock to *FC* would eventually require an interest rate response. So, for example, a negative shock in the FX market requires an increase in the compensating interest rate and an increase in the amount of Treasury bills sold. However, the latter depends on the size of the elasticity of demand for the government security. On the other hand, a positive shock to *FC* implies the central bank can ease off on the rate of interest at which

it bids. These responses are different from the typical analysis relating to the advanced economies which do not operate under a stringent FX constraint.

The case of a tightening FX constraint

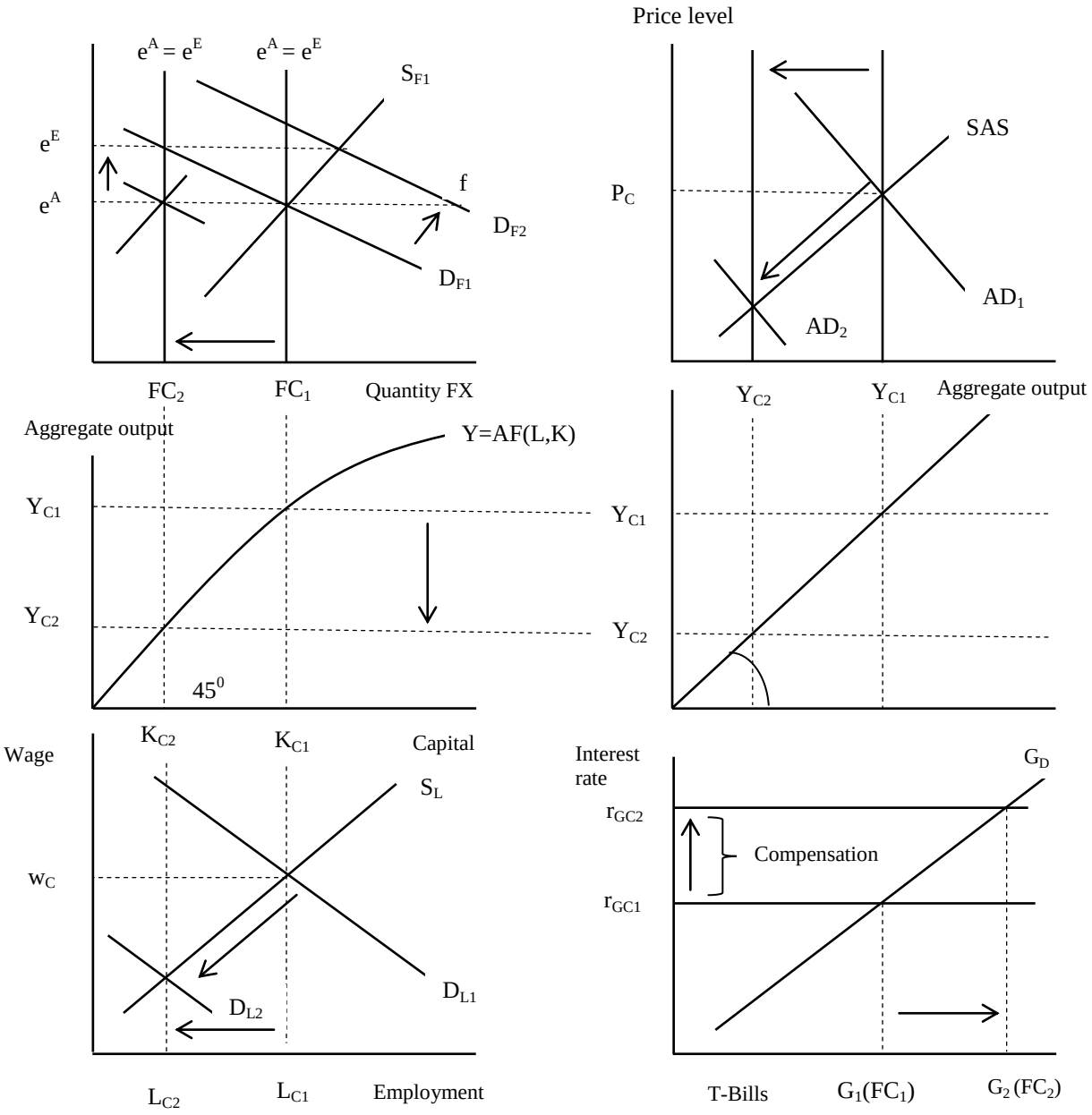
Let us assume a positive demand shock – indicated by an outward shift in the demand for foreign exchange – in the FX market. The model could easily be used to demonstrate the effects of negative demand shocks, which is a favourable outcome as the economy is saving hard currencies. The negative demand shock would make the FX constraint less binding. The positive demand shock may occur because of a sudden increase in the demand for foreign currencies owing, for example, to higher oil price requiring more foreign exchange or a substantial increase in wages of public workers. To simplify the analysis we must assume only one shock occurs – an outward shift in the demand for foreign exchange that would occur by a deterioration of terms of trade (Figure 8). The analysis starts from the foreign exchange market. The demand shifts outward from D_{F1} to D_{F2} causing an initial diversion in market expectation from the fixed peg ($e^E > e^A$). If the central bank wants to restore confidence and maintain the peg it has to increase supply of hard currencies in the FX market. It will have to shift the market supply curve outward until point *f*. However, doing so means the central bank loses foreign reserves. Moreover, when $e^E > e^A$ the market's net demand is positive. This implies that the foreign exchange constraint will shift inward from FC_1 to FC_2, thus indicating a tightening of the constraint.

Following equation 5, there is a movement downward along the production function as there is a decline in capital accumulation from K_{C1} to K_{C2}, at the specified foreign exchange constraint. Aggregate output declines from Y_{C1} to Y_{C2}. In the labour market this leads to an inward shift in the demand for labour from D_{L1} to D_{L2} because less labour is required for working with a smaller stock of capital. Employment falls from L_{C1} to L_{C2}. This mechanism is similar to Lewis (1954). Aggregate demand will also contract given the potential output associated with the new foreign exchange constraint declines from Y_{C1} to Y_{C2}. Aggregate demand shifts inward from AD_1 to AD_2.

The monetary authority responds by increasing the supply of Treasury bills and compensating at a higher interest rate, which increases from r_{GC1} to r_{GC2}. The level of governments securities sold consistent with the previous FX constraint and output is $G_1(FC_1)$. This monetary intervention increases when the constraint shifts inward giving a new level

$G_2(FC_2)$. Note that $G_1(FC_1)$ and $G_2(FC_2)$ are functional operators showing the Treasury bill sales consistent with a specific level of the constraint.

Figure 8 Compensation given a positive FX demand shock



This analysis indicates that the small open economy operating in a FX constraint is caught between a rock and a hard place. On the one hand, negative shocks to the FX constraint require central bank's intervention by selling government securities to private investors. The compensating interest rate helps to make domestic securities relatively more attractive to foreign

assets. Therefore, the policy helps to ease the pressure in the FX market already buffeted by a negative shock. On the other hand, the policy of compensation through an interest rate reaction framework has implications for debt sustainability (Moore and Skeete 2010). As noted above, the cost of compensation will depend on the degree of competition among the buyers of the securities. If they are large institutional investors with monopsony buying power, the large scale purchases imply they can still make a profit with a lower interest rate. Smaller investors in a purely competitive market will require higher interest rates to make profits.

7. DISCUSSION AND CONCLUSION

Our analysis tentatively suggests a role for monetary policy as a mechanism of stabilizing the foreign exchange market in the short run using an interest rate benchmark. This role involves smoothing out the flow of hard currencies around the pegged exchange rate given changes in market expectation. Monetary policy would tend to play a more short-term role. In the long-term, the credibility of the peg depends on prudent fiscal policy and debt sustainability. If there is going to be an interest rate rule as part of the monetary policy apparatus it will not be in the shape of the classic Taylor rule, whereby the benchmark interest rate reacts to an output gap and inflationary gap. Instead, a benchmark interest rate could be utilized as a mechanism to stabilize the flow of hard currencies given changes in FX market expectations. In FX constrained small open economies, in the long run, output and inflation are more a function of the foreign currency constraint rather than being determined by monetary shocks expressed in a Taylor rule. Indeed, the theoretical model presented herein carries this feature. Therefore, the interest rate benchmark is more reactive to foreign exchange market conditions while the standard mainstream New Keynesian framework has the Taylor rule at the centre of analysis.

The interest rate benchmark in the Barbadian and Caribbean context would not be defended by classic open market operations as the conventional money and banking textbooks have it. Rather the interest rate policy is promoted through a system of compensation which can sometimes be confused for open market operations (OMO). OMOs have two sides – at times the central bank buys Treasury bills to inject cash reserves and in other moments the monetary authority sells sovereign securities to drain excess reserves. Compensation mainly takes the form of sales of sovereign liquid assets at a benchmark interest rate intended to compensate private institutional investors when the central bank accumulates foreign reserves that inject liquidity

into the system. Compensation could also be relevant in times of acute shortages of hard currencies in the domestic FX market.

This process ostensibly has been given a purely monetarist interpretation in Guyana and several small open economies in Africa. It is often assumed that Treasury bills are sold to mop up excess reserves. The monetarist interpretation holds that non-remunerated excess reserves engender loan expansion. Our empirical findings and previous research indicate this is not the case. Our approach argues Treasury bills are sold to compensate for the fact that the economy faces a long-term FX constraint. Moreover, it is this process that accounts for the structural excess liquidity in the banking system of much of the developing world. The long-term trend of excess liquidity cannot be determined by short-term volatility measures such as a GARCH estimate or a variance. The trend is structural and is determined by the fact that a central bank has to accumulate foreign reserves consistent with an expanding economy to have a comfortable number of months of import cover.

The closest thing to open market operations in the Caribbean takes place in the foreign exchange market when the central bank either buys or sells foreign currencies to smooth the flow of foreign exchange around a targeted exchange rate. Here, the smoothing does not take place around a targeted interest rate, but a targeted flow of foreign currencies consistent with maintaining an exchange rate anchor. These transactions occur at different periods on the buy and sell sides of the market. The asset used is not Treasury bills but foreign currencies that exchange for local currency units, bank reserves or bank deposits. These interventions have implications for the asset allocations and liquidity preference of commercial banks. They also influence the portfolio holdings of other large oligopolistic institutional investors like insurance companies and monopolistic pension funds. We argue that shocks to central bank reserves also have implications for output and price level fluctuations. A theoretical model was presented to explain the mechanisms through which this may occur.

One issue pertaining to central bank's monetary policy is debt management. An interest rate rule – for example, responding to the flow of hard currencies in the FX market – could have adverse implications for debt management, primarily domestic debt. This problem can become more acute in purely competitive secondary Treasury bill markets. However, the authorities have more control of the interest rate target in the primary market where the bill is sold for the first time. There is very little development of secondary bond markets in the Caribbean whereby

yields respond flexibly to changes in industry and macroeconomic conditions. Therefore, the secondary market is not the problem for a policy of compensation. Debt burden cost may rise for the government when the monetary authority decides to increase the compensating interest rate in times of tightening of the FX constraint. In purely competitive markets, the bid interest rate would likely be higher because each trader is small and therefore needs a higher price to make profits. However, the banking system is oligopsonistic and therefore is likely to be able to purchase Treasury bills in larger quantities at lower interest rates while still making a profit. The pension fund is a monopsony. Such imperfect competition among the buyers implies the central government and central bank can dampen the interest cost associated with an interest rate rule using the Treasury bill rate.

Traditional theories in open economy macroeconomics indicate that a country cannot have an open capital account, an exchange rate target and an independent monetary policy such as an interest rate rule. This is the classic trilemma. On the surface, our analysis appears to be leaning against the trilemma given the de facto openness of the capital account in Barbados. To begin, moral suasion always allows the central bank some autonomy and independence. The interest rate policy in the primary market of Treasury bills with monopsony buyers can also grant this independence even with de facto capital mobility and an exchange rate anchor. In addition, a foreign exchange constraint adds friction in the market that prevents the smooth substitutability between foreign securities and domestic ones. For example, a commercial bank may not obtain all the hard currencies it needs on the spot to invest in foreign financial assets. Therefore, it is up to the central bank to alter preference of the commercial banks by offering them another profit making opportunity in domestic securities in the primary market where interest rate is not a flexible market yield that can escape the control of the monetary authority.

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