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Currency Intervention: A Case Study of an Emerging Market*

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Abstract

Using a unique dataset on daily foreign exchange intervention and a new methodological framework of a latent factor model of central bank intervention, this paper addresses the effects of intervention in an emerging market. Events in financial markets from 2002 to 2010 provide a natural experiment to evaluate the short and medium term objectives of the central bank to contain excessive exchange rate volatility and to accumulate foreign reserves respectively. In the low volatility period in the first part of the sample, the central bank is successful in influencing the currency when pressure is to appreciate, accumulating international reserves. The same model estimated for the global volatility period in the second part of the sample shows the central bank intervening to mitigate excessive exchange rate volatility in line with the short-term objective.

Keywords: Foreign exchange intervention, currency intervention, exchange rate volatility, reserve accumulation, factor model, emerging markets

JEL Classification: F31, F36, F41

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1 Introduction

The motives for central banks to intervene in the foreign exchange market include reducing the economic costs associated with exchange rate volatility which affects international trade, financial flows, foreign investment and economic growth, and accumulating international reserves to strengthen a country's macroeconomic fundamentals (Szakmary and Mathur, 1997; Sarno and Taylor, 2001; Disyatat and Galati, 2007; Pontines and Rajan, 2011). These objectives are particularly important for emerging markets as they are more prone to and affected by external shocks than their developed counterparts. Meanwhile, accumulating international reserves helps to establish the confidence of foreign investors in the domestic economy by positively affecting sovereign risk, and vulnerability to external shocks can be alleviated through a high level of reserve adequacy (Mulder and Perrelli, 2001; Dominguez et al., 2011). Using a unique dataset on daily foreign exchange intervention and a new methodological framework, this paper addresses the effects of intervention on exchange rate volatility and reserve accumulation for emerging markets using Sri Lanka as an example.[1]

The officially announced intentions of the Central Bank of Sri Lanka are exactly those mentioned above but with a time frame associated with each objective in that in the short term, intervention is to contain excessive volatility in the exchange rate, and in the medium term is to accumulate international reserves (Central Bank of Sri Lanka, 2007).[2] Determining the effects of intervention for emerging markets is constrained by data availability and with the exception of Disyatat and Galati (2007) for the Czech Koruna, there are few published works in this area.[3] Sarno and Taylor (2001) and Disyatat and Galati (2007) provide good surveys to evaluate intervention and its effects on exchange rate volatility with the conclusions tending to be that intervention can be effective and is conducted mainly in response to a rapidly appreciating domestic currency. From a reserve accumulation perspective, the large stocks of reserves held by emerging markets is now attracting attention following the economic and financial market collapses of the last five years. Important papers examining this issue include

[1]We are grateful to the Central Bank of Sri Lanka for providing us with all data, particularly the intervention data.

[2]Intervention in Sri Lanka is not aimed at targeting an exchange rate level (Central Bank of Sri Lanka, 2007), implying that the intervention strategy is to 'lean against the wind' to reduce exchange rate volatility.

[3]Emerging country central banks and organisations such as the International Monetary Fund aim to fill this gap (Pattanaik and Sahoo, 2001; Mandeng, 2003; Guimarães and Karacadag, 2004; Herrera and Ozbay, 2005; Kamil, 2008; Adler and Tovar, 2011).

Dominguez et al., (2011) and Dominguez (2010).

A framework which naturally lends itself to modeling central bank foreign exchange intervention but which has not previously been applied to this topic is the latent factor framework.[4] This class of models is often used to calculate volatility decompositions to decompose financial market asset returns into specified sources of volatility associated with the factor structure such as global, domestic, asset market or country factors (Diebold and Nerlove, 1989; Mahieu and Schotman, 1994; Dungey, 1999). This paper constructs a factor model of intervention for a set of daily currency returns of Sri Lanka and its major trading partners as well as Sri Lankan intervention data which is modeled endogenously.

The weight placed on the objectives of a central bank's intervention policy at any point in time is a function of the prevailing external global economic environment, the domestic economic environment including policy regime choices, as well as the general level of development of a country. Our model reflects this environment for an emerging country by specifying each Sri Lankan and trading partner currency return as a function of global, domestic and intervention factors. The global factor affects all currency returns in the model but allows each market to respond in different ways. It captures movements external to the domestic economy and encompasses concepts such as but not exclusively global market fundamentals, global liquidity conditions and general trader risk aversion. A domestic factor is specified for each variable and captures movements specific to each market. Intervention is also a function of global and domestic factors. Using the fact that it is known on which days intervention policy is enacted, an additional intervention factor is specified for the Sri Lankan currency equation which shares features of the net intervention equation. This relationship exists only on days on which the central bank intervenes and the feature of known intervention days is also used as part of the identification of the model.

Events in financial markets in the sample period from January 2002 to December 2010 provide a natural experiment to evaluate the short and medium term objectives of the Central Bank. The model is estimated over two periods. The first corresponds to the relative calm and low volatility of financial markets in the first half of the sample, and the second to the period of global volatility associated with the global financial crisis in the second half. If the commitment to the medium term objective of

[4]The manuscript, Aruman (2003) considers intervention in a latent factor framework but uses a factor structure different to that adopted here.

reserve accumulation and the short term objective of reducing exchange rate volatility is met, the volatility decompositions for each period should differ. The data provided distinguishes between days of intervention through net sales and net purchases of US dollars providing further evidence on the commitment of the central bank to each objective.

The results suggest that the central bank is successful in achieving its short-term and medium-term objectives of containing exchange rate volatility and accumulating reserves. In the low volatility period, the central bank tends to intervene in response to global rather than domestic factors and is able to influence overall foreign exchange return volatility by 5.5 percent. Splitting the data into days of intervening through purchases versus sales of US dollars shows that intervention is most effective when the bank purchases US dollars. This suggests that the central bank is successful in influencing the exchange rate when the pressure in currency markets is to appreciate the Sri Lankan rupee, hence accumulating international reserves in line with their medium-term target as is expected during a period of calm. The same model estimated for the global volatility period presents strikingly different results. Sales of US dollars is important during this time with the central bank intervening to mitigate the exchange rate volatility in line with the short-term objective.

The rest of the paper proceeds as follows. Section 2 presents the exchange rate and intervention data used in the empirical application. The modeling framework is developed in Section 3, and Section 4 discusses the GMM methodology adopted to estimate the models of intervention. Section 5 presents the empirical results, first focussing on the low volatility period and later the global volatility period. Section 6 concludes.

2 Exchange Rates and Intervention

This section presents a preliminary analysis of the data used in the model of foreign exchange intervention in Sri Lanka. The data comprise of $n = 5$ daily exchange rate returns of the euro (EUR_t), the Indian rupee (INR_t), the Japanese yen (JPY_t), the British pound (GBP_t) and the Sri Lankan rupee (SLR_t), expressed in US dollars, as well as daily net foreign exchange purchases by the Central Bank of Sri Lanka (INT_t). Exchange rate returns are computed by taking the first difference of the natural logarithm of the exchange rates and multiplying them by 100. Net foreign exchange purchases are in millions of US dollars. All series are demeaned and scaled by their respective standard deviations, and are expressed in standardized units. The exchange rates and returns are shown in Figure 1.[5] An increase in the value of the exchange rate indicates an appreciation of the US dollar against the local currency.

The selection of exchange rates corresponds to Sri Lanka's main trading partner countries according to the weights assigned by the Central Bank of Sri Lanka in calculating the 24-currency real effective exchange rate. The top six countries' trade weights in the calculation of the real effective exchange rate are the US (19.74 percent), India (15.57 percent), the UK (9.86 percent), China (6.41 percent), Germany (5.88 percent) and Japan (4.99 percent).[6] The Chinese yuan is excluded from the model as the focus is on countries with floating exchange rate regimes. The sample consists of a selection of developed-market exchange rates, as well as the emerging-market exchange rate of the Indian rupee. The Indian rupee provides a convenient point of comparison with the Sri Lankan rupee in the model.

The intervention data is net foreign exchange purchases data for Sri Lanka as shown in Figure 2 and is plotted against the log of the level of the Sri Lankan rupee in panel (a), and the percentage returns in (b). Positive values of the intervention series represent purchases of US dollars and negative values represent sales. Net daily foreign exchange purchases are conducted only in the US dollar market; however, by doing so, the central bank indirectly influences the exchange rates of other currencies against the Sri Lankan rupee.

The sample period extends from January 1, 2002 to December 31, 2010, and is chosen based on the availability of the daily foreign exchange intervention data after the floating of the Sri Lankan rupee in 2001. For estimation of the model for the low volatility period in Sections 5.1 to 5.3, the sample period is chosen to end on June 29, 2007. The model for the high global-volatility period in Section 5.4 is estimated from July 2, 2007 to December 31, 2010. The global volatility period is the shaded area in the figures.

Table 1 presents descriptive statistics on the rupee and other exchange rate returns in the model for the total sample period, as well as for low volatility and global volatil-

[5] The outliers in the euro on March 1 and 2, 2005, as depicted in Figure 1, are removed by regressing the euro returns against a dummy variable for each outlier.

[6] See Box Article 12 of the Central Bank of Sri Lanka Annual Report 2010, *Revision of Effective Exchange Rate Indices*, http://www.cbsl.gov.lk/pics_n_docs/10_pub/_docs/efr/annual_report/AR2010/English/9_Chapter_05.pdf (accessed June 5, 2011).

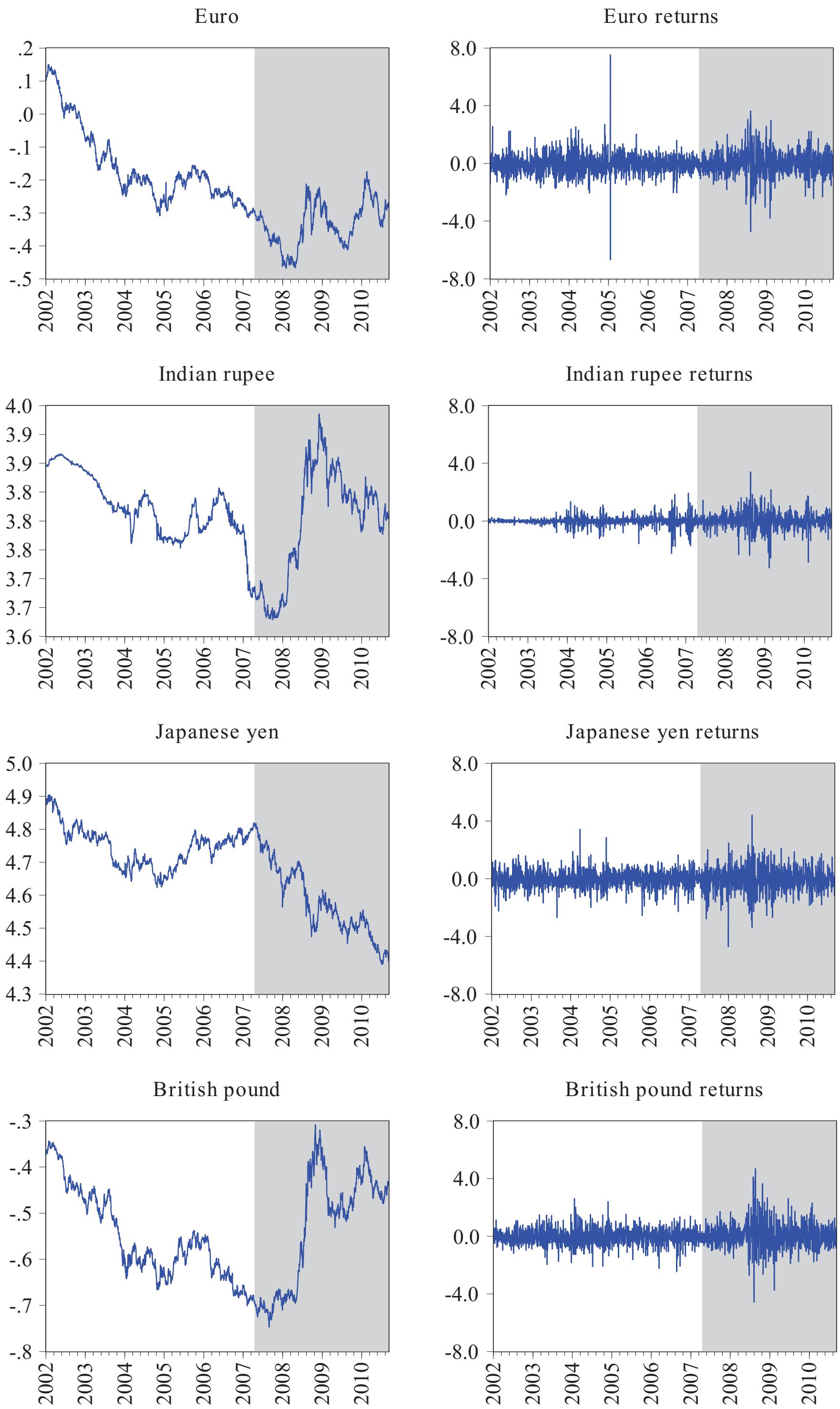

Figure 1: Daily Log Exchange Rates and Percentage Exchange Rate Returns, January 2002-December 2010. Notes: Returns are for the euro, the Indian rupee, the Japanese yen and the British pound against the US dollar. The shaded area indicates the period of global volatility from July 2, 2007-December 31, 2010. (Source: Central Bank of Sri Lanka).

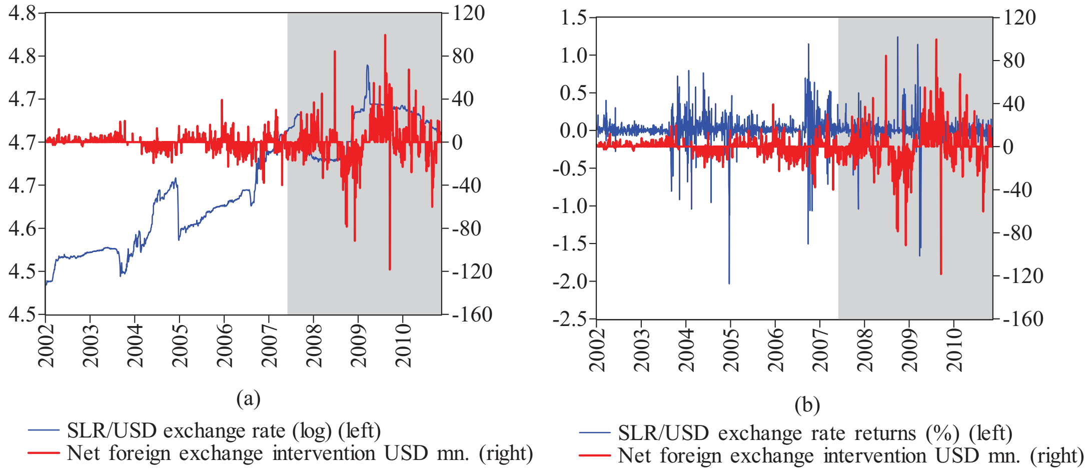

Figure 2: Sri Lankan Rupee Exchange Rate and Intervention Data, January 2002-December 2010. Notes: Panel (a) is the daily log exchange rate against the US dollar and net foreign exchange intervention (USD mn). Panel (b) is the percentage daily exchange rate returns against the US dollar and net foreign exchange intervention (USD mn). The scale on the left of each panel is for the exchange rate variables and on the right is the intervention data. The shaded areas indicate the period of global volatility from July 2, 2007-December 31, 2010. (Source: Central Bank of Sri Lanka).

ity periods for all days, days of intervention and days on which there is no intervention. Table 2 presents similar statistics for the net intervention data.[7] The central bank does not define the meaning of "excessive volatility" when defining it's objectives in relation to intervention, hence, there is no formal rule governing when intervention should occur. However, Figure 2 and Table 2 show that the Central Bank of Sri Lanka intervenes frequently. Over the sample period, intervention takes place on approximately 50 percent of all days, with a fairly even split between net purchases (547 days) and sales (535 days). There is more intervention in the global volatility period (62 percent of days) compared to the low volatility period (43 percent of days).

[7]Note that changes in cross rates for example between the Sri Lankan rupee and the euro, are not formally modeled in this paper, with all exchange rates expressed against the US dollar.

Table 1:
Descriptive Statistics of the Exchange Rate Returns (percent). Notes: The exchange rates are expressed in terms of US dollars. The statistics are calculated for each sub-period for all days (All), days on which there is no intervention (Non-int) and days on which there is intervention (Int). The total sample period is from January 1, 2002-December 31, 2010, the low volatility period is from January 1, 2002-June 29, 2007, and the global volatility period is from July 2, 2007 - December 31, 2010.

		Total sample			Low volatility period			Global volatility period		
Statistics	Variable	All	Non-int	Int	All	Non-int	Int	All	Non-int	Int
No. of obs.		2171	1089	1082	1324	763	561	847	326	521
Max	EUR	7.53	7.53	3.65	7.53	7.53	2.55	3.65	2.99	3.65
	INR	3.40	1.93	3.40	1.93	1.93	0.98	3.40	1.74	3.40
	JPY	4.41	3.44	4.41	3.44	3.44	1.29	4.41	2.47	4.41
	GBP	4.68	2.61	4.68	2.61	2.61	1.47	4.68	2.39	4.68
	SLR	1.25	1.15	1.25	1.15	1.15	0.77	1.25	1.14	1.25
Min	EUR	-6.69	-6.69	-4.73	-6.69	-6.69	-2.19	-4.73	-3.80	-4.73
	INR	-3.25	-3.25	-2.58	-2.26	-2.26	-1.57	-3.25	-3.25	-2.56
	JPY	-4.73	-2.71	-4.73	-2.71	-2.71	-2.56	-4.73	-2.21	-4.73
	GBP	-4.58	-2.71	-4.58	-2.46	-2.46	-2.08	-4.58	-2.71	-4.58
	SLR	-2.04	-2.04	-1.06	-2.04	-2.04	-1.06	-1.67	-1.67	-1.04
Mean	EUR	-0.02	-0.01	-0.03	-0.03	-0.03	-0.04	0.00	0.02	-0.01
	INR	-0.00	-0.01	-0.00	-0.01	-0.01	-0.02	0.01	-0.00	0.02
	JPY	-0.02	0.02	-0.06	-0.01	0.02	-0.04	-0.05	0.02	-0.09
	GBP	-0.00	-0.01	0.01	-0.02	-0.02	-0.03	0.03	0.01	0.04
	SLR	0.01	0.01	0.01	-0.01	0.01	0.01	0.00	0.00	-0.00
Std. dev.	EUR	0.75	0.77	0.73	0.69	0.75	0.59	0.84	0.81	0.85
	INR	0.43	0.44	0.42	0.31	0.35	0.24	0.57	0.58	0.56
	JPY	0.69	0.64	0.73	0.59	0.61	0.55	0.82	0.72	0.88
	GBP	0.69	0.64	0.74	0.56	0.60	0.50	0.86	0.75	0.93
	SLR	0.17	0.21	0.14	0.19	0.21	0.15	0.16	0.20	0.12

Figure 2 and Table 2 show that the magnitude of volatility for the intervention data is greater during the global volatility period. The standard deviation of intervention increased from 7.81 million in the low volatility period to 20.03 million in the global volatility period. During this time, the Central Bank of Sri Lanka went from being a net seller to a net purchaser, as shown by the mean across the sub-periods. For Sri Lanka, the increased volatility probably results from domestic and external reasons. This period not only coincides with the global financial crisis, but also the final phase of the 25 year civil war in Sri Lanka. Turning again to Table 1, on days during the global volatility period when the central bank intervenes, volatility is higher on intervention days than on days of no intervention for all countries excluding India and Sri Lanka. For example, on non-intervention days, the standard deviation of the euro returns is 0.81 percent compared to 0.85 percent on the intervention days, and increases from 0.75 percent to 0.93 percent for the pound. In contrast, the standard deviation for the Sri Lankan rupee returns falls from 0.20 percent to 0.12 percent perhaps suggesting that the central bank is effective in containing exchange rate return volatility through intervention when volatility is high, or perhaps reflecting the improvement of domestic conditions.

It should be noted that foreign exchange intervention in the broad sense includes measures which affect the exchange rate both directly and indirectly. Intervention from a more narrow perspective is restricted to purchases or sales of foreign exchange by a monetary authority with a view to influencing the exchange rate directly. This paper analyses the narrow perspective of intervention. No stance is taken on whether intervention here is sterilized or not, although it is probably partially sterilized, as

Table 2:
Descriptive Statistics for the Intervention Data. Notes: The intervention data are expressed in millions of US dollars. The statistics are calculated for each sub-period on all days there are purchases or sales of US dollars (Intervention), days on which US dollars are purchased (Purchases) and days on which US dollars are sold (Sales). The total sample is from January 1, 2002-December 31, 2010, the low volatility period is from January 1, 2002 - June 29, 2007, and the global volatility period is from July 2, 2007 - December 31, 2010.

Statistics	Intervention	Purchases	Sales
Total sample			
No. of obs.	1082	547	535
Mean	0.11	9.71	-9.68
Max	99.75	99.75	-0.25
Min	-118.45	0.25	-118.45
Std. dev.	14.99	11.60	11.27
Low volatility period			
No. of obs.	561	307	254
Mean	-0.35	4.80	-6.60
Max	39.15	39.15	-0.25
Min	-40.00	0.25	-40.00
Std. dev.	7.81	4.89	5.89
Global volatility period			
No. of obs.	521	240	281
Mean	0.60	16.00	-12.47
Max	99.75	99.75	-0.25
Min	-118.45	0.50	-118.45
Std. dev.	20.03	14.36	13.91

Canales-Kriljenko (2003) points out, in contrast to developed countries it is not common for central banks in emerging countries to fully sterilize.

3 Model Specification

The analytical framework employed in this paper is a latent factor model of exchange rate returns in the tradition of Mahieu and Schotman (1994), Diebold and Nerlove (1989) and Dungey (1999), where exchange rate returns are presented as functions of a set of independent latent factors. The factors in this application capture movements that are common to all exchange rate returns (global factors), idiosyncratic to each asset (domestic factors), and related to intervention (intervention factors). Adopting a factor structure has several advantages. First, the approach provides a parsimonious representation of the data. Second, observable variables do not have to be identified or modeled. Third, the approach is convenient to use, as the model implicitly takes into account all disturbances affecting the system of exchange rate returns. Finally, *iid* and unit variance assumptions on the factor structure allow the decomposition of exchange rate returns into the contribution that each of the factors makes to overall volatility. The volatility decompositions are the main vehicle for analysis.

In finalizing the factor model of central bank intervention, the model is built up in two stages. Section 3.1 specifies a factor model of exchange rate returns without formally modeling the effect of intervention. However, the model distinguishes between non-intervention and intervention days. On non-intervention days, exchange rate returns are a function of global and domestic factors. On intervention days, the exchange rate returns are a function of the same factors; however, the effect of each factor on each exchange rate return, as given by the factor loadings, is allowed to change through the formal modeling of structural breaks. These are designed to capture changes in the global and domestic dependence structures among the exchange rate returns which may be prevalent on the days that a central bank chooses to intervene in the foreign exchange market. The modeling of only the exchange rate returns in the first stage is to provide a sense of these dependence structures before the formal introduction of intervention.

In the second stage of modeling described in Section 3.2, care is again taken to distinguish between non-intervention and intervention days. The intervention variable is introduced into the model of exchange rate returns and follows the same factor structure as the exchange rates, in that it is specified as a function of a global and an idiosyncratic factor. However, on intervention days the Sri Lankan rupee exchange rate returns are allowed to be a function of the idiosyncratic factor associated with the intervention data, effectively specifying an additional domestic factor (an intervention factor) for the two Sri Lankan equations on these days. This model is able to provide evidence on the effectiveness of intervention by the Central Bank of Sri Lanka, as the contribution of intervention to the volatility of the Sri Lankan exchange rate returns in comparison to the global and idiosyncratic factors is able to be assessed.

3.1 A factor model of exchange rate returns

This section specifies a latent factor model of exchange rate returns for the intervention and non-intervention days, while suppressing the formal role for intervention. The model consists of n zero mean daily bilateral exchange rate returns expressed against the US dollar. The data-set is separated into two parts, which aids identification as outlined in the discussion of the Estimation Method in Section 4. Let e_t^0 denote the exchange rate returns on non-intervention days ($j = 0$), and let e_t^1 denote the exchange rate returns on intervention days ($j = 1$), such that

$$e_t^j = \left\{EUR_t^j, INR_t^j, JPY_t^j, GBP_t^j, SLR_t^j\right\} \qquad j = 0, 1. \tag{1}$$

Non-intervention days The dynamics of the i^{th} exchange rate returns on non-intervention days ($j = 0$) is governed by a set of independent latent factors

$$e_{i,t}^0 = \lambda_i^0 w_t + \gamma_i^0 u_{i,t} \qquad i = 1, 2, ..., n; j = 0. \tag{2}$$

The global factor in the model (w_t) captures common shocks affecting each of the n exchange rate returns in the model with their own parameter loading λ_i^0.[8] The domestic factor $u_{i,t}$ captures shocks specific to each currency market, and reflects own-country fundamentals that are independent of global conditions. The loadings on the idiosyncratic factors are γ_i^0.

[8] An alternative structure is to formally model a common numeraire factor to show that all returns are expressed in US dollars. This factor would affect each exchange rate return with a fixed loading in each equation. The presence of the numeraire factor imposes a no-arbitrage condition on the model, as shown in Dungey (1999). However, computationally this specification did not work for this application.

Intervention days On intervention days ($j = 1$), it is assumed that there is a possibility of higher volatility in the exchange rate market, perhaps prompting intervention. To allow for this, structural breaks in the factor structure are specified for intervention days. The dynamics of exchange rate returns for intervention days ($j = 1$) is expressed as

$$e^1_{i,t} = (\lambda^0_i + \lambda^1_i) w_t + (\gamma^0_i + \gamma^1_i) u_{i,t} \qquad i = 1, 2, ..., n; j = 1 \tag{3}$$

where λ^1_i and γ^1_i are the structural breaks in the parameters on the global and idiosyncratic factors.

In matrix form, the model of exchange rate returns is expressed as

$$\mathbf{e^j_t} = \Lambda^j \mathbf{F_t}, \tag{4}$$

where for intervention days ($j = 1$)

$$\begin{bmatrix} EUR^1_t \\ INR^1_t \\ JPY^1_t \\ GBP^1_t \\ SLR^1_t \end{bmatrix} = \begin{bmatrix} (\lambda^0_1 + \lambda^1_1) \\ (\lambda^0_2 + \lambda^1_2) \\ (\lambda^0_3 + \lambda^1_3) \\ (\lambda^0_4 + \lambda^1_4) \\ (\lambda^0_5 + \lambda^1_5) \end{bmatrix} w_t$$
$$+ \begin{bmatrix} (\gamma^0_1 + \gamma^1_1) & 0 & 0 & 0 & 0 \\ 0 & (\gamma^0_2 + \gamma^1_2) & 0 & 0 & 0 \\ 0 & 0 & (\gamma^0_3 + \gamma^1_3) & 0 & 0 \\ 0 & 0 & 0 & (\gamma^0_4 + \gamma^1_4) & 0 \\ 0 & 0 & 0 & 0 & (\gamma^0_5 + \gamma^1_5) \end{bmatrix} \begin{bmatrix} u_{1,t} \\ u_{2,t} \\ u_{3,t} \\ u_{4,t} \\ u_{5,t} \end{bmatrix}. \tag{5}$$

Variance decompositions Using the assumption that the factors are $iid\,(0, 1)$ random variables, equations (2) and (3) is used to express the volatility of each of the currency returns into its component factors. For intervention days the total volatility of each currency return is

$$\begin{aligned} Var\left(e^1_{i,t}\right) &= E[(e^1)^2_{i,t}] \\ &= (\lambda^0_i + \lambda^1_i)^2 + (\gamma^0_i + \gamma^1_i)^2. \end{aligned} \tag{6}$$

The proportion of the volatility of the return of exchange rate i when $j = 1$ explained by the global factor w_t, is

$$\frac{(\lambda^0_i + \lambda^1_i)^2}{(\lambda^0_i + \lambda^1_i)^2 + (\gamma^0_i + \gamma^1_i)^2}. \tag{7}$$

The proportion of the volatility of the return of exchange rate i, explained by the domestic factor $u_{i,t}$, is

$$\frac{(\gamma_i^0 + \gamma_i^1)^2}{(\lambda_i^0 + \lambda_i^1)^2 + (\gamma_i^0 + \gamma_i^1)^2}. \tag{8}$$

On non-intervention days ($j = 0$), the variance decompositions are the same, but with the structural break terms suppressed.

3.2 A factor model of central bank intervention

To examine the effectiveness of central bank intervention, the model in Section 3.1 is extended by introducing intervention (net purchases of US dollars) as an endogenous variable. The data set is again separated into the two parts ($j = 0, 1$) of non-intervention vis-à-vis intervention days. Redefining e_t^j to consist of $n = 6$ series of zero mean bilateral exchange rate returns expressed against the US dollar and demeaned net intervention in millions of US dollars, the data set is

$$e_t^j = \left\{EUR_t^j, INR_t^j, JPY_t^j, GBP_t^j, SLR_t^j, INT_t^j\right\} \qquad j = 0, 1. \tag{9}$$

The model for intervention in the Sri Lankan rupee exchange rate returns market rests on the assumption that intervention conducted by the Central Bank of Sri Lanka does not directly affect the exchange rate returns against the US dollar for the remaining exchange rates in the sample. Hence, the equations for the exchange rate returns for $n = 1, 2...4$ are the same as those stated in equations (2) and (3).

The new variable intervention $\left(INT_t^j\right)$, is a function of the global factor w_t with parameter loading λ_{int}^j, and an idiosyncratic factor v_t with loading γ_{int}^j such that when $j = 0$

$$INT_t^0 = \lambda_{int}^0 w_t + \gamma_{int}^0 v_t, \tag{10}$$

and when $j = 1$

$$INT_t^1 = (\lambda_{int}^0 + \lambda_{int}^1) w_t + (\gamma_{int}^0 + \gamma_{int}^1) v_t.$$

The endogenous treatment of intervention and its inclusion when $j = 0$ provides a natural test of the model, as the variation in intervention is expected to be explained only by its own idiosyncratic factor, with no effect from the global factors.

The equation for the Sri Lankan rupee returns is the same as in equation (2) for non-intervention days, but differs from equation (3) for intervention days where

$$e_{5,t}^1 = (\lambda_5^0 + \lambda_5^1) w_t + (\gamma_5^0 + \gamma_5^1) u_{5,t} + \sigma_{int}^1 v_t. \tag{11}$$

The Sri Lankan rupee returns are now explained by the global factor w_t, and two domestic factors. These are its own domestic factor $u_{5,t}$ and the domestic component of the intervention factor v_t. On intervention days, the factor v_t becomes an intervention factor, with the effectiveness of foreign exchange intervention by the central bank measured by the loading on the intervention factor in the Sri Lankan rupee exchange rate returns equation, σ^1_{int}. Only the domestic intervention factor is included in the Sri Lankan returns equation on intervention days as the global factor already affects both the Sri Lankan returns and Sri Lankan intervention decision. Hence the domestic intervention factor represents pure intervention as the effectiveness of this component of intervention is what the central bank controls outside of the impact of global shocks.

In matrix form

$$\mathbf{e_t}^j = \Lambda^j \mathbf{F_t}, \tag{12}$$

and the model of central bank intervention is expressed as

$$\begin{bmatrix} EUR_t^1 \\ INR_t^1 \\ JPY_t^1 \\ GBP_t^1 \\ SLR_t^1 \\ INT_t^1 \end{bmatrix} = \begin{bmatrix} (\lambda_1^0 + \lambda_1^1) \\ (\lambda_2^0 + \lambda_2^1) \\ (\lambda_3^0 + \lambda_3^1) \\ (\lambda_4^0 + \lambda_4^1) \\ (\lambda_5^0 + \lambda_5^1) \\ (\lambda_{int}^0 + \lambda_{int}^1) \end{bmatrix} w_t$$

$$+ \begin{bmatrix} (\gamma_1^0 + \gamma_1^1) & 0 & 0 & 0 & 0 & 0 \\ 0 & (\gamma_2^0 + \gamma_2^1) & 0 & 0 & 0 & 0 \\ 0 & 0 & (\gamma_3^0 + \gamma_3^1) & 0 & 0 & 0 \\ 0 & 0 & 0 & (\gamma_4^0 + \gamma_4^1) & 0 & 0 \\ 0 & 0 & 0 & 0 & (\gamma_5^0 + \gamma_5^1) & \sigma_{int}^1 \\ 0 & 0 & 0 & 0 & 0 & (\gamma_{int}^0 + \gamma_{int}^1) \end{bmatrix} \begin{bmatrix} u_{1,t} \\ u_{2,t} \\ u_{3,t} \\ u_{4,t} \\ u_{5,t} \\ v_t \end{bmatrix}, \tag{13}$$

when $j = 1$.

Volatility decompositions Analogous to the factor model of exchange rate returns, the volatility decompositions for the factor model of central bank intervention is calculated using the expressions for the total variance for each type of variable

$$\begin{aligned} Var(e_{i,t}^1) &= (\lambda_i^0 + \lambda_i^1)^2 + (\gamma_i^0 + \gamma_i^1)^2, \qquad i = 1, 2, ..., 4 \\ Var(e_{5,t}^1) &= (\lambda_5^0 + \lambda_5^1)^2 + (\gamma_5^0 + \gamma_5^1)^2 + (\sigma_{intv}^1)^2, \\ Var(INT_t^1) &= (\lambda_{int}^0 + \lambda_{int}^1)^2 + (\gamma_{int}^0 + \gamma_{int}^1)^2. \end{aligned} \tag{14}$$

For the Sri Lankan rupee returns, the percentage of the volatility of the returns explained by the global factor w_t is

$$\frac{(\lambda_i^0+\lambda_i^1)^2}{(\lambda_i^0+\lambda_i^1)^2+(\gamma_i^0+\gamma_i^1)^2+(\sigma_{intv}^1)^2}.100. \tag{15}$$

The percentage of the volatility of the returns explained by its own domestic factor $u_{5,t}$ is

$$\frac{(\gamma_i^0+\gamma_i^1)^2}{(\lambda_i^0+\lambda_i^1)^2+(\gamma_i^0+\gamma_i^1)^2+(\sigma_{intv}^1)^2}.100. \tag{16}$$

Finally, the percentage of the volatility of the returns explained by the intervention factor v_t is

$$\frac{(\sigma_{int}^1)^2}{(\lambda_i^0+\lambda_i^1)^2+(\gamma_i^0+\gamma_i^1)^2+(\sigma_{intv}^1)^2}.100. \tag{17}$$

In the same manner, the percentage of the volatility of intervention is decomposed into global (w_t) and idiosyncratic (v_t) factors, as

$$\frac{(\lambda_{int}^0+\lambda_{int}^1)^2}{(\lambda_{int}^0+\lambda_{int}^1)^2+(\gamma_{int}^0+\gamma_{int}^1)^2}, \tag{18}$$

and

$$\frac{(\gamma_{int}^0+\gamma_{int}^1)^2}{(\lambda_{int}^0+\lambda_{int}^1)^2+(\gamma_{int}^0+\gamma_{int}^1)^2}, \tag{19}$$

respectively.

4 Estimation Method

The factor models of exchange rate returns and central bank intervention specified in the previous section use a GMM estimator, the estimates of which are known to be consistent, asymptotically normal and efficient (Hansen, 1982). GMM estimation does not require any extra information aside from that contained in the moment conditions. The estimation involves computing the unknown parameters by equating the theoretical moments of the model to the empirical moments of the data for both intervention and non-intervention day regimes in both models.

As alluded to in Section 3, the model of intervention is identified and estimated by exploiting the feature of the data that intervention did not occur on some days and did occur on others.[9] In the case of the factor model of central bank intervention,

[9] Dungey, Fry, González-Hermosillo, Martin and Tang (2010) use the regimes of a non-crisis and a crisis period to identify models of contagion in much the same way that intervention is identified through the two regimes here of non-intervention days and intervention days.

which contains $n = 6$ variables, there are a total of 42 moment conditions with which to identify 27 parameters by equating the empirical and theoretical moments of the model. Of the moment conditions, $((6 \times 7)/2) = 21$ derive from non-intervention day data, with the additional 21 derived from intervention day data.

The difference between the empirical moments and the theoretical moments of the model for each of the (non-intervention and intervention) regimes is

$$M_0 = vech\left(\Omega^0\right) - vech\left(\Lambda^0 \Lambda^{0\prime}\right), \tag{20}$$

and

$$M_1 = vech\left(\Omega^1\right) - vech\left(\Lambda^1 \Lambda^{1\prime}\right), \tag{21}$$

where Ω^j refers to the empirical variance-covariance matrices for non-intervention and intervention days, and $\Lambda^j \Lambda^{j\prime}$ refers to the corresponding theoretical variance-covariance matrices for the two regimes. The Λ^j derives from equation (12) and uses the assumption that the factors are zero mean and unit variance, the empirical variance-covariance matrices are

$$\Omega^j = \frac{1}{T_j} \sum_{t \in T_j} e_t^j e_t^{j\prime}.$$

where T_j represents the sample size of non-intervention and intervention day regimes.[10]

The objective function of the GMM estimator Q accounting jointly for both non-intervention days and intervention days is minimized according to

$$Q = M_0' W_0^{-1} M_0 + M_1' W_1^{-1} M_1, \tag{22}$$

where W_j are the optimal weighting matrices that correct for heteroskedasticity corresponding to $j = 0, 1$ (Hamilton, 1994; Newey and West, 1987). All calculations are undertaken using the library MAXLIK in GAUSS version 11. The GMM estimates are computed by iterating over the parameters and the weighting matrices using the BFGS algorithm with the gradients computed numerically. Note that in estimating the model, initial estimates of the variance-covariance matrices are obtained using identity weighting matrices. That is $W_j = I$.[11]

When the number of moment conditions is greater than the dimensions of the parameter vectors, the model is over-identified. Empirically, an over-identification test

[10] Attempts to identify the model described in Section 3 using the variance-covariance matrices of the total dataset is infeasible, as this would generate only 21 empirical moments to identify 27 parameters in the theoretical model, leaving the model unidentified.

[11] For some variants of the models, the use of optimal weighting matrices was infeasible; thus, for consistency, results using the identity-weighting matrix for all models are reported.

can be used to check whether the model's moment conditions match the data well or not. Using Hansen's $J-$statistic, a test of the over-identification restrictions is given by

$$J = TQ, \tag{23}$$

where $T = T_0 + T_1$. The minimized distance given in Equation (23) is asymptotically distributed as a χ^2 with $m - b$ degrees of freedom, where m is the number of moment conditions and b is the number of parameters. A rejection of these restrictions indicates that some variables in the information set fail to satisfy the orthogonality conditions.

5 Foreign Exchange Intervention and Volatility

This section examines the effect of foreign exchange intervention by estimating the models outlined in Section 3. The first set of models are estimated for the low volatility period. Before estimating the fully specified model of central bank intervention in 5.2, a model of exchange rate returns without a formal role for intervention is first estimated in 5.1. The role of intervention is formally introduced in Sections 5.2 and 5.3. Section 5.2 evaluates the effectiveness of intervention in general, and Section 5.3 evaluates the differences in the effectiveness of intervention when the Central Bank of Sri Lanka intervenes by purchasing US dollars vis-à-vis when intervention occurs through sales. Finally, in Section 5.4, the model of central bank intervention distinguishing between purchases and sales is re-run over the global volatility sample period.

5.1 A factor model of exchange rate returns

The results of the factor model of exchange rate returns outlined in Section 3.1 are presented in Table 3. To recap, this model does not formally model intervention, but it does separate the data into non-intervention days and intervention days. The factor model of exchange rate returns examines the contribution of the global and domestic factors to overall volatility in exchange rate returns for Sri Lanka (and the other currencies) on the two types of days. The discussion is framed in terms of the contribution of each factor to the volatility of each variable in percentage terms as shown in equations (15)-(19). The top panel of Table 3 provides the percentage contribution of the global and domestic factors to overall volatility on non-intervention days. The bottom panel provides the percentage contribution of the global and domestic factors to overall volatility on intervention days.

Table 3:
Volatility Decomposition of the Factor Model of Exchange Rate Returns. Notes: Contribution of each factor to total volatility, in percent. The model is estimated over the period January 1, 2002-June 29, 2007 (see equations (7) and (8)).

	Factors		
	Global	Domestic	Total
Non-intervention days ($j = 0$)			
EUR_t	41.983	58.017	100.00
INR_t	7.001	92.999	100.00
YEN_t	41.614	58.386	100.00
GBP_t	70.751	29.249	100.00
SLR_t	0.245	99.755	100.00
Intervention days ($j = 1$)			
EUR_t	39.999	60.001	100.00
INR_t	25.010	74.990	100.00
YEN_t	45.028	54.972	100.00
GBP_t	53.091	46.909	100.00
SLR_t	15.445	84.555	100.00

The $J-$test for this model with 10 degrees of freedom is satisfied with a value of 13.481 and a p-value of 0.198. The results provide interesting insights into overall movements in currency markets during the two regimes. On days when there is no intervention, the Sri Lankan rupee returns are dominated by the domestic factor with almost 100 percent of volatility arising from purely domestic sources. Table 4 presents the parameter estimates for the factor model along with the p-values. On days when there is intervention, the volatility decomposition for Sri Lanka changes substantially. As shown in the bottom panel of Table 3, on intervention days, the global factor increases in importance from 0.2 percent to 15 percent. This suggests that Sri Lankan policy makers respond to global movements rather than domestic market movements when intervening in currency markets. Providing further support to this view is that, on non-intervention days, the only insignificant parameter is the global factor for the Sri Lankan rupee returns $\left(\lambda_5^0\right)$. Similarly, on intervention days, the only significant structural break parameter is the global factor for Sri Lanka $\left(\lambda_5^1\right)$ (see Table 3). The analysis in Section 5.2 provides further evidence on whether this is actually the case when intervention is formally introduced into the model.

On both non-intervention and intervention days, the emerging economy of India is most similar to Sri Lanka, with 93 percent of its volatility a result of domestic factors

Table 4:
Parameter Estimates of the Factor Model of Exchange Rate Returns. Notes: The model is estimated over the period January 1, 2002 - June 29, 2007 (see equations (2) and (3)). p-values are in parentheses.

	Global factors		Domestic factors	
	Parameters	Estimates	Parameters	Estimates
Non-intervention days ($j = 0$)				
EUR_t	λ_1^0	0.646	γ_1^0	0.760
		(0.000)		(0.000)
INR_t	λ_2^0	0.234	γ_2^0	0.855
		(0.000)		(0.000)
JPY_t	λ_3^0	0.668	γ_3^0	0.791
		(0.000)		(0.000)
GBP_t	λ_4^0	0.854	γ_4^0	0.549
		(0.000)		(0.000)
SLR_t	λ_5^0	-0.043	γ_5^0	0.873
		(0.460)		(0.000)
Intervention days ($j = 1$)				
EUR_t	λ_1^1	-0.289	γ_1^1	0.250
		(0.914)		(0.627)
INR_t	λ_2^1	-0.093	γ_2^1	-0.016
		(0.381)		(0.975)
JPY_t	λ_3^1	-0.036	γ_3^1	0.379
		(0.878)		(0.577)
GBP_t	λ_4^1	-0.178	γ_4^1	-0.003
		(0.358)		(0.986)
SLR_t	λ_5^1	-1.185	γ_5^1	-0.087
		(0.000)		(0.889)

on non-intervention days. On intervention days, the weight of the global factor is also larger for India, at 25 percent compared to 7 percent for non-intervention days. Global factors play a larger role for developed countries, with around 42 percent of volatility for the euro and yen returns, and 71 percent for the pound on non-intervention days.

5.2 A factor model of central bank intervention

Estimating the factor model of central bank intervention, which adds an equation for intervention to the factor model of exchange rate returns provides a good overall fit to the data, with the p-value of the $J-$test of 0.120. The inclusion of intervention does not change the volatility decomposition too dramatically as shown by comparing Table 5 and Table 3. The equations for the currency returns in the factor model of central bank intervention remain the same as those in the factor model of exchange rate returns for all currencies apart from the Sri Lankan rupee. Inspection of the second panel of the volatility decomposition in Table 5 shows that the central bank is able to influence the volatility outcomes by 5.5 percent through intervention which is arguably a substantial magnitude given that the data is in terms of daily returns. Table 6 reports the results of Wald tests on the joint significance of the intervention parameters and the intervention terms with all being statistically significant.

Comparing the results from the factor model of exchange rate returns (Table 3) to the model of central bank intervention (Table 5) for Sri Lanka shows that in both models, global factors contribute around 16 percent to Sri Lankan rupee return volatility. The intervention factor absorbs some of the volatility that is attributed to the domestic factor in the previous model. Note that all of the structural break parameters in the model are jointly significant as shown in Table 6.

The biggest difference in the results for the currency returns between the two models is in the contribution of the global factor on non-intervention days to the returns of India and Sri Lanka. For India, the contribution of the global factor rises from 7 percent to 18 percent; for Sri Lanka, it rises from 0.2 percent to 5.5 percent. These increases in magnitude suggest that the inclusion of Sri Lankan central bank intervention means that greater weight is placed on the emerging markets in the global factor in the model and alludes to similarities between currency movements and the factors driving them for India and Sri Lanka.

Table 5:
Volatility Decomposition of the Factor Model of Central Bank Intervention. Contribution of each factor to total volatility, in percent. The model is estimated over the period January 1, 2002-June 29, 2007 (see equation (13)).

	Factors			
	Global	Domestic	Intervention	Total
Non-intervention days ($j = 0$)				
EUR_t	44.039	55.961	-	100.00
INR_t	18.367	81.633	-	100.00
YEN_t	41.741	58.259	-	100.00
GBP_t	64.577	35.423	-	100.00
SLR_t	5.455	94.545	-	100.00
INT_t	0.010	99.990	-	100.00
Intervention days ($j = 1$)				
EUR_t	37.796	62.204	-	100.00
INR_t	30.425	69.575	-	100.00
YEN_t	40.812	59.188	-	100.00
GBP_t	48.183	51.817	-	100.00
SLR_t	16.782	77.697	5.521	100.00
INT_t	3.265	96.735	-	100.00

Table 6:
Wald Tests of Intervention and Structural Breaks in the Factor Model of Central Bank Intervention. The model is estimated over the period January 1, 2002-June 29, 2007 (see equation (13)).

Hypothesis	DOF	Test statistic	p-value
Joint intervention parameters	2	90.248	0.000
$H_0 : \sigma^1_{int} = \gamma^1_{int} = 0$			
Joint idiosyncratic and intervention parameters	3	69.368	0.000
$H_0 : \gamma^0_{int} = \sigma^1_{int} = \gamma^1_{int} = 0$			
Joint structural break parameters	12	2270.097	0.000
$H_0 : \lambda^1_i = \gamma^1_i = 0, \qquad i = 1, 2...6$			

5.3 Purchases versus sales

To further investigate the effectiveness of intervention, the intervention data are split into days when the Central Bank of Sri Lanka intervenes by purchasing US dollars, and days when intervention occurs through sales. The model for intervention days is written as

$$e^{+}_{5,t} = (\lambda^{0}_{5} + \lambda^{+}_{5})w_t + (\gamma^{0}_{5} + \gamma^{+}_{5})u_{5,t} + \sigma^{+}_{int}v^{+}_{t}, \tag{24}$$

where + denotes days of US dollar purchases, and

$$e^{-}_{5,t} = (\lambda^{0}_{5} + \lambda^{-}_{5})w_t + (\gamma^{0}_{5} + \gamma^{-}_{5})u_{5,t} + \sigma^{-}_{int}v^{-}_{t}, \tag{25}$$

where − denotes days of US dollar sales. Hence, the factor model is jointly estimated in three parts rather than two, and this model again satisfies the $J-$test with 25 degrees of freedom and a p-value of 0.921.

Table 7 presents the volatility decomposition for the three regimes. The results clearly indicate that the central bank is more effective on days of US dollar purchases (sales of Sri Lankan rupee), with 11 percent of volatility in the Sri Lankan rupee returns being due to central bank intervention. In contrast, on days of sales of US dollars (purchases of Sri Lankan rupee), intervention is less effective and explains only 2 percent of volatility. This suggests that the Central Bank of Sri Lanka is more successful in influencing the exchange rate when the pressure in currency markets is to appreciate the Sri Lankan rupee. This result also are consistent with the Central Bank of Sri Lanka being focussed on achieving its medium-term target of accumulating international reserves in the low volatility period.

It is worth commenting on the changing role of the Indian rupee in this model. On days when intervention occurs, through either purchases or sales, the global factor affects Indian rupee returns by substantially more than on non-intervention days, again alluding to a possible common factor between India and Sri Lanka.

5.4 Intervention in the global volatility period

The first objective of the central bank is to contain excessive volatility in the exchange rate in the short run. This objective is examined in this section using the period of global volatility corresponding to the recent global financial crisis. It is expected that increased volatility in currency markets leads to more intervention as monetary authorities move to curb some of the volatility. This is verified in Table 1 which presents

Table 7:
Volatility Decomposition of the Factor Model of Central Bank Intervention Distinguishing between Intervention through Purchases of US Dollars and Sales of US Dollars. Notes: Contribution of each factor to total volatility, in percent. The model is estimated over the period January 1, 2002-June 29, 2007.

	Factors			
	Global	Domestic	Intervention	Total
Non-intervention days ($j = 0$)				
EUR_t	44.386	55.614	-	100.00
INR_t	18.349	81.651	-	100.00
YEN_t	41.547	58.453	-	100.00
GBP_t	63.083	36.917	-	100.00
SLR_t	5.698	94.302	-	100.00
INT_t	0.000	100.000	-	100.00
Days of purchases ($j = +$)				
EUR_t	28.033	71.967	-	100.00
INR_t	41.976	58.024	-	100.00
YEN_t	39.258	60.742	-	100.00
GBP_t	39.272	60.728	-	100.00
SLR_t	22.183	67.004	10.813	100.00
INT_t	2.583	97.417	-	100.00
Days of sales ($j = -$)				
EUR_t	36.253	63.747	-	100.00
INR_t	28.499	71.501	-	100.00
YEN_t	41.472	58.528	-	100.00
GBP_t	0.000	100.000	-	100.00
SLR_t	17.225	80.722	2.053	100.00
INT_t	4.104	95.896	-	100.00

statistics on intervention during the global volatility period. There are proportionately more days when intervention took place in the global volatility period, and the standard deviation of intervention is also higher. Notably, the number of intervention days through sales of US dollars is higher than the number of days of purchases, suggesting that the central bank aims to prevent excess currency market volatility arising from negative short-run shocks (or those placing pressure on the domestic currency to depreciate).

The model in Section 5.3, which distinguishes the effects of intervention through the purchases and sales of US dollars, is estimated for the period July 2, 2007 to December 31, 2010. The results reinforce the suggestion that the Central Bank of Sri Lanka is successful in meeting its first objective of containing excessive currency market volatility in the short run, particularly when pressure is for a rupee depreciation. Table 8 shows the volatility decomposition corresponding to this period, and it clearly indicates that central bank intervention is more effective on days of US dollar sales than on days of purchases, with 11 percent of volatility in Sri Lankan rupee returns due to central bank intervention. In contrast, on days of purchases, intervention explains only 3 percent of total volatility.

The results for the global volatility period are in contrast to the low volatility period, where purchases of US dollars are more effective than sales. Intervention during the global volatility period on days of purchases is consistent with the model for the low volatility period, which sees the global factor increase in importance for overall volatility compared with non-intervention days. On days of US dollar purchases the global factor does not change by much. Most of the effects of intervention are absorbed from the domestic factor which falls from around 96 percent of total volatility when there is no volatility to 85 percent of total volatility on days of purchases.

Although this paper does not to focus in detail on changes to decompositions for the remaining countries in sample, it is interesting to glean an insight into the global volatility period and the dynamics of the currency markets during this time. The results differ markedly in terms of decompositions for most currencies in the model in the global volatility period, particularly for the euro and yen. The global factor now contributes 80 percent to the euro exchange rate volatility on non-intervention days, reflecting that the euro US dollar relationship is a key source of volatility. Similarly, the yen is now completely driven by idiosyncratic factors (96 percent).

Table 8:
Volatility Decomposition of the Factor Model of Central Bank Intervention Distinguishing between Intervention through Purchases of US Dollars and Sales of US Dollars. Notes: Contribution to total volatility, in percent. The model is estimated over the period July 2, 2007-December 31, 2010.

	Factors			
	Global	Domestic	Intervention	Total
Non-intervention days ($j = 0$)				
EUR_t	79.921	20.079	-	100.00
INR_t	12.583	87.417	-	100.00
YEN_t	3.641	96.359	-	100.00
GBP_t	59.704	40.296	-	100.00
SLR_t	3.898	96.102	-	100.00
INT_t	4.093	95.907	-	100.00
Days of purchases ($j = +$)				
EUR_t	65.314	34.686	-	100.00
INR_t	29.451	70.549	-	100.00
YEN_t	2.650	97.350	-	100.00
GBP_t	51.721	48.279	-	100.00
SLR_t	15.384	82.210	2.406	100.00
INT_t	0.823	99.177	-	100.00
Days of sales ($j = -$)				
EUR_t	58.055	41.945	-	100.00
INR_t	24.616	75.384	-	100.00
YEN_t	2.042	97.958	-	100.00
GBP_t	0.000	100.000	-	100.00
SLR_t	4.170	84.649	11.181	100.00
INT_t	3.399	96.601	-	100.00

6 Conclusion

Foreign exchange intervention by central banks in emerging economies has only been studied to a limited extent, and the effect of such intervention is not well understood. Using a unique dataset and a new modeling framework, this paper contributed to this literature by estimating a latent factor model of central bank intervention. The case study was for the emerging economy of Sri Lanka, whose intervention policy objectives are in the short run to contain excessive exchange rate volatility, and in the medium run to accumulate international reserves.

The factor structure provided a convenient method of identifying sources of currency market volatility by decomposing the currency returns of Sri Lanka and Sri Lanka's major trading partners into a set of factors that included global, domestic and intervention factors. The model was identified using information on the absence or presence of intervention on a particular day. The moments of the data on days of no intervention were used to estimate global and domestic factors. The moments of the data on days of intervention were used to estimate structural change to the factor structure on the days of intervention, as well as the effect of pure intervention by the central bank. The advantage of latent factors meant that observable variables did not need to be formally specified. The effectiveness of intervention was assessed over two periods: i) a period of relatively low volatility in global financial markets, from January 2002 to June 2007; and ii) a period of high volatility (a global volatility period), corresponding to the global financial crisis from July 2007 to December 2010. The results were directly linked to the objectives of the central bank listed above.

The empirical results were supportive of intervention being effective in Sri Lanka over the two periods, albeit in different ways. The results during both periods showed that the Central Bank of Sri Lanka responded to global movements in currency markets when they intervened, rather than movements specific to the domestic foreign exchange market. This suggests that the central bank attempted to shield the domestic economy from externally sourced fluctuations. In the low volatility period, eleven percent of total volatility was explained by intervention through purchases of US dollars, compared to two percent of volatility in the case of intervention through sales of US dollars. These findings were consistent with the medium-term objective of the Central Bank of Sri Lanka of accumulating foreign exchange reserves, suggesting successful reserves management between 2002 and 2007.

In contrast to the dominance of intervention through purchases relative to sales for the low volatility period, the central bank was focused on mitigating excess currency market volatility arising from short-run shocks during the global volatility period in the late part of the sample. The variance decompositions calculated for 2007 to 2010 clearly showed that eleven percent of Sri Lankan currency market volatility was explained by sales of US dollars as the central bank attempted to absorb some of the global turmoil in currency markets through exchange rate management.

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