Direct Intervention in the Foreign Exchange Market and Monetary Policy in the Caribbean: Signaling or Leaning Against the Wind

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Abstract

Direct intervention in the foreign exchange market and monetary policy, particularly interest rate policy, seems to be inextricable linked, even when direct interventions are fully and immediately sterilized. Looking at them separately in empirical studies may therefore give misleading results. Some research also suggests that direct intervention and monetary policy changes are more effective when coordinated, highlighting the need to look at the impact of intervention and interest rate policy on exchange rates in a joint framework. However, most studies looking at the impact of these policy instruments on exchange rate dynamics look at these policy instruments in isolation. This study seeks to close this gap by investigating in a joint framework whether direct intervention "signals" the future monetary policy stance in select countries in the Caribbean, in particular their interest rate policy, or whether monetary policy decisions induce interventions designed to "lean against the wind" of exchange rate trends. If the former relation dominates it would suggest that direct intervention is used to reinforce monetary policy initiatives but if the latter dominates it would suggest that direct interventions are used to resist exchange rate changes generated by fundamentals. In the latter case this may reflects a policy conflict between monetary policy and direct interventions generated by vulnerability to external shocks.

JEL Classification: E58; E43; F31

Keywords: Central Bank Intervention; Interest Rates; Foreign Exchange Market Dynamics

Draft
(Not for Quoting)

Presented at the 39th CCMS Annual Monetary Studies Conference
Best Western Belize Biltmore Plaza
6-9 November 2007
Belize City

1. Introduction

Most central bank operating flexible exchange rate regimes have intervened with direct intervention in the foreign exchange market. These interventions are usually executed together with offsetting operations in the domestic money market so that the money supply is not affected. In this sense they are *sterilized* interventions and therefore cannot be thought of as monetary policy initiatives. Over time there has been a growing pessimism about the effectiveness of intervention, especially in developed market economies (Schwartz, 2000). The results of empirical studies on the effectiveness of intervention in the 1980s and 1990s, done almost exclusively on developed markets, indicate that there is mixed evidence that intervention can affect the level and variance of exchange rate returns (Edison, 1993 and Sarno and Taylor, 2001).

In the case of developing countries, there is less pessimism since in these markets the intervention volumes are larger relative to total turnover in the market. Additionally, a variety of regulations restricts the size of the market and helps to give the central bank leverage. The central bank also has an information advantage in the market due to reporting requirements. These advantages impact on the channels through which intervention is thought to affect exchange rates and may detract from or enhance the strength of a particular channel. These channels are not mutually exclusive and include the signaling, portfolio balance channel and market microstructure channels, all of which are based on their respective models of exchange rate determination. The portfolio balance channel works by generating rebalancing in terms of the currency composition of market participants' portfolios which generates changes in the exchange rate, the microstructure channel works by intervention emitting information to the market which modifies expectations and generates huge order flows which change exchange rate dynamics and, the signaling channels works by indicating to agents what future monetary policy would be which cause them to alter current exchange rate dynamics. In spite of these supposed advantages of central banks in developing countries, a review of studies on the effectiveness of direct intervention in the foreign exchange markets in developing and transition economies by Disyatat and Galati (2007) showed that

there is mixed evidence on the effectiveness of intervention in these countries.

Nevertheless, the effectiveness of intervention and tangential issues related to this policy instrument, such as the links between monetary policy and interventions remains a serious policy area in need of research in developing countries. This is particularly so since exchange rate stability is still a major policy objective given that the pass-through from exchange rate movements to inflation in higher in these markets compared to developed economies (Calvo and Reinhart, 2002). The exposure of financial assets denominated in local currency to significant capital loss and their vulnerability to external shocks also lead to a high premium being placed on exchange rate stability in developing countries with flexible exchange rate regimes (Guimaraes and Karacadag, 2004). So whereas central banks intervention in the largest markets has declined (with the notable exception of Japan), in many developing markets with flexible exchange rate regimes direct interventions have actually become rather common.
Central banks must therefore have some policy objective in mind when they intervene in the foreign exchange market because they continue to do so in increasing numbers. In this study we are primarily interested in the relationship and feedback effects between monetary policy and direct intervention in developing countries especially since interventions are often not fully or immediately sterilized in these jurisdictions, leading to situations in which they may reinforce or counter monetary policy objectives. Direct interventions often run counter to monetary policy in developing economies because of their vulnerability to external shocks. For example, central banks in jurisdictions with high debt burdens may attempt to lower interest rates to spur growth but this can lead to capital outflows and depreciation which damages growth[1] and creates inflationary spirals[2], the so called “contractionary depreciations”. In this situation a central bank may intervene “leaning against the wind” by selling foreign currency to bolster the exchange rate in the short term rather than buying foreign exchange to signal its more accommodating monetary policy stance.

Since we are interested in the links between monetary policy and direct intervention, the signaling channel is a useful starting point to explore this issue. The empirical literature on the veracity of the signaling channel is mixed with most studies finding evidence supporting the signaling hypothesis with positive correlation between monetary policy variables and direct intervention, as well as evidence

[1] The empirical literature has generally found that depreciations tend to slow growth (Ahmed, 2003)
[2] See (Calvo and Reinhart 2002).

of “leaning against the wind”, that is, negative correlation between monetary policy and intervention (Kim, 2003, Lewis, 1995 and Kaminsky and Lewis, 1996). If the latter case predominates it implies that direct intervention does not drive or signal future monetary policy but instead is a response to economic conditions as reflected in monetary variables. In this case the central bank would be “leaning against the wind” in its intervention operations, that is trying to counter a short-term trend in the exchange rate driven by fundamental which include monetary policy. We are also interested in these links because central banks in liberalized financial systems have to respond to shocks and other challenges on an increasingly frequent basis. In fact some markets where excess liquidity is problem central banks have begun managing liquidity on a daily basis. In this regard intervention and monetary policy measure must increasingly be implemented and evaluated at this frequency.

In this study, we therefore look at whether the relationship between direct intervention and monetary policy in a select Caribbean country, Jamaica, can best be described as “signaling” or “leaning against the wind”. We use the VAR methodology to investigate the links between intervention and monetary policy since it is ideal for investigating inter-relations, causality and feedback effects among variable which are not independent of each other[3]. We also utilize daily data on intervention, monetary policy variables and exchange rates because increasingly central banks are faced with challenges in the market on an increasingly frequent basis to which they have to respond. We would therefore like to measure the interaction of shocks, policy instruments and policy targets at a frequency which allows us to capture all the dynamics of policy implementation and impact. The paper is structured as follows. Section 2 details very briefly the literature on the channels through which intervention may impact the exchange rate as well as a simple model of the signaling hypothesis. Section 3 evaluates whether the relationship between intervention and monetary policy in Jamaica is best described as “signaling” or “leaning against the wind” in a VAR framework and section 4 concludes.

2. Theory

Theoretically, *sterilized* interventions in the foreign exchange market can affect the exchange rate through a variety of channels that are not mutually exclusive. These include the portfolio balance, market

[3] While the VAR methodology offers some advantages in these types of situations there are also problems associated with it use such as difficulties interpreting the VAR coefficients and the validity of the identifying restrictions (See Leeper et al., 1996).

microstructure and signaling channels, all of which are based on their respective models of exchange rate determination[4]. In terms of the literature on intervention channels, the portfolio balance channel works by generating rebalancing in terms of the currency composition of market participants' portfolios which generates changes in the exchange rate. The key assumptions of this framework are that domestic and foreign-currency denominated financial assets are imperfect substitutes and that investors are risk-averse (Edison, 1993 and Dominquez and Frankel, 1993b). The microstructure approach to foreign exchange markets focus on order flow[5], information asymmetries, trading mechanisms, liquidity and the price discovery process. Central bank intervention works in this framework by emitting information to the market which modifies expectations and generates huge order flows which change exchange rate dynamics (Evens and Lyons, 2002).

The signaling channel works by signaling to market participants the future stance of monetary policy, shifting their expectations about future monetary policy leading to a change in present exchange rate dynamics. This relationship holds even if interventions are sterilized (Dominguez and Frankel, 1993a) and Kaminsky and Lewis, 1996). In this framework the exchange rate is treated as an asset price which is determined by the money supply. This channel can only work effectively if the central bank has policy credibility since the lack of credibility may increase the likelihood of speculative attacks against the currency where market participants speculate against the defensive (usually) interventions of the central bank (Sarno and Taylor 2001). The fact that this channel works by changing perceptions means that it can be more effective if it is well publicized to strengthen the central bank's policy signal.

In developing countries where central banks' credibility may be weak, this channel may not be as effective as in developed market economies where the central bank has a long history of prudent macroeconomic management. As such, the magnitude of the interventions by central banks in these jurisdictions may have to use relatively larger intervention amounts to have an impact, in other words they would have to "buy credibility" for their signal of future monetary policy stance to be as effective as in a developed market context (Mussa 1981). On the other hand, central banks in developing

[4] See Mussa (1981), Taylor (1995) and Lyons (2001) for outlines of the signaling, portfolio balance and microstructure approaches to exchange rates respectively.
[5] Order flow is transaction volumes that are *signed*. That is if you are the *active initiator* of a *sell* order this takes on a *negative sign* while the *active initiator* of a *buy* order takes on a *positive sign*. Markets with a negative sign and a positive sign indicate net selling and buying pressure respectively.

countries enjoy certain benefits relative to their developed market counterparts such as information advantages over the market and the ability to intervene with larger amounts relative to the market given the size of turnover in these markets (Canales-Kriljenko, Guimaraes and Karacadag, 2003). These factors may therefore give central banks in some developing countries an advantage over even some of their developed market counterparts in the use of the signaling channel, particularly where the size of the intervention amount relative to the overall market is large given the small size of the market.

The signaling hypothesis requires that intervention leads to future changes in monetary policy in line with the initial intervention. That is if the signaling channel is dominant future sales (purchases) of foreign exchange must be backed up by contractionary (expansionary) monetary policy. This is best explained by a simple model as outlined in Lewis (1995). Consider a standard asset pricing model

$$s_t = (1-\theta)\sum_{J=0}^{\infty}\theta^j E_t f_{t+j} \qquad (1)$$

where s_t is the log exchange rate, f is the log of fundamentals and θ is a discount factor. Furthermore, if fundamental are defined by:

$$f_t = (m_t - m_t^*) + v_t \qquad (2)$$

Where m and m^* are the domestic and foreign monetary policy variables and v_t are fundaments which are not controlled by central banks. Following Lewis (1995) we assume that m^* and v are exogenous and uncorrelated which means that the exchange rate solution is dependent on current expectations of future domestic monetary policy, as well as current expectations of foreign monetary policy and other fundamental out of central banks' control. We set the values of m^* and v to zero to focus on the role of domestic shocks so that $f_t = m_t$. This does not affect the inferences that can be drawn from this simple model regarding the impact of intervention and domestic monetary policy on exchange rates because by assumption future values of m^* and v are independent of m and direct intervention (I). Assuming that the process of fundamentals is autoregressive in 1st difference we have:

$$\Delta m_t = \rho_m \Delta m_{t-1} + \beta I_{t-k} + \mu_t \qquad (3)$$

Where Δ is the backward difference operator, ρ_m is the autoregressive coefficient of the first difference of fundamentals on their on lag, I_t is direct intervention at time t and β is a parameter relating intervention k periods in the past to a current change in the domestic monetary supply. If I is measured as sales of foreign currency and the central bank is effectively signaling with these interventions then β should be negative if m is a monetary aggregate. The logic behind this is that an intervention sale is contractionary since it takes domestic liquidity out of the system. Therefore, for an intervention sale to be consistent with the signaling hypothesis future changes in monetary policy must be contractionary, that is, it must be correlated with a fall in m in the future. If a policy interest rate was used as a proxy for monetary policy then an intervention sale would have to be correlated with a rise in the interest rates, that is β must be positive. The process for intervention is assumed to be autoregressive and is defined as:

$$I_t = \rho_I I_{t-1} + e_t \qquad \text{where} \qquad E(e_t, \mu_t) = 0 \tag{4}$$

For a given lag k then the exchange rate solution is:

$$s_t = m_{t-1} + \delta_m(\Delta m_t - \beta I_{t-k}) + \beta\delta_m \sum_{j=0}^{\infty} \theta^j E_t I_{t-k+j} \tag{5}$$

Where $\delta_m \equiv (1 - \theta\rho_m)^{-1}$. Equation 5 therefore shows that in this framework the exchange rate depends on lagged money supply, the discounted present value of changes in the money supply adjusted by lagged intervention and the expected discounted present value of all future interventions. In sum, current interventions affect the exchange rate by shifting the agents' expectations of future money supplies – that is signaling. When $\beta = 0$ interventions have no impact on the exchange rate but when $\beta < 0$ sales of foreign currency will signal future declines in money supplies and current and expected future interventions will lead to appreciation today.

If $k = 1$, that is, the lag between intervention and changes in the money supply is one period, the exchange rate solution is:

$$s_t = m_{t-1} + \delta_m \Delta m_t + \beta\theta\delta_m\delta_I I_t \tag{6}$$

where $\delta_I \equiv (1 - \theta\rho_I)^{-1}$. From equation 6, once $\beta < 0$, current intervention will increase the expected money supply in the next

period, changing the discount rate on money and therefore the exchange rate. The present value of the intervention effect on all future expected interventions and therefore money supplies is captured by $\delta_m\delta_I$, the product of the discount factor of money and the discount factor of intervention.

3. The Links between Intervention and Monetary Policy

Data

The proxies used for monetary policy in Jamaica are the monetary base and the high rate on 30-day reverse repurchases (repo rate). There are problems involved in determining the appropriate monetary policy variable to use in studies of this nature. The discussion on the monetary transmission mechanism helps inform this choice. In particular, when monetary aggregates contains elements which are positively correlated with interest rates then this is an inappropriate proxy for monetary policy based analysis based on a monetary model since monetary models are driven by liquidity effects which predicts that monetary aggregates would be *negatively* related to interest rates (Christiano and Eichenbaum, 1992).

Also, Bernanke and Blinder (1992) argue that the federal funds rate is a better predictor of economic trends since it is truly exogenous because it is targeted by the Federal Reserve. Policy interest rates are therefore seen as a better proxy of monetary policy. Robinson and Robinson (1997) in a study of the monetary transmission mechanism in Jamaica also argue that the transmission of monetary policy begins with the repo rate and it is the main policy instrument.

Intervention is defined as daily sales of foreign currency in millions of US dollars. The data on exchange rates is the weighted average of the buying and selling rate of the domestic currency per unit of the intervention currency. The exchange rate is defined as the midpoint between the weighted average buying and selling rate. The intervention currency for Jamaica is the United Sates dollar. The data set comprises daily data from February 2, 2002 to September 28, 2006. After omitting holidays the final data set includes 1161 observations.

Empirical Methodology

We now look at the empirics of testing the signaling hypothesis. One approach of testing interventions links to monetary policy under the signaling hypothesis is to estimate equation (6), attempting to measure the impact of current interventions on the exchange rate in excess of the impact of current money supplies[6]. Another approach adopted by Lewis (1995) and Watanabe (1994) is to estimate equation (3) in an attempt to measure the ability of intervention to correctly forecast movements in monetary policy measures in a bivariate VAR framework, where monetary policy variables are the only fundamental considered[7]. Another approach is to directly estimate the impact of current interventions on expected future monetary policy, using independent measures of changes in expectations of future monetary policy[8]. Fatum and Hutchison (1999) adopt this approach in a study looking at the signaling hypothesis in the US, using the Federal Fund Future rate as their independent measure of expected monetary policy.

We adopt the VAR approach of Lewis (1995) to evaluate whether intervention helps predict monetary policy by estimating bivariate vector autoregressions (VARs) for intervention on the monetary base and intervention on the repo rate. In particular, equations were estimated for:

$$[\Delta M(i)_t, I_t]' = B(L)[\Delta M(i)_t, I_t]' + \varepsilon_t \qquad (7)$$

and $E(\varepsilon_t \varepsilon_t') = V$, where $\Delta M(i)$ is the change in the monetary policy variable, that is the monetary base and the repo rate. Also, $B(L)$ is a polynomial matrix in the lag operator L and ε_t is a bivariate (i.i.d) random variable with mean vector zero[9].

Tests for the optimal lag length for the various bivariate VARs indicated that the likelihood ratio, final prediction error and Akaike information criterion tests indicated a lag length of eight with the Schwarz information criterion indicating a lag length of one and the Hannan-Quinn information criterion test a lag length of three (See Appendix Table A1). An eight lag VAR was therefore estimated. Granger causality/block exogeneity Wald tests indicate that the hypothesis that intervention does not predict monetary policy cannot

[6] See Dominquez (1993b).

[7] Kim(2003) and Kearns and Rigobon (2005) also use the VAR framework to look at the effectiveness of intervention but used structural vector autoregressions (SVARs) where many fundamentals other than the money supply were considered.

[8] This can be done using survey based measures or information on futures prices and rates.

[9] Unit root test indicate that intervention as well as the change in the monetary policy variable were all stationary.

be rejected at the 5% significance level when changes in the monetary base is used as the monetary policy variable but it is rejected when we use changes in the repo rate. Interventions therefore seem to be significantly related to the repo rate but not to the monetary base (See Table 1A). Recall also from Section 2 that for the signaling hypothesis to be right the coefficients on lagged intervention sales of foreign currency should be negative if the monetary base is used and positive if the repo rate is used. The coefficients from the VAR reveal that when the monetary base was used as the proxy for monetary policy most of the lagged coefficients of intervention were not significantly different from zero, except the coefficient on intervention lagged three days which also had the correct sign. When the repo rate was used as the proxy for monetary policy, most of the coefficients on lagged intervention were not significantly different from zero, except the coefficients on the first and seventh lag which also correctly signed (See Table 1B). These two results indicate that there is some weak evidence in support of the signaling hypothesis.

This relatively weak evidence in support of the signaling hypothesis could be due to the evolution of policy over time. That is, for a significant length of time the central bank intervention activities may indeed be best characterized by the signaling hypothesis but at other times the authorities may be "leaning against the wind". As noted before, this is often the case when domestic monetary policy initiatives produce exchange rate trends which are inconsistent with domestic policy objectives. Central banks then intervene to halt these trends which were caused by monetary policy innovations in the first place. In this case monetary policy changes would drive intervention activity. In particular, intervention sales of foreign currency (tightening) would be positively correlated with changes in the monetary base and negatively related to changes in the repo rate. Granger causality/block exogeneity tests of intervention on lagged changes in the monetary policy variables indicate that changes in the repo rate help predict intervention but changes in the monetary base do not (See Table 1A). The coefficients on lagged changes in the monetary base were all insignificant. The coefficients on lagged values of changes in the repo rate were generally negative and significant for three lags, however, which support the view that the central bank was "leaning against the wind"[10] (See Tables 1C and 1E).

[10] The fact that interventions are episodic, with long periods of no intervention followed by periods with frequent interventions, means that interventions may be better modeled as a limited dependent variable. As a check of the robustness of the above approach the ability of changes in monetary policy to predict intervention was examined using the logit approach, with the dependent variable, being 0 or 1 if there was no intervention or intervention sales, respectively. Again, changes in the monetary base and changes in the repo rate were the explanatory variables used. The results were supportive of the evidence produced in the above analysis.

There therefore seems to be some evidence that intervention helps to predict monetary policy. There also is some support for the "leaning against the wind hypothesis".

Table 1A: Granger Causality

Variable	Statistics		
	Chi-sq	df	Prob.
Dependent Var. Δmbase			
Intervention	9.67	8	0.288
Dependent Var. ΔRepo rate			
Intervention	19.46	8	0.012
Dependent Var. ΔIntervention			
mbase	4.45	8	0.814
Dependent Var. ΔIntervention			
Repo rate	20.28	8	0.009

Table 1B: Coefficients on Lagged Intervention

Variable	Lags							
	1	2	3	4	5	6	7	8
Δmbase	-6.37E-05 (-0.97)	9.96E-05 (1.37)	-0.0002 (-2.31)	7.34E-05 (1.01)	9.14E-05 (1.26)	-5.55E-05 (-0.76)	5.86E-05 (0.80)	1.55E-05 (0.23)
ΔRepo rate	0.001 (3.54)	-0.0003 (-0.52)	-0.0001 (-0.23)	-0.002 (-0.29)	0.0003 (0.62)	-0.0009 (-1.72)	0.001 (2.00)	1.10E-05 (0.02)

Note: t-statistics are in parentheses

Table 1C: Coefficients on Lagged mbase

Variable	Lags							
	1	2	3	4	5	6	7	8
Inter	-10.99 (-0.82)	2.44 (0.18)	2.96 (0.22)	-20.63 (-1.58)	8.71 (0.67)	7.89 (0.59)	5.76 (0.43)	6.81 (0.51)

Table 1E: Coefficients on Lagged Repo Rate

Variable	Lags							
	1	2	3	4	5	6	7	8
Inter	2.81 (1.56)	-4.67 (-2.53)	-4.59 (-2.47)	-4.20 (-2.25)	-2.84 (-1.51)	-2.26 (-1.21)	-2.81 (-1.51)	-1.16 (-0.64)

The simple model outlined in Section 2 indicates that interventions move the exchange rate because it drives future monetary policy which in turn drives exchange rate. For the "signaling" hypothesis to work monetary policy must move the exchange rate. "Leaning against the wind" on the other hand implies that intervention impacts on the exchange rate directly, possibly through portfolio balance of microstructure channels. It also suggests that the monetary authorities believe that intervention and monetary policy could be used as different instruments, at least in the short-run. Interventions that are designed to "lean against the wind" may not have to reverse

the trend in exchange rate to be considered useful, it may only have to slow the pace of appreciation or depreciation to achieve the objectives of the monetary authorities. In this case, studies that look at the success of intervention in periods dominated by a "leaning against the wind" strategy may find coefficient of intervention that are insignificant or significant with the incorrect sign. This may not be surprising if monetary policy is considered a separate instrument to intervention but at the same time monetary policy dominates intervention as an instrument in the foreign exchange market.

Based on the above discussion we can identify two types of intervention policy regimes a "signaling" regime and a "leaning against the wind" regime. If the signaling regime dominates then we would expect lagged intervention to predict monetary policy and exchange rate changes to be consistent with developments both in intervention and monetary policy. Therefore, in the current scenario for Jamaica intervention sales of foreign currency should lead to contractionary monetary policy (a rising repo rate or falling monetary base) together with appreciating exchange rate. For a "leaning against the wind" regime to dominate, working backwards, intervention sales of foreign exchange would be caused by a depreciating exchange rate which would have in turn been caused by expansionary monetary policy (falling repo rate (*RR*) and increasing monetary base (*MB*)). Intervention sales of foreign currency would be correlated with expansionary monetary policy and depreciating exchange rates. Lagged changes in the exchange rate should therefore be positively related to intervention sales of foreign currency and expansionary monetary policy.

To investigate the veracity of these links we estimate trivariate VARs similar to the systems estimated above but including the change in the exchange rate. The exchange rate innovations variable was placed last in the VAR order. The system estimated was:

$$[\Delta m(i)_t, I_t, \Delta s_t]' = B(L)[\Delta m(i)_t, I_t, \Delta s_t]' + \varepsilon_t$$

where $\Delta m(i)$ is the monetary policy proxy with $i = RR, MB$ and Δs is the change in the exchange rate. Tests for the appropriate lag length again revealed that the majority of the test indicates a lag length of 8 days. Granger causality/block exogeneity tests of changes in the repo rate on lagged intervention sales and changes in the exchange rate suggest that there is multi-directional causality between the variables in the VAR. This multi-directional causality is a common result in

studies of this nature (Kim, 2003)[11]. When the monetary base is used as the proxy for monetary policy there is only bi-directional links between changes in the monetary base and exchange rate changes. Again when the change in the monetary is used as the monetary policy proxy there is no significant link between this variable and innovations to intervention sales of foreign currency (See Table 2).

The above results imply that there are multiple links and feedback effects inherent in the relationship among the variable included in the VAR. This dynamic structure is used to evaluate the response of the system to shocks by looking at the impulse response functions. Given this apparent disconnect between innovations in the monetary base and intervention sales of foreign currency, we concentrate only on a specification including the repo rate.

Tabel 2: VAR Granger Causality/Block Exogeneity Wald Tests

Sample: 1 1161
Included observations: 1152

Dependent variable: Repo Rate Changes

Excluded	Chi-sq	df	Prob.
Intervention	19.64449	8	0.0118
Exchange Rate Changes	31.34148	8	0.0001

Dependent variable: Intervention

Excluded	Chi-sq	df	Prob.
Repo Rate Changes	13.76805	8	0.0880
Exchange Rate Changes	38.65736	8	0.0000

Dependent variable: Exchange Rate Changes

Excluded	Chi-sq	df	Prob.
Repo Rate Changes	36.35198	8	0.0000
Intervention	20.67733	8	0.0081

[11] Robinson and Robinson (1997) also find these feedback effects but between monetary policy changes and exchange rate changes for Jamaica.

Figure 1 shows the impulse response functions together with the 95% confidence intervals[12] for variable included in the VAR. This shows that a shock to intervention sales increases the repo rate but the response is very short lived, dieing out by the third day. This shock also leads to the appreciation of the exchange rate but again it is very short lived with the effect dissipating after the second day. This seems to support the notion that the Central Bank is signaling with its intervention. A shock to the repo rate elicits increases in intervention sales but again its effect is very short lived. Surprisingly, the a shock to the repo rate leads to an initial depreciation in the exchange rate followed by appreciation but these effect again die out very quickly. This may simply reflect the fact that it was difficult to reverse the general trend of depreciation for any length of time. Very interestingly, a shock to the exchange rate leads to a significant increase in intervention sales for up to 3 days which then tapers of and dies out by the 8th day. This seems to provide some measure of support for "leaning against the wind behavior" on the part of the Central Bank. The repo rate oscillates between increases and declines dieing out by the 8th day. This seems to support the notion that both "signaling" and "leaning against the wind" behaviour was being displayed by the Central Bank.

4. Conclusion and Directions for Future Research

This paper presents some initial empirical results on the empirical relationship between direct central bank intervention in the foreign exchange market and monetary policy in Jamaica. In many cases the relationship is seen to be positive but in other instances the instruments appear to run counter to each other. This paper suggests a theoretical framework which can help explain this duality, in particular, it suggests that the use of direct intervention as a "signaling" device may explain the positive correlation while "leaning against the wind" behaviour may help explain the conflicting parts observed during certain periods.

This hypothesis is then tested using a VAR framework which looks at the links between innovations to proxies of monetary policy, intervention sales of foreign exchange and changes in the exchange rate. This is done using data at a daily frequency because we would like to observe the interaction of policy and target variables at a frequency at which policy challenges increasingly present themselves. In this regard we have omitted variable such as inflation and economic growth which affect monetary policy decision but for which

[12] Standard errors generated by Monte Carlo simulations.

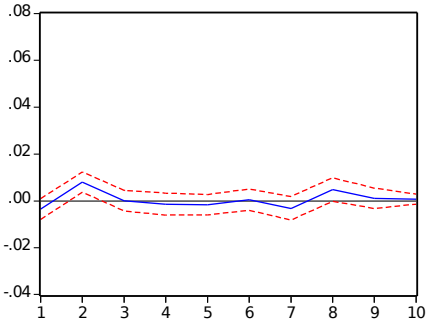
data are not available on a daily frequency. This is one of the weakness of the approach adopted.

The results indicate that particularly when the repo rate is used as the proxy for monetary policy, intervention predicts monetary policy and visa versa. When intervention predicts monetary policy this is attributed to the “signaling” hypothesis dominating in the market. When the policy instruments are at odds this is attributed to “leaning against the wind” on the part of the Central Bank. The results provide some support for the Bank of Jamaica using interventions to signal it future monetary policy stance but stronger support for the “leaning against the wind” behaviour on the part of the bank. The fact that the exchange rate has been on a downward trajectory in Jamaica for the period under review would suggest that the latter process predominated in the market.

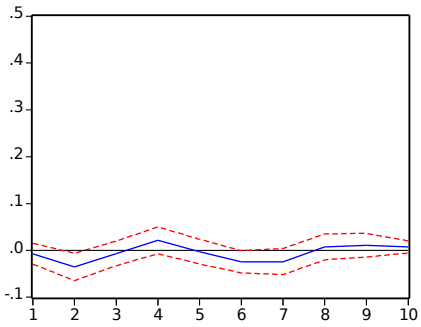
These initial results also indicate the relationship between intervention and monetary policy may be better modeled in a regime switching framework with a “signaling” regime and a “leaning against the wind” regime, with both regimes based on a different relationship between monetary policy and intervention. Initial empirical work along this line has been very promising and is likely to provide better estimates of the relationship over time. This approach will also allow one to identify from the data when a central bank is “signaling” and when it is “leaning against the wind”.

Figure 1: Response to Generalized One S.D. Innovations ±2 S.E.

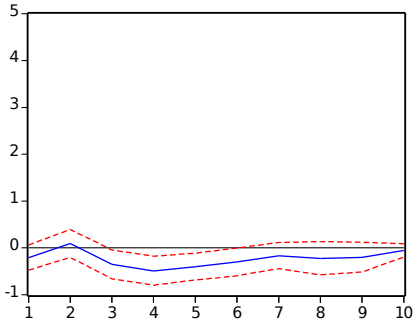
Response of the Repo Rate to Intervention Sales



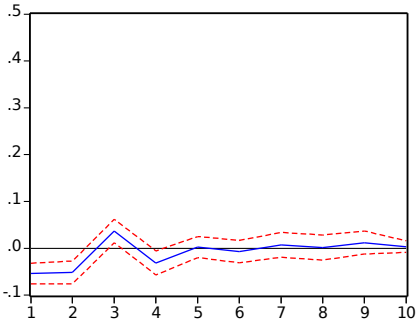
Response of the Exchange Rate to Intervention Sales



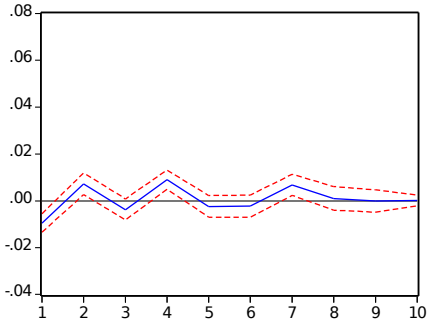
Response of Intervention Sales to changes in the Repo Rate



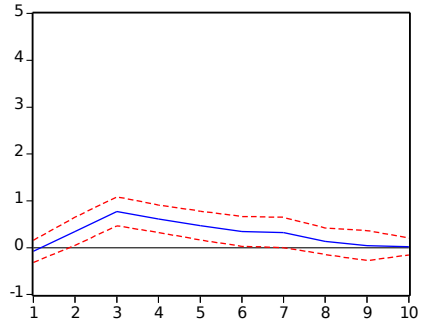
Response of Exchange Rate to changes in the Reporate



Response of the Repo Rate to Exchange Rate Changes



Response of Intervention Sales to Exchange Rate Changes



Appendix

Table A1: VAR Lag Order Selection Criteria for the 1st Difference of the Money Base and Intervention

Endogenous variables: Money Base Intervention
Exogenous variables: C
Sample: 1 1161
Included observations: 1150

Lag	LogL	LR	FPE	AIC	SC	HQ
0	53.74435	NA	0.003133	-0.089990	-0.081212	-0.086677
1	175.6794	243.2340	0.002552	-0.295095	-0.268760*	-0.285154
2	182.7862	14.15170	0.002538	-0.300498	-0.256606	-0.283929
3	189.2318	12.81277	0.002528	-0.304751	-0.243303	-0.281555
4	197.0722	15.55809	0.002511	-0.311430	-0.232425	-0.281607
5	221.8214	49.02504	0.002422	-0.347516	-0.250954	-0.311065
6	222.1635	0.676454	0.002437	-0.341154	-0.227036	-0.298076
7	234.7213	24.78785	0.002401	-0.356037	-0.224363	-0.306332
8	248.4370	27.02592*	0.002361*	-0.372934*	-0.223703	-0.316602*
9	252.2349	7.470345	0.002362	-0.372582	-0.205795	-0.309623
10	253.3786	2.245718	0.002374	-0.367615	-0.183271	-0.298028

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Table A2: VAR Lag Order Selection Criteria for the 1st Difference of the Repo Rate and Intervention

VAR Lag Order Selection Criteria
Endogenous variables: Change in Repo Rate Intervention
Exogenous variables: C
Sample: 1 1161
Included observations: 1150

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-2243.140	NA	0.170135	3.904591	3.913370	3.907905
1	-2091.776	301.9384	0.131671	3.648306	3.674641*	3.658247
2	-2080.599	22.25709	0.130038	3.635824	3.679716	3.652392
3	-2072.242	16.61298	0.129056	3.628246	3.689694	3.651442*
4	-2066.430	11.53159	0.128650	3.625096	3.704101	3.654919
5	-2057.727	17.23952	0.127602	3.616917	3.713478	3.653367
6	-2055.892	3.629439	0.128084	3.620681	3.734799	3.663759
7	-2047.417	16.72856	0.127091	3.612899	3.744573	3.662604
8	-2041.283	12.08753*	0.126620*	3.609187*	3.758418	3.665519
9	-2039.361	3.779168	0.127079	3.612802	3.779590	3.675761
10	-2036.491	5.635005	0.127329	3.614767	3.799112	3.684354

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Table A3: VAR Lag Order Selection Criteria for Repo Rate, Intervention Sales and Exchange Rate Changes

Endogenous variables: Change in the Repo Rate Intervention Sales Exchange Rate Changes
Exogenous variables: C
Sample: 1 1161
Included observations: 1150

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-2906.772	NA	0.031646	5.060474	5.073641	5.065444
1	-2730.825	350.6717	0.023671	4.770130	4.822799*	4.790012
2	-2708.587	44.20469	0.023132	4.747108	4.839280	4.781901
3	-2689.427	37.98628	0.022727	4.729438	4.861113	4.779143*
4	-2681.033	16.59758	0.022751	4.730493	4.901670	4.795109
5	-2664.205	33.18759	0.022444	4.716879	4.927558	4.796407
6	-2655.383	17.35306	0.022451	4.717188	4.967369	4.811627
7	-2643.760	22.80254	0.022349	4.712625	5.002309	4.821976
8	-2633.472	20.12713*	0.022299*	4.710387*	5.039573	4.834649
9	-2629.314	8.113500	0.022488	4.718808	5.087496	4.857981
10	-2622.434	13.38897	0.022571	4.722495	5.130685	4.876580

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

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