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The impact of changes in monetary aggregates on exchange rate volatility in a developing country: Do structural breaks matter?

Andrew Ojede[a,*], Eddery Lam[b]

[a] Department of Finance & Economics, McCoy College of Business Administration, Texas State University, 601 University Drive, San Marcos TX 78666, United States
[b] Department of Economics, College of Liberal Arts, Rochester Institute of Technology, 92 Lomb Memorial Drive, Rochester, NY 14623, United States

HIGHLIGHTS

- This paper investigates the nexus between monetary aggregates and exchange rates.
- The analysis is conducted using ARCH/GARCH methodology.
- We test and account for endogenous structural breaks in monetary aggregates.
- Results support theoretical predictions of money supply-exchange rate nexus.

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ABSTRACT

Theoretical models of exchange rate determination predict that increases in monetary aggregates lead to depreciation. However, several empirical studies do find exchange rate response anomalies to innovations in monetary policy. In this paper, we show that accounting for major structural break points in monetary variables leads to empirical results that are statistically consistent with predictions from theoretical monetary models of exchange rate determination.

1. Introduction

Following collapse of the Bretton Woods, many countries have switched to flexible exchange rate regimes. The transition from fixed exchange rates to floating exchange rate systems has resulted in large volatility of many currencies. This has led to a proliferation of empirical and theoretical studies that examine whether monetary policy shocks are possible drivers of exchange rate volatility. The Dornbusch's (1976) overshooting model of exchange rate determination ignited the proposition that monetary policy shocks cause exchange rates to overshoot their long-run trends. However, a significant number of empirical studies based on vector autoregressions (VARs) do find an exchange rate "response puzzle" to a monetary policy shock (Grilli and Roubini, 1996; Eichenbaum and Evans, 1995).

Many VAR-based studies that attempt to investigate the effects of monetary policy shocks on exchange rate volatility concentrate on developed countries. Considerably fewer studies have looked at experiences in developing economies. A recent study by Hnatkovska et al. (2016) finds that, while the effect of a positive innovation in monetary policy is associated with an exchange rate appreciation in developed economies, it leads to significant depreciation in currencies of developing economies. A possible limitation to this inconsistency is that previous studies using VAR models achieve stationarity by discarding valuable information about monetary variables of interest through differencing. Recent time series studies that test for endogenous structural breaks do suggest that conventional Augmented Dickey Fuller (ADF) tests for unit roots often fail to reject the null of a unit root when the true data generating process (DGP) is trend-break stationary (Sen, 2003; Lee and Strazicich, 2003; Dawson et al., 2007). This implies that there is a deterministic trend that changes slope and intercept for each time series in consideration. While different detrending methods may render the series stationary, they also lead to losing valuable information at major structural break dates. One could instead use intercept and slope dummies that

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* Corresponding author. Fax: +512 245 3089.
E-mail addresses: Andrew.Ojede@txstate.edu (A. Ojede), eddery@rit.edu (E. Lam).

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Table 1
Summary statistics on non-dummy variables.

Variable	Variable description	Mean	Std. dev
$M2$	The log monetary aggregate	28.41	1.06
$M3$	The log of monetary aggregate	28.65	1.12
$Reserves$	The log of total bank reserves	27.78	0.82
$Trade.Def$	The log of trade deficit	18.06	0.91
$NEER$	The log of nominal effective exchange rate	7.46	0.34
$INTDIFF$	The difference between the interest rate on domestic and U.S. 3-months treasury bills in percent	8.15	5.34

Table 2
Two-break minimum LM unit root tests.

Variable	k	TB_1, TB_2	Test statistics
$M2$	7	1998:03, 2009:09	-3.743^{***}
$M3$	10	2004:05, 2010:06	-3.684^{***}
$Reserves$	5	1999:05, 2007:04	-3.945^{***}
$NEER$	3	1998:03, 2004:09	-3.035^{***}
$INTDIFF$	13	2000:01, 2005:051	-4.995^{***}

k is the optimal number of lagged first difference terms included in the unit root test to correct for serial correlation. TB_1 is the estimated first break point and TB_2 is the estimated second break point.

Table 3
GARCH (1,1) estimates based on detrended series.

Variable	GARCH (1,1)	GARCH (1,1)	GARCH (1,1)
$Constant$	-0.011^{***} (0.004)	-0.012^{**} (0.004)	-0.007^{*} (0.004)
$M2_{t-1}$	0.007 (0.042)		
$M3_{t-1}$		0.060 (0.067)	
$Reserves_{t-1}$			-0.070^{**} (0.033)
$INDIFF_{t-1}$	0.001 (0.001)	0.001 (0.001)	0.001 (0.001)
JAN	0.005 (0.004)	0.006 (0.005)	0.001 (0.005)
FEB	0.016^{***} (0.005)	0.017^{***} (0.005)	0.012^{***} (0.004)
$MARCH$	0.003 (0.005)	0.004 (0.005)	-0.002 (0.005)
$APRIL$	0.022^{***} (0.004)	0.023^{***} (0.006)	0.018^{***} (0.006)
MAY	0.012^{*} (0.006)	0.012^{**} (0.006)	0.523^{***} (0.007)
JUN	0.015^{***} (0.005)	0.015^{***} (0.005)	0.011^{*} (0.006)
JUL	0.010 (0.006)	0.011^{*} (0.006)	0.007 (0.006)
AUG	0.011^{*} (0.006)	0.012^{**} (0.006)	0.005 (0.005)
SEP	0.018^{***} (0.006)	0.019^{***} (0.007)	0.011^{*} (0.006)
OCT	0.015^{**} (0.005)	0.016^{***} (0.005)	0.009^{**} (0.004)
NOV	0.016^{**} (0.007)	0.017^{***} (0.007)	0.012^{**} (0.006)
Variance equation			
$CONSTANT(\hat{\omega})$	0.0001 (0.0000)	0.0001^{*} (0.000)	0.0001^{**} (0.000)
$ARCH-Term(\hat{f}_1)$	0.206 (0.200)	1.199 (0.189)	0.230^{*} (0.132)
$GARCH-Term(\hat{g}_1)$	0.673^{***} (0.151)	0.680^{***} (0.139)	0.648^{***} (0.112)

The numbers in parentheses are the Bollerslev-Wooldrige robust standard errors.

account for structural break points of monetary variable(s) under consideration.

The above discussion suggests that in order to effectively investigate the effect of changes in monetary variables on exchange rates, one needs to account for major structural break points of determining variables. Faust and Rogers (2003) conjecture that monetary policy shocks account for a smaller portion of variation in exchange rate. The immediate implication from this conjecture, is that, for monetary policy variables to have noticeable impact on exchange rates, one has to account for unusually large rather than small changes in monetary aggregates.

In this paper, we employ minimum Lagrange Multiplier (LM) unit root tests with ARCH and GARCH models to investigate how changes in monetary aggregates (i.e., $M2$ & $M3$), reserves and interest rate differential affect the Uganda shilling nominal effective exchange rate. We chose Uganda for two main reasons. First, there is consistent monthly data collections on key variables of interest that are necessary for a meaningful time series study. Second, Uganda has been cited by the World Bank and International Monetary Fund as a success story for implementing structural adjustment macroeconomic reforms of the 1990s (Naiman and Watkins, 1999). One of these successes was attributed to liberalization of the exchange rate market in 1993. This allowed the country to smoothly transition from fixing exchange rates to a floating exchange rate system albeit with occasional Central Bank interventions in the currency market.

We find that increases in $M2$, $M3$ and interest rate differential lead to significant depreciation. In what follows, we present a brief methodology and data transformations in Section 2. Results are in Section 3 and Section 4 concludes.

2. Methodology & data

2.1. Baseline model

Our baseline model takes the following form:

$$NEER_t = \lambda_0 + \lambda_1 Trade.Def_{t-1} + \alpha[Maggregate_{t-1}]^{|} + \beta(Month)^{|} \tag{1}$$

where $Trade.Def$ represents size of trade deficit. $Maggregate$ is a vector of monetary variables. These monetary variables include $M2$, $M3$, $reserves$, and interest rate differential ($INTDIFF$). Uncovered interest parity (UIP) condition predicts that the rate of expected depreciation depends on domestic–foreign interest rate differential, i.e., $\left(\frac{(NEER^e_{t+1} - NEER_t)}{NEER_t}\right) = INTDIFF_t$, where $INTDIFF$ is the difference in yields between domestic and foreign (world) three-month treasury bonds. The interest rate on three month U.S. treasury bonds is used as a proxy for world interest rate. We estimate the impact of each monetary variable in Eq. (1) one at a time to avoid multicollinearity. The variable $Month$ represents monthly dummies used to capture seasonality.[1]

2.2. Data transformations

Monthly macro data from July 1993 to March 2016 was obtained from the Central Bank of Uganda. Data on three month U.S. Treasury bills was obtained from Saint Louis Federal Reserve Economic Database. Summary statistics are presented in Table 1. We begin with standard ADF tests for unit roots. With exception of $Trade.Def$, all variables exhibit non-stationarity.

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[1] These seasonality effects on exchange rates could be tied to external variables, such as budget support from donors, foreign aid, remittances. Disbursements of these external sources of financing have seasonal characteristics and their effects on exchange rate can be controlled with monthly dummies.