

# **Excess Liquidity, Oligopoly Banking and Monetary Policy in a Small Open Economy**

**By**

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## **Abstract**

This paper examines why non-regulated commercial banks in Guyana demand non-remunerative and remunerative excess liquidity. The paper breaks from past studies by proposing two hypotheses that work simultaneously to explain the excess liquidity phenomenon. Firstly, banks desire a minimum rate of interest in the loan market and the government security market before investing in private sector loans or government securities, respectively. The minimum rate is derived from a Cournot oligopoly model. Hence, this is termed the *minimum rate hypothesis*. Secondly, banks do not invest all excess reserves in a safe foreign asset because the central bank maintains an unofficial *foreign currency constraint* (in the domestic foreign currency market) by accumulating international reserves. The results of this paper point to another way of looking at the monetary transmission mechanism for a small open developing economy.

**Key words:** minimum rate hypothesis, oligopoly banking, foreign currency constraint, excess liquidity, monetary policy, Guyana.

JEL Classifications: O16, O23, O54

## 1. Introduction

The purpose of this paper is to explain why non-regulated commercial banks demand excess liquid assets – both remunerative and non-remunerative liquidity – in a small open economy, Guyana, which has undergone significant financial reforms. The framework, however, is general enough to be applicable to other small open developing countries that have liberalized their financial system, interest rate determination, and capital flows. Excess liquidity is defined as total commercial bank liquid assets minus

required liquid assets. The required ratio is set by the central bank. Some aspects of excess liquidity are remunerated; namely domestic government securities. However, excess bank reserves in Guyana are not remunerated. Despite the fact that banks do not earn interest on reserves, they hold large quantities of the asset in excess of the required amount; and despite the fact banks can earn more on making loans to private agents, they choose to hold government securities in excess of the required level.

The literature on the demand for excess bank reserves in developing countries is very sparse. The few papers that have examined the excess liquidity phenomenon in developing countries have relied on the classic reserve management model as outlined by Baltensperger (1980; 1973), Frost (1971), and Morrison (1966). As outlined in those papers, the model is more applicable to the advanced economies, or more specifically to the United States. More recently Agenor, Aizenman, and Hoffmaister (2004) extended this model in order to derive a testable empirical demand function for excess liquidity in Thailand. Their primary objective was to decipher whether the curtailment of bank credit in Thailand after the Asian financial crisis was consistent with a credit crunch. Saxegaard (2006) extended the empirical model of Agenor, Aizenman, and Hoffmaister (2004) to include a vector of variables that account for “involuntary” excess reserves in the Central African Economic and Monetary Community (CEMAC), Nigeria and Uganda<sup>1</sup>. In another paper, Fielding and Shorthand (2005) estimated an autoregressive distributed lag (ARDL) model of excess liquidity for Egypt. Political violence was found to be an important determinant of excess liquidity in Egypt. Caprio and Honohan (1993)

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<sup>1</sup> According to Saxegaard (2006) several variables that account for involuntary reserve accumulation include inflows of foreign aid, newfound oil revenue, weak demand for bank loans (resulting from high loan rates), and government deposits in commercial banks.

proposed two reasons why banks might demand excess liquidity. Their explanation, however, went beyond the classic reserve management model. They proposed the credit rationing hypothesis and money overhang hypothesis<sup>2</sup>.

This paper proposes *two* different hypotheses that conspire to cause banks to demand large quantities of excess liquidity over several years in spite of the far-reaching economic reforms that commenced in 1988. Commercial banks in Guyana demand a minimum rate of interest before they make loans to households and firms and purchase the domestic government security. Hence, it is called the *minimum rate hypothesis*. However, given the fact that there is no official exchange control regime, why would profit maximizing banks – which refuse to lend or buy government securities over certain range of the respective interest rate – also refuse to invest all non-remunerative excess reserves in a counterpart bank in New York or buy the relatively safe US Treasury bills<sup>3</sup>? This puzzle is explained by postulating the existence of an unofficial foreign currency constraint in the interbank foreign exchange market. The paper will demonstrate that the level of excess reserves is highly correlated with the surplus or deficit of US dollars traded in the domestic foreign currency market. Moreover, the paper will demonstrate that the central bank enforces the constraint by accumulating international reserves. Hence, this paper deciphers another channel of the monetary transmission mechanism in

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<sup>2</sup>Caprio and Honohan (1993) noted that the money overhang hypothesis is more applicable to former planned economies in which there was a period of goods rationing in the commodity market. Credit rationing, on the other hand, is likely to occur in both advanced and developing countries.

<sup>3</sup> One aspect of the literature uses the transaction costs argument to explain the home bias that exists in international portfolio choice. This theory is not directly related to the banking firm and in most cases it is applied to equity portfolios. Using a mean-variance framework, Lewis (1999) demonstrates that an investor can achieve higher returns and lower risk by holding an internationally diversified equity portfolio rather than a portfolio comprising 100 percent US stocks. Yet the investor chooses a portfolio in which domestic equities predominate. Lewis explains this tendency by introducing transaction costs to the mean-variance portfolio model. However, it is unlikely that there will be substantial transaction costs involved when purchasing US Treasury bills or investing in deposits in a foreign counterpart bank.

a small open developing economy. To maintain price stability, the central bank buys up the US dollars that are traded in the local market. By enforcing the unofficial foreign currency constraint, the monetary authority forces the commercial banks to hold excess reserves rather than US dollar assets. Stability in the nominal exchange rate is maintained, and so too is price stability.

In spite of the enforced foreign currency constraint, however, commercial banks do not necessarily make loans to the private sector because of the desired minimum rate. The minimum interest rate in the loan and government bond market is derived from a Cournot oligopoly model of the banking firm. This framework is labeled by Freixas and Roche (1999) as the industrial organization approach to banking. The model traces its origin to the work of Klein (1971). In the loan market, the minimum rate can be derived as a mark-up over transaction costs, market-specific risks, and a suitable exogenous reference rate. In the government security market, it is derived as a mark-up over the exogenous reference rate and market-specific risks. Already, it would be noted that the commercial banks do not take the domestic government security rate as given, as is typical in Klein (1971), Slovin and Sushka (1983), and by Prisman, Slovin and Sushka (1986). In Guyana, as is the case in other small economies, the purchase of the domestic government security is dominated by a few large institutional investors. Hence, the market is oligoposonistic. Banks, therefore, face an upward sloping supply curve for the government paper. In addition, the derived theoretical pricing equations can be used to study the effectiveness of indirect monetary policy<sup>4</sup> that is applied to developing countries around the world by the International Monetary Fund (IMF).

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<sup>4</sup> Alexander et al (1995, p. 2) define direct versus indirect monetary policy instruments. Direct instruments set or limit prices (interest rates) or quantity (credit). The quantity-based direct instruments often place

An important piece of background information is the fact that the Guyanese financial system has undergone significant reforms since 1988. For instance, loan and deposit rates are no longer controlled, but are determined freely by the banks (or the market). Similarly, credit is no longer rationed by government nor is it directed to priority sectors. All banks were privatized and foreign banks are allowed to invest in the local economy. The capital account has been fully liberalized and the exchange rate regime shifted from a fixed to a flexible regime<sup>5</sup>. Inflation has been curtailed and averages in single digit after the reforms. Monetary policy uses indirect instruments such as open market operations. The indirect policy operates on the reserve position of the banking system since excess reserves is assumed to engender changes in bank credit and bank investments in foreign assets.

The paper takes the following format. Section 2 argues why there is need for a model that can represent the observed minimum rate tendency. The oligopoly banking model is presented in section 3. This section derives the mark-up pricing equations for the loan, deposit, and government security markets. Section 4 uses the derived equations to perform several comparative static exercises. This section examines the potency of monetary policy under conditions of excess liquidity and market power. Section 5

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restrictions on commercial banks' balance sheet. Indirect instruments, in contrast, operate through the market by influencing the demand and supply conditions of commercial bank reserves. Embedded within the IMF's financial programming framework is the view that the reserve position of the banking system determines bank credit and broad money supply, a view that was labeled by Meigs (1962) as the reserve position theory.

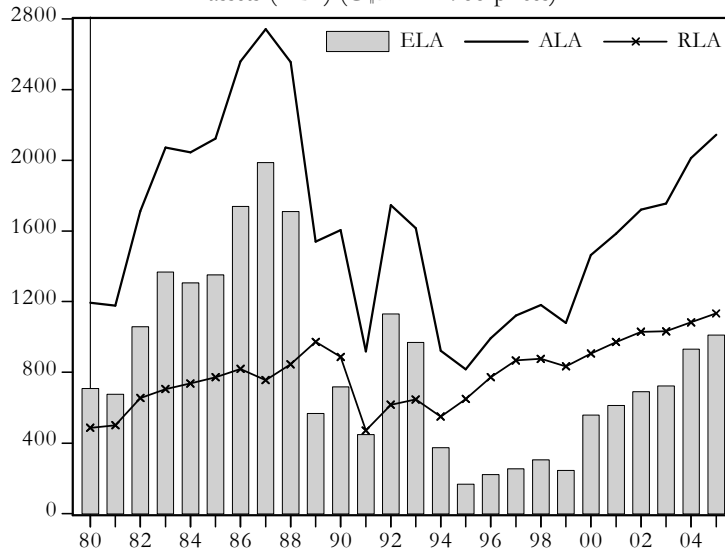
<sup>5</sup> In 1991 the Guyanese authorities merged the parallel foreign currency market with the official market. Since then there has been no misalignment between the official rate and the "street" rate. The exchange rate is determined freely by market traders in foreign currencies – mainly commercial banks and other authorized non-bank traders who must obtain a license from the central bank. The Guyanese central bank (the Bank of Guyana) defends the rate by accumulating foreign currency reserves. On several occasions the central bank sells from its reserves. However, most times it must buy United States dollars and other currencies from the local market since the domestic currency is not convertible in the main international financial centers.

performs an econometric analysis of the determinants excess reserves. Section 6 outlines an alternative view of the monetary transmission mechanism. Finally, section 7 concludes.

## 2. Why a Minimum Rate?

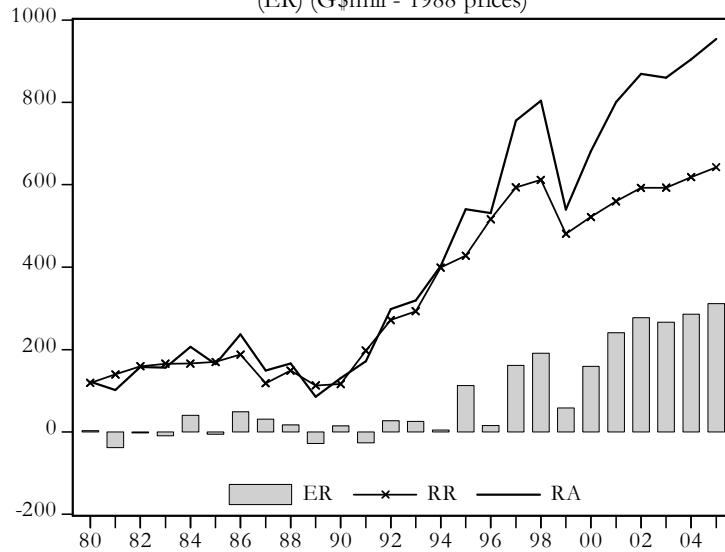
The two figures below show the extent of the excess liquidity phenomenon in Guyana. Fig. 1 presents actual or total liquid assets (ALA), required liquid assets (RLA) and excess liquid assets over the period 1980 to 2005 (in constant local dollars). After the year 1988 when significant financial reforms were introduced, the level fell precipitously, but increased again continually (since 1995) on account of the new monetary policy framework which focuses on mopping up excess reserves with domestic government securities – namely Guyana Treasury bills. Fig. 2 documents non-remunerative excess reserves (ER) (in constant local dollars) over the period 1980 to 2005. The figure shows that excess reserves are a post-reform phenomenon, which expanded steeply after 1995. As at the end of 2004, Guyana's banking system held a total of G\$22,623 million (in nominal terms) in excess liquidity, while at the end of 2005 that number increased to G\$26,615 million representing 14.4 percent and 16.9 percent of GDP, respectively.

Fig. 1: Actual (ALA), required (RLA), and excess liquid assets (ELA) (G\$mill - 1988 prices)



Source: Bank of Guyana Statistical Bulletin

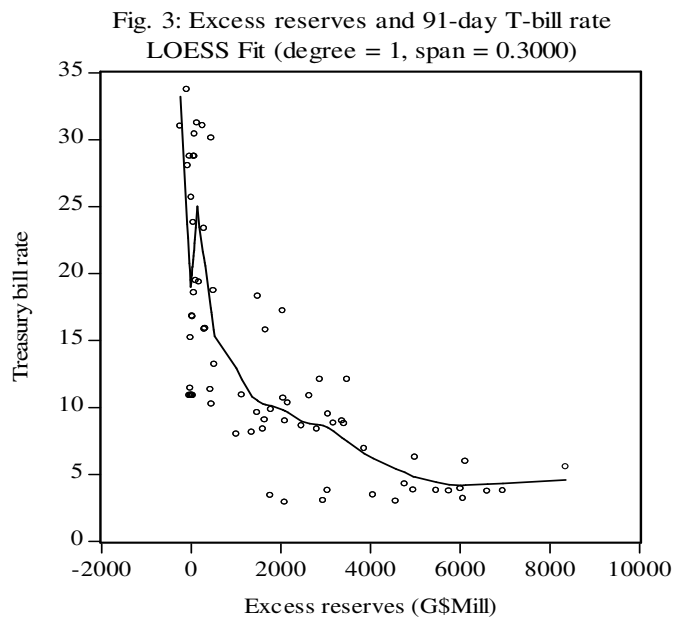
Fig. 2: Actual (RA), required (RR), and excess reserves (ER) (G\$mill - 1988 prices)

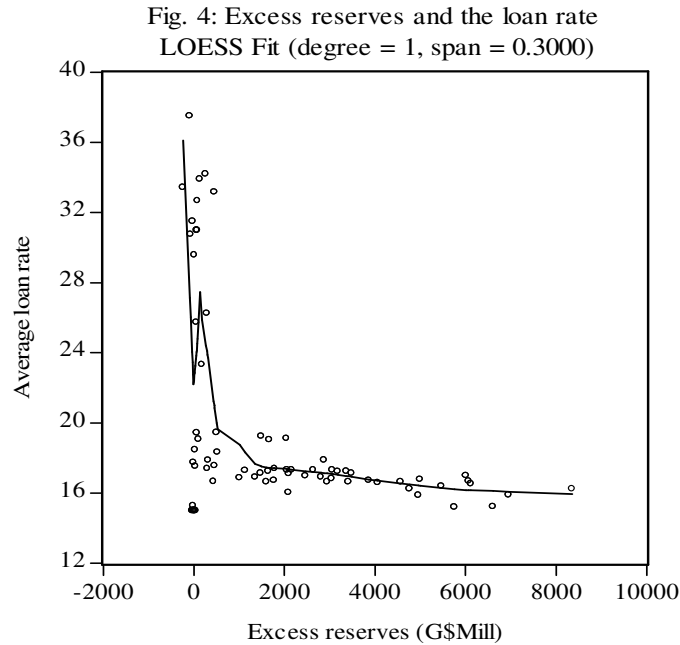


Source: Bank of Guyana Statistical Bulletin

The level of nominal non-remunerative excess reserves is plotted against two opportunity cost rates of interest – the Guyana 91-day Treasury bill rate and the average loan rate. The purpose is to extract the liquidity preference curves. The curves are fitted using locally weighted polynomial regressions of degree one. They are local regressions

because only a subset of observations within a neighborhood of the point to fit the curve is used. The regression is weighted so that observations further from the given data point are given less weight. This technique was proposed by Cleveland (1979) and further developed by Cleveland and Devlin (1988). The subset of data used in each weighted least squares fit is comprised of  $\alpha N$ , where  $\alpha$  = the smoothing parameter and  $N$  = number of data points. A higher parameter,  $\alpha$ , gives a smoother fit, but the fitted curve is less “local”. Throughout the exercise a smoothing parameter of 0.3 is used. For instance, given the 76 data points for Guyana, in any neighborhood 23 data points (rounded to the next largest integer) are utilized. The curves are fitted using quarterly data from 1988q1 to 2005q4.





Figures 3 and 4 present the scatter plot, respectively, for the domestic Treasury bill market and the loan market. In the Treasury bill market the curve flattens at approximately five percent, while in the loan market the fitted liquidity preference becomes flat at just over sixteen percent<sup>6</sup>. The flatness of the curve in the Treasury bill market suggests excess reserves and the government security become substitutes at a very high rate of interest. While at first glance this might be reminiscent of a liquidity trap –in which the bond rate falls to zero and as a result money and government bonds become perfect substitutes – it does not seem to be the case because of the high interest rate at which excess reserves become a perfect substitute for the government security. A similar plot of excess reserves against the short-term interest rate (the 90-day bankers’ acceptance rate) for the US during the 1930s shows a flat liquidity preference curve at a zero bond rate (Morrison, 1966, p. 44). Eggertsson and Ostry (2005, p. 8) made a similar

<sup>6</sup> This behavior is not unique to Guyana. See Appendix 1 for similar fitted bank liquidity preference curves – using the same technique – for Barbados, The Bahamas and Jamaica.

observation for Japan using data over the period 1980 to 2004 to plot the monetary base against the Japanese short-term interest rate. In the Japanese case the curve also becomes flat at zero. These two cases are often declared by several authors to be the classic liquidity trap scenario. However, this is still a contentious issue and is the subject of a large literature<sup>7</sup>.

In the Guyanese case, the flatness of the curve in the Treasury bill market implies the banks do not take this rate as given. They could demand a minimum rate before they bid for the said asset. Hence, the market is not competitive as would be the case in the US or other developed economies. This has important implications in developing countries that have tried to liberalize interest rates by implementing a bidding system for the government paper. The deposit and discount rates are usually pinned to the 91-day Treasury bill rate. Fry (1997, Chapter 6) noted that the development of a voluntary Treasury bill market in developing countries can have several advantages such as: (i) enabling a shift from direct to indirect monetary policy techniques (hence improving efficiency and effectiveness of monetary policy); and (ii) provide a reference rate in the form of market determined yields on Treasury bills. However, if the government security rate is not competitive, then by extension, the other rates will also be determined by oligopolistic forces. In such non-competitive markets open market operations will exert limited influence on interest rates. This will be demonstrated conceptually later in the paper.

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<sup>7</sup> Morrison (1966) and Frost (1971) proposed different explanations for the demand for excess bank reserves in the US during the 1930s. Bronfenbrenner and Mayer (1960) and Pifer (1969) also refuted the liquidity trap hypothesis empirically. However, Eisner (1971) and Wilcox (1984) – using different econometric tools – supported the existence of a liquidity trap in the US during the Great Depression. More recently Weberpals (1997) rejected the hypothesis for Japan during the 1990s. Krugman (1998), however, argued in favor of a Japanese liquidity trap.

### 3. The Oligopoly Model

Banks are assumed to possess some amount of market power in the loan, deposit and government security markets. The monopoly banking model was first introduced by Klein (1971) and later applied to a liquidity management model under uncertainty by Prisman, Slovin and Sushka (1986). However, an important difference between the model in this paper and the industrial organization approach is the fact that the government security market is not perfectly competitive as was originally postulated by Klein (1971), Slovin and Sushka (1983), and by Prisman, Slovin and Sushka (1986). While the government security market is likely to be highly developed and liquid in the advanced economies – hence the individual bank accepts this rate as given – it is not the case in Guyana where a few institutional investors dominate the purchase of Treasury bills. Therefore, the individual bank faces an upward sloping Treasury bill supply curve, thus making the bank an oligopsonist. If the Treasury bill market is uncompetitive, then the Treasury bill yield cannot be used as the exogenous reference rate which pins down the domestic term structure. The discount rate is another candidate rate that can serve as the exogenous reference rate since it is clearly exogenous and under the control of the central bank. However, given the persistence of excess liquidity, this rate has not been very useful to signal monetary policy stance since banks seldom borrow reserves from the central bank.

In light of the very open nature of the Guyanese economy, and owing to the abandonment of foreign exchange control, bank managers must always be mindful, subject to suitable adjustments for exchange rate risks, of the prevailing rate of interest on foreign assets (which can be represented by the US Treasury bill rate). Bank managers

need to compare the international rate (adjusted for exchange rate movements) with the prevailing domestic Treasury bill rate and the loan rate (also adjusted for domestic risk scenarios and transaction costs).

The non-bank public must also consider the international safe rate and exchange rate movements when making investment decisions particularly in domestic deposit accounts. Banks will lose deposits and market share if the deposit rate becomes too low vis-à-vis the risk adjusted foreign rate. The existence of such an arbitrage mechanism in an unregulated open economy provides for a link between the asset and liability sides (of the bank's balance sheet) in a banking model even though domestic financial markets are subjected to market power. Therefore, the foreign interest rate, which is clearly exogenous to the domestic economy, can be used as the exogenous reference rate in the modeling exercise. Hence, the model is applied in an open economy environment, thereby accounting for another important difference between the approach of this paper and the traditional industrial organization model that is always presented in a closed economy setting.

Equation 1 is the representative bank's profit function that is assumed to be concave in loans to the private sector ( $L$ ); domestic government securities ( $G$ ); foreign assets ( $F$ ); and deposits ( $D$ ). The  $i$  subscript attached to each variable signals the quantity of the respective variable held by the representative bank. Other key variables include  $r_L$  = the average loan rate;  $r_D$  = average deposit rate;  $r_F$  = rate of interest on the international security;  $c_i(L)$  = transaction and monitoring costs associated with making loans to private agents;  $\rho$  = the proportion of borrowers (where  $0 \leq \rho \leq 1$ ) who are likely to default on their loans; and  $\psi$  = the probability (where  $0 \leq \psi \leq 1$ ) that the government

will fail to meet its debt obligations. The latter probability, for instance, is a function of the debt-GDP ratio or some other measure of debt sustainability. The bank's balance sheet identity in which  $E$  = excess reserves and  $zD$  = required reserves (where  $z$  = statutory required reserve ratio) is given by the identity equation 2.  $E$  cancels out during the process of differentiation.

$$\Pi_i = (1-\rho)r_L(L)L_i + (1-\psi)r_G(G)G_i + r_F F_i - r_D(D)D_i - c_i(L) \quad (1)$$

$$E_i + zD_i + G_i + F_i + L_i = D_i \quad (2)$$

After solving the balance sheet constraint for  $F_i$  and substituting into equation 2, the profit function (equation 3) is derived.

$$\Pi_i = [(1-\rho)r_L(L) - r_F]L_i + [(1-\psi)r_G(G) - r_F]G_i - [r_D(D) - r_F(1-z)]D_i - c_i(L) \quad (3)$$

$$L = L_i + \sum_{i \neq j} L_j; \quad G = G_i + \sum_{i \neq j} G_j; \quad D = D_i + \sum_{i \neq j} D_j \quad (3a)$$

In a Cournot equilibrium the  $i$ th bank maximizes profit by taking the volume of loans, Treasury bills, and deposits of other banks as given. In other words, for the  $i$ th bank,  $(L_i^*, G_i^*, D_i^*)$ , solves equation 3; where (3a) denotes the aggregate quantity of loans, Treasury bills and deposits demanded, respectively, by the entire banking sector.

### The loan market

The author is now in a position to derive a pricing equation for the representative bank in the loan market. Equation 4 is the first order condition after maximizing the profit function with respect to  $L_i$ . The market demand curve the bank faces is downward sloping giving rise to the elasticity of demand expression in equation (4c) in which  $\epsilon_L$  denotes the elasticity of demand. Bank  $i$  accounts for the fraction  $s_i^L$  out of the industry's total quantity of loans (4b). The expression  $r'_L(L)$  represents the first

derivative of the loan rate with respect to  $L$ . As demonstrated by (4a) it is simply the inverse of  $L'(r_L)$ .

$$\frac{d\Pi_i}{dL_i} = (1-\rho)r_L(L) + (1-\rho)r'_L(L)L_i - r_F - c'_i(L) = 0 \quad (4)$$

$$r'_L(L) = 1/L'(r_L) \quad (4a)$$

$$s_i^L = L_i/L \quad (4b)$$

$$\varepsilon_L = r_L \cdot L'(r_L)/L \quad (4c)$$

Upon substituting 4a, 4b and 4c into the first order condition, equation 5 is obtained. The equation shows that the loan rate is a mark-up over the foreign rate and the marginal cost of transacting,  $c'_i(L)$ . The mark-up is dependent on the market elasticity of demand and the share of the individual bank's demand for loan out of the total for the industry. As  $s_i^L \rightarrow 1$  there is the case of a monopoly and the mark-up is highest, while as  $s_i^L \rightarrow 0$  one bank has an infinitesimal share of the market; the equilibrium approaches the competitive state in which the mark-up approaches zero. The bank also increases the mark-up rate once the perceived probability of default increases (that is:  $\rho \rightarrow 1$ ).

$$r_L \left(1 + \frac{s_i^L}{\varepsilon_L}\right) = [r_F + c'_i(L)]/(1-\rho) \quad (5)$$

This equation helps to explain the existence of a minimum loan rate, at which point excess reserves and loans become perfect substitutes; hence, it explains the flattening of the empirical liquidity preference curve that was observed in the last section. Since the bank possesses the ability to choose a minimum rate, it will simply accumulate excess reserves passively when the market rate is below the desired minimum since the marginal benefit from the additional unit of loan is less than the marginal cost of that

same unit of loan. The minimum rate also implies that the removal of financial repression<sup>8</sup> will give rise to high loan rates as banks behave more like theoretical oligopolies.

The Treasury bill market

As noted earlier the commercial banks do not take the domestic Treasury bill rate as given. With only a few large institutional purchasers of government securities, it is assumed that buyers do exert some influence over the Treasury bill rate when they place bids for the security. In other words, banks face an upward sloping supply curve rather than a flat curve as is typically assumed in the literature. Therefore, the Treasury bill rate can also be derived as a mark-up over the international rate, especially since banks will compare the two interest rates in any highly open economy with liberalized capital flows.

$$\frac{d\Pi_i}{dG_i} = (1-\psi)r'_G(G) + (1-\psi)r'_G(G)G_i - r_F = 0 \quad (6)$$

Maximizing the profit function with respect to  $G_i$  gives the first order condition in equation 6. Substitute 6a, 6b and 6c into equation 6 to obtain the new pricing equation 7. The equation postulates that the minimum Treasury bill rate at which a bank will bid for the security is denoted by a mark-up over the exogenous foreign rate and market-specific risk. The minimum mark-up rate increases as  $s_i^G \rightarrow 1$  (where  $s_i^G$  is the share of total outstanding bills bought by bank  $i$ ). The minimum rate also increases as  $\psi \rightarrow 1$ , hence the bank will bid at a higher rate once the likelihood of a government default increases. This result is also consistent with the notion that a market Treasury bill rate that is below the minimum stipulated by the mark-up rule will result in the bank

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<sup>8</sup> Fry (1982) explains the main forms of financial repression as nominal interest rate ceilings for deposit and loan rates, directed credit to particular industries, and the expropriation by government of seigniorage by the use of high cash and liquid asset requirements and obligatory holding of government securities.

accumulating excess reserves passively. Should the central bank choose a bid rate that is below the minimum desired rate, bank  $i$  will demand excess reserves since the marginal cost of making the investment in Treasury bills is greater than its perceived marginal benefit. In such a situation commercial banks simply under subscribe for Treasury bills. The equation, therefore, is consistent with the observed tendency for the liquidity preference curve to flatten at a high Treasury bill rate. As noted earlier, such a behavior is inconsistent with the classic liquidity trap in which the bond rate falls to zero and the liquidity preference curve flattens at zero bond rate.

$$r'_G(G) = 1/G'(r_G) \quad (6a)$$

$$s_i^G = G_i / G \quad (6b)$$

$$\varepsilon_G = r_G \cdot G'(r_G) / G \quad (6c)$$

$$r_G \left(1 + \frac{s_i^G}{\varepsilon_G}\right) = r_F / (1 - \psi) \quad (7)$$

### The deposit market

It is now possible, using a similar procedure, to derive a pricing equation for the deposit rate. The first order condition is given by equation 8. The deposit rate is a mark-up over the foreign interest rate. This is not hard to envisage since an unfavorable rate of return on Guyanese deposit accounts will encourage capital flight and a loss of reserves by commercial banks. The larger banks, measured by when  $s_i^D \rightarrow 1$ , are in a position to offer a higher mark-up over the international rate and therefore attract more deposits and market share. The equation also suggests that the higher the required reserve ratio the lower the deposit rate. Hence, an important policy for preventing capital flight would be to lower the statutory required reserve ratio.

$$\frac{d\Pi_i}{dD_i} = r_D(D) + r'_D(D)D_i - r_F(1-z) = 0 \quad (8)$$

$$r'_D(D) = 1/D'(r_D) \quad (8a)$$

$$s_i^D = D_i/D \quad (8b)$$

$$\varepsilon_D = r_D \cdot D'(r_D)/D \quad (8c)$$

$$r_D \left(1 + \frac{s_i^D}{\varepsilon_D}\right) = r_F(1-z) \quad (9)$$

#### 4. Comparative Statics

It is interesting to see the extent to which indirect monetary policy can influence the loan and deposit rates. Guyana's monetary authority, the Bank of Guyana, has consistently focused on mopping up excess reserves by selling domestic Treasury bills from its asset portfolio. Therefore, the objective is to analyze the effect on  $r_D$  and  $r_L$  when the central bank manages bank liquidity by varying the quantity of  $G$  (where  $G$  is an exogenous variable and  $r_D$  and  $r_L$  are endogenous variables). To derive the effect on the deposit rate, equations 7 and 9 are combined since they both include the common term  $r_F$ . The combined equation is given by equation 10. An increase in the sale of Treasury bills is indicative of a monetary tightening and a concomitant increase in  $r_G$  (that is:  $r'_G(G) > 0$ ); the opposite occurs when the sale of  $G$  declines. Equation 10 can now be used to find the derivative  $dr_D/dG$  (equation 11), which suggests that tightening domestic monetary policy increases  $r_D$ , while an expansion will have the opposite effect. Equation 11 implies that the effect of indirect monetary policy on the deposit rate depends on the parameters  $z$ ,  $\psi$ ,  $s_i^D$ ,  $s_i^G$  and  $r'_G(G)$ . The impact of the liquidity

management policy on the deposit rate is weakened as  $s_i^D \rightarrow 1$  and the higher the required reserve ratio ( $z$ ). The effect also weakens as  $\psi \rightarrow 1$ . The pass-through from instrument ( $G$ ) to the deposit rate is stronger the more responsive is the Treasury bill rate to the open market policy (that is:  $r'_G(G)$  is high). Conversely, a weak  $r'_G(G)$  diminishes the pass-through. Interestingly, the policy becomes more effective as  $s_i^G \rightarrow 1$ ; this result indicates that when banks are willing to bid up the rate on domestic Treasury bills they will have to be willing to increase the deposit rate also since they risk losing deposits and market share as the non-bank investors move deposit funds into government securities.

$$r_D \frac{1 + \frac{s_i^D}{\epsilon_D}}{(1-z)(1-\psi)(1 + \frac{s_i^G}{\epsilon_G})} - r_G(G) = 0 \quad (10)$$

$$\frac{dr_D}{dG} = \frac{r'_G(G)(1-z)(1-\psi)(1 + \frac{s_i^G}{\epsilon_G})}{1 + \frac{s_i^D}{\epsilon_D}} > 0 \quad (11)$$

Similarly, to analyze the effect of  $G$  on the loan rate, equations 5 and 7 are combined to form equation 12, which can then be used to find the derivative:  $dr_L / dG$ . Again it can be seen that the loan rate, like the deposit rate, is affected positively by a monetary contraction (increased sales of  $G$ ) and negatively by a monetary expansion (decrease sales of  $G$ ). However, the pass-through effect is weakened given the oligopolistic nature of the loan market. As  $s_i^L \rightarrow 1$  the effect gets smaller; while it gets stronger as  $s_i^G \rightarrow 0$ , which in turn implies that as banks bid up the government security rate the loan rate will also rise to maintain the positive correlation between asset returns.

Equation 12 further implies that efforts to persistently mop up excess reserves are likely to lead to higher loan rates and the possible crowding out of private sector investments.

$$r_L \frac{(1 + \frac{s_i^L}{\epsilon_L})(1 - \rho)}{(1 + \frac{s_i^G}{\epsilon_G})(1 - \psi)} - \frac{c'(L)}{(1 + \frac{s_i^G}{\epsilon_G})(1 - \psi)} - r_G(G) = 0 \quad (12)$$

$$\frac{dr_L}{dG} = \frac{r'_G(G)(1 + \frac{s_i^G}{\epsilon_G})(1 - \psi)}{(1 + \frac{s_i^L}{\epsilon_L})(1 - \rho)} > 0 \quad (13)$$

The higher loan rate – which results from indirect monetary policy – is likely to increase the level of excess reserves in the banking system as various borrowers are crowded out from the loan market. In other words, the excess reserves result from the new monetary policy framework that was instituted in the mid-1990s. Indeed, Fig. 2 shows that excess reserves is a post-reform phenomenon.

### 5. Empirical Analysis

The paper so far demonstrates that the loan, Treasury bill and deposit markets are oligopolistic. Consequently, banks desire a minimum loan rate to compensate for the marginal cost of transacting and risks that are peculiar to the loan market before they make loans to the private sector. Similarly, banks also desire a minimum rate of interest on government securities that can compensate for risks that are unique to this market before buying Treasury bills. The respective minimum rate in both markets causes banks to passively hold low-yielding reserve assets especially in light of the exogenous build-up of deposits. This characteristic was depicted by the flattening of the liquidity preference

curve at a high rate of interest, a phenomenon which is different from the classic liquidity trap scenario.

However, there is still the outstanding puzzle as to why banks will choose to hold zero-interest excess reserves rather than invest in a safe foreign asset, whose rate might be low but still compensates for the inevitable exchange rate risk associated with holding cash in terms of Guyanese currency. It is an intriguing behavior especially in light of the fact that restrictions on the outflow and inflow of foreign currencies have been dismantled since the early 1990s. One theoretical explanation that comes to mind is the encumbrance of transaction costs when investing in foreign assets. Transaction costs are known to enforce an inherent home bias in asset portfolios (Lewis, 1999). However, Guyanese banks are not likely to face these costs when buying US Treasury bills or deposits in counterpart banks abroad since these are not inherently costly operations.

#### *The foreign currency constraint*

The foreign currency constraint is introduced in order to explain this puzzle. The extent to which a surplus or deficit of US dollars in the domestic foreign exchange market can influence the level of excess reserves, the change in foreign assets, and the flow of loans to the private sector is crucial to this discussion. The foreign exchange market is made up of bank and non-bank traders who buy and sell mainly the US dollar. The stock of US dollars traded at any time comes mainly from export proceeds, foreign aid, remittances, and foreign loans. The stock is used for imports, servicing the external debt, accumulation by the central bank of international reserves, and investments in foreign assets by commercial banks<sup>9</sup>.

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<sup>9</sup>Mainly the US currency is traded in the Guyanese foreign currency market. As at the end of 2005 US\$674 million was purchased, while £23.8 million was bought by traders. At the same time US\$651.9 million

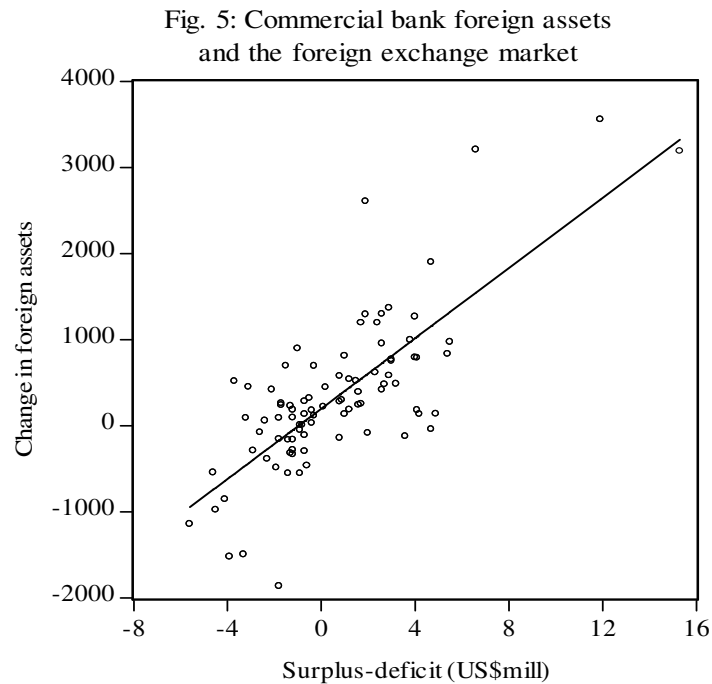
When faced with a foreign currency constraint, commercial banks are unable to purchase all desired amounts of foreign assets. In other words, if the foreign exchange market is in a deficit the change in foreign assets will decline, while at the same time the level of excess bank reserves will increase. It is therefore expected that the change in foreign assets will be positively related to a surplus in the foreign exchange market, while excess reserves will be negatively correlated with such a surplus. It is also interesting to see the extent to which a surplus or deficit in the foreign exchange market can influence the flow of bank loans to the private sector. However, if there is no such relationship it implies banks prefer to acquire excess reserves rather than make loans to the private sector when the foreign exchange market is in a deficit. Such an outcome can be interpreted as being consistent with the minimum rate hypothesis that was proposed earlier. Moreover, such information is very important for understanding the monetary transmission mechanism in a small open economy.

The scatter plots (Figures 5, 6 and 7) are based on monthly data from Jan 1999 to Jun 2006. Fig. 5 shows a positive correlation between the change in the level of commercial bank foreign assets and the surplus or deficit in the foreign exchange market. The market is in surplus when the total purchase of US dollars is greater than the aggregate sale of US dollars. There is a deficit when the converse occurs. The information contained in Fig. 5 is largely consistent with the existence of a foreign currency constraint. Fig. 6 shows the correlation, which is negative, between the surplus/deficit in the foreign exchange market and the ratio of total bank reserves divided by required bank reserves. The ratio of total reserves to required reserves will be one if

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was sold compared with £21.7 million. Small amounts of the Canadian dollar and the Euro were bought and sold during that period.

the level of excess reserves is zero. The fitted line in Fig. 6 shows that the ratio approaches one as the quantity of US dollars in circulation rises. On the other hand, banks are willing to amass excess reserves when there is a shortage of US dollars.



It is now interesting to see the extent to which the surplus or deficit in the foreign currency market can influence the loan market. If a deficit in the foreign exchange market induces the banks to make loans it implies bank portfolios are responsive to liquidity shocks. If liquidity shocks do not elicit much of a change in the loan market, then bank portfolios are static, a position that is consistent with the hypothesis of the minimum rate. Fig. 7 – which is based on monthly data from Jan 1999 to Jun 2006 – illustrates an almost flat fitted line that intersects the vertical axis just below zero. The implication being a surplus or deficit in the foreign exchange market is not likely to elicit a substantial change in the supply of bank loans to private agents. The reason being the

quantity of loans is determined by different dynamics – principally in our context, the minimum rate determined by the banks which customers are required to pay. The loan market, then, is very sticky and does not respond readily to changes in liquidity conditions.

Fig. 6: Excess reserves and the foreign exchange market

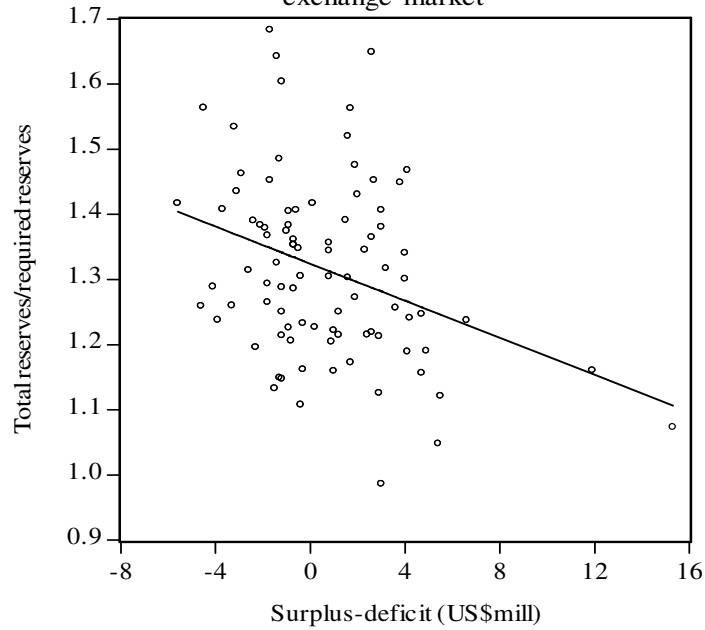
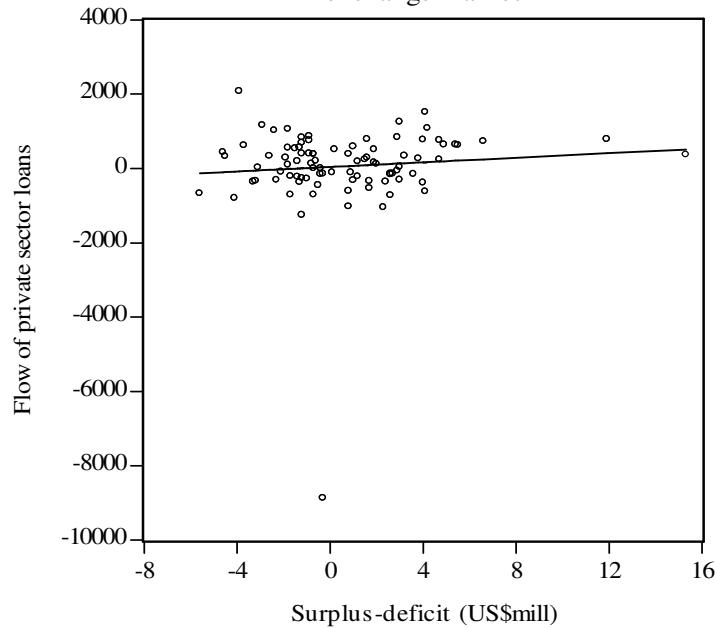


Fig. 7: Private loan flows and the foreign exchange market



*Econometric analysis of excess reserves*

This section examines the determinants of excess reserves by estimating an autoregressive distributed lag model (ARDL). In keeping with the empirical models of Agenor, Aizenman, and Hoffmaister (2004), Saxegaard (2006), and Fielding and Shorthand (2005), a very general model was first estimated. Variables representing both precautionary and involuntary factors were included. However, the central bank discount rate, the required reserve ratio, currency volatility, deposit volatility, and the ratio of demand deposits to total deposits were all found to be insignificant and they possessed the wrong coefficient sign. In particular, the required reserve ratio changed only three times during the period of analysis and that might explain why it was found to be insignificant. Interestingly, the insignificance of the currency volatility measure, deposit

volatility<sup>10</sup>, the ratio of demand deposits to total deposits, and the discount rate underscore the fact that liquidity risks are not very important in an environment of persistent excess reserves.

Given these findings, the ARDL model presented in equation 14 uses variables that can better explain the Guyanese situation. The relevant variables are  $er_t$  which denotes the ratio of total reserves to required reserves;  $fx$  which denotes the foreign exchange market surplus or deficit;  $\Delta ir$  which represents the change in the level of the central bank's international reserves; and  $volfer$  that represents the volatility of the Guyana dollar-US dollar nominal exchange rate. The term  $\varepsilon_t$  denotes the serially uncorrelated, homoskedastic, and normally distributed error term.

$$er_t = \alpha_0 + \sum_{i=0}^n \alpha_i fx_{t-i} + \sum_{j=0}^p \alpha_j \Delta ir_{t-j} + \sum_{k=0}^q \alpha_k volfer_{t-k} + \sum_{l=1}^m \alpha_l er_{t-l} + \varepsilon_t \quad (14)$$

As noted earlier, a surplus in the foreign exchange market diminishes excess reserves while a deficit exerts the opposite effect. Therefore, the coefficient  $\sum \alpha_i$  is expected to be negative. On the other hand, if the central bank engages in asymmetric foreign exchange market interventions – meaning most of the time the central bank buys the reserve currency rather than sells – the result will be the build-up of excess reserves if there is insufficient sterilization (that is the sterilization coefficient is between 0 and -1). Hence, the coefficient  $\sum \alpha_j$  is expected to be positive. That is because the main focus of Guyanese monetary policy is on preserving the stability of the currency vis-à-vis the US dollar. It does this under the advice of the IMF financial programming<sup>11</sup> framework by

<sup>10</sup> In each case volatility was measured using a method similar to equation 15. Experimentation with a GARCH (1, 1) model as a measure of volatility of the different series could not change the result.

<sup>11</sup> See Tarp (1993) for detailed discussion of the financial programming framework.

maintaining sufficient import cover in terms of foreign reserves. Import cover, measured in number of months, is therefore a target variable under financial programming. This target is intended to signal to market participants the central bank is willing to support the value of the local currency in the event it comes under pressure. The central bank obtains the hard currency by buying (and paying with Guyanese currency) from the domestic foreign exchange market. The process therefore injects liquidity into the system. To remove (or sterilize) these liquidities the monetary authority sells government Treasury bills to the domestic market. Therefore, if the coefficient is -1 it signals the central banks has removed all prior injected liquidities. A coefficient between 0 and -1 indicates partial removal of reserve money.

It is expected that a volatile exchange rate will induce banks to reduce excess reserves and purchase a safe foreign asset since the depreciation increases the expected return in terms of Guyana dollars. Guyanese banks are likely to associate higher volatility with depreciations since past evidence suggests the rate can only depreciate further against the main international reserve currency – the US dollar. Therefore, the coefficient  $\sum \alpha_k$  is expected to be negative. An important issue now emerges: how to measure volatility? Equation 15 identifies the measure that is adopted in this paper. According to the formula the volatility is the sample standard deviation of the change in the nominal monthly Guyana-dollar/US-dollar exchange rate ( $E$ ). In this case  $n$  is the averaging period, which is taken to be three months.

$$volfer_t = \left[ (1/n) \sum_{i=1}^n (E_{t-i} - \bar{E})^2 \right]^{1/2} \quad (15)$$

The estimation is based on a sample of monthly data that ranges from January 1999 to June 2006, a total of ninety observations<sup>12</sup>. However, before estimating equation 14, it is important to examine the time series properties of each variable in the equation. To do so, the Augmented Dickey Fuller (ADF) test is applied to each univariate time series in order to establish the order of integration. In other words, it is important to determine whether the variable is stationary in its level, in first or in second difference. The results of the unit root tests, based on a unit root null hypothesis versus a stationary alternative, are reported in Appendix 2. The exchange rate volatility variable (*voler*) and the foreign exchange market surplus/deficit (*fx*) are stationary in their levels. The ratio of total reserves to required reserves (*er*) is stationary at the one percent level when the equation includes only the intercept term. However, when both intercept and trend are included, the null of non-stationarity cannot be rejected. This finding, however, does not imply it is true and it could be that the sample size is too short to enable a rejection of the null. Indeed, when the sample size is expanded from January 1991 to June 2006, the ADF test rejects the null at the 1 percent level when an intercept alone is used, and when both intercept and trend are included in the equation. The test statistics turn out to be -4.36 and -7.13, respectively, for the intercept alone and the intercept and trend alternative. Furthermore, visual examination of the autocorrelation and partial autocorrelation functions does not detect long memory in the level of the ratio (*er*). It is therefore concluded that *er* is stationary in its level. Finally, the unit root test for *ir* suggests it is non-stationary in its level but becomes stationary after differencing once ( $\Delta ir$ ).

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<sup>12</sup> The excess reserves and foreign exchange market purchases and sales data were obtained from the Bank of Guyana *Statistical Bulletin*, while all other series were obtained from the IMF *International Financial Statistics*.

Given the unit root test, each variable in equation 14 is stationary. The inclusion of  $\Delta ir$  does not mean the equation is unbalanced since the focus is on how the change in (and not the level of) international reserves impacts on the ratio  $er$ . Moreover, the possibility that the regression is spurious is greatly diminished when each variable is stationary. The estimation results are presented in Table 1. Each coefficient has the expected sign and the  $fx$  term is highly significant.  $\Delta ir$  is significant at the 10 percent level, while  $voler$  is not significant but it is maintained because it carries the correct sign.  $er$  is also explained by its one period lag  $er_{t-1}$ . The equation performs very well on the diagnostic tests. The Lagrange Multiplier tests for first and fourth order serial correlation of the residuals do not reveal this problem. In light of the Jarque-Bera test, the null hypothesis of normality cannot be rejected. White's test could not reject the null hypothesis of homoskedasticity, thus indicating that the errors of the model have a constant variance. And finally, Ramsey's RESET test for general misspecification could not reject the null hypothesis of correct specification – suggesting that the model is constructed in its correct functional form and not omit relevant variables.

In order to test for coefficient and variance stability the CUSUM and CUSUMSQ tests that were proposed by Brown, Dublin and Evans (1975) are utilized. The tests are applied to the residuals of the estimated model. The CUSUM test is based on the cumulative sum of the recursive residuals based on the first  $n$  observations. It is then updated recursively and plotted against time. The model coefficients are unstable when the plot of CUSUM strays outside the 5 percent significance lines. The result is presented in Fig. 2A (Appendix 2). It suggests stability at the five percent level of significance. The procedure for the CUSUMSQ is similar (Appendix 2, Fig. 2B). Coefficient and

variance instability are indicated by a movement of cumulative sum of recursive residuals outside the 5 percent critical lines. Fig. 2B (Appendix 2) shows no such tendency, thereby leading to the conclusion that the model is stable.

Table 1: Regression results-the ARDL model

Dependent Variable: er				
Included observations: 89 after adjustments (Jan1999-Jun2006)				
Variable	Coefficient	Std. Error	t-statistic	p-value
Constant	0.5354	0.098	5.49	0.000
fx	-0.0115	0.003	-3.80	0.000
$\Delta$ ir	0.0019	0.001	1.62	0.109
voler	-0.0762	0.058	-1.31	0.192
er (t-1)	0.6106	0.072	8.44	0.000
Adj-R <sup>2</sup>	0.52			
Serial corr. LM (1)	n*R <sup>2</sup> =3.15	p-value=0.075		
Serial corr. LM (4)	n*R <sup>2</sup> =5.77	p-value=0.217		
Heteroskedasticity (White)	n*R <sup>2</sup> =4.72	p-value=0.786		
Normality (J-B, $\chi^2$ (2))	0.627	p-value=0.730		
Ramsey RESET (F-stat)	2.15	p-value=0.123		

### The sterilization coefficient

The reason for estimating the sterilization coefficient is because its size gives a clue of the monetary policy stance of the Bank of Guyana (Guyana's central bank). The coefficient takes values from 0 to -1. A coefficient value closer to -1 signals the extent to which the central bank compensates the commercial banks for the foreign currency constraint it imposes on them when it buys the hard currency from the domestic market. It should be noted that the Guyana dollar is not convertible; hence, the central bank can only pay for foreign currencies using the domestic currency that can only be spent at home. Commercial banks could use the foreign currency to purchase foreign assets and earn a rate of return instead of holding non-remunerative excess reserves. Instead, the banks are compensated with domestic government Treasury bills. Therefore, the size of the coefficient gives

information on the central bank's monetary policy objective. A coefficient closer to -1 would signal a strong desire for stabilization of the exchange rate and prices.

On the other hand, a coefficient that approaches 0 will indicate a desire for monetary expansion – and by extension economic expansion – since liquidity is injected into the system. If the coefficient equals 0, then a change in the international reserve position of the central bank is completely reflected in the monetary base. One can conclude that the stimulation of bank lending and economic growth is paramount. However, a coefficient closer to 0 indicates partial sterilization and one can therefore conclude the accumulation of international reserves by the central has contributed to the build-up of commercial bank excess reserves, which they accept passively when borrowers cannot meet the desired minimum loan rate that is set by a representative bank.

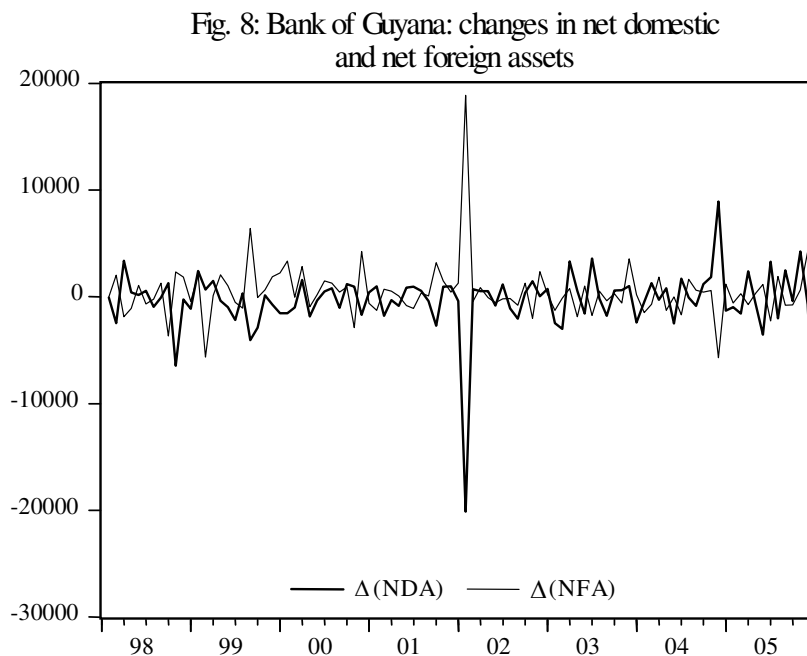


Figure 8 graphs the change in net foreign assets,  $\Delta(NFA)$ , and the change in net domestic assets,  $\Delta(NDA)$ , of the central bank. The figure underscores a tendency for one

to offset the other – a behavior that is typical of Guyana’s monetary policy in which the central bank varies its net domestic assets (the main component being Guyana government Treasury bills) in order to offset variations in net foreign assets. The latter is comprised of foreign currency reserves that the monetary authority must purchase from the domestic foreign currency market paying with the national currency. To prevent the unwanted build-up of the monetary base and bank reserves, the central bank sterilizes the prior liquidity injections by selling Treasury bills from its asset portfolio.

In order to estimate the sterilization coefficient, the central bank reaction function given by equation 16 is estimated. The sterilization coefficient is denoted by  $\beta_1$ . During the estimation exercise the reaction function also sought to measure explicitly the extent to which the Bank of Guyana varies its instrument (NDA) when there are changes in inflation and exchange rate volatility. Since these variables possessed the incorrect coefficient sign and were insignificant, only the estimation results of the parsimonious dynamic equation given by equation 16 is presented. It is possible that these variables are insignificant because the information is already encapsulated in the coefficient  $\beta_1$ .

$$\Delta(NDA/RM)_t = \beta_0 + \sum_{i=0}^n \beta_i \Delta(NFA/RM)_{t-i} + \sum_{j=1}^m \beta_j \Delta(NDA/RM)_{t-j} + \varepsilon_t \quad (16)$$

There is, however, an important methodological issue – which was raised by Magee (1976) – which emerges when one tries to estimate equation 16. It is the problem of simultaneity that results from the fact that  $\Delta NFA$  is an endogenous variable and is therefore correlated with the equation error term  $\varepsilon_t$ . In such a situation the use OLS is not recommended; therefore, most researchers have instead utilized two-stage least squares (TSLS). Others who have used TSLS to estimate the sterilization coefficient include Cumby and Obstfeld (1983), Brissimis, Gibson and Tsakalotos (2002), and Seo

(2005). In equation 16, reserve money (RM) – which is the central bank’s main liability – serves as the scale variable.

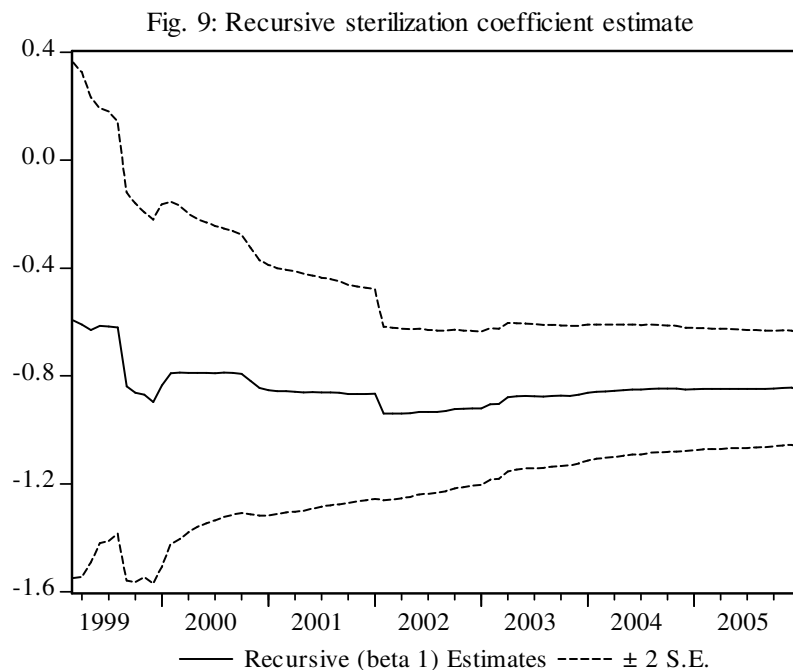
Both  $\Delta(NDA/RM)$  and  $\Delta(NFA/RM)$  are stationary variables with Augmented Dickey Fuller test statistics of -10.1 and -11.5, respectively, when an intercept alone is included in the test equation. The Schwarz Information Criterion suggests one lag in the ADF equation. The stationary nature of the variables greatly diminishes the chance of getting spurious results. The variables are also stationary when both a trend and intercept term are included in the ADF equation.

The estimation results are presented in Table 2. The estimated sterilization coefficient is -0.855 and is statistically significant as the p-value indicates. This result implies the central bank is successful, on average, in neutralizing 85.5 percent of the liquidity which has been inserted into the banking system. The diagnostic tests are favourable, except for the rejection of the null hypothesis of normality and fourth order serial correlation.

Table 2: Sterilization coefficient (TSLS)

Dependent Variable: $\Delta(NDA/RM)$				
Included observations: 94 after adjustments (1998:1-2006:6)				
Variable	Coefficient	Std. Error	t-statistic	p-value
Constant	-0.004	0.01	-0.46	0.647
$\Delta(NDA/RM)_{t-1}$	0.096	0.07	1.33	0.188
$\Delta(NFA/RM)$	-0.855	0.10	-8.15	0.000
Adj-R <sup>2</sup>	0.52			
Serial corr. LM (1)	n*R <sup>2</sup> =0.16	p-value=0.688		
Serial corr. LM (4)	n*R <sup>2</sup> =30.5	p-value=0.000		
Heteroskedasticity (White)	n*R <sup>2</sup> =3.42	p-value=0.489		
Normality (J-B, $\chi^2$ (2))	305	p-value=0.000		
Ramsey RESET (F-stat)	2.2	p-value=0.131		
Instrument list: $\Delta(NFA/RM)_{t-1}$ and $\Delta(NDA/RM)$				

Fig. 9 presents the recursive least squares estimate of the sterilization coefficient. The recursive coefficient is computed using ever larger subsets of the sample data until all the sample data points are utilized. The recursive estimate shows whether the coefficient changes over time. The coefficient is unstable in the early sample periods and eventually it stabilized at approximately -0.85. While the point estimate and recursive estimate do signal incomplete sterilization, they both provide more evidence in favor of a desire for monetary contraction, which is done by compensating the commercial banks for the induced foreign currency constraint. Stabilization, therefore, is the priority of the Guyanese central bank.



## 7. Alternative Monetary Transmission Mechanism

In light of the findings in the preceding sections, the following view of the monetary transmission mechanism (as outlined in Fig. 10) is postulated. This view is very different from that of the current literature. Mishkin (1995) summarizes the main

channels through which monetary policy can affect prices and output. The ultimate objective of the central bank is inflation, which it achieves through exchange rate stability. Output does not feature prominently as a central bank goal since the oligopoly structure of the loan and Treasury bill market obviate this objective. It was demonstrated in section 4 that liquidity will have very little effect on interest rates when the banking system is uncompetitive.

Therefore, prices are stabilized by accumulating international reserves (which form the bulk of NFA of the central bank). The increase in NFA means a build-up of excess reserves that can stimulate bank loans and domestic demand (consumption + business investments) once borrowers are willing to pay the rate of interest stipulated by the desired minimum loan rate, which was derived earlier. Also an exogenous increase of bank loans diminishes excess reserves as is shown by the double-sided arrow linking the loan market with excess reserves. However, when banks choose to accumulate excess reserves the loan market exert limited influence on domestic demand.

However, the central bank has a more potent weapon against inflation when it accumulates NFA. By buying foreign currency from the local market it enforces a foreign currency constraint in that market. It prevents banks from investing all excess reserves in a safe foreign asset and it curtails the import of foreign goods and services. As was argued earlier, commercial banks are forced to hold excess reserves when the constraint and minimum mark-up loan rates are binding. The exchange rate and therefore inflation are stabilized.

As a result of the imposed foreign currency constraint, the central bank compensates the commercial banks by selling them the domestic government Treasury



preference curves flatten at very high interest rates. Over the flat portion of the respective liquidity preference curve, excess reserves and the interest earning asset are perfect substitutes. Therefore, the demand for excess reserves is embedded in the oligopolistic structure of the loan market and the oligoposonistic nature of the Treasury bill market. The commercial bank sets the loan rate at which a customer must borrow. A customer's bid rate below the desired minimum loan rate will cause the bank to accumulate excess reserves passively because the marginal benefit yielded from making the investment does not compensate for the marginal cost and the perceived risk of the specific investment. Similarly, in the government security market a bank bids at a desired minimum rate. The bank simply under subscribe for the asset when the government's offer rate is below the minimum bid rate of the commercial bank.

Commercial banks also demand excess reserves because they cannot invest the entire holdings of non-remunerative assets in a safe foreign asset (in spite of the fact there is no legal barrier prohibiting such outflows) because the central bank creates a foreign currency constraint by accumulating foreign exchange reserves. The banks are in turn compensated by the central bank which sells them government securities.

The findings of this paper provide an alternative view of the monetary transmission mechanism in developing countries. The central bank can only focus on price stability in a highly open developing economy. Interest rates are unresponsive to liquidity changes that result from open market operations. This is because of the way unregulated oligopoly banks will set interest rates. Therefore, the central bank cannot easily achieve its growth objective by injecting excess reserves into the banking system since the loan and deposit rates are unresponsive to liquidity changes. In contrast, the

central bank can achieve its objective of price stability (through exchange rate stability) by accumulating international reserves. High levels of international reserves tame expectations of future exchange rate depreciations and therefore engender expectations of stable future prices. Also importantly, the accumulation of international reserves creates a shortage or constraint in the foreign currency market. Commercial banks are unable to invest all excess reserves in a foreign asset and at the same time importers have to curtail imports. By curtailing the demand for foreign financial securities and foreign goods, the demand for the scarce foreign currency is diminished. In the process, the price level and the exchange rate are stabilized.

#### References

Agenor, P., J. Aizenman, and A. Hoffmaister. (2004). "The Credit Crunch in East Asia: What Can Bank Excess Liquid Assets Tell Us?" *Journal of International Money and Finance* 23, 27-49.

Alexander, William, Thomas Balino, Charles Enoch and others. (1995). "The Adoption of Indirect Instruments of Monetary Policy." *IMF Occasional Paper 126*, International Monetary Fund.

Baltensperger, Ernst. (1980). "Alternative Approaches to the Theory of the Banking Firm." *Journal of Monetary Economics* 6, 1-37.

Baltensperger, Ernst .(1974). "The Precautionary Demand for Reserves." *American Economic Review* 64, 205-210.

Bernanke, Ben and Mark Gertler. (1995). "Inside the Black Box: the Credit Channel of the Monetary Transmission Mechanism." *Journal of Economic Perspectives* 9, 27-48.

Brissimis, Sophocles, Heather Gibson and Euclid Tsakalotos. (2002). "A Unifying Framework for Analyzing Offsetting Capital Flows and Sterilization: Germany and the ERM." *International Journal of Finance and Economics* 7, 63-78.

Bronfenbrenner, Martin and Thomas Mayer. (1960), "Liquidity Functions in the American Economy." *Econometrica* 28, 810-834.

Brown, R. L., J. Dublin and J.M. Evans. (1975). "Techniques for Testing the Constancy of Regression Relations Over Time." *Journal of the Royal Statistical Society* 37 (Series B), 149-192.

Caprio, Gerald and Patrick Honohan. (1993). "Excess Liquidity and Monetary Overhangs." *World Development* 21, 523-533.

Cleveland, William. (1979). "Robust Locally Weighted Regression and Smoothing Scatterplots." *Journal of the American Statistical Association* 74, 829-836.

Cleveland, William and Susan Devlin. (1988). "Locally Weighted Regression: An Approach to Regression Analysis by Local Fitting." *Journal of the American Statistical Association* 83, 596-510.

Cumby, Robert and Maurice Obstfeld. (1983). "Capital Mobility and the Scope for Sterilization: Mexico in the 1970s." In *Financial Policies and the World Capital Market: the Problem of Latin American Countries*, edited by P. Armella, R. Dornbusch and M. Obstfeld, pp. 245-276. Chicago: University of Chicago Press.

Eggertsson, Gauti and Jonathan Ostry. (2005). "Does Excess Liquidity Pose a Threat in Japan." *IMF Policy Discussion Paper (PDP 05/5)*, International Monetary Fund.

Egoume-Bossogo, Philippe., Ebrima Faal, Raj Nallari, and Ethan Weisman. (2003). *Guyana: Experience with Macroeconomic Stabilization, Structural Adjustment, and Poverty Reduction*. Washington, DC: International Monetary Fund.

Eisner, Robert. (1971). "Non-linear Estimates of the Liquidity Trap." *Econometrica* 39, 861-864.

Fielding, David and Anja Shorthand. (2005). "Political Violence and Excess Liquidity in Egypt." *Journal of Development Studies* 41, 542-557.

Freixas, Xavier and Jean-Charles Rochet. (1999). *Microeconomics of Banking*. Cambridge, Massachusetts: MIT Press.

Frost, Peter. (1971). "Banks' Demand for Excess Reserves." *Journal of Political Economy* 79, 805-825.

Fry, Maxwell. (1997). *Emancipating the Banking System and Developing Markets for Government Debt*. London: Routledge.

Fry, Maxwell. (1982). "Models of Financially Repressed Developing Economies." *World Development* 10, 731-750.

Klein, Michael. (1971). "A Theory of the Banking Firm." *Journal of Money, Credit and Banking* 3, 205-218.

Krugman, Paul. (1998). "It's Baaack: Japan's Slump and the Return of the Liquidity Trap." *Brookings Paper on Economic Policy* 2, 137-205.

Lewis, Karen. (1999). "Trying to Explain Home Bias in Equities and Consumption." *Journal of Economic Literature*, 37, 571-608.

Magee, Stephen. (1976). "The Empirical Evidence on the Monetary Approach to the Balance of Payments and Exchange Rates." *American Economic Review Papers and Proceedings* 66, 163-170.

Meigs, A. James. (1962). *Free Reserves and the Money Supply*. Chicago: University of Chicago Press.

Mishkin, Frederic. (1995). "Symposium on the Monetary Transmission Mechanism." *Journal of Economic Perspectives* 9, 3-10.

Morrison, George. (1966). *Liquidity Preference of Commercial Banks*. Chicago: University of Chicago Press.

Patterson, Kerry. (2000). *An Introduction to Applied Econometrics: A Time Series Approach*. New York: Palgrave.

Prisman, Eliezer, Myron Slovin and Marie Sushka. (1986). "A General Model of the Banking Firm under Conditions of Monopoly, Uncertainty, and Recourse." *Journal of Monetary Economics* 17, 293-304.

Santomero, Anthony. (1984). "Modeling the Banking Firm: A Survey." *Journal of Money, Credit and Banking* 16, 576-602.

Saxegaard, Magnus. (2006). "Excess Liquidity and the Effectiveness of Monetary Policy: Evidence from Sub-Saharan Africa." *Working Paper 06/115*, International Monetary Fund.

Seo, Byung Han. (2005). "Sterilized Intervention and Monetary Control: The Case of Korea." In *Foreign Exchange Rates, Capital Flows and Policy*, edited by R. Driver, P. Sinclair and C. Thoenissen, pp. 344-368. New York: Routledge.

Singh, S. (1997). *Bank of Guyana: Reserve Money Programming Manual*. Georgetown: Bank of Guyana.

Slovin, Myron and Marie Sushka. (1983). "A Model of the Commercial Loan Rate." *Journal of Finance* 38, 1583-1596.

Tarp, Finn. (1993). *Stabilization and Structural Adjustment: Macroeconomic Frameworks for Analyzing the Crisis in Sub-Saharan Africa*. London: Routledge.

Varian, Hal. (1992). *Microeconomic Analysis* (Third edition). New York: W.W. Norton and Company.

Verbeek, Marno. (2004). *A Guide to Modern Econometrics* (Second edition). Sussex: John Wiley & Sons Ltd.

Weberpals, Isabelle. (1997). "The Liquidity Trap: Evidence from Japan." *Working Paper 97-4*, Bank of Canada.

Wilcox, James. (1984). "Excess Reserves in the Great Depression." *Working Paper No. 1374*, National Bureau of Economic Research.

## APPENDIX 1

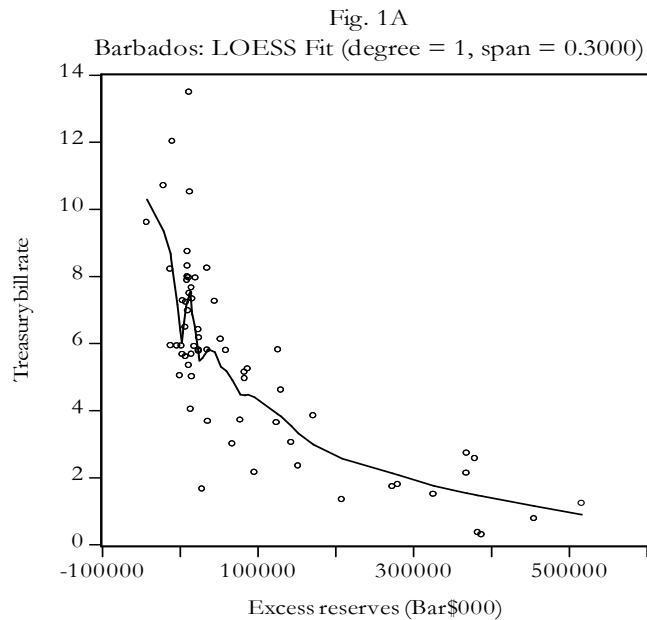


Fig. 1B

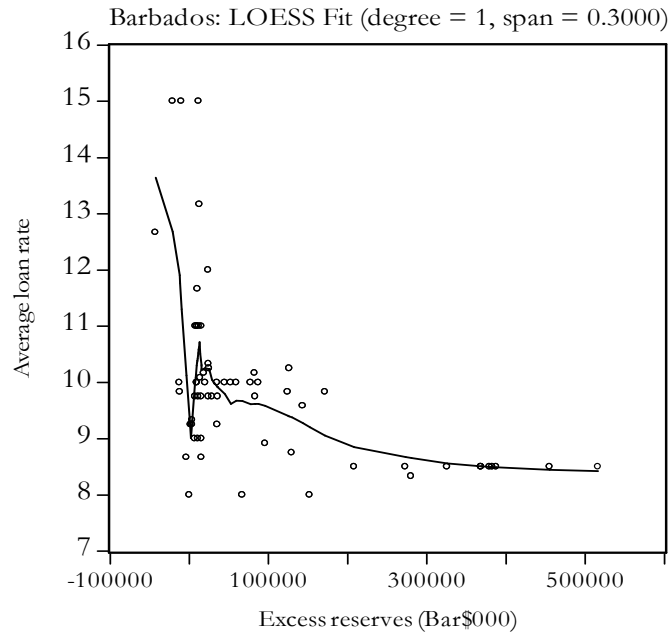
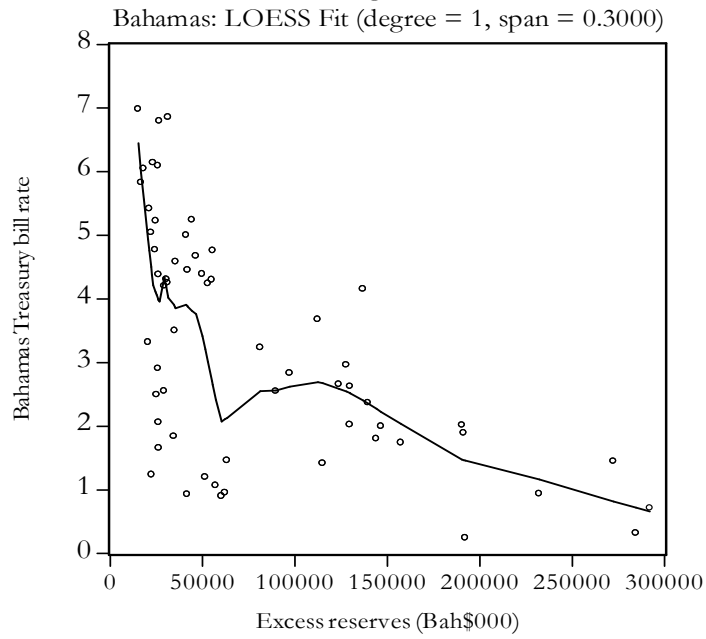
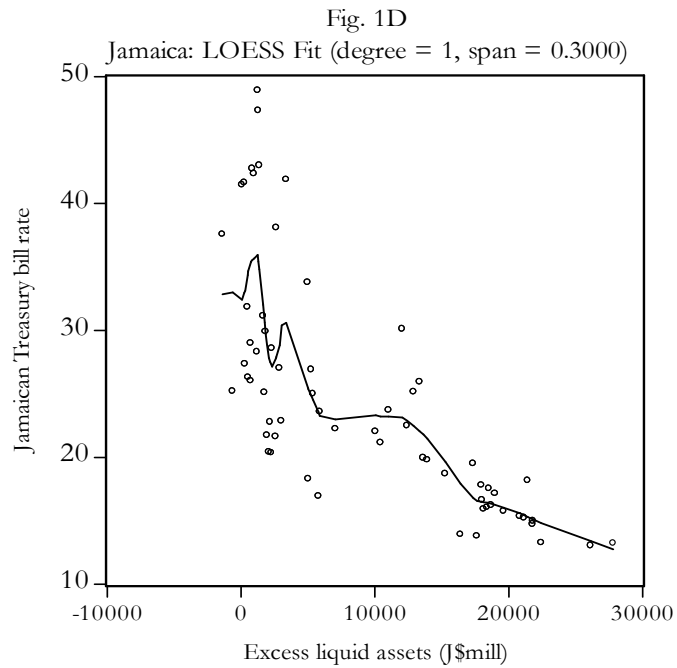
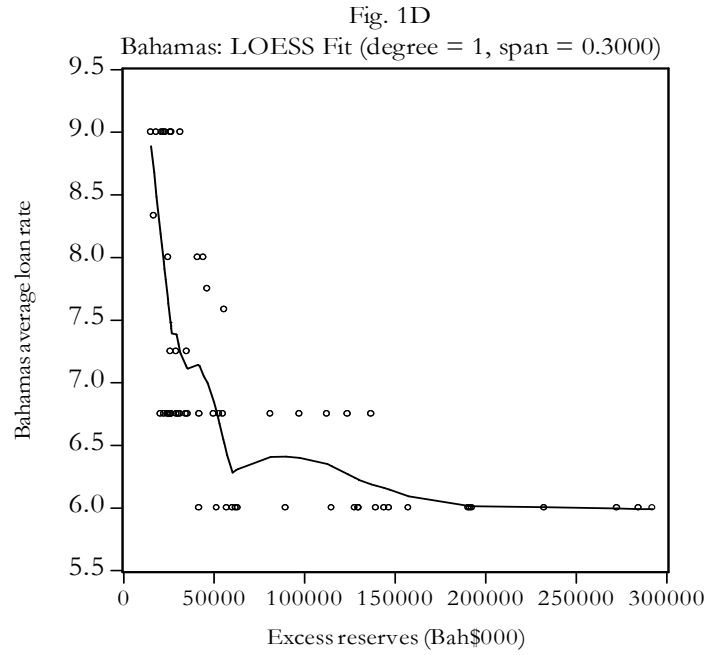
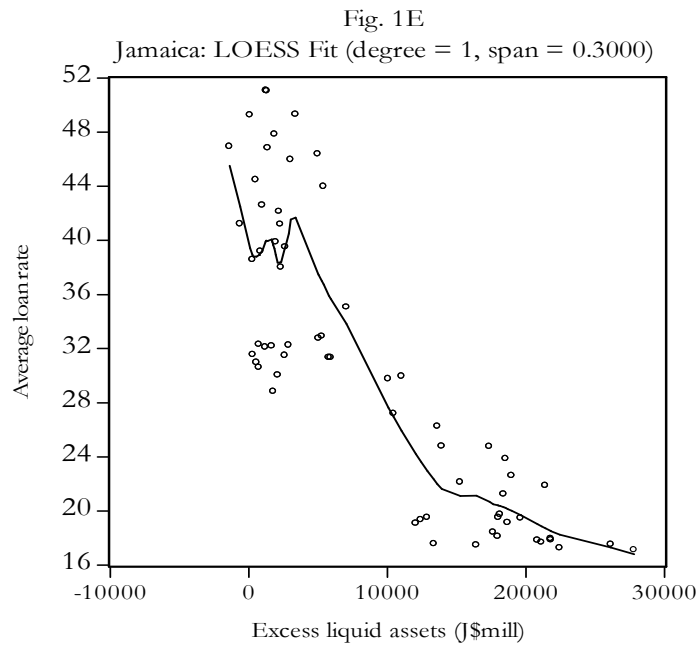


Fig. 1C







## APPENDIX 2

Table 2A: Augmented Dickey-Fuller (ADF) tests

Variable	lags	Intercept		Trend & intercept
		alone	lags	
er	1	-4.55*	1	-3.14
$\Delta$ er	1	-13.59*	1	-13.59*
voler	1	-16.07*	1	-16.49*
fx	1	-8.55*	1	-8.82*
ir	1	-2.33	1	-3.02
$\Delta$ ir	2	-9.62*	2	-9.68*

\*Significant at the 1 percent level.

The optimum number of lags were chosen by Schwarz Information Criterion.

Fig. 2A: Plot of cumulative sum of recursive residuals (CUSUM)

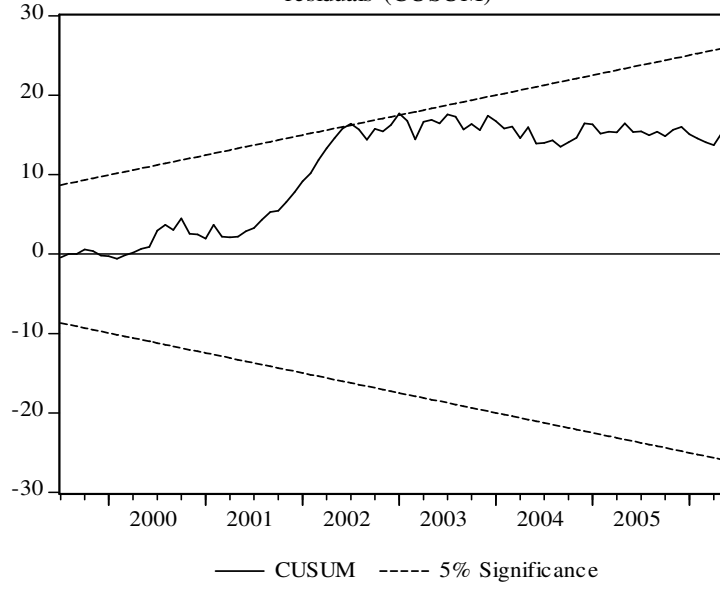


Fig. 2B: Plot of cumulative sum of squares of recursive residuals (CUSUMSQ)

