



## **BID-ASK SPREADS IN THE FOREIGN EXCHANGE MARKETS OF SELECTED CARIBBEAN COUNTRIES**

By

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### **1.0 Introduction**

At the beginning of the 1990s a number of Caribbean countries sought to liberalise their foreign exchange markets<sup>1</sup>. This involved the elimination of exchange controls, the removal of restrictions on both the current and capital transactions, the widening of the number of market players in the foreign exchange markets (brokers (inter-dealers), dealers and cambios) and the move from a fixed to a floating exchange rate regime. These developments were precipitated by the severe imbalances that had built up in these economies in the 1980s, especially with respect to the over-valuation of the foreign exchange rate and the huge imbalances between demand and supply in the foreign exchange markets in these jurisdictions. This resulted in “black markets” for foreign exchange where foreign exchange transactions were executed at a much more realistic exchange rate and where the efficiency was higher in terms of the smaller bid-ask spreads on foreign exchange.

The reform of the foreign exchange market represented a fundamental change in the way some of these markets in the region were organized. It meant that the way agents in the foreign exchange market behaved was now driven more by considerations such as the effective demand and supply of foreign exchange and less by rationing and proscribed spreads. Very importantly also the market was now increasingly driven by competition for the sale and purchase of foreign exchange which implies that bid-ask spreads should fall. These developments raise issues that center on the microstructure of this market how this impacts on the efficiency and liquidity of the market.

The issues that are addressed in the market microstructure literature include trading infrastructure, decentralisation, the heterogeneity of agents in the market, the size and liquidity of the market, the efficiency of the clearing mechanism, the relationship between the spot and derivative market, how information flows affect the functioning of the market, how micro-structural features affect the bid-ask spreads in the market and the impact of these factors on the pricing efficiency, liquidity and stability of the market.

The size of foreign exchange markets in the Caribbean countries and the importance this market to the efficiency of economies in the region warrants a closer look at the market microstructure of these markets in the region the impact it has on the efficiency and liquidity in these markets. In particular, the bid-ask spreads in these markets could be considered an indicator of the transactional efficiency of the market which have a profound impact on returns to agents in the financial market and the economy in general. High spreads can in fact negatively affects the willingness of agents to trade in the market, which in turn, hampers the liquidity, efficiency and development of the market. In spite of this fact, however, this issue has not received the attention it deserves in the Caribbean.

In this context, this paper attempts to help fill this gap in our understanding of these issues by exploring one of the more important aspects of the microstructure of Caribbean foreign exchange markets – that of the behaviour of bid-ask spreads in this market and the factors that drive the spread in selected Caribbean countries. The paper is structured as follows. Section 2 reviews the theory of market microstructure especially as it pertains to the determinants of the bid-ask spreads. Section 3 reviews the evolution of the microstructure of the foreign exchange market in select Caribbean countries. Section 4 looks at some stylized facts on bid-ask spreads in the foreign exchange market and attempts to decompose the main determinants of the spread in select

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<sup>1</sup> Guyana and Jamaica started the process of liberalization in 1990 while Trinidad and Tobago started its programme of liberalization a little later in 1993.

Caribbean countries. Section 5 concludes by highlighting some policy implications that flow from the theory, as well as the experience and the performance of these markets.

## 2.0 Market Microstructure Theory

One possible definition of market microstructure is the one used by O'Hara (1995, p. 1) which states "Market microstructure is the process and outcomes of exchanging assets under explicit trading rules". Admati (1991 p. 355) defines market microstructure as "the literature on asset markets with asymmetric information and especially on trading mechanisms". Microstructure therefore focuses on the mechanics of trading and how these affect the price formation process. The term market microstructure was first used by Garman (1976) to describe the transactions based nature of realistic exchange processes. German examined dealership and auction market-maker models and how bid-ask spreads, inventories of market-makers and the degree of market power of the market-makers interacted with each other to affect outcomes in the market.

The two main strands of the market microstructure literature include the inventory based and information economics based models. Much of the literature in both strands focuses on the problem facing intermediaries of determining market-clearing prices. The inventory-based models essentially look at how price forms based on order flow and the market clearing protocol. There are three distinct approaches to inventory based models. The first strand of this research started by Garman (1976) is based on the impact order flow has on trading prices. The second strand looks at the dealer optimization problem (Stoll (1978), Ho and Stoll (1981)). The third strand is based on the impact multiple dealers has on liquidity and prices (Cohen, Maier, Schwartz and Whitcomb (1981)). The single unifying factor in these approaches is the uncertainty in order flow, which result in inventory and execution problems. This approach therefore boils down to how prices is set by dealers in different settings and how these prices change as we introduce different types of uncertainties.

An alternative approach to the market-clearing price is based on the impact of asymmetric information, the origins of which can be located in a simple paper by Bagehot (1971). This approach is based on the information dichotomy between informed and liquidity/uninformed traders (Copeland and Galai 1983); models where the superior information of informed traders mean that their trades could signal the underlying value of the asset and affect the behavior of prices and how prices respond to information flows (Glosten and Milgrom 1985, Easley and O'Hara 1987); models that look at the strategic behaviour of traders that incorporate expectations about market-makers' pricing strategy (Kayle 1985); and models which look at the strategic behaviour of uninformed traders an prices (Admati and Pfleiderer 1988). The information-based approach has helped to improve our understanding of markets by focusing on the information implicit in market data and the Bayesian learning process that translates this information into prices. The information-based approach is especially useful because they allow for the examination of market dynamics and strategic behavior from informed and uninformed traders.

This study focuses on the bid-ask spread in the foreign exchange market and the factors driving the spread, therefore, the strand of the market microstructure literature that deals specifically with the determinants of bid-ask spreads in the market is outlined in a little more detail here. In the case of factors driving the bid-ask spreads, market microstructure theory is driven by information and inventory costs dynamics as outlined above and identifies three main determinants: The cost of dealer services related to order processing, the cost of information asymmetries to market makers (adverse selection) and the cost of holding inventory. In each of these cases trading volume plays a critical role.

Order processing microstructure models often assume that there is fixed cost in market making, these costs would for example be due to subscriptions to electronic information and trading systems, the costs of acquiring or training suitable personnel and the costs associated with meeting certain prudential requirements. Demsetz (1968) actually characterized this as the costs of providing "predictable immediacy" for which agents in the market are willing to pay. The ability to execute either buy or sell transactions immediately suggests that this is inextricably linked to liquidity. In a busy market, a constant stream of agents willing to buy or sell creates "predictable immediacy" or enhances the liquidity of the market as a by-product of their activities. Market makers by offering to execute transactions at prices (bid and ask prices) on both sides (buying or selling) facilitate this process and the fixed costs related to providing these services are reflected in the bid-ask spreads in the market.

The level of fixed cost of market making that can be extracted from agents is, however, constrained by competition in the foreign exchange market. Competition from other market makers and dealers tend to force market makers to lower their spreads to avoid losing business. Hence fixed costs of market maker services and the level of competition (number of market makers and dealers) would tend to drive spreads in the market (Stoll 1978, Cohen, Maier, Schwartz and Whitcomb 1981, Black 1991).

Information costs models are based on the arrival of new information or the presence of agents with better information than market makers and, the impact these factors have on the bid-ask spread. Bagehot (1971) was the first to examine bid-ask spreads in the framework of information-based models. His model was based on the existence of two type of agents in the market: liquidity traders (uninformed agents) who were willing to pay the costs of "predictable immediacy" and informed agents who possess inside information and can speculate at the expense of the market maker. The market maker cannot distinguish between these two types of agents and must therefore charge everyone a wider spread to compensate from losses arising from trading with the informed agents. This adverse selection type model basically posits that the arrival of new information is positively related to bid-ask spreads (Copeland and Galai 1983, Glosten and Milgrom 1985, Kyle 1985). The problem with this approach is that empirical estimation requires data on the rate of information arrival and the proportion of informed trading relative to overall trading, which are both unobservable. This problem has been addressed in the literature by using unpredictable foreign exchange trading volume or unpredictable price volatility as proxies for information arrival (Easley and O'Hara 1992, Jorion 1996 and Hartmann 1998).

The bid-ask spread is also driven by inventory costs considerations. Barnea and Logue (1975) were the first to introduce the notion of inventory carrying costs which view market makers not only as providers of liquidity services but also as optimizers of their own portfolios. In this framework they try to choose the risk/return dynamics of their portfolios in such a way as to maximize their utility. Holding an inventory of foreign exchange may be risky because the holder is exposed to the risk of depreciation in the value of the asset and because there are costs associated with holding inventory such as funding costs (Bessembinder 1994). The bid-ask spread is therefore regarded as a the premium for market makers as compensation for the risk they take on and the potential costs inherent in holding an open position in foreign exchange. In the simplest versions of the inventory costs model, the optimal inventory is zero and a constant spread is shifted up or down to equalize the probability of receiving a purchase order with the probability of receiving a sale order. The result is that the expected change in inventory is always equal to zero and inventory levels follow a random walk. An undesirable characteristic of the random walk model of inventory is that it inevitably leads to the bankruptcy of the market maker.

This is so because capitalization requirements impose upper and lower bounds on inventories and since inventories follow a random walk, market makers will reach these bounds in a finite number of trades (Ross 1983).

The more advanced dynamic inventory optimization models deals with this weakness by arguing that market makers optimize their bid-ask prices over time in the face of order flow which follow a random walk, by adjusting bid and ask prices downwards (upwards) and increasing the spread when a positive (negative) inventory is accumulated (Stoll 1978, Amihud and Mendelson 1980, Sirri 1989). In these models, larger transaction sizes will push the market maker further away from his desired portfolio and thus widen the spread. On the other hand, if order flow is expected to come in many small independent orders, then by the scale effects increased (predictable) order flow would tend to decrease spreads. This implies therefore that unpredictable order flow increase spreads but predictable order flow decrease spreads.

Market makers (in most cases commercial banks) in the foreign market take positions in foreign currencies for a range of business activities in which they are engaged including loans to business customers and market making in derivatives. Since currency positions are taken for reasons other than market making, the identification of inventory carrying costs relevant to the provision of immediacy in the spot foreign exchange market is complicated. A bank can promise to provide immediacy to its clients by holding a liquid inventory of currencies and/or by purchasing liquidity from other market participants. Holding a currency imposes opportunity costs and the risk of depreciation in value. Opportunity cost arise because the interest rate which can be earned on highly liquid holdings of foreign currency is less than the rate that can be earned on holdings of less liquid securities. The alternative to maintaining liquid holdings of foreign currencies is to purchase these holding from other market participants or from correspondent banks for which there are costs (Bessembinder 1994). In the first case, market makers have to bid on the open market for the funds, the costs of which are proxied by the bid ask prices of the other market makers. In the second case, the costs are in the form of interest rate and closing costs. Moreover, these costs may increase over non-trading intervals such as weekends and public holidays because the opportunity costs increases as the inventory is held for more days and the risk of depreciation is greater since the bank cannot unbundle positions during these periods since the market is not open.

It is clear from the above review of the literature that the order processing costs, information asymmetry cost and inventory carryings costs strands of the market microstructure literature on the determinants of the bid-ask spread are inter-related. For example, in some cases it is very difficult to distinguish between order processing costs and inventory carrying costs. In the case of information asymmetry costs, spreads are likely to increase as new information come into the marketplace but the volatility that this causes also impact on inventory carrying costs. The relationship between volume and volatility in the microstructure setting is driven by agent heterogeneity and asymmetric information where informed traders gain at the expense of uninformed traders or customers who trade to eliminate exposure, especially when new information flow into the market. This is related to the mixture of distributions hypothesis (MDH) outlined by Easley and O'Hara (1992). In this framework volume and volatility in prices are positively related because both aggregates are driven by common dynamics as new information comes into the market during normal periods (Frankel and Froot 1990, Tauchen and Pitts 1983), however, during periods of market turmoil traders withdraw from the market and there is a negative relationship (Galati 2000). The greater volatility in the run up to non-trading periods is also driven by the greater sensitivity of prices to liquidity before non-trading periods as traders try to reduce their exposure to avoid high inventory cost over these periods (Lyons 1995).

Consolidating all the strands of the literature one can therefore argue that the spread is driven by the risk of depreciating value normally proxied by the volatility of the exchange rate, predictable volume, information arrivals proxied by unpredictable volume or by unpredictable price volatility and other funding costs such as the interest on borrowed foreign currency. We turn next to a review of the microstructure of the foreign exchange markets in selected Caribbean countries.

### **3.0 The Microstructure of the Foreign Exchange Markets in the Caribbean**

The basic microstructure of foreign exchange markets consists of a number of core elements. These include the major players in the market, the mechanisms for trading and the regulatory and management systems in place for the smooth operation of the market. The major players in the foreign exchange market include dealers who facilitate trade and who may double as market makers, central banks which structure the policy regime for the market and the public. The public includes individuals but also corporations and speculators that drive demand and supply in the markets. The mechanisms for trading are critically important to the operation of the market. The trading mechanism could be based on auctions or inter-bank markets, as well as on traditional and non-traditional price discovery mechanisms. Last but by no means least is the regulatory and management systems on which the market is based. These include systems such as internal risk management systems, the exchange rate regime and prudential standards on open positions. The market microstructure elements of the foreign exchange markets in Jamaica and Trinidad and Tobago are outlined below.

#### **Jamaica**

Jamaica liberalised its foreign exchange market substantially during the 1990s. In this period, exchange controls were eliminated in 1990, the exchange rate regime changed from a fixed to a floating regime in 1991 and the number of dealers increased in 1994 as cambios and merchant banks were included. The institutional structure of the market in 2001 consisted of 15 authorised dealers and 136 cambios (which include about 88 bureaux de change). The non-financial firms and individuals which underlie the demand and supply conditions in the market is fairly heterogeneous and the supply of foreign exchange is fairly evenly distributed among sources such as export of goods and services, remittances, direct investment flows, private portfolio flows and official loan inflows. There are some dominant players in the market who can have a significant impact on the market from the supply side. The Jamaican dollar is not a vehicle currency so shortages of foreign currencies cannot be filled by selling Jamaican dollars to foreign banks. If a particular market-making bank is short it must either enter the local market to bid for supplies or it must borrow foreign currency from a foreign correspondent bank.

Cambios are only permitted to buy and sell foreign exchange and there are limits of US\$250,000 on cheques and drafts and US\$10,000 on cash transactions. These cambios are licensed by and monitored by the Bank of Jamaica (BOJ) to ensure compliance with the BOJ's operational guidelines and the Money laundering Act. Cambios are also required to report to the Director of Public Prosecution any cash transaction greater than or equal to US\$8,000. Cambios currently sell 5% of their gross daily purchases of foreign exchange to the BOJ by mutual agreement. The major difference between cambios and authorised dealers is that they are not permitted to grant loans or take deposits. There are currently approximately 88 bureaux de change in operation which exist primarily to facilitate the exchange of currency for hotel guests. These institutions sell 10% of their gross daily purchases to the BOJ.

The authorised dealers in the market consist of all commercial banks, merchant banks and the two largest building societies. These authorised dealers are engaged in all types of foreign exchange

transactions, they buy and sell, intermediate and make a market in foreign exchange by posting bid and ask quotes for foreign exchange. No limits are placed on the value of transactions, however, under the Money laundering Act, these financial institutions are required to report to the Director of Public Prosecution any cash transaction at or above US\$50,000. The authorised dealers, though not statutory bound, have also agreed to sell 5% of their daily gross purchases of foreign exchange to the BOJ. These institutions are monitored and regulated by the BOJ under the Financial Institutions Act and the Building Societies Act.

The commercial banks also make up the inter-bank market on which the system is based and which facilitates price discovery and trading. The information transmission mechanisms in the market were relatively unsophisticated consisting of informal contacts and telephone calls until 2001 when EGATE an electronic bulletin board was set up by the BOJ. Authorised dealers lists two way bid and ask quotations which are posted on the system so price discovery is much more efficient. Dealers now have better information on prices so trading is done on a more informed basis. The system is based on a system where an inter-bank system makes a market in foreign exchange through indicative bid and ask quotes and where demand and supply and the intervention strategy of the BOJ determines prices. When spot transactions (transactions settled within 2 business days) between dealers and the public and between the two categories of dealers are executed different spot rates are realised. The official exchange rate is computed as a weighted average of all trades. A forward market for foreign exchange to hedge foreign exchange rate risk has also been in existence in Jamaica for several years but the volume of transaction and price data is not readily available.

The BOJ undertakes market surveillance, collects and disseminates information on the foreign exchange market and intervenes directly in the market to control volatility. Its information dissemination function is an important part of the market microstructure as it helps the price discovery process in the market, especially since private mechanisms for price discovery are not well developed. The BOJ intervenes in the market directly to prevent excessive price (exchange rate) fluctuations by selling (buying) foreign exchange through authorised dealers and cambios since these institutions dominate the market and can affect liquidity condition and the rate very quickly. The rate at which the bank intervenes usually mirrors the weighted average buying or selling rates in the market.

### **Trinidad and Tobago**

In April 1993 exchange controls on current and capital transactions were abolished in Trinidad and Tobago. The exchange rate regime was also changed from a fixed to a floating regime. The market for foreign exchange consists of commercial banks, the public (both firms and individuals) and the Central Bank. The system is based on an interbank market where demand and supply and the interventions of the Central Bank in the spot market drive the performance of the market. The market is also structured around a sharing agreement for foreign exchange where inflows of foreign exchange from the major suppliers is shared among the market making banks based on a formula. Since demand in the market is continuous but supply is discontinuous, the central bank intervenes in the market to smooth out temporary mismatches between demand and supply to ensure that the exchange rate is driven more by stable fundamentals rather than by transitory mismatches.

In the wholesale end of the market which comprises the market making banks, large suppliers of foreign exchange and the central bank, the bid-ask spreads are much more competitive than in the retail end of the market. In this system, commercial banks act as market makers by posting indicative bid and ask quotes for foreign exchange. Spot trades are then executed for particular

transactions at prices based on the initial bid/ask quotes. Since the Trinidad and Tobago dollar is not a vehicle currency market making banks that are short must enter the domestic market and bid for supplies or they must borrow foreign currency from foreign banks (they usually have correspondent banks). Since the Central Bank intervenes in the market to keep the exchange rate at a target level, bid and ask prices are likely to exhibit bound or limits at a point where the Central Bank intervenes. The exchange rate is, therefore, generated by the demand and supply for foreign exchange and the intervention activities of the Central Bank, and the rate is computed as a weighted average of the spot rates of all transactions both on the wholesale and retail ends of the market. The market also has a forward market for foreign exchange, which though small has shown signs of growth.

The major players in the market are commercial banks (and their correspondent international bank), bureaux de change, the public (which include a few large suppliers of foreign exchange (John 1994) and the Central Bank. The commercial banks are the heart of the systems as they are the market makers in the foreign exchange market. Commercial banks trade with the public and among themselves to meet the liquidity needs of the market. The interbank system in particular was used to good effect to deal with peaks and valleys in individual banks' liquidity. This is buttressed by the Central Bank's intervention when the swings in liquidity are too large. The characteristics of the banks themselves affect the operation of the market. Some may have large corporate clients whereas some may concentrate on the retail market while some banks have a large branch network and others do not. These features impact on the price discovery process and the exchange rate that is eventually generated by the market. The bureaux de change acts in a supportive role to the dominant commercial banks. The market is comprised of 7 authorized dealers, all commercial banks except one non-bank financial institution whose bureaux de change license was upgraded to authorised dealership status in 1999. The number of bureaux de change remains at 5. These institutions are licensed by the Central Bank and monitored and regulated under the Financial Institution Act of 1993.

The trading mechanism in this market, like the Jamaican market, is based on a quote driven interbank system. The commercial banks act as market makers by quoting indicative bid/ask prices in the spot market which act as a guide for the prices at which trades are executed. These quotes also are important parts of the price discovery process. The actual systems in place for price discovery in the interbank market are underdeveloped. Most trading is still done over the telephone and transactions are confirmed by fax. This weakness in the system has been recognised and there are plans to introduce a common electronic platform so the two-way bid/ask quotes could be posted to facilitate interbank activity.

The Central Bank also collect and disseminates information on the foreign exchange market which helps the process of price discovery in the market. More importantly, the Central Bank intervenes directly in the market to smooth out volatile swings in liquidity to prevent high volatility in the exchange rate. The central bank also provides a venue for commercial banks to meet and share information, which helps to manage the interbank system.

### **A Comparison of the Microstructure of the Foreign Exchange Markets in Jamaica and Trinidad and Tobago**

There are many similarities in the form of the foreign exchange markets in these two jurisdictions. They are both organised as interbank markets where commercial banks act as market makers rather than auction markets, although Jamaica experimented with an auction market. Both markets are quote driven systems rather than order driven systems. The central banks in both jurisdictions intervene in the market to smooth out volatility.

There are, however, some important differences. The number of dealers in the Jamaican market is much greater than in Trinidad and Tobago, even if one adjusts for the different size of these countries. Dealers in the Jamaican market also by mutual agreement have to sell a small percentage ranging from 5% to 10% percent of their gross daily purchases of foreign exchange to the BOJ. To the extent that purchases by the BOJ under this agreement are below market rate, this arrangement could be thought of as a tax. The systems in place for the price discovery process in the inter-bank markets in Jamaica is, however, more developed than in Trinidad and Tobago. The electronic bulletin board EGATE set up by the BOJ allows dealers and market makers to have information on bid and ask prices in the market which allows facilitate more efficient pricing which should lead to narrower spreads. Trinidad and Tobago's system is still based on telephone contacts but there is discussion ongoing to set up a similar electronic price discover mechanism based on a Bloomberg platform.

Most importantly, however, is the fact that in Trinidad and Tobago the conduit for the major part of the foreign exchange that is supplied to the market by a few companies is the Central Bank, since these flows in large part represent government's petroleum tax revenue. This gives the Central Bank a degree of market power and leverage that the BOJ does not have. The ability to intervene is therefore greater, as well as less costly. The system in Trinidad and Tobago is also defined by a supply sharing arrangement where the major suppliers distribute the supplies according to a pre-arranged formula. These features of the market in effect restricts bid and ask prices to a range that is bounded by the central bank interventions, especially on the high side. We turn next to an analysis of the stylized facts of bid-ask spreads in these two markets and to an empirical estimation of the factors driving the bid-ask spreads in the foreign exchange markets in these two selected Caribbean Countries.

#### 4.0 Empirical Methodology: The Short-Term Determinants of Bid-Ask Spreads in Selected Foreign Exchange Markets in the Caribbean

##### 4.1 Data Dynamics

This study focuses on the short-term dynamics of bid-ask prices in the foreign exchange markets of Trinidad and Tobago and Jamaica. The data used in this study comprise daily data on the bid-ask spread measured as the percentage difference between the daily weighted average bid and ask prices for United States dollars as a ratio of the midpoint between the bid and ask prices, daily US\$/domestic currency exchange rates measured as the midpoint between the bid and ask prices for United states dollars and daily trading volumes in the foreign exchange markets measured as the sum of purchases and sales of United States Dollars. The data covers the period June 24, 2002 to June 22, 2004. Tables 1 and 2 present descriptive statistics on average bid-ask spreads and exchange rate changes for Jamaica and Trinidad and Tobago. It also reports differences in averages between the beginning of weekends and holidays and the normal work-week.

**Table 1**  
**Average Bid-Ask Spreads, Exchange Rate Changes and Differences Between Trading and Non-Trading Periods for Trinidad and Tobago**

Statistic	Variable					
	Spread	Spread (wk)	Spread (Hol)	Exchange Rate Change	Exchange Rate Change (wk)	Exchange Rate Change (Hol)
Mean	1.03	1.04	0.97	0.03	-0.02	0.21
Max.	2.11	2.11	1.83	3.95	3.95	3.27
Min.	0.16	0.28	0.16	-4.39	-4.39	-3.39
CV.	32.04	32.69	32.99	4633.33	6950.00	657.14

**Table 2**  
**Average Bid-Ask Spreads, Exchange Rate Changes and Differences Between Trading and Non-Trading Periods for Jamaica**

Statistic	Variable					
	Spread	Spread (wk)	Spread (Hol)	Exchange Rate Change	Exchange Rate Change (wk)	Exchange Rate Change (Hol)
Mean	0.43	0.44	0.40	0.05	0.04	0.09
Max.	2.70	2.70	1.24	3.13	2.43	3.13
Min.	0.17	0.17	0.16	-6.60	-6.60	-1.81
C.V.	53.49	54.54	42.50	1020.00	1325.00	466.67

The average spreads in Jamaica are much lower relative to Trinidad and Tobago but there is more variability in the spreads in Jamaica. Interestingly, although the average exchange rate change in Jamaica was generally higher in Jamaica as is to be expected, the dispersion of those changes in Trinidad tended to be wider. In terms of the differences in spreads between normal trading periods and the day before non-trading periods such as week ends and holidays, the expectations were that spreads would widen in these periods given increased concerns about inventory holding costs in these non-trading periods. Although the evidence on the exchange rate changes on the day before non-trading periods are higher the spreads does not give credence to this hypothesis. In fact, in both Jamaica and Trinidad and Tobago the average spreads in the normal trading days are higher than the average spreads on the days before non-trading periods. In this context, the next section attempts to decompose the determinants of short-term bid-ask spreads in the foreign exchange markets of Jamaica and Trinidad and Tobago.

##### 4.2 Model and Estimation

Base on the theoretical review in section 2 it is clear that the critical determinants of the spread in the short term include trading volumes, forecasts of price risk (exchange rate risk) and the flow of new information into the market. One can therefore write the following model of bid-ask spread determination in the foreign exchange market as

$$s = f(\sigma^p, x, I) \quad (1)$$

where  $s$  is the bid-ask spread,  $\sigma^p$  is predictable volatility of the exchange rate (a forecast of price risk),  $x$  is expected trading volume and  $I$  is the flow of new information into the market. The theoretical foundations of market microstructure posits that the  $\partial f / \partial \sigma^p > 0$ ,  $\partial f / \partial I > 0$  and that  $\partial f / \partial x < 0$ . The above positive relationship between bid-ask spreads and the forecast of price risk

is driven by the need of market makers to cover for the possibility of the decline in asset value by charging a higher spread. The positive relationship between spreads and new information flows is related to the possibility of loss by the market maker from trading with better informed agents, the market makers therefore charges all agents a higher spread to cover these losses. The negative relationship between spreads and the expected or normal liquidity is driven by economies of scale in market making which enables the market maker to charge lower spreads and still increase his margin through volume (Easley and O'Hara 1992). The problem with the above specification is that  $I$  is not observable. However, in the spirit of the mixture-of-distributions hypothesis of Tauchen and Pitt (1983) there appears to be a link between volume and price volatility because both variables seem to be driven by information flows. Following the advice of Hartmann (1998) therefore, one can write unpredictable price volatility  $\sigma^u$  as a function  $g$  of the rate of arrival of new information

$$\sigma^u = g(I) \quad (2)$$

combining equations (1) and (2) yields an equation which contains only observable variables in the spread equation

$$s = f(\sigma^p, x, g^{-1}(\sigma^u)) \quad (3)$$

It should be noted also that the MDH hypothesis implies that  $\sigma^u$  and the unexpected part of trading volume are driven by new information flows and are therefore strongly correlated. In any case  $\sigma^u$  is endogenous and therefore has to be instrumented in the estimation of (3), a fact which was ignored in earlier studies. Some authors have also argued that the approach of non-trading periods drive up spreads (Bessembinder 1994, Hartmann 1998). The basis for this argument is that during non-trading periods the inventory opportunity costs element increases because the market maker has to hold inventory for no other reason than that no trading is taking place. Moreover, the risk of change in the inventory value may increase over the non-trading period. Equation (3) is therefore augmented by the inclusion of a proxy for non-trading periods.

The proxy used in this study for the costs related to the uncertainty in the underlying asset value is a forecast of US\$/domestic currency price volatility. This asserts that market makers base their bid and ask prices on an assessment of future volatility. To do this, the well-known fact that daily foreign exchange prices often exhibit the presence of autoregressive conditional heteroscedasticity (ARCH) is used to construct this forecast (Bollerslev et al. 1992). In this context, Baillie and Bollerslev (1989) finds that a GARCH(1,1) is a reasonably good specification of daily foreign exchange price changes. The forecast of price risk  $\sigma^p$  used in this study is the conditional variance from a GARCH(1,1) led by one day. This specification also includes a non-trading period dummy and trading volume in the variance equation.

In terms of the proxy used for information arrival and its impact on the spread, we exploit the notion raised in the mixture of distributions hypothesis (MDH) that new information drives unexpected changes in volumes<sup>2</sup> as well as unexpected changes in price volatility (Tauchen and Pitts 1983, Easley and O'Hara 1992, Hartmann 1998). We therefore extract and use the error

<sup>2</sup> Other studies have used unexpected volumes as the observable proxy for information arrival using an ARIMA model to decompose predictable and unpredictable volume (Bessembinder 1994). This study uses unexpected price volatility since new information seem to manifests itself faster in prices relative to volumes.

term from the GARCH(1,1) model as a proxy for unpredictability price volatility  $\sigma^u$  (itself a manifestation of new information flows into the market).

The trading volume variables used in the study are the sum of daily sales and purchases of US dollars by commercial banks in Trinidad and Tobago and the sum of daily sales and purchase of US dollars in Jamaica (which would include cambios and inter-dealers in addition to the commercial banks). To determine whether the approach of non-trading periods such as weekends and public holidays impact on the spreads, a non-trading indicator variable set equal to 1 on the day immediately preceding the non-trading periods (that is on Fridays and the day before public holidays) and zero otherwise is included in the empirical model.

The Generalized Method of Moments (GMM)<sup>3</sup> is used to estimate the parameters of the following semi-log specification of model (3). For the specifications reported in the results table, the set of instruments used were the constant,  $\sigma^p$ ,  $\sigma^u$ ,  $x$  and the dummy variable.

$$s_t = \beta_0 + \beta_1 Ln\sigma_t^p + \beta_2 Ln\sigma_t^u + \beta_3 Lnx_t + \beta_4 Dumm + \varepsilon_t, \varepsilon \sim (0, \Sigma), t = 1, \dots, T. \quad (4)$$

The GMM estimator finds (for a given  $(T \times 1)$  instruments vector  $Z$ , the parameter vector  $\hat{\beta}$  for which the squared moment functions  $J(\hat{\beta}) = (T^{-1}Z'\varepsilon)'W^{-1}(T^{-1}Z'\varepsilon)$  are closest to zero. It is consistent and asymptotically normal under weak distributional assumptions. Moreover, with the weighting matrix  $W$  equal to the covariance matrix of the moment functions  $(Z'\varepsilon)$  it is also asymptotically efficient. GMM is most appropriate for financial data since it does not require knowledge of the likelihood function's form and residual covariance matrices are directly available that are robust against conditional heteroscedasticity and autocorrelation of any order (Andrews 1991).

The results of the GMM regression of percentage spot bid-ask spreads in the foreign exchange markets of Jamaica and Trinidad and Tobago on the determinants mentioned above are presented in Table 3.

**Table 3**  
**Parameter Estimates of Determinants of Bid-Ask Spreads in the Foreign Exchange Markets In Jamaica and Trinidad and Tobago**

$$s_t = \beta_0 + \beta_1 Ln\sigma_t^p + \beta_2 Ln\sigma_t^u + \beta_3 Lnx_t + \beta_4 Dumm + \varepsilon_t$$

Country	Coefficients				
	$\beta_0$	$\beta_1$	$\beta_2$	$\beta_3$	$\beta_4$
Trinidad and Tobago	8.701* <sup>o</sup> (11.52)	0.199* <sup>o</sup> (3.04)	-0.027 (-1.89)	-0.327* <sup>o</sup> (-5.44)	-0.044 (-1.31)
	Adj. R <sup>2</sup> = 0.33				
Jamaica	8.468* <sup>o</sup> (6.34)	0.072* <sup>o</sup> (4.69)	0.008 (0.99)	-0.399* <sup>o</sup> (-6.06)	-0.008 (-0.50)
	Adj. R <sup>2</sup> = 0.45				

<sup>3</sup> Hansen (1982).

- Notes: 1. Figures in parentheses is t-statistics  
2. \* Significant at 1% level  
3. ° Significant at 5% level

The point estimates reported in Table 3 are generally consistent with the market microstructure basis of the spread model. In particular, the estimated coefficient for the proxy for foreign exchange price risk is positive and significant for both Jamaica and Trinidad and Tobago. This is consistent with greater price risk increasing inventory carrying costs and therefore the bid-ask spread.

The coefficient of the trading volume variable is also consistent with the theory in that the coefficient for this variable for both countries is both negative and significant. Bid-Ask spreads therefore decrease as trading volume increases, implying that there are significant order processing costs in the foreign exchange markets and also there are economies of scale in market making in these foreign exchange markets.

In terms of the proxy for new information arrival the results are mixed. In the case of Jamaica the sign on the coefficient is positive and consistent with the information cost strand of market microstructure which posits that new information increases the pressure the costs of the market makers related to trading with informed agents which they attempt to cover through higher spreads, hence the positive relationship. The coefficient is however not significant. In the case of Trinidad and Tobago, however, it is negative indicating that spreads actually fall with the arrival of new information. This is noteworthy because even though the coefficient is not significant at the 1% and 5% level of significance, it is at the 10% level of significance. Moreover, this particular result hints at another complication in the issue of information costs, that is, the asymmetric impact of good and bad news. This could be due to the nature of information arrivals in the market. If new information arrivals are normally related to the intervention strategies of the central bank, which generally intervenes to correct temporary imbalances in sales and purchases, effectively placing restrictions on the behaviour of bid and ask prices and a tendency for spreads to decline, then information could be negatively related to spreads. This is a fruitful area for research but is beyond the scope of this paper. The fact that the coefficient of the information cost proxy is not a priori correct and/or not significant is not totally unexpected as Bessembinder (1994) in his study got coefficient estimates which had the correct sign but were not significantly different from zero.

In the case of the non-trading indicator, the coefficient was negative and insignificant in both countries. This reflects the patterns that were evident in the stylized facts in the markets in Tables 1 and 2, that is, that average spreads on the day immediately preceding the non-trading period and normal trading days did not appear to be different. This implies that market makers do not perceive the non-trading period to present much price risk and the related uncertainty of the value of their inventories and, that opportunity costs related to keeping the inventories such as the return they could earn on less liquid US dollar denominated assets are not considered significant. This in turn could reflect the still relatively underdeveloped asset/liability management practice of market makers as it pertains to US dollar denominated assets. It could also be related to the significant influence the central bank intervention strategies have on the market and the pattern of intervention. For example, if the central bank generally intervenes in mid-week then there would tend not to be a significant relationship between non-trading periods and spreads.

To summarize, the results indicate that there is strong evidence that bid-ask spread in the foreign exchange markets of Jamaica and Trinidad and Tobago widens with increased price risks (forecast of foreign exchange price volatility) and narrows with increases in trading volume. The

information is, however, inconclusive on the impact of information costs and the impact of non-trading periods on spreads.

## 5.0 Conclusions

This study looked at the short-term dynamics of bid-ask spreads in the foreign exchange markets of Trinidad and Tobago and Jamaica. Spreads on foreign exchange markets are important as it is considered as a measure of the transactional efficiency of the market. Foreign exchange markets – the volume of supplies and especially the price at which it is exchanged have a profound effect on the Caribbean economies given their extremely open nature. The spreads in the market have real impacts on the returns to agents in the market and indeed on the willingness of agents to transact in the market. This can in turn impact on the depth and efficiency of the market.

The short-term dynamics of bid-ask spreads, especially the factors driving the behaviour of the spread is also important to policy makers because it provides information on the need for intervention, as well as the scope and modalities of intervention. This area of study is also important to private agents since it can help them to forecast the spread which impacts on their business strategies. Market microstructure theory provides an especially effective framework in which to evaluate the short-term dynamics of bid-ask spreads because the institutional features of the markets often drive outcomes in terms of price.

This study provides strong evidence that the bid-ask spread in the foreign exchange markets in Trinidad and Tobago and Jamaica widens with increased price volatility but narrows with increases in trading volumes. These findings corroborate the results of other studies evaluating foreign exchange price volatility and trading volumes as determinants of bid-ask prices in foreign exchange markets. The study's findings with respect to the impact of information costs and non-trading periods on the bid-ask spread are, however, not in congruence with other market microstructure studies on bid-ask spreads. This is most likely due to the fact that these markets are still relatively underdeveloped, the currencies being evaluated are not *vehicle* currencies and the fact that the central banks in both Jamaica and Trinidad and Tobago actively intervenes in the market which effectively places limits on bid and ask prices in the market. These factors would all tend to frustrate the relationships between bid-ask spreads and the type of factors driving their behaviour that are alluded to in the market microstructure literature. The study therefore also advances the literature on market microstructure of financial markets in the Caribbean by demonstrating that market microstructure elements drive the short-term bid-ask spread dynamics in selected Caribbean countries.

The policy implication flowing from the results of this study include the fact that exchange rate volatility in flexible exchange rate regime countries drives up transactions cost as represented by bid-ask spreads in the foreign exchange market. Attempts by the monetary authorities to control volatility, apart from helping to foster a level of stability, has real benefits in terms of lowering transactions costs to agents in the market. Additionally, larger and more liquid markets promote greater transactional efficiency in the form of lower bid-ask spreads. Efforts to increase the size of the market by encouraging more agents to trade in the market rather than out, therefore generates tangible benefits for the market and economy. The fact that the design of the market microstructure such as the number and range of market makers and dealers in the market can impact on market outcomes requires that policy makers in the region be careful in the design of policy regimes. This is so especially in an area such as the foreign exchange market, which is so important to Caribbean economies. The foreign exchange market in particular, and market makers in particular, offers services which are quasi-public goods in nature, getting the design wrong can therefore create real problems for regional economies. Attention to market microstructure details could go some way in ensuring that we avoid making that mistake.

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