Foreign exchange market bid-ask spread and market power in an underdeveloped economy

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ABSTRACT

This paper explores the influence of trader (or cambio) market power in determining the foreign exchange market bid-ask spread. It presents a theoretical model that incorporates the notion of oligopolistic market power into the foreign exchange market. The econometric results are consistent with the hypothesis of oligopolistic trader market power. Moreover, the results confirm the prediction of standard market microstructure theory that volatility exerts a positive effect on spread. We also uncovered a positive relationship between liquidity (the quantity of foreign exchange traded) and spread, a result which differs from the existing literature. We interpret this finding to mean that oligopolistic traders set the mark-up exchange rate above where the purely competitive rate would have been so as to generate a surplus of US$ that is then hoarded. The econometric exercise utilizes a unique data set of trading volumes and buying/selling exchange rates for each cambio from January 2000 to December 2007. It must be emphasized early that this data are not order flows. Our data measure realized trading volumes and prices.

Key Words: bid-ask spread, foreign exchange market, GLS

JEL Codes: D43, O11, N16, G10

I. INTRODUCTION

This paper investigates the determinants of the persistent bid-ask spread in the Guyanese foreign exchange market. The large literature that focuses on bid-ask spread concentrates on either equity markets or foreign exchange markets in the advanced developed economies and the large developing or emerging market economies. We present evidence for a small open economy, Guyana, which has undergone significant reforms in its foreign exchange (hereafter FX) regime since 1990.

The theoretical literature suggests a positive relationship between bid-ask spread and volatility (or uncertainty). This positive relationship is formalized in a model developed by Bollerslev and Melvin (1994). There has been much empirical verification of the positive association between spread and volatility. For instance, Boothe (1988) – who presented a seven country comparison – found exchange rate uncertainty as a main determinant of spread. Glassman (1987) found exchange rate risk – modelled as the lagged absolute change in the exchange rate – to be a key determinant. She also found that volume was positively related to bid-ask spread, albeit statistically insignificant in some regressions.

An important paper by Melvin and Tan (1996) qualifies uncertainty as political and social unrest such as riots, demonstrations, strikes and armed attacks. These two authors conclude that FX market spread is positively related to the country risk factors for South Africa. Melvin and Tan also presented cross-sectional evidence for thirty-six countries. Becker and Sy (2006) examined FX market bid-ask spreads during the Asian crisis; their results suggest that exchange rate risk – owing to the rapid depreciation of the Asian currencies – played an important role.

Another theoretical issue pertains to the relationship between trading volumes and volatility. The mixture distribution hypothesis[1] holds there is a strong positive correlation between volatility and unexpected trading volumes. Market microstructure theory[2] implies that inventory costs associated with volume holding position increases as

[1] See Galati (2000) and Mende (2006) for a survey of the literature relating to this hypothesis.

[2] Sarno and Taylor (2001) present a comprehensive review of the market microstructure literature. They delineate the methodology from macro-based theories of the foreign exchange market. Instead of utilizing money demand functions, purchasing power parity theory, interest rate parity theory, and other macro constructs, the microstructure approach analyzes the trading activities of individual participants.

uncertainty rises. Becker and Sy (2006) found that expected volume has a negative effect on spread for four countries out of the eight Asian countries they examined. On the other hand, unexpected volume was found to be positive in six countries. However, their strongest result is the positive association between the conditional variance and spread.

This paper introduces the notion of market power in determining the spread and therefore ultimately the nominal exchange rate. Dealer market power would be important in economies with nascent flexible exchange rate regimes. Especially those underdeveloped economies that have implemented since the late 1980s market-based reforms in the financial sector in general and the FX market in particular[3]. In this paper, we model the FX dealer as a Cournot oligopoly. The dealer (cambio) sets the buying rate (bid rate) to obtain a percentage of the finite stock of foreign currencies that the economy earns from exports, remittances, foreign aid and so on. The selling rate (ask rate) is a mark-up over the buying rate and the marginal cost of doing business. The dealer then either sells the mobilized FX or hoards a percentage. The dealer earns the selling rate when he or she sells or earns the selling rate plus the rate of depreciation of the Guyana dollar vis-à-vis the primary trading currency (the US dollar) when FX is hoarded.

We hypothesize that the representative dealer sets the mark-up exchange rate above what would have been the purely competitive rate. The purpose for doing that is to mobilize an excess supply of FX in order to facilitate investments in foreign assets and even partake in conspicuous consumption. However, it should be noted that the nominal mark-up exchange rate is not a fixed rate; rather it is flexible above the purely competitive rate (see figure 4).

[3] See Galbis (1993) for an examination of foreign exchange market reforms in other developing countries.

The empirical results suggest that spread: (i) is positively related to volatility; (ii) positively related to transaction volume; and (iii) positively related to a measure of market power. Unlike many studies we were fortunate to have access to a unique dataset that comprise of trading volume and the exchange rates for each cambio that operated during January 2000 to December 2007. It must be emphasized early that our data are not order flow data, which measure desired flows. Our data are realized data that do not say anything about desired magnitudes. The paper is structured as follows. Section II outlines the institutional features of the Guyanese FX market. Section III presents the oligopolistic model of the FX trader or cambio. Section IV outlines the econometric methodology. Section V explains our empirical results, while section VI concludes.

II. INSTITUTIONAL FEATURES OF THE GUYANA FX MARKET

The nominal rates of exchange between the Guyanese currency (the Guyana dollar: G$) and foreign currencies is determined in the local foreign exchange market (or the cambio market). This market – and by extension the exchange rate regime – was reformed in 1990 when the parallel exchange rate was merged with the official rate. The current exchange rate regime must be seen within the context of general macroeconomic and financial sector reforms and liberalization since the late 1980s. For an early chronicle of the main foreign exchange reforms see Thomas and Rampersaud (1991), who noted that the nascent market was susceptible to trader pricing power. Das and Ganga (1997) and Egoume-Bossogo et al (2003) situate the reforms – and so too Thomas and Rampersaud – as part of a larger financial liberalization exercise which included interest rate deregulation, the dismantling of directed credit facilities, bank privatization, indirect monetary policy, and various legal innovations to promote financial sector

development. Many other developing countries have followed a similar reform path for their FX market and regime (see Galbis 1993).

The cambio market was established in March 1990. The purpose was to integrate official rate with the parallel or street rate. The official exchange rate was devalued several times to converge to the parallel rate. The cambio market system, therefore, effectively dismantled the government mandated fixed exchange rate regime.

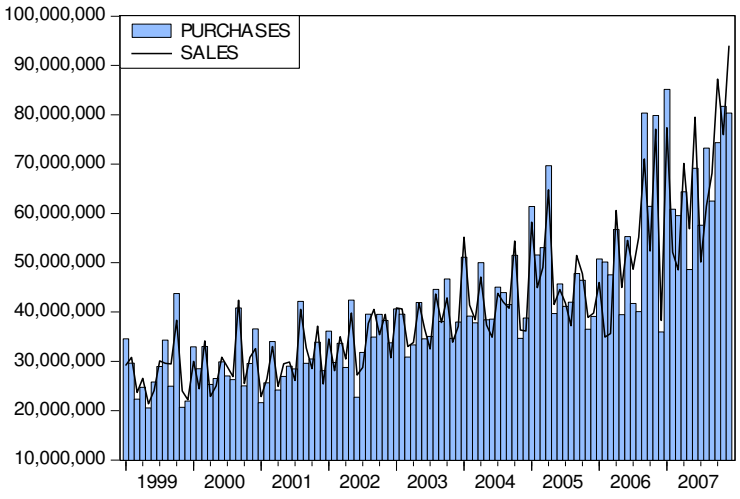
The dealers or cambios – which are given the right to trade by the Bank of Guyana buy and sell the stock of primary foreign currencies; namely the US dollars, but there are also small quantities of Canadian dollars, Euros and the British Pound. As at the end of 2007 the US dollar accounted for 89.8% of total volume trade; while the British Pound accounted for 3.8% thereby representing the second largest volume currency[4]. Figure 1 shows the stock of purchases and sales of FX in the local market since there is no offshore trading of the Guyana dollar (G$). Analysts who collect the trading data believe that the stock reported to the central bank does not represent all hard currencies that pass through the economy. This is because most of the traders are based in the capital city, Georgetown.

The dealers purchase the stock of foreign exchange that is available; and in doing so they establish the buying rate. The source of foreign exchange comes mainly from export earnings, tourism, remittances, foreign aid, central bank sales and underground economic activities. Therefore, the cambios do not control the stock of FX, but rather the buying rate at which they hope to lure hard currencies. The finite stock of FX, in the

[4] These percentages are based on data reported by the Bank of Guyana (Mar 2008) *Statistical Bulletin*.

long-term, is largely dependent on the economic fortunes of the country and therefore it is exogenous to the cambio system.

Figure 1: Trading volumes, 1999-2007 (US$)



Data source: Bank of Guyana

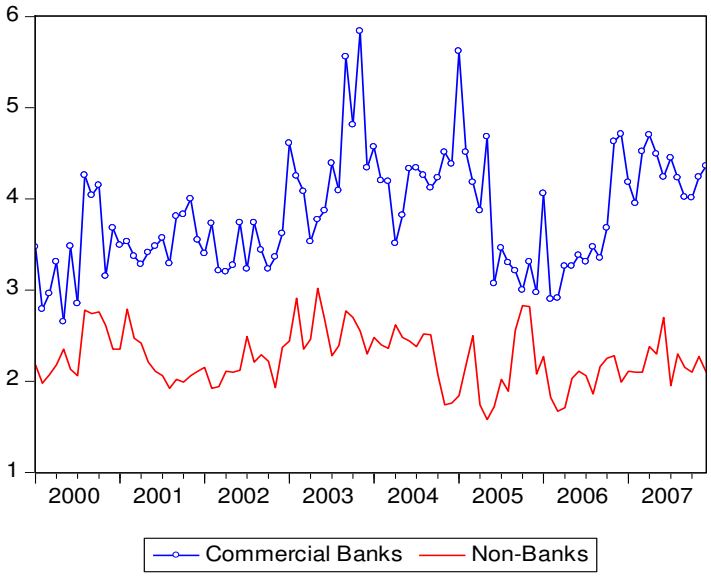
The dealers then sell or hoard the purchased or mobilized quantity of FX. They earn the selling rate if the quantity is sold to the central bank (which has a desire to accumulate international reserves) or sold to potential importers or those who wish to remit hard currencies abroad for various reasons. If foreign currencies are hoarded they also earn the selling rate and the foreign interest rate[5].

The difference between the cambios' buying and selling rates gives the spread, which is presented by figure 2 for both commercial bank and non-bank traders. It is clear the commercial banks have the persistently higher spread. The six commercial banks account for 90% for all trading activities; while the other 10% of FX volume is divided

[5] Khemraj (2008a) found that the level of non-remunerated excess bank liquidity and foreign assets are highly correlated with the level foreign exchange available in the FX market. For instance, when there is a deficit of foreign currencies commercial banks inadvertently accumulate excess liquidity and reduce foreign assets. The opposite occurs when there is a surplus.

among the other fifteen non-bank participants. Figure 3 presents the average market share of commercial bank versus non-bank dealers. This observation, moreover, is consistent with the hypothesis that the spread reflects the role of market power.

Figure 2: Average spreads of bank and non-bank cambios (G$), 2000-2007

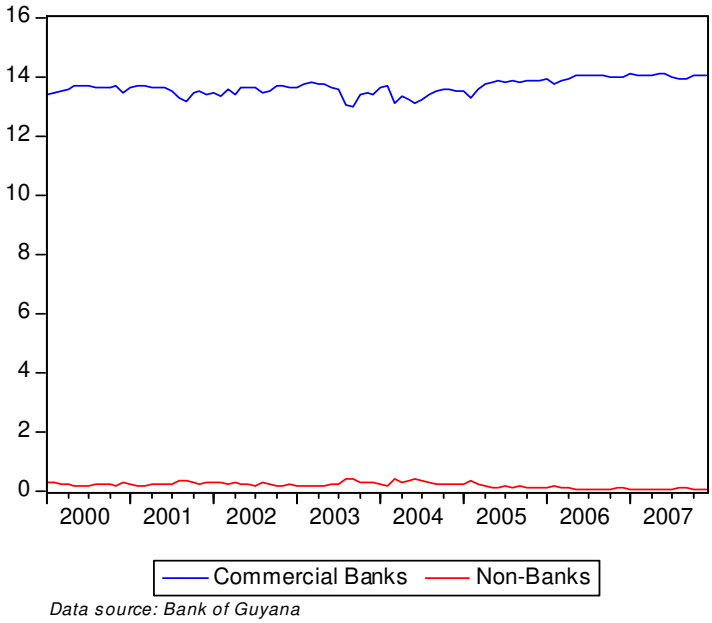


Data source: Bank of Guyana

As at the end of 2007 there were twenty-one cambios – fifteen non-bank cambios and six commercial banks. There are substantial barriers to entry, both legal and institutional. Moreover, the country's capacity to earn foreign currencies provides a natural entry barrier for many dealers. As noted earlier there is a finite stock of FX that allows for the existence of a limited number of profitable participants. The FX market is dominated by three of the six largest commercial banks. There are natural entry barriers inhibiting the entry of new private profit-maximizing commercial banks even though the sector has been liberalized. Hence, the number of participants in the FX market is also limited. This implies the FX market – and the commercial banking sector in general – is not very

contestable; meaning the price does not have to be squeezed to marginal cost as a way to keep out potential entrants.

Figure 3: Average market share of bank and non-bank traders (%), 2000-2007



Data source: Bank of Guyana

III. THEORETICAL FRAMEWORK

Finance theory suggests three primary determinants of bid-ask spreads whether in equity or FX markets. These are cost of dealer services, cost of adverse selection and cost of holding inventory (see Sarno and Taylor 2001). We hope to introduce the idea of market power into the mechanism of foreign exchange bid-ask spread. Therefore, the selling rate is assumed to be a mark-up over the buying rate and the marginal cost of doing business.

The FX dealer must optimize profits within the institutional context that was described in section II. First, there is a scarce and finite stock of foreign currencies (X_B) available to the cambios at any moment. This finite stock of X_B is determined by the

economy's long-term capacity to earn hard currencies. The representative cambio sets the buying rate (e_B) to mobilize a percentage of this finite stock – which is beyond the control of any individual cambio – in order to maximize profits. The public must then accept the buying rate.

Second, the cambio allocates the mobilized X_B into two uses. (i) It sells to those who wish to participate in importation or to the central bank which wants to accumulate foreign currency reserves. When it sells the cambio earns the selling rate (e_S). The nominal selling and buying rates are quoted as G$/US$. The quantity that is sold to the public is represented by X_S. (ii) It hoards a percentage of the foreign currencies. The quantity of hoarding is denoted by *H*. Hoarding gives an expected rate of return of $(\Delta e_S + r_F)p_D + (\Delta e_S + r_F)p_A$; where $\Delta e_S > 0$ signals a depreciation (with probability of depreciation = p_D) and $\Delta e_S < 0$ signals an appreciation (with probability of appreciation = p_A); and $p_D + p_A = 1$.

We model the representative dealer as a Cournot oligopoly. An analogous oligopoly model of the banking firm is presented by Khemraj (2008b). Equation 1 is the representative *i*th cambio's profit function that is concave in (X_S, X_B, H).

$$\Pi_i = e_s(X_s)\cdot X_{si} - e_B(X_B)\cdot X_{Bi} + [(\Delta e_S + r_F)p_D + (\Delta e_S + r_F)p_A]\cdot H_i - C_i(X_S, X_B, H) \quad (1)$$

The dealer faces the following constraint $X_{Bi} = X_{si} + H_i$, which says the mobilized (or purchased) foreign currencies (X_{Bi}) can be sold (X_{si}) to the public or hoarded (H_i). By substituting the constraint into equation 1, we obtain the profit function (equation 2) from which the first-order conditions are derived.

$$\Pi_i = e_s(X_s)\cdot X_{si} - e_B(X_B)\cdot[X_S + H] + [(\Delta e_S + r_F)p_D + (\Delta e_S + r_F)p_A]\cdot H_i - C_i(X_S, X_B, H) \quad (2)$$

$$X_S = X_{Si} + \sum_{i\neq j} X_{Sj}; X_B = X_{Bi} + \sum_{i\neq j} X_{Bj}; H = H_i + \sum_{i\neq j} H_j \quad (2a)$$

In a Cournot equilibrium the *i*th cambio maximizes profit – given by equation 1 – by taking the trading volumes and hoarding quantities of other cambios as given. In other words, the *i*th cambio maximizes equation 2 to obtain the equilibrium quantities (X^*_{Si}, H^*_i). The condition 2a denotes the aggregate quantities available to the system.

The cost function, $C_i(X_S, X_B, H)$, encapsulates the transaction and other costs associated with doing business. In an economy such as Guyana's labour cost, the cost of security (in light of high crimes), cost of electricity (which is one of the highest in the Caribbean and Latin America) and similar factors are likely to drive the traders' cost of production and therefore the exchange rate spread.

<u>The mark-up selling rate</u>

Assume there is a unique equilibrium $X^*_S = X*/N$ where N = the number of cambios. The cambio faces a downward sloping demand curve (in light of the notion of market power) with elasticity of demand of $\varepsilon_S = e_S \cdot X'_S(e_S)/X_S$. The inverse slope condition is given as $e'_S(X_S) = 1/X'_S(e_S)$. Hence, we can now obtain the first condition by differentiating the profit function with respect to X_S. Substitute into the derivative the demand elasticity and the inverse slope. This gives equation 3, which says the selling rate is a mark up over the buying rate plus the marginal cost of doing business.

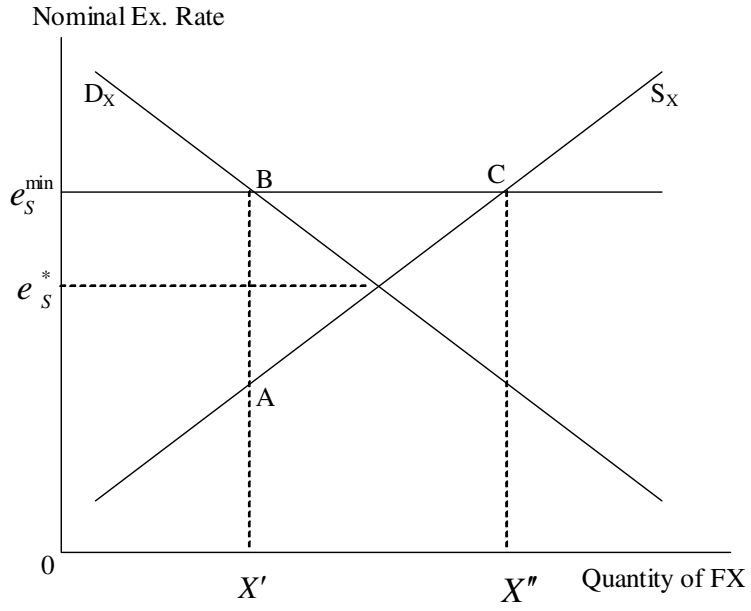
$$\frac{d\Pi_i}{dX_S} = e_S(1 + \frac{1}{N\varepsilon_S}) - e_B - C'_i(X_S) = 0 \quad (3)$$

The extent of the mark-up is dependent on $1/N\varepsilon_S$. The mark-up diminishes as $N \to \infty$ while it is highest when $N = 1$. We argue it is the non contestability of the market which makes this a possibility. Equation 3 gives us an oligopolistically determined selling rate that is above the purely competitive equilibrium exchange rate. This oligopolistic rate is given by the first-order condition above.

We can call the oligopolistic exchange rate a minimum rate ($e_S^{\min}$), which the powerful trader sets above the pure rate e_S^*. The pure rate clears the market at which point $D_X = S_X$. D_X = the society's demand curve for the economy's finite stock of FX; while S_X = the economy's supply curve of the finite stock of FX. $e_S^{\min}$ is set above e_S^* because the dealer (s) with market power would like to mobilize as much as possible the finite FX; the higher the mobilization the greater the possibility to hoard. At the purely competitive rate marginal cost is equal to marginal revenue [$e_S^* = e_B + C'(X_S)$]; while the minimum exchange rate is given by $e_S^{\min} = [e_B + C_i'(X_S)]/(1 + \frac{1}{N\varepsilon_S})$.

Figure 4 summarizes the basic ideas. $e_S^{\min}$ is not a fixed rate but rather a flexible rate that can fluctuate above the pure exchange rate. However, the trader is more likely to depreciate the rate rather than appreciate it. This rate allows the dealers to mobilize $0X'' - 0X'$ amount of the stock of FX. This is amount that is hoarded in the post-liberalization environment.

Figure 4: A model of the FX market



Hoarding does not only occur in a liberalized setting, however. It also occurs when government induces a fixed rate on the economy[6]. Assume this rate was set below the pure rate at, say, point A in figure 4. That creates a blackmarket rate (parallel exchange rate at B). At the parallel rate, B, there is also hoarding of the same amount $0X'' - 0X'$. What happens, basically, is hoarding is now legitimized by the reform agenda. The laws and reforms of the society now take the conduit of hoarding from the parallel market to the licensed cambio market.

We have noted above that the mark-up rate can change when there is an upward or downward shift in the flat line at e_S^{min}. But the minimum rate can also change when demand and supply shocks cause the pure rate to overshoot e_S^{min}. Given the assumption that $e_S^{min} > e_S^*$ we would expect the oligopoly rate to once again adjust above e_S^*. For

[6] In the Guyanese context this would be the pre-1990 era.

instance, a negative supply shock, *ceteris paribus*, which breaches the threshold point *B* will cause an upward adjustment in the minimum rate. Similarly, a positive demand shock, *ceteris paribus*, which breaches threshold point *C* will also engender a similar upward adjustment. In light of the assumption that bank and non-bank cambios set the mark-up rate above the competitive rate, the initial overshoot of the competitive rate over the mark-up rate will lead to an upward jump in the latter as traders again settle into a new threshold[7]. Central bank interventions could shift both the supply and demand curves. Notice, however, the interventions are only effective after a certain threshold is superseded. The supply curve can also shift owing to shocks to export earnings and remittances.

The optimum level of hoarding

Differentiating equation 2 with respect to *H* gives equation 4, which says the cambio chooses *H* at the point where the expected return equals the buying rate plus marginal cost of hoarding. Moreover, we can obtain a general expression for the buying rate from equation 4.

$$\frac{d\Pi_i}{dH} = -e_B + [(\Delta e_S + r_F)\, p_D + (\Delta e_S + r_F)\, p_A] - C_i'(H) = 0 \qquad (4)$$

By rearranging equation 4 we can obtain a general expression for the buying rate

$$e_B[p_D, r_F^*, C_i'(X_S)] \qquad (5)$$

Where: $r_F^* = \Delta e_S + r_F$ (the return on holding foreign based assets); $e_B'(p_D) > 0$, $e_B'(r_F^*) > 0$ and $e_B'[C_i'(X_S)] < 0$.

[7] The time series econometric identification of the supply and demand shocks and the inherent asymmetric effects on exchange rate (for various developing countries) is the subject of another paper.

IV. ECONOMETRIC AND DATA ISSUES

We follow an econometric procedure proposed by Litzenberger and Ramaswamy (1980; 1979) in which the generalized least squares (GLS) estimator is obtained. This methodology, which is used extensively in cross-sectional studies that examines stock returns, was adopted in this paper owing to the availability of granular data on the trade of foreign currency in Guyana. We were fortunate to have access to data on the purchase and sale of foreign currency based on individual market dealers.[8] The methodology was also used my Datar et al (1998). The outline given below is similar to that used by Datar et al. However, we utilize the methodology for the foreign exchange market, while Datar et al examined stock returns. Moreover, this econometric procedure is employed because the GLS estimator is usually more efficient than the ordinary least square (OLS) and generalized method of moment (GMM) estimators.[9]

The econometric procedure proposed by Litzenberger and Ramsawamy can be divided into three stages.[10]

Stage one: during this stage, the bid-ask spread is regressed on the liquidity conditions in the foreign exchange market, the volatility associated with the mobilization of foreign currency and the proxy for market power of each cambio. In particular, the

[8] To the authors' knowledge, all of the previous studies on the bid-ask spread of the foreign exchange market were based on aggregated data, i.e., data that captures the operation of the entire foreign exchange market.

[9] See for instance Brennan and Subrahmanyam (1996), Amihud and Mendelson (1986), Davidson and MacKinnon (2004) and Greene (2003).

[10] See for instance Brennan and Subrahmanyam (1996), Amihud and Mendelson (1986) and Datar et al (1998).

regression model (equation 6) is estimated using cross-section methodology for each month in our sample period, i.e., January 2000 to December 2007[11].

$$BAS_{i,t} = \beta_1 + \beta_2 LIQ_{i,t} + \beta_3 LIQ_{i,t-1} + \beta_4 VOL_{i,t} + \beta_5 VOL_{i,t-1} + \beta_6 MKP_{i,t} + \varepsilon_{i,t} \qquad (6)$$

where $BAS_{i,t}$ is the bid-ask spread of cambio *i* at time *t*; $LIQ_{i,t}$ and $LIQ_{i,t-1}$ represent the liquidity of foreign exchange holdings of each cambio at time *t* ant *t-1* respectively; $MKP_{i,t}$ is the relative market power of each cambio *i* at time *t*; $VOL_{i,t}$ and $VOL_{i,t-1}$ represent the volatility associated with mobilizing foreign currency by each cambio at time *t* and *t-1* respectively; and $\varepsilon_{i,t}$ is the stochastic error term.

The cross-sectional models are estimated using ordinary least squares. Given the nature of the estimation technique used at this stage, it is possible that the standard errors our models may be under/over-estimated due to the presence of extreme data. Therefore, White's heteroskedasticity-robust procedure is employed to correct for heteroskedasticity. This technique is particularly useful when the form of heteroskedasticity is unknown.[12]

Stage two: the second stage of the exercise involves computing the weighted average coefficients (or GLS estimators) for the entire sample period based on equation (7) below.

$$\hat{\beta}_k = \sum_{t=1}^{T} W_{kt} \hat{\beta}_{kt} \qquad (7)$$

Where:

[11] Over the period of analysis there were twenty-four cambios in 2000 and 2001; twenty-three cambios in 2002; and twenty-one cambios for the period 2003 to 2007. Out of the total number seven were commercial banks from 2000 to 2003, while six commercial bank cambios existed from 2004 to 2007.

[12] See White (1980) and Wooldridge (2002) for a comprehensive discussion of the White's estimator.

$\hat{\beta}_k$ = weighted average of each of the estimated $\hat{\beta}_{kt}$ (or the GLS estimators) for the entire sample period.

$\hat{\beta}_{kt}$ = the estimated betas for each month obtained from the first-step regression.

W_{kt} = the weight of each beta defined according to:

$$W_{kt} = \frac{[\text{Var}\,(\hat{\beta}_{\text{kt}})]^{-1}}{\sum_{t=1}^{T}[Var(\hat{\beta}_{kt})]^{-1}}$$

Where:

$[Var(\hat{\beta}_{\text{kt}})]^{-1}$ = the inverse of the variance obtained for the estimated betas for each time period.

$\sum_{t=1}^{T}[Var(\hat{\beta}_{kt})]^{-1}$ = the sum of the inverse of the variance over the entire sample period

The standard errors from the first-step regression are used to compute the variance associated with the estimated betas.

The statistical significance of the estimated betas is determined using t-statistics computed as follows:

$$t-ratio = \frac{\hat{\beta}_{\text{k}}}{\sqrt{Var\left(\hat{\beta}_k\right)}} \qquad (8)$$

where: $Var(\hat{\beta}_k) = \sum_{\text{t=1}}^{\text{T}} W^2{}_{kt} Var(\hat{\beta}_{kt})$

Stage three: the final stage of the exercise involves checking the robustness of our results. This is done by computing the GLS estimator for different time periods and testing the statistical significance of these estimators using the *t-statistics* above. Following Datar et al (1998) we divide our sample into two equal non-overlapping sub-

periods and compute the GLS estimator. The GLS estimator for each sub-period is then examined to determine whether they are stable over time.

Data Issues

The study utilizes a dataset which comprise of weekly data on the purchase and sale of US dollar (US$) by all the cambios that operated from January 2000 to December 2007. In order to preclude survivorship bias, we did not exclude dead cambios from our sample. Specifically, we take weekly data from the Bank of Guyana on the trade of US$ by each trader (cambio) to construct appropriate proxies to determine the impact of liquidity, risk and market power on the bid-ask spread. This unique dataset provides us with the opportunity to employ the GLS estimation technique. Using our dataset we construct the bid-ask spread ($BAS_{i,t}$) for each cambio i by subtracting the buying-rate (e_B) from the selling-rate (e_S) of the US$.

The liquidity variable, LIQ, is defined as the ratio of foreign currency sold (X_S) to the stock of foreign currency at hand (that is, the foreign currency purchased X_B plus the amount which is hoarded H). It is important to note that this variable does not only capture the rate at which foreign currency is being disposed of after it is mobilized but it also reflects the mismatch between the demand for foreign currency and the amount available at each cambio at different time intervals. To the extent that the market dealers are desirous of disposing of foreign currency we would expect that in periods of high liquidity (i.e., when the amount of foreign currency available is relatively higher than the amount being demanded by investors) the spread should be set at a low level to encourage higher sales. However, if the market dealers are intent on hoarding foreign currency, we would expect the reverse to hold true, i.e., in periods of high liquidity the

spread and by extension the US$ exchange rate will be higher to discourage investors from purchasing US$. In line with our reasoning, we expect the *LIQ* variable to exert a negative effect on the *BAS* if the intention of the market dealers is to use the mobilized foreign currency for the purpose of re-selling. Where the intention of the market dealers is to hoard the mobilized foreign currency a positive relationship between the *LIQ* variable and *BAS* is expected. In our model the *LIQ* variable is introduced contemporaneously and with a lag of one month.

We test the notion of market power, *MKP*, by creating a dummy that captures the market share of each dealer[13]. In this study we make the explicit assumption that a bigger cambio possesses more power to increase the spread. To construct this dummy, we first identify the average market share of each cambio[14]. The average market share is then compared with the actual market share of each trader and a value of one is assigned if the latter is greater than the former. Otherwise a value of zero is assigned. Given the manner in which this variable is constructed it is important to note that it does not necessarily represent the absolute size of the market dealer but the relative size (or market shares) of each dealer for different time periods. Based on our proposition that the spread increases with market power, we expect a positive relationship between *MKP* and the *BAS*.

To test the impact of risk we construct a variable which captures the volatility (*VOL*) associated with the mobilization of foreign currency (X_B). Since there is little variation in the nominal buying and selling rates for the US$ we focus on the volatility

[13] We used a dummy variable instead of the actual percentages to circumvent the problem of extreme values in the actual percentage shares.

[14] The other side of this argument is larger traders and banks earn economies of scale and therefore are able to offer lower spreads. We have noted that the Guyanese financial system has significant entry barriers, thus price is not squeezed to marginal cost.

associated with the volume of foreign currency mobilized by the cambios[15]. In particular, we measure volatility by taking the standard deviation in the weekly sale of foreign currency (X_S) of each cambio. This variable is introduced contemporaneously and with a lag of one month. Consistent with previous studies we expect a positive relationship between this risk proxy and the *BAS* at time *t* and *t-1*.

Table 1 provides the summary statistics of the variables used in our regression model. These statistics were computed after pooling our dataset for the entire sample period (that is, from January 2000 – December 2007). Based on Table 1, the bank-cambios are relatively larger and usually maintain higher spreads than their non-bank counterparts. This evidence is consistent with our hypothesis that size promotes greater market power and ability to maintain larger spread.

The volatility associated with the foreign currency mobilized by the bank cambios is also higher than that of non-bank cambios suggesting that the former is exposed to more risk in mobilizing foreign currency when compared to the latter. However, the turnover rate of the non-bank cambios is higher than those of the bank cambios even though the latter undertake larger volumes of transactions. This probably suggests that non-bank cambios are more inclined at disposing foreign currency rather than hoarding same.

[15] The measure of volatility was computed from trading volumes instead of the buying or selling rate because volume exhibited more variability. Also as noted the exchange rate is a mark-up rate and thus it is not exogenous to the traders. Volume we have noted is exogenous to the traders and dependent on the economy's capacity to earn FX.

Table 1: Summary Statistics – January 2000 to December 2007

Descriptive Statistics	Commercial Bank Cambios				Non-Bank Cambios			
	$BAS_{i,t}$	$MKP_{i,t}$	$VOL_{i,t}$	$LIQ_{i,t}$	$BAS_{i,t}$	$MKP_{i,t}$	$VOL_{i,t}$	$LIQ_{i,t}$
Mean	3.83	13.66	0.98	0.46	2.25	0.22	0.51	0.78
Median	3.76	13.64	0.85	0.44	2.21	0.23	0.47	0.80
Maximum	5.84	14.12	3.71	0.81	3.02	0.46	1.42	0.93
Minimum	2.65	12.98	0.30	0.15	1.58	0.06	0.21	0.42
Std. Dev	0.62	0.27	0.53	0.15	0.31	0.09	0.22	0.10

Where:
$BAS_{i,t}$ = the bid-ask spread of each cambio at time *t*.
$MKP_{i,t}$ = the relative market share of each cambio at time *t*.
$VOL_{i,t}$ = the volatility associated with the mobilization of foreign currency by each cambio at time t.
$LIQ_{i,t}$ = the turnover rate of foreign currency obtained each trader at time *t*.

V. DISCUSSION OF RESULTS

During the estimation stage, we estimated several cross-sectional regression models of the *BAS* on the *MKP*, *LIQ* and *VOL* individually and jointly. These models were estimated for each month of our sample period starting from January 2000 to December 2007. The coefficients of these models were then aggregated across time using equation 7 to obtain the GLS estimator, while the t-statistics were obtained by equation 8.

Table 2: Regression results

This table shows the GLS estimates obtained by computing the average slopes of various monthly cross-section regression models of *BAS* (bid-ask spread) on *MKP* (market power), *LIQ* (liquidity) and *VOL* (risk). The GLS estimators and associated t-statistics (in parentheses) are computed based on the methodology in section IV. The monthly cross-section regression models are estimated with the dependent variables individually and jointly using the equation below and data for the entire sample period (from January 2000 December 2007.

	Constant	MKP	$LIQ_{i,t}$	$LIQ_{i,t-1}$	$VOL_{i,t}$	$VOL_{i,t-1}$
			Entire Sample			
Model 1	1.40	2.20				
	(9.62)*	(7.83)*				
Model 2	1.24		0.22			
	(6.02)*		(2.25)**			
Model 3	1.25			0.05		
	(5.97)*			(1.77)***		
Model 4	1.54				0.55	
	(10.22)*				(5.71)*	
Model 5	1.53					0.58
	(10.38)*					(5.17)*
Model 6	0.46	2.13	0.48			
	(3.48)*	(7.53)*	(3.39)*			
Model 7	1.37	2.06			0.05	
	(9.43)*	(6.08)*			(0.62)	
Model 8	0.86		0.22		0.49	
	(4.71)*		(2.55)**		(5.43)*	
Model 9	0.45	2.13	0.20		0.05	
	(3.34)*	(6.53)*	(2.42)*		(0.62)	

*, ** and *** imply statistical significance at the 1%, 5% and 10% levels respectively.

Table 2 summarizes the results of the aggregated coefficients and accompanying t-statistics for the entire sample period. Based on the results, the *LIQ* variable is significantly and positively related to the *BAS* indicating that the market power of foreign exchange dealers is an important determinant of the *BAS*. This evidence also provides support to our earlier observation that bank cambios (which are the large cambios) charge relatively higher spread than their non-bank counterparts (the small cambios).

The results also suggest that *LIQ* has a strong positive contemporaneous relationship with the *BAS*, indicating that higher liquidity in the foreign exchange market

leads to larger spreads. While our evidence is inconsistent with the evidence in the existing literature it is consistent with our proposition that the market dealers are motivated by the desire to hoard foreign currency. In other words, our evidence is suggesting that whenever the demand for foreign currency is relatively high the market dealers are likely to increase the spread. This may have the effect of increasing the minimum selling rate above the purely competitive rate, consequently discouraging investors from purchasing the US$. Furthermore, the relationship between the turnover rate variable with a one month lag has a positive relationship with the *BAS* but is insignificant.

The results provide mixed evidence with respect to the relationship between the volatility in the level of transactions and the *BAS*. There is a significant positive contemporaneous relationship between volatility and *BAS* in models 4 and 8. This can be interpreted to mean that the spread is likely to be larger in periods where there is greater volatility in the level of transaction. We find that the volatility in the past period is also positively and significantly related to the *BAS* in model 5. This means that *BAS* is influenced by the volatility in the level of transactions in the previous month. However, while the volatility variable is positive in model 6 and 9 it is insignificant.

Table 3: Regression results (GLS estimates)

Panel A contains the results of the dataset for the first sub-period from 2000 to 2003 while panel B shows the results for the second sub-period (i.e., from 2004 to 2007).

	Constant	MKP	$LIQ_{i,t}$	$LIQ_{i,t-1}$	$VOL_{i,t}$	$VOL_{i,t-1}$
Panel A: Sub-sample (2000 - 2003)						
Model 1	1.48	2.01				
	(7.29)*	(5.64)*				
Model 2	1.20		0.76			
	(4.08)*		(2.43)**			
Model 3	1.25			0.39		
	(4.15)*			(2.32)**		
Model 4	1.63				0.61	
	(7.82)*				(4.18)*	
Model 5	1.62					0.71
	(7.78)*					(4.15)*
Model 6	0.34	1.92	0.91			
	(1.99)**	(5.35)*	(3.40)*			
Model 7	1.46	1.85			0.04	
	(7.03)*	(3.97)*			(0.33)	
Model 8	0.85		0.68		0.50	
	(3.09)*		(2.27)**		(3.67)*	
Model 9	0.44	2.02	0.99		0.03	
	(2.19)*	(4.51)*	(3.66)*		(0.21)	
Panel B: Sub-sample (2004 - 2007)						
Model 1	1.31	2.50				
	(6.30)*	(5.50)*				
Model 2	1.28		0.16			
	(4.43)*		(2.30)**			
Model 3	1.25			0.05		
	(4.29)*			(1.64)***		
Model 4	1.44				0.50	
	(6.60)*				(3.93)*	
Model 5	1.44					0.48
	(6.90)*					(3.23)*
Model 6	0.65	2.49	0.31			
	(3.07)*	(5.40)*	(2.54)**			
Model 7	1.29	2.30			0.05	
	(6.31)*	(4.66)*			(0.53)	
Model 8	0.87		0.18		0.48	
	(3.55)*		(2.80)*		(4.00)*	
Model 9	0.66	2.27	0.39		0.07	
	(3.06)*	(4.74)*	(2.42)**		(0.84)	

*, ** and *** imply statistical significance at the 1%, 5% and 10% levels respectively.

As a robustness check, we divide our sample into two equal non-overlapping periods and aggregate the coefficients using the methodology that was described. Table 4

provides the results from this exercise. The results are not significantly different from those we obtain from looking at the entire sample period. In particular, we find that the slope coefficient of *LIQ* remains positive and highly significant in both sub-periods. The *BAS* is also positively and significantly related to *MKP*. The same can be said for the volatility in the level of transaction during the current and past periods. Also, the magnitudes of the slope coefficients are not significantly different between the two sub-periods.

VI. CONCLUSIONS

In this paper we used the GLS methodology to ascertain the factors that determine the *BAS* of the G$/US$ exchange rate. We found that the spread is affected by the volatility in the level of transactions during the current and past period. In particular, the evidence suggests that higher volatility leads to higher spread. We also uncovered a significant positive relationship between *MKP* (the proxy for market power) and the spread. This is an indication that there is segmentation in the foreign exchange market, whereby large cambios (the commercial banks) are able to set higher spreads and consequently dictate the nominal exchange rate.

The level of liquidity in the market also affects the spread. Our evidence suggests that the *BAS* tends to be wider during periods when there are high levels of transaction (or liquidity) in the market. While this evidence is inconsistent with the existing literature in financial economics, it is consistent with our proposition that the market dealers are motivated by the desire to hoard foreign exchange. The robustness testing, using different sub-periods, confirms that our results are consistent over time. Our findings led

us to propose a theoretical model of the foreign exchange market in which the oligopolistic mark-up rate is placed above the purely competitive rate.

For future research we intend to identify the foreign exchange supply and demand shocks and then test to determine whether the shocks have asymmetric effects on exchange rate dynamics. Such asymmetric effects would be consistent with the notion of a sticky oligopolistic exchange rate.

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