Exchange Rates and Market Microstructure – the case of Guyana

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ABSTRACT: This paper uses monthly data from March 2001 to December 2007 to test the Evans and Lyons (2002) model in the Guyanese Foreign Exchange Market (GFM). It also extends the basic model in Evans and Lyons (2002) by testing an alternative specification that includes risk (measured by GARCH-based volatilities in the nominal exchange rate). The results provide mixed evidence with respect to the impact of order flow on the exchange rates in the Guyanese Foreign Exchange Market. In particular, it reveals that while order flow is an important determinant of the nominal G$/US$ exchange rate it does not have a statistically significant effect on the exchange rates between Guyanese Dollar and Canadian Dollar (G$/Cdn$) and the Guyanese Dollar and the Pound Sterling (G$/£). Additionally, our regression results show that the models with order flow only explains 11% of the variation in the log of the US$/G$ nominal exchange rates and less than 10% in the log the (G$/Cdn$) and (G$/£) exchange rates respectively. There are marginal improvements in the explanatory power of the basic model when it is adjusted to include risk. Estimation of the basic model with GARCH techniques also provides superior results when compared with those obtained by OLS.

Key words: Guyana, order flow, market microstructure, GARCH

I. INTRODUCTION

Guyana is a small open economy with a high level of imports and exports to GDP. Consequently, movements in the exchange rate tend to impact significantly on the real economy which in turn affects the financial services sector (Khemraj and Pasha, 2009).In these circumstances, exchange rate dynamics have serious implications not only for economic development but the stability and soundness of the Guyanese financial services sector.

Despite the importance of the exchange rate in the context of Guyana, however, there are a limited number of studies on the Guyanese Foreign Exchange Market (GFEM). More importantly, all of the previous studies fail to examine the short-term dynamics that influences the exchange rates in Guyana. Our study attempts to fill this gap by testing the GFEM with the portfolio shift model that was originally proposed by Evans and Lyons (2002). This model essentially allows for the combination of macroeconomic variables with one of the most important microstructure variable, namely, *order flow* to explain the short run movements in exchange rates.

The *order flow* variables emerged in the literature with the publication of the seminal study by Evans and Lyons (2001). According to Evans and Lyons (2001), order flow captures non-public information that influences the short-run movements and is defined as the imbalance between buyer-initiated and seller-initiated trades. Using daily data the study shows that order flow accounts for more than 60 percent and 40 percent of the variation in deutsche mark/dollar and yen/dollar exchange rates. Since the publication of Evans and Lyons (2001), there has been tremendous growth in the use of this variable to model and forecast exchange rates.[1] Some of the studies which provides strong empirical support for the forecasting accuracy of order flow includes, Payne (2003), Breedon and Vitale (2004), Evans and Lyons (2005), Gradojevic and Yang (2006), and Killeen et al. (2006).

The ensuing sections of the paper are as follows: the Section 2 discusses the empirical features of our data; Section 3 describes our model and econometric procedure;

[1] The growth in order flow studies may be attributed to the fact that order flow explains short-run movements in exchange rates better than macroeconomic variables (Sarno and Taylor, 2001). Another factor that may be responsible for the growth in order flow studies is the availability of data on the inter-day activities of various foreign exchange markets (Laurini et al, 2008).

Section 4 presents the empirical results and finally, Section 5 concludes and summarizes our findings.

II. THE EMPIRICAL FEATURES OF EXCHANGE RATES IN GUYANA

Foreign exchange markets, like most asset markets tend to exhibit certain regularities (or common features). Some of these features which include volatility clustering, asymmetry and leverage effects does not only point to the development of a particular Foreign Exchange Market but also require the use of special estimation techniques (such as GARCH models) to model and forecast exchange rates. In this section we will examine the exchange rates of the three most traded currencies on the GFEM, namely, the exchange rates G$/US$, G$/Cdn$ and G$/£.

Figure 1 shows the evolution of the buying rate of three major foreign currencies (G$/US$, G$/Cdn$ and G$/£) over the entire sample period along with the accumulated order flows for these currencies. According to Figure 1, the Guyana dollar depreciated continuously against all the major foreign currencies. The correlation between the exchange rates and order flow appears to be mixed based on Figure 1. While the co-movement between the G$/US$ exchange rate and order flow is strong, there is clearly little correlation between order flow and the other exchange rates.

[INSERT FIGURE 1]

Figure 2 provides a time plot of the returns series (i.e. the rate of change of the log of the buying rate, ΔP_t) for the three major foreign currencies. Based on **Figure 2**, our returns series exhibit episodes of extreme volatility as well as relatively low volatility. This pattern is consistent with the volatility clustering hypothesis which proposes that financial data is affected by shocks that tend to be persistent (Baille and Bollerslev, 1989, Baille et al., 1992, Hsieh, 1988b).

[INSERT FIGURE 2]

The summary statistics and histograms of the returns series are shown in **Figure 3**. All the returns series are positively skewed and leptokurtic (i.e., they exhibit excess peakedness at the mean and have fat tails). The positive skewness confirms that depreciation occurs more frequently than appreciation while the excess kurtosis and fat tails indicate that exchange rates are affected by extreme shocks.

[**INSERT FIGURE 3**]

In summary, the foregoing analysis suggests that the exchange rates are not normally distributed. For instance, the returns series have empirical distributions which are leptokurtic and skewed. The returns series also exhibit patterns which suggest that the conditional variance in the exchange rates may not be stable over time.

III. ECONOMETRIC MODEL AND ESTIMATION PROCEDURE

In order to test whether order flow is an important determinant of exchange rates in the Guyanese Foreign Exchange Market we adopt the portfolio shift model from Evans and Lyons (2002). This model assumes that exchange rate is dependent on order flow and relative interest rate and takes the following general form:

$$\Delta P_t = \Delta m_t + \gamma \Delta x_t + e_t \qquad \textbf{Eq. (1)}$$

where P_t is the change in the nominal exchange rate; m_t represent the incremental change in public information (or announcement of public information); x_t is the order flow; and e_t is the error term. The model can be expressed more specifically for estimation purposes as follows:

$$p_t = \beta_1 \Delta(i_t - i_t^*) + \beta_2 \Delta x_t + e_t \qquad \textbf{Eq. (2)}$$

where ΔP_t is the rate of change of the log of the buying rate; Δx_t represents order flow which is defined as the net of buyer-initiated and seller initiated orders; the $\Delta(i_t - i_t^*)$ the rate of change in the interest rate differential; and ε_t is the error term that independent and identically distributed (*i.i.d.*). Similar to Evans and Lyons (2002) the model is estimated with OLS and tests for serial correlation and heteroskedasticity are performed to ensure the adequacy of the model. According to Evans and Lyons (2002) since the order flow variable is exogenous the OLS technique will not be subject to simultaneity bias.

Notwithstanding the efficiency of the OLS in this instance, it may be more appropriate to use the GARCH methodology where exchange rate data exhibits the ARCH effect. We have reasons to suspect the presence of ARCH effect in our exchange rate data series, especially, the G$/US$ exchange rate. This suspicion is motivated by evidence in Egoume-Bossogo et al. (2003) that points to the time varying nature of the volatility associated with the G$/US$ exchange rate. Moreover, the empirical distribution of our exchange series exhibit patterns which lend support to this conjecture. Given this situation it may be more efficient to estimate our regression model with the GARCH methodology.

There is extensive empirical evidence which suggest that the GARCH methodology is not only good at capturing ARCH effect but may account for the empirical features (such as, leptokurtosis and asymmetric shocks) in our exchange rate data series. Hsieh (1988b), for instance, using 10 years of daily data for five foreign currencies provides evidence that a variety of ARCH and GARCH models are extremely good at capturing the conditional heteroscedasticity in the exchange rate movements. Baille and Bollerslev (1989) shows that the GARCH (1,1) model accounts for the conditional heteroscedasticity in the daily spot rates of six major currencies. In an extensive survey Baille et al. (1992) reports that the ARCH model by Engle (1982) and its various extensions are very effective in modelling the temporal variation in the volatility process that characterizes the exchange rate for high frequency data. In this study, we employ the Basic GARCH (1,1), Exponential GARCH (1,1), and GJR-GARCH (1,1) models. Below is a description of these models.

Basic GARCH (1,1) model

The GARCH (1,1) is model was developed by Bollerslev (1986) and Taylor (1986). This model is widely used in the finance literature since it is capable of capturing features such as leptokurtosis and volatility clustering which are common features in financial data. The general form of the conditional variance equation in the GARCH (1,1) model is:

$$ht^2 = \alpha_0 + \alpha_1 u^2_{t-1} + \beta h^2_{t-1}$$

Where $\alpha_1 + \beta < 1$ the conditional variance (h_t^2) is said to be well defined.

Exponential GARCH model

The Exponential GARCH (EGARCH) model which was developed by Nelson (1991) is an extension of the basic GARCH model. In the finance literature the EGARCH model is applied to overcome some of the shortcomings of the basic GARCH model. For instance, unlike the basic GARCH model the EGARCH model captures the 'leverage effect' that may be present in financial data. In addition, because the log is taken for the conditional variance in the EGARCH model it eliminates the need to impose the non-negativity constraints which is necessary for the basic GARCH model. The general specification of the conditional variance equation in the EGARCH model is:

$$\log(h_t^2) = \alpha_0 + \beta \log(h_{t-1}^2) + \alpha_1 \left[\left\| \frac{u_{t-1}}{h_{t-1}} \right\| - \sqrt{\frac{2}{\pi}} \right] + \gamma \frac{u_{t-1}}{h_{t-1}}$$

GJR-GARCH Model

This model also represents an extension of the basic GARCH model and was proposed by Golsten, Jagannathan and Runkle (1993). Like the EGARCH model, the GJR-GARCH model is capable of capturing the leverage effect which may be present in financial data. The conditional variance equation of the GJR model is expressed generally as:

$$h_t^2 = \alpha_0 + \alpha_1 u^2_{,t-1} + \beta h^2_{t-1} + \gamma\, \alpha_1 u^2_{t-1} I_{t-1}$$

subject to: α_0, α_1 and $\beta > 0$ and $\alpha_1 + \gamma > 0$

As is customary, our GARCH models are estimated with maximum likelihood using Berndt-Hall-Hall-Hausman (BHHH) algorithm. The adequacy of the various GARCH (1,1) models are tested with several non-linearity diagnostic test such as, the ARCH-LM test and the Ljung-Box (1978) Q-statistics.

Before we estimate our models with GARCH techniques, we will first examine residual from the OLS models to confirm the presence of ARCH effect. This is done using the ARCH-LM test and Ljung-Box (1978) Q statistics. If the null hypotheses for these tests are rejected, it can be concluded that there is the presence of ARCH effect in the exchange rate data thus making the GARCH methodology more appropriate than the OLS estimation technique.

Apart from using a different estimation technique than the one proposed by Evans and Lyons (2002), we also extend the original model by testing an alternative specification that incorporates risk and takes the form:

$$\Delta P_t = \Delta(i_t - i_t^*) + \Delta r_t + i_{t-1} - i_{t-1}^* + VOL_t + \varepsilon_t \qquad \textbf{Eq. (4)}$$

The risk variable (VOL_t) is measured by the conditional variance of the returns series. To estimate the model we employ a two-stage procedure similar to Bollerslev and Melvin, 1994. The first step involves forecasting the conditional variance of the returns series using the GARCH models identified above. For the second step, we include the forecasted conditional variance as an exogenous variable and estimate the model with the OLS technique. We subject our model to a battery of diagnostic tests similar to those discussed earlier.

IV. EMPIRICAL RESULTS

We estimate the Evans and Lyons (2002) portfolio shift model using the OLS technique and monthly data covering the period March 2001 to December 2007. The exact definition and data sources are provided in **Appendix A**. In estimating the model we use different combinations of the variables, as well as, different estimation techniques. Further, we perform a battery of diagnostic test to ensure that the models are well behaved.

[INSERT TABLE 1]

Table 1 provides the regression results for Evans and Lyons (2002) model estimated with the OLS technique. Based on **Table 1**, order flow is an important determinant of the G$/US$ exchange rate. However, this variable does not have a statistically significant impact on the other exchange rates. We also find that while absolute interest rate differential $(i_t - i_t^*)$ explains the short-run movements in the three exchange rates, the absolute change in differential $\Delta(i_t - i_t^*)$ does not exert any significant impact on any of the exchange rates (**see Table 1**).

The explanatory powers of the models in **Table 1** are significantly lower than those in Evans and Lyons. According to **Table 1**, the basic model of Evans and Lyons when applied in its original form fails the serial correlation test consistently. The errors from the models in **Table 1** also exhibit the presence of ARCH effect based on the ARCH-LM and Ljung-Box (1978) Q-statistics.

In order to overcome the latter problem we re-estimate the regression equation (1) with GARCH (1,1) models. According to Tables **2-4**, order flow is only statistically significant in the model that examines the G$/US$ exchange rate. This is consistent with our previous results. However, contrary to the results in **Table 1**, we find the significance of the interest rate differential variables to be mixed. In **Tables 3** and **4**, the absolute interest rate differential and change in the interest rate differential are important determinants of the short-run changes in the exchange rates. However, **Table 2** shows that the interest rate variables are not always significant. Despite the conflicting results, all the GARCH models are extremely successful in removing the conditional heteroskedasticity from the monthly changes in the exchange rates.

[INSERT TABLES 3 -4]

We extend the basic model in Evans and Lyons (2002) by including a variable that captures risk (measured by GARCH-based volatility) to determine whether our empirical results would improve with the addition of other variables. The results are presented in **Table 5**. The explanatory powers of our models with the risk variable are superior to those in **Table 1**. We also find that the risk variable consistently explains changes in the three exchange rates. These results suggest that the basic Evans and Lyons probably exclude variables which may be more effective in explaining the exchange rate in Guyana. Future research may therefore consider other variants of the Evans and Lyons (2002).

V. CONCLUSION AND SUMMARY

This study test the Evans and Lyons model on the GFEM using monthly data from March 2001 to December 2007. It estimates the model with the Ordinary Least Squares (OLS) and GARCH techniques and also extends the basic model in Evans and Lyons (2002) by testing an alternative specification that includes risk (measured by GARCH-based volatilities).

Our empirical results provide mixed evidence with respect to the importance of *order flow* in determining the exchange rates in Guyana. Specifically, it reveals that order flow only explains the movements in the G$/US$ exchange rate and not the exchange rates between the Guyanese Dollar and Canadian Dollar (G$/Cdn$) and the Guyanese Dollar and Pound Sterling (G$/£). The results also show that the basic model in Evans and Lyons (2002) has poor explanatory powers (as reflected in the low R-squares) and is affected by serial correlation and heteroskedasticity. This suggests the exclusion of other important variables which are not accounted for in the Evans and Lyons (2002) model and the inadequacy of the OLS technique to study the exchange rates in Guyana. Our conjecture is supported by the improved results obtained from re-estimating the basic Evans and Lyons model with GARCH techniques and a variable that captures risk.

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Appendix A

The study uses monthly data from March 2001 to December 2007 to perform the empirical exercise. The data come from two primary sources: (a) the Statistical Bulletin of the Bank of Guyana; and (b) International Financial Statistics of the International Monetary Fund.

Variables:

Δp_t = the change in the log of spot rate proxied by the nominal buying rate.

$\Delta(i_t - i_t^*)$ = the change in the absolute interest rate differential. This variable is measured by taking the difference between the local 91-day Treasury bill and similar instruments in the United States, Canada and United Kingdom.

Δx_t = the change in the order flow. We define order flow as the difference between the value of signed sales and purchases.

$RISK_t$ = represents risk and is measured by the conditional variance of the nominal buying rate which is generated by the various GARCH (1,1) models described in section 3.

The definitions used for the first two variables are different from those used in Evans and Lyons (2002). In our study, we define order flow as the difference between the *value*, rather than the *number*, of signed sales and purchases of foreign currency. Unlike Evans and Lyons (2002) which constructed the interest rate differential variable with the daily *overnight interest rates*, we measure this variable by taking the difference between the *interest rate* of the local 91-day treasury bill and the corresponding interest rates in the US, UK and Canada. These differences are not necessarily trivial and should therefore be noted.

Table 1: Regression Results: Ordinary Least Square (OLS)

Specification	$\Delta(i_t - i_t^*)$	Δx_t	$i_{t-1} - i_{t-1}^*$	R^2	Diagnostic Tests *LM Test*	*Whites Test*	*JB Test*	*ARCH Test*
					Panel A: Guyana Dollar/ US Dollar			
I	0.0007 [0.414]	0.0002 [2.056]*		0.10	69.181	2.105	6071.33	15.17
II		0.0002 [2.061]*		0.11	69.996	1.771	6023.26	15.62
III	0.0007 [0.430]			0.11	69.252	0.329	6049.14	15.250
IV		0.0003 [1.890]**	0.0008 [2.278]*	0.10	66.137	20.696	4424.31	6.401
V			0.0008 [2.283]*	0.10	66.343	20.618	4400.77	6.455
	Panel B: Guyana Dollar/ Canadian Dollar							
I	0.0002 [0.070]	0.0058 [1.327]		0.07	51.75	3.77	3884.81	6.41
II		0.0059 [1.314]		0.07	49.75	1.18	3911.93	6.45
III	0.0003 [0.109]			0.07	51.27	2.35	3892.17	6.29
IV		0.0062 [1.208]	0.0006 [1.731]**	0.03	49.75	6.95	3384.74	3.11
V			0.0006 [1.733]**	0.02	49.23	6.26	3400.57	3.05
	Panel C: Guyana Dollar/ Pound Sterling							
I	0.0015 [0.465]	0.0041 [0.432]		0.07	63.17	2.18	601.35	42.62
II		0.0043 [0.444]		0.07	62.90	1.43	598.99	43.56
III	0.0015 [0.546]			0.07	63.21	0.88	601.58	42.57
IV		0.0048 [0.482]	0.0008 [1.519]***	0.01	63.584	16.534	463.43	33.46
V			0.0008 [1.524]***	0.01	64.480	15.183	478.68	34.00

*, ** and *** represent the 5%, 10% and 15% level of significance respectively.

Table 2: Regression Results: GARCH (1,1)

Specification	$\Delta(i_t - i_t^*)$	Δx_t	$i_{t-1} - i_{t-1}^*$	Diagnostic Tests R^2	*SIC*	*LL*	*JB Test*	*ARCH Test*
	Panel A: Guyana Dollar/ US Dollar							
I	0.0004 [0.8737]	0.0001 [0.9347]		0.11	6.940	661.932	134.742	0.012
II		0.0001 [1.0438]		0.11	6.960	661.250	155.009	0.003
III	0.0004 1.1798			0.11	6.959	661.168	125.325	0.008
IV		0.0001 1.0254	0.0000 0.89081	0.09	6.935	661.534	159.046	0.004
V			0.0000 0.7847	0.10	6.953	660.589	148.424	0.001
	Panel B: Guyana Dollar/ Canadian Dollar							
I	0.0006 1.1286	0.0009 0.291751		0.07	5.77	465.44	57.86	0.03
II		0.000763 0.255376		0.07	5.80	465.13	57.49	0.06
III	0.0006 0.493508			0.08	5.80	465.40	60.54	0.03
IV		0.0026 1.093261	0.0003 [4.9764]*	0.00	5.82	469.47	22.85	0.06
V			0.0003 [5.1223]*	0.00	5.84	468.92	25.63	0.07
	Panel C: Guyana Dollar/ Pound Sterling							
I	0.0039 [3.0605]*	0.0008 0.170607		0.07	5.16	407.53	57.01	0.06
II		0.0031 0.542284		0.07	5.160	404.804	48.800	4.705
III	0.0039 1.3567			0.07	5.195	407.516	56.485	0.064
IV		0.0030 0.533491	0.0001 0.690384	0.04	5.117	398.909	44.658	5.074
V			0.0001 0.6828	0.04	5.163	405.053	49.153	5.030

*, ** and *** represent the 5%, 10% and 15% level of significance respectively.

Table 3: Regression Results: E-GARCH (1,1)

Specification	$\Delta(i_t - i_t^*)$	Δx_t	$i_{t-1} - i_{t-1}^*$	R^2	Diagnostic Tests: *LM Test*	*Whites Test*	*JB Test*	*ARCH Test*
	Panel A: Guyana Dollar/ US Dollar							
I	0.0009 [2.6669]	0.0001 [1.2520]		0.11	6.841	655.292	139.23	0.063
II		0.0000 0.9082		0.11	6.836	652.269	157.293	0.021
III	0.0008 [2.4594]*			0.11	6.862	654.706	130.564	0.156
IV		0.0000 0.628204	0.0001 [1.691]**	0.08	6.814	652.789	207.113	0.246
V			0.0002 [3.1388]*	0.03	6.818	650.569	142.765	1.895
	Panel B: Guyana Dollar/ Canadian Dollar							
I	0.0010 [1.8225]**	0.0035 1.052998		0.08	5.71	463.36	105.59	0.05
II		0.000536 0.118875		0.07	5.69	459.22	293.47	0.19
III	0.0013 1.062751			0.08	5.70	459.99	260.73	0.13
IV		0.0025 1.038365	0.0003 [4.1706]*	0.01	5.79	470.05	11.08	0.01
V			0.0003 [4.2128]*	0.00	5.821	469.554	15.569	0.018
	Panel C: Guyana Dollar/ Pound Sterling							
I	0.0029 [1.644]**	0.0043 0.927178		0.07	5.154	409.355	27.911	1.494
II		0.0045 0.946496		0.07	5.168	407.926	19.266	2.669
III	0.0028 [1.7826]**			0.07	5.183	409.098	35.276	1.370
IV		0.0009 0.1770	0.0005 [4.5627]*	0.00	5.212	408.578	1.823	3.605
V			0.0005 [4.4187]*	0.00	5.244	413.779	1.833	3.913

*, ** and *** represent the 5%, 10% and 15% level of significance respectively.

Table 4: Regression Results: GJR-GARCH (1,1)

					Diagnostic Tests			
Specification	$\Delta(i_t - i_t^*)$	Δx_t	$i_{t-1} - i_{t-1}^*$	R^2	***LM Test***	***Whites Test***	***JB Test***	***ARCH Test***
	Panel A: Guyana Dollar/ US Dollar							
I	0.0005 [1.1171]*	0.0001 [0.8724]		0.11	6.936	664.231	124.610	0.420
II		0.0001 1.0167		-0.106278	6.953	663.144	141.669	0.240
III	-0.0005 -1.364971			-0.108767	-6.956	663.505	119.064	0.422
IV		0.0001 [0.9647]	0.0001 [2.3484]*	0.07	6.940	664.614	137.113	0.582
V			0.0001 [2.1896]*	0.08	6.957	663.557	133.078	0.582
	Panel B: Guyana Dollar/ Canadian Dollar							
I	0.0006 0.8136	0.0011 0.342988		0.07	5.74	465.51	64.09	0.03
II		0.001097 0.341384		0.07	5.77	465.29	64.41	0.04
III	0.0006 0.434444			0.07	5.77	465.44	66.43	0.03
IV		0.0026 1.044957	0.0003 [4.1610]*	0.00	5.79	469.49	23.82	0.04
V			0.0003 [4.1734]*	0.00	5.81	468.94	27.12	0.05
	Panel C: Guyana Dollar/ Pound Sterling							
I	0.0036 [2.6235]*	0.0005 0.112024		0.07	5.137	408.03	73.57	0.10
II		0.0025 0.516861		0.07	5.166	407.80	14.09	5.77
III	0.0036 1.3937			0.07	5.169	408.03	73.96	0.10
IV		0.0044 0.596545	0.0004 [9.9352]*	0.01	5.222	409.35	4.814	2.158
V			0.0005 [3.5501]*	0.00	5.202	410.54	3.474	4.841

*, ** and *** represent the 5%, 10% and 15% level of significance respectively.

Table 5: Extended Model

						Diagnostic Tests		
Specification	***$\Delta(i_t - i_t^*)$***	***Δx_t***	***$i_{t-1} - i_{t-1}^*$***	***VOL_t***	***R^2***	***LM Test***	***Whites Test***	***JB Test***
	Panel A: Guyana Dollar/ US Dollar							
I	0.0012	0.0003	0.0028	3.2040	0.18			
	[1.1359]	[1.9478]*	[0.7219]	[1.9025]*				
II	0.0019	0.0003	0.0029	0.1152	0.05			
	[1.4479]**	[1.9468]*	[0.6985]	[5.3118]*				
III	0.0012	0.0003	0.0028	2.7508	0.18			
	[1.1140]	[1.9549]**	[0.7200]	[1.9034]**				
	Panel B: Guyana Dollar/ Canadian Dollar							
I	0.0021	0.0049	0.0028	3.4780	0.09			
	[0.9503]	[1.3306]	[1.1351]	[1.7848]*				
II	0.0021	0.0049	0.0026	4.9501	0.08			
	[1.0204]	[1.3150]	[1.0772]	[1.9541]**				
III	0.0022	0.0048	0.0030	3.4265	0.10			
	[0.9870]	[1.3018]	[1.2060]	[1.7988]**				
	Panel C: Guyana Dollar/ Pound Sterling							
I	0.0022	0.0057	0.0010	9.0418	0.22			
	[0.8818]	[0.6204]	[0.2415]	[2.4517]*				
II	0.0016	0.0057	0.0015	8.7174	0.24			
	[0.6786]	[0.6053]	[0.3705]	[2.6166]*				
III	0.002	0.006	0.001	7.571	0.21			
	[0.7875]	[0.6068]	[0.3481]	[2.3664]*				

*, ** and *** represent the 5%, 10% and 15% level of significance respectively.

NOTE: The forecasted conditional variances from the GARCH (1,1), EGARCH (1,1) and GJR-GARCH (1,1) are used as risk variables for specifications I, II and III respectively.

Figure 1: Exchange Rates and Order Flow

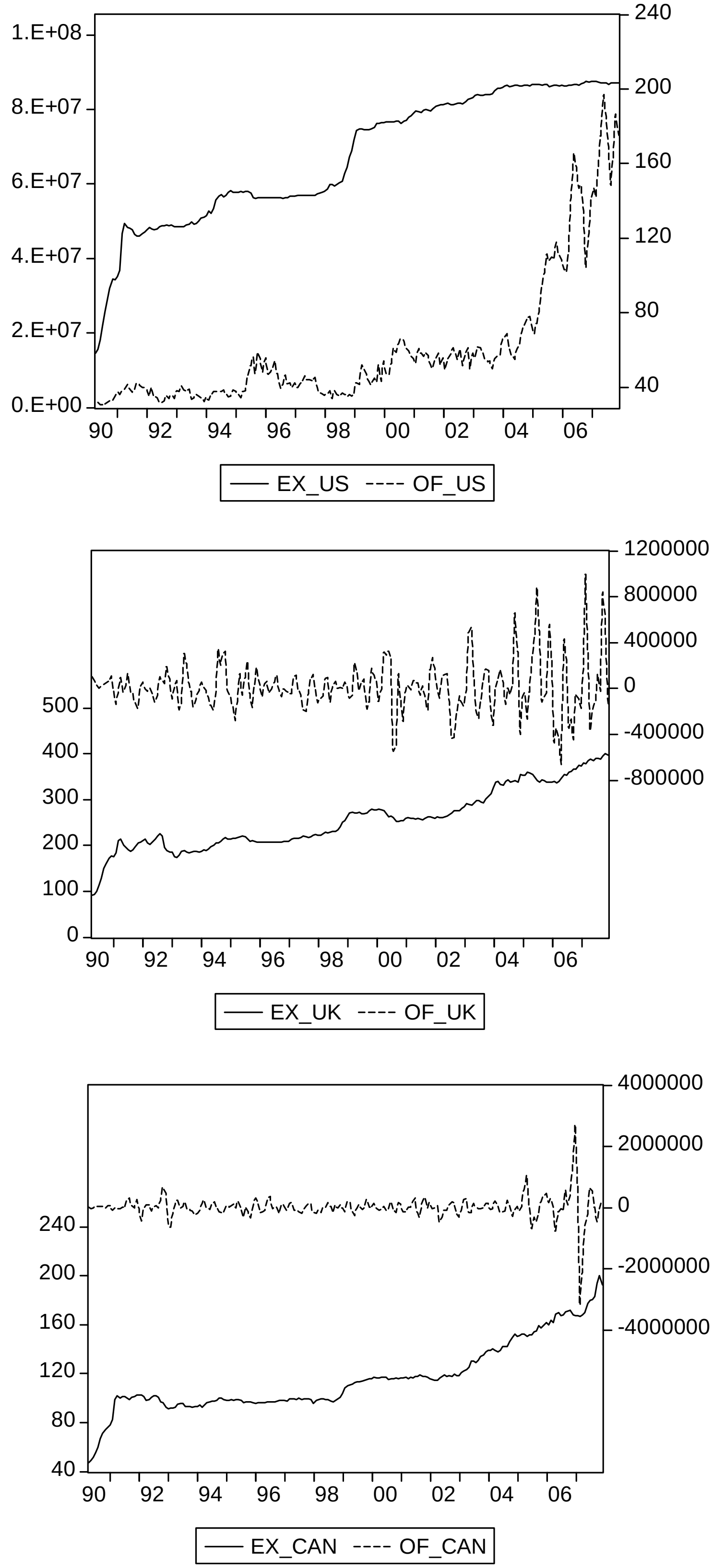

Figure 2: Distribution of Returns Series

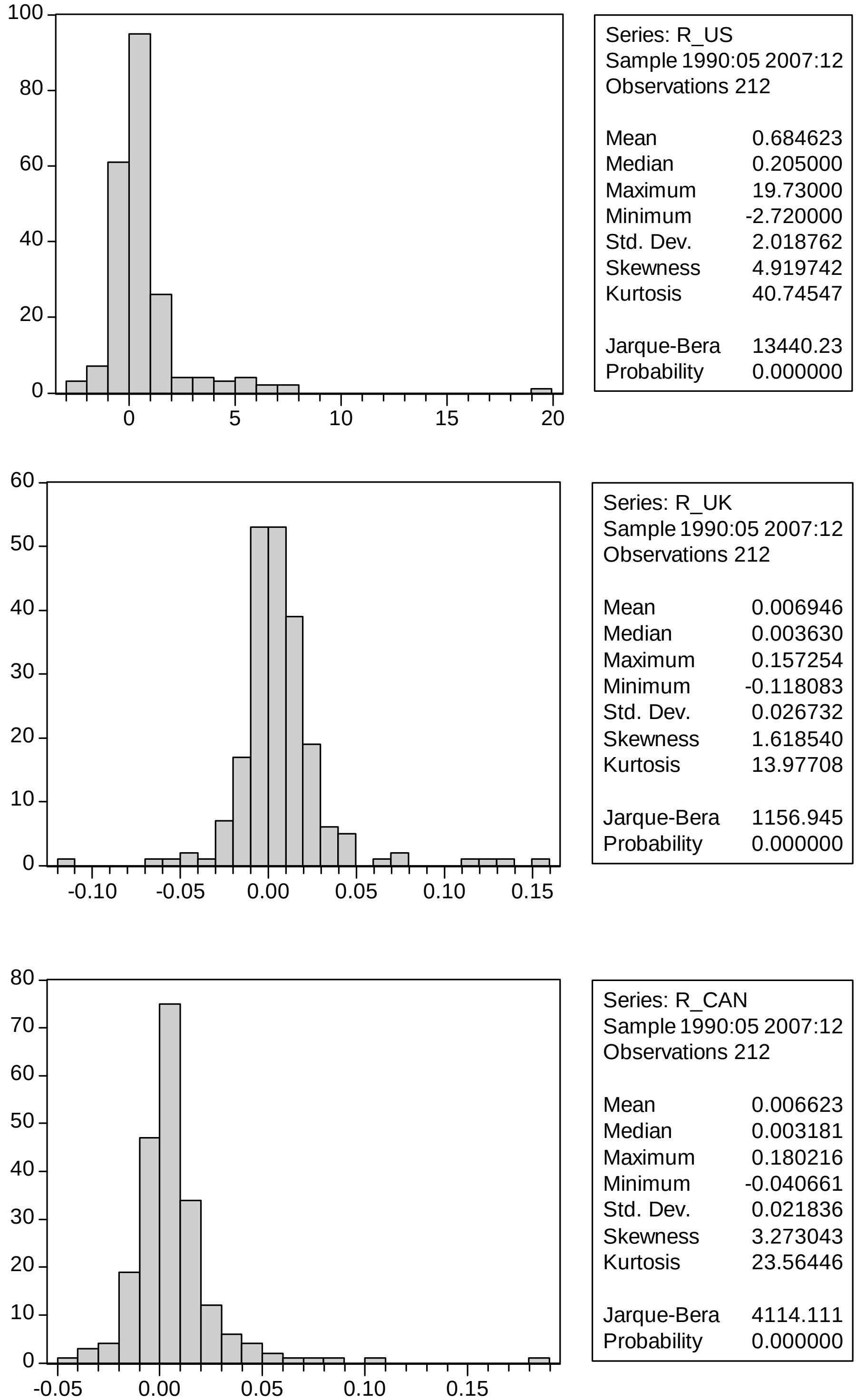

Figure 3: Time plot of returns series