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THE EFFECTIVENESS OF EXCHANGE RATE CHANNEL OF MONETARY POLICY TRANSMISSION MECHANISM IN SRI LANKA

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Abstract

This study examines the effectiveness of the exchange rate channel in the transmission mechanism of monetary policy in Sri Lanka during the period from 1978 to 2015. A negative relationship between the two variables is accepted in theoretical insights on the topic. An increase in interest rate leads to appreciation of domestic currency against other foreign currencies. If the empirical situation is different to theoretical explanations, decision makers would not be able to make proper decisions to achieve macroeconomic targets in the economy. Monetary policy is conducted to achieve economic and price stability, and its policy shocks transforms to the economy through various transmission channels. A developing country like Sri Lanka usually prefers to depreciate local currency in order to increase export earnings and to reduce import expenditure to gain a balance of trade. Expansionary monetary policy tends to result in currency depreciation, thus increasing net exports. Higher economic growth can be achieved with domestic currency depreciation through increasing exports. In an inflationary situation, contractionary monetary policy can reduce aggregate demand with domestic currency appreciation. If there is no negative relationship between interest rate and exchange rate, the exchange rate transmission channel of monetary policy does not support the achievement of monetary policy co-objectives. The study uses the variables nominal exchange rate, Treasury bill rate, net exports and total external debt. Co-integration and Vector Error Correction tests are employed for the analysis due to the non-stationary of all the variables used in the study, and the results prove the negative relationship between exchange rate and interest rate as expected in the long run. Estimated value of the interest rate elasticity of exchange rate is -0.178, which proves that exchange rate channel is efficient in the Sri Lankan context. According to short run dynamics, 5% of the error in exchange rate is corrected annually.

Key Words*: Exchange rate channel, transmission mechanism, interest rate elasticity of exchange rate, Co-integration test, Vector Error Correction Test*

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INTRODUCTION

The role and efficiency of monetary policy can be justified by improved macroeconomic performance over the past few decades, especially in developed countries. Inflation and inflation volatility in developed countries have fallen significantly and output has fluctuated only marginally. Monetary policy is the driving force behind this improved performance of the developed world. In 2001, Sri Lanka moved towards a free-floating exchange rate policy and subsequently modified the monetary policy framework placing greater emphasis on market-based monetary policy instruments (Central Bank of Sri Lanka, 2005).

The study examines the effectiveness of the exchange rate channel of the monetary policy transmission mechanism in Sri Lanka. The exchange rate channel becomes an important channel of transmission mechanism in small open economies. The negative relationship between exchange rate and interest rate is to be expected for the efficiency of the exchange rate channel.

The Central Bank conducts the monetary policy to achieve the ultimate economic goals such as sustainable growth, full employment, price stability and a healthy balance of payments. There are several channels along which monetary policy is transmitted to the macro economy. These channels are named the traditional interest rate channel, exchange rate channel, other assets channel, credit channel and expectations channel (Mishkin, 1995).

The exchange rate is one of the intermediate policy variables, and changes in the exchange rate might induce changes in the relative prices of goods and services as well as in the aggregate spending by individuals and firms, especially when significant portions of their wealth is held in foreign currencies.

An expansionary monetary policy (lower interest rate) will depreciate the domestic currency under a floating exchange rate system. In recent years, there has been a special focus on the relationship between exchange rates and interest rates in both developed and developing countries. These two variables play an important role in the development of the nominal and real sides of the economy, such as domestic inflation and real output. The study examines the consistency and magnitude of the interest rate elasticity of the exchange rate for the purpose of investigating the effectiveness of the exchange rate channel to transmit monetary policy shocks to the macro economy.

THEORETICAL FRAMEWORK

Monetary policy plays an important role in achieving ultimate economic objectives while the Central Bank sets intermediate objectives for monetary policy. The latter are targets which relate to using interest rates, growth in money supply and the exchange rate to achieve the ultimate goals of monetary policy. At 111 In other words, the intermediate targets are termed as channels through which monetary policy is transmitted to the macroeconomics.

In the influential publication 'Journal of Economic Perspectives', Mishkin (1996), writing on the monetary transmission mechanism, describes various channels by which monetary policy innovations are conveyed to the economy, such as: interest rates channel, exchange rates channel, other asset prices channel, and credit channel.

Taylor (1995) classifies these transmission channels into two broad categories: financial market prices (short-term interest rates, bond yields, exchange rates), and financial market quantities (money supply, bank credit, supply of government bonds, foreign denominated assets).

Boivin et al. (2010) categorizes the channels of monetary transmission mechanism into two broad categories: neoclassical channels in which financial markets are perfect and non-neoclassical channels which involve financial market imperfections. These neoclassical channels; interest rate channel, exchange rate channel, wealth or other assets channel are built upon basic models of investment, consumption, and international trade behavior. The non-neoclassical channels are credit channels which include effects on credit supply from government interventions in credit markets, and balance sheet channel.

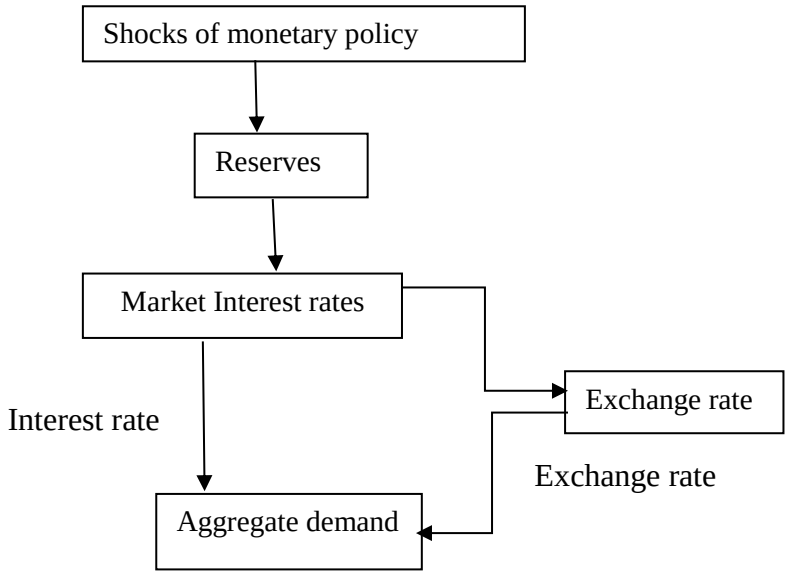
Exchange rate channel plays an important role in the context of the ongoing internationalization of economies and due to flexible exchange rates especially in advanced countries (Mishkin, 1996). The exchange rate is changed through the impact of the interest rate, and the value of foreign currency in terms of domestic (nominal exchange rate) is negatively related to interest rate. Higher interest rates appreciate the domestic currency (low exchange rate), and stronger currencies discourage exports and encourage imports. Conversely, lower interest rates depreciate the domestic currency, and encourage exports and discourage imports. Finally, higher exchange rates result in a rise in domestic output, and then in price level.

Changes in the bank rate indicate the monetary policy intentions of the Central Bank. If these changes are unanticipated, the expectations of economic agents are adjusted according to future monetary policy. A positive innovation in the bank rate indicates a contraction monetary policy, and economic agents expect that the bank rate will decline

in future. This leads to a depreciation of domestic currency. A decline in bank rate leads to an appreciation of the domestic currency.

This is called the exchange rate channel of monetary policy transmission mechanism. The negative relationship between interest rate and exchange rate means that lower domestic interest rates lead to a depreciation in domestic currency (Mishra and Montiel, 2012).

Figure 1: Exchange Rate Channel



LITERATURE REVIEW

Most previous research about the behavior of exchange rates have been devoted to explaining and forecasting exchange rate levels. Several structural models have been proposed to analyze the determinants of exchange rate. Previous researchers have used market interest rates, current account, trade balance, exports and imports, external debts, economic growth, and capital inflows to explain the behavior of exchange rates according to research purpose.

A study done by Mirchandani investigates various macroeconomic variables leading to acute variations in the exchange rate of a currency. An attempt has been made to analyze different macroeconomic determinants that have impacted the volatility of exchange rates and their extent of correlation. Results prove that the interest rate and exchange rate are highly correlated, and that there is a negative relationship between interest rate and exchange rate.

Perera (2016) provides a comprehensive assessment of the transmission of monetary policy in Sri Lanka starting from central bank policy shocks to the response of ultimate targets -output and price level. The study observes that monetary policy in Sri Lanka is quite effective in influencing the final objectives of the central bank, and that policy changes affect output and price level through different intermediate transmission channels such as bank credit, exchange rates and asset prices.

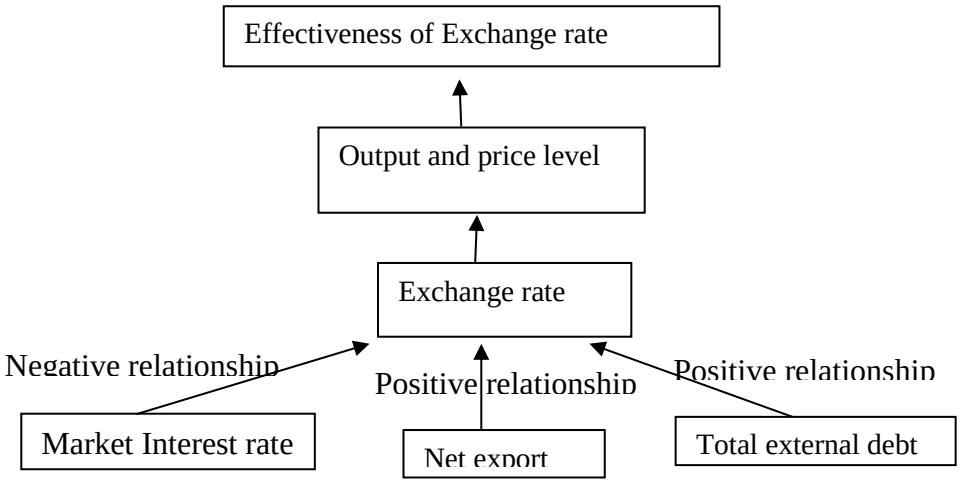
Dude (2014) finds that interventions are less effective in economies with high levels of financial or external liability dollarization and under high inflation. The evidence proves that Central Bank intervention can influence the exchange rate in the short run.

Exchange rate transmission mechanism is important to understand the conduct of monetary policy under floating exchange rates.

Smets and Wouters (1999) find the role of the exchange rate in the monetary transmission mechanism (MTM) estimating an identified VAR model. Two features of the results are highlighted. The effect of a policy shock on the exchange rate accelerates the pass-through of policy into prices and leads to a different response of the various components of GDP**.**

Morales and Raei (2013) find reasonable evidence for the existence of interest rate and exchange rate channels of transmission of monetary policy in the East African Community (EAC). Over time, both the interest rate and the exchange rate channels have been effective with differences between countries consistent with their particular macroeconomic and institutional environments. Even in countries with imperfect financial markets, the exchange rate channel proves a strong vehicle for translating monetary policy decisions into changes in expenditure patterns.

Figure 2: Framework of the Study



PROBLEM OF THE STUDY

Is the exchange rate channel efficient to achieve monetary policy objectives in Sri Lanka?

OBJECTIVES OF THE STUDY

To estimate interest rate elasticity of exchange rate.

To examine the efficiency of exchange rate channel of monetary policy transmission mechanism in Sri Lanka.

DATA AND METHODOLOGY

Annual data of the period 1978 -2015 are used for the study, and the sources of data collected for the study are the annual reports of the Central Bank of Sri Lanka and the Department of Senses and Statistics, Sri Lanka. According to the theoretical background the variables exchange rate (Rupees per Dollar) (ER), three-month Treasury bill rate (TBR), net export (NX) and total external debt (TED) are used for analysis. Theoretically there should be a negative relationship between interest rate and exchange rate. Because treasury bill rate is more sensitive to money supply, TBR is used as a proxy for market interest rate. In literature, external debt has used as a determinant of exchange rate, and net export is used as the proxy for trade balance.

Normally, macro-economic variables show non-stationarity, and VAR method does not capture non-linear elements that exist with certainty in level variables because a VAR is a linear model. The better way to respond to this problem is to linearize the data by taking the logs of the levels data. For this testing purpose, the original data series are transformed to logs - except TBR (due it being a ratio), and the transformation forms are mentioned as LER, LNX, and LTED.

Augmented Dickey Fuller (ADF) unit-root testing developed by David Dickey and Wayne Fuller in 1981 was carried out for each variables used in the study to determine whether the data series are stationary or non-stationary and to identify the degree of stationary of data series as I (0), I (1) or I (2) to avoid spurious estimations. The ADF approach tests the null hypothesis that a series does contain a unit root (non-stationary) as against the alternative hypothesis that there is not a unit root (stationary). The results of unit root test show that all data series used for the study are non-stationary, and that they will be stationary at the first difference (See Tables 01 and 02).

Good time series modeling should describe both short-run dynamics and the long-run equilibrium simultaneously, and this study employs the Johansen co-integration test developed by Johansen in 1988 and Vector Error Correction Modeling (VECM) to

estimate more sophisticated relationships. An error correction model belongs to a category of multiple time series models most commonly used for co-integrated variables (which have a long-run stochastic trend). Johansen proposes two different likelihood ratio tests such as Trace test and Maximum Eigen-value test to find co-integration relations among the series.

HYPOTHESIS

When the market interest rate is changed, the exchange rate (Rupees per Dollar) changes in the opposite direction. (Interest rate elasticity of exchange rate should be negative).

$$H_0;\ \varphi_1 = 0$$
$$H_1;\ \varphi_1 < 0$$

φ_1= Interest rate elasticity of exchange rate

Expected Model

$LER = \varphi_0 - \varphi_1 TBR - \varphi_2 LNX - \varphi_3 LTED + \mu_{t-1}$ Where,

LER – Log of exchange rate (Rupees per Dollar)
TBR – Three months Treasury bill rate
LNX – Log of net exports
LTED – Log of total external debt
φ_0 –Autonomous exchange rate
φ_1 – Interest rate coefficient of exchange rate model (Expected to be negative)
φ_2– Net export coefficient of exchange rate model (expected to be negative)
φ_3 – External debt coefficient of exchange rate model (Expected to be negative)
ε_{t-1} – Deviation of exchange rate from the long run equilibrium in the previous year

ANALYSIS

Results of Unit Root Test

Unit root tests were conducted for each variable (LER, TBR, LNX, and LTED) used for the analysis, and all of them were identified as non-stationary variables. Tables 01 and 02 report the results of the ADF test on 1%, 5% and 10% significance levels. The test results for all the variables in level show that the null hypothesis: i.e, that the series does contain a unit root, is accepted. The ADF test statistics for all the data in level are smaller than the critical value at 5% significance level (see Table 01). The results of ADF test of first differenced data show that the null hypothesis is rejected. This means that the alternative hypothesis: series does not contain unit root, is accepted. The ADF test statistics for all

the first differenced series is greater than the critical value at 1% significance level (See table 02).

Table 01: ADF Test Results (Level- Intercept)

Variable	ADF Test statistics	Critical values 1%	Critical values 5%	Critical values 10%
LER	-2.508345	-3.621023	-2.943427	-2.610263
TBR	-1.452434	-3.621023	-2.943427	-2.610263
LNX	0.026998	-3.632900	-2.948404	-2.612874
LTED	-1.124779	-3.621023	-2.943427	-2.610263

Table 02: ADF Test Results (1st Difference- Intercept)

Variable	ADF Test statistics	Critical values 1%	Critical values 5%	Critical values 10%
LER	-5.922496*	-3.626784	-2.945842	-2.611531
TBR	-5.091087*	-3.626784	-2.945842	-2.611531
LNX	-8.646157*	-3.632900	-2.948404	-2.612874
LTED	-3.857276*	3.626784	-2.945842	-2.611531

Note: sign * for Rejecting at 99% significant level.

Therefore, ADF unit root test indicates that these variables are integrated in the order one. Then the next step is to test whether the variables have long run relationships. For this purpose, we use the co-integration test.

Result of the Co-Integration Test

Johansson co-integration methodology is conducted using E-views 07 to test whether there are any long run relationships among the set of non-stationary variables LER, TBR, LNX, and LTED. At the beginning, the null hypothesis, that these non-stationary variables are not co-integrated, was tested by the Engle and Granger methodology. This test proved that these variables are co-integrated (see Appendix 01). VAR Lag Order Selection Criteria proved that lag one is proper to run the regression (See appendix 02).

The co-integration vector Π is solved out with maximum Eigen value statistics and trace statistics. The number of co-integrating relations is calculated assuming that there is no linear time trend. Tables 03 and 04 below report the values of Johansen λ_{trace} and λ_{max} test statistics. To test the null hypothesis, the number of co-integrating vectors is zero ($r = 0$) against the alternative $r = 1,\ 2, or\ 3$ the λ_{trace} statistics were used. Since the null hypothesis $\mathrm{r} = 0$ and there are four variables, the test equation runs from 1 to 3. Since λ_{trace} statistic of $\mathrm{r} = 0,$ is 60.29 and it is larger than the critical value of 47.86,

the null hypothesis is rejected at the 5% significance level and this test confirmed that the variables are co-integrated and that there may be two co-integration relations (see Table 03) among the variables.

Table 03: Johansen Co-Integration Test –Trace Statistics

Hypothesized No. of CE(s)	Eigenvalue	Trace statistics	5%critical value	Probability
None *	0.540637	60.29362	47.85613	0.0022
At most 1 *	0.384169	32.28872	29.79707	0.0253
At most 2	0.298283	14.83653	15.49471	0.0627
At most 3	0.056257	2.084433	3.841466	0.1488

* denotes rejection of the hypothesis at the 0.05 level

Table 04: Johansen Co-Integration Test – Maximum Egan Statistics

Hypothesized No. of CE(s)	Eigenvalue	Maximum Egan statistics	5% critical value	Probability
None *	0.540637	28.00490	27.58434	0.0442
At most 1	0.384169	17.45219	21.13162	0.1517
At most 2	0.298283	12.75209	14.26460	0.0855
At most 3	0.056257	2.084433	3.841466	0.1488

* denotes rejection of the hypothesis at the 0.05 level

In contrast to the λ_{trace} statistic, the λ_{max}statistic test was used to test the null hypothesis specific $r = 1$ against the specific alternative $r = 2$. According to the λ_{max} test, λ_{max} statistic of null hypothesis$r = 1$ is 17.45 and it is less than the critical value of 21.13 and $r = 1$ null hypothesis is accepted at the 5% significance level and alternative hypothesis is rejected (see Table 04), and the maximum Egan value test indicates that there is one co-integrating equation (at the 0.05 significant levels).The presence of one co-integration vector implies that Granger-causality should exist in one direction among the variables.

Long Run Model for Exchange Rate

In the long run, only one co-integration relationship is there among the set of series. The long run equilibrium equation of exchange rate, which estimated by the co-integration test, is written below.

$$LER = 6.95 - 0.18TBR - 0.26LNX + 0.27LTED + \mu_{t-1}$$
$$[-5.02284] \quad [-1.22467] \quad [0.75252]$$

Nominal exchange rate (LER) is used as dependent variable, and examines the effectiveness of interest rate on exchange rate. In the long run model of exchange rate, interest rate (TBR) is negatively related with exchange rate. According to exchange

market theories, the interest rate sensitivity of exchange rate should be negative, and the estimated coefficient of the model has taken the expected sign and is highly significant. Higher Treasury bill rates lead to low exchange rates, which means that domestic currency appreciates. This negative significant coefficient (-0.18) of TBR in the estimated model shows that the impact of 1% increase in TBR would decrease exchange rate by 0.18% ceteris paribus. This means that domestic currency would be appreciated by 0.18%. The net export elasticity of exchange rate also has taken expected negative sign, and it is not significant. The insignificance of an individual coefficient does not matter due to the joint significance of all the variables (according to the F test).

The coefficient of total external debt is not significant and is consistent with theory. Negative sign for this external debt coefficient is expected assuming that loans are converted to rupees and will be spent domestically. If dollars are used as foreign reserves this result can't be expected. The estimated result shows a positive impact of 0.27 on the exchange rate and the external debt elasticity of exchange rate represents the impact of a 1% increase in debt, which would increase exchange rate by 0.27% *ceteris paribus*.

Short Run Dynamics among Variables

The results of Vector Error Correction model, which was estimated to analyze short run dynamics among variables, are presented in this part. As all four variables are co-integrated and stationary in their first differences, the causality test was carried out using VECM form. Each error correction model (ECM) obtains an error correction coefficient (α) called as the speed of adjustment in which the system moves towards its equilibrium.

The term of error-correction relates to the fact that previous periods deviation from a long-run equilibrium (the error term), influences its short-run dynamics.

The co-integration equation established in the previous co-integration test is presented below, and vector error correction results are presented in table 05. Each column in table 05 includes the error correction model for each variable in the model. The third column of the table presents the best model which shows the short run adjustment within the system (with highest R squared of 48%, acceptable Error Correction Term with negative sign, and highest F statistic).

Co-Integration Equation for Exchange Rate, Estimated by the Co-Integration Test

$$\mu_{t-1} = LER_{(-1)} + 0.18TBR_{(-1)} + 0.26LNX_{(-1)} - 0.27LTED_{(-1)} - 6.95$$

Estimated Best Error Correction Model

D(LER)=-0.05$(LER_{(-1)} + 0.18TBR_{(-1)} + 0.26LNX_{(-1)} - 0.27LTED_{(-1)} - 6.95) +$

0.326

The magnitude of the error correction term shows how quickly the deviation of each variable from the long run equilibrium is corrected gradually towards the equilibrium level through a series of partial short run adjustments. According to the vector error correction model, the error correction coefficient has the correct expected sign which is negative. The error correction term is –0.05 which is significant at 5% level. The interpretation of this error correction term is that 5% of the disequilibrium (μ_{t-1}) in exchange rate is corrected towards equilibrium within a one-year period. This 5% is the adjustment rate of the exchange rate and it is called the speed of adjustment of exchange rate towards long run equilibrium. In the short run dynamics, R-squared of the model is not satisfied, and the explanation power of the model is 33%. According to the F-test, joint significance of the model is high. There is no serial correlation according to the results of Breusch-Godfrey serial correlation LM test (see appendix 03). There is no heteroscedasticity, and homoscedasticity is accepted by ARCH test (see Appendix 04). Normality and stability tests were done and satisfied (see Appendices 05 and 06).

Table 05: Vector Error Correction Estimates for Investment Model

Error Correction:	D(LER)ƎR)	D(TBR)ƷR)	D(LNX)NX)	D(LTED)ƮED)
CointEq1	-0.050041	-2.433086	-0.275155	0.022823
	(0.01529)	(0.66709)	(0.12781)	(0.02968)
	[-3.27373]	[-3.64732]	[-2.15286]	[0.76901]
D(LER(-1))	-0.003085	-10.17756	-5.098710	-0.211536
	(0.17943)	(7.83066)	(1.50029)	(0.34839)
	[-0.01719]	[-1.29971]	[-3.39848]	[-0.60719]
D(TBR(-1))	0.003328	0.466876	0.104720	0.000692
	(0.00424)	(0.18495)	(0.03544)	(0.00823)
	[0.78521]	[2.52431]	[2.95524]	[0.08409]
D(LNX(-1))	0.021599	0.281493	-0.508421	0.028867
	(0.01528)	(0.66667)	(0.12773)	(0.02966)
	[1.41387]	[0.42224]	[-3.98047]	[0.97327]
D(LTED(-1))	0.036878	3.714863	-1.128121	0.353806
	(0.08544)	(3.72867)	(0.71438)	(0.16589)
	[0.43163]	[0.99630]	[-1.57915]	[2.13279]
C	0.053669*	0.037570	0.665073	0.071214
	(0.01691)	(0.73794)	(0.14138)	(0.03283)
	[3.17393]	[0.05091]	[4.70404]	[2.16911]
R-squared	0.326218	0.355224	0.485209	0.212281

Note: The * signs denote the statistically significant coefficients at 5% level. Corresponding t-values are in parentheses.

CONCLUSION

The variables interest rate (TBR) and net exports (NX) are negatively related to exchange rate, and the results are consistent with theories. Total external debt was positively related to exchange rate in the Sri Lankan context. Higher nominal short term interest rates lead higher demand for Sri Lankan Rupees and appreciate domestic currency. Higher interest rates in Sri Lanka than those will lead to the appreciation of the rupee, while lower interest rates will lead to a higher exchange rate. As a developing country, Sri Lanka uses monetary policy to achieve objectives such as economic and price stability. The negative and significant magnitude of interest rate sensitivity of the exchange rate shows the effectiveness of exchange rate transmission mechanism of monetary policy. Monetary policy shocks such as money supply and interest rate can be transferred to the macro economy via exchange rate in the country. According to short run dynamics, -0.05% of the disequilibrium (μ_{t-1}) in exchange rate is corrected towards equilibrium, within a one year period.

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APPENDICES

Appendix 01: Engle and Granger two steps method

Dependent Variable: LER
Method: Least Squares
Date: 07/15/16 Time: 02:17
Sample: 1978 2015
Included observations: 38

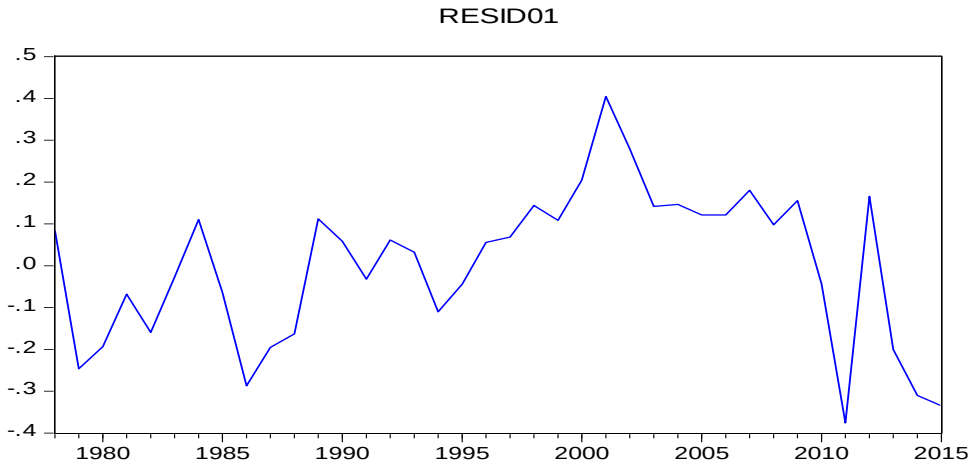
Variable	Coefficient	Std. Error	t-Statistic	Prob.
TBR	-0.026947	0.011261	-2.392930	0.0224
LTED	0.251901	0.106444	2.366520	0.0238
LNX	0.226277	0.061584	3.674274	0.0008
C	-0.433539	0.548950	-0.789762	0.4351

R-squared	0.929776	Mean dependent var	4.028754
Adjusted R-squared	0.923579	S.D. dependent var	0.684195
S.E. of regression	0.189141	Akaike info criterion	-0.393351
Sum squared resid	1.216323	Schwarz criterion	-0.220973
Log likelihood	11.47366	Hannan-Quinn criter.	-0.332020
F-statistic	150.0543	Durbin-Watson stat	0.895258
Prob(F-statistic)	0.000000		

Dependent Variable: LER
Method: Least Squares
Date: 07/15/16 Time: 02:31
Sample: 1978 2015
Included observations: 38

Variable	Coefficient	Std. Error	t-Statistic	Prob.
TBR	-0.026947	7.14E-16	-3.78E+13	0.0000
LTED	0.251901	6.75E-15	3.73E+13	0.0000
LNX	0.226277	3.90E-15	5.80E+13	0.0000
RESID01	1.000000	1.09E-14	9.20E+13	0.0000
C	-0.433539	3.48E-14	-1.25E+13	0.0000

R-squared	1.000000	Mean dependent var	4.028754
Adjusted R-squared	1.000000	S.D. dependent var	0.684195
S.E. of regression	1.20E-14	Sum squared resid	4.74E-27
F-statistic	3.01E+28	Durbin-Watson stat	0.838709
Prob(F-statistic)	0.000000		



Null Hypothesis: RESID01 has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.953744	0.0489
Test critical values:	1% level	-3.621023	
	5% level	-2.943427	
	10% level	-2.610263	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(RESID01)
Method: Least Squares
Date: 07/15/16 Time: 02:30
Sample (adjusted): 1979 2015
Included observations: 37 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
RESID01(-1)	-0.443284	0.150075	-2.953744	0.0056
C	-0.007318	0.025923	-0.282314	0.7794

R-squared	0.199535	Mean dependent var	-0.011335
Adjusted R-squared	0.176665	S.D. dependent var	0.173539
S.E. of regression	0.157466	Akaike info criterion	-0.806681
Sum squared resid	0.867840	Schwarz criterion	-0.719605
Log likelihood	16.92360	Hannan-Quinn criter.	-0.775983
F-statistic	8.724605	Durbin-Watson stat	1.919124
Prob(F-statistic)	0.005580		

Appendix 02

VAR Lag Order Selection Criteria
Endogenous variables: LER TBR LTED LNX
Exogenous variables: C
Date: 07/15/16 Time: 02:30
Sample: 1978 2015
Included observations: 35

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-137.5307	NA	0.038236	8.087468	8.265223	8.148829
1	23.77228	276.5194	9.55e-06	-0.215559	0.673211*	0.091244*
2	42.72020	28.15119*	8.39e-06*	-0.384011*	1.215775	0.168235
3	51.74962	11.35127	1.38e-05	0.014308	2.325110	0.811996

* 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

Appendix 03

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	1.180245	Prob. F(2,28)	0.3220
Obs*R-squared	2.798954	Prob. Chi-Square(2)	0.2467

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 07/15/16 Time: 02:06
Sample: 1980 2015
Included observations: 36
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C(13)	-0.030346	0.133193	-0.227836	0.8214
C(14)	0.565157	1.536059	0.367926	0.7157
C(15)	-0.010125	0.036969	-0.273892	0.7862
C(16)	-0.025698	0.209650	-0.122577	0.9033
C(17)	0.352124	0.776294	0.453596	0.6536
C(18)	-0.070343	0.156111	-0.450596	0.6558
RESID(-1)	-0.148986	0.294288	-0.506259	0.6166
RESID(-2)	-0.301462	0.245495	-1.227974	0.2297

R-squared	0.077749	Mean dependent var	6.63E-17
Adjusted R-squared	-0.152814	S.D. dependent var	0.358333
S.E. of regression	0.384740	Akaike info criterion	1.120631
Sum squared resid	4.144691	Schwarz criterion	1.472524
Log likelihood	-12.17135	Hannan-Quinn criter.	1.243451
F-statistic	0.337213	Durbin-Watson stat	1.939670
Prob(F-statistic)	0.929913		

Appendix 04

Heteroskedasticity Test: ARCH

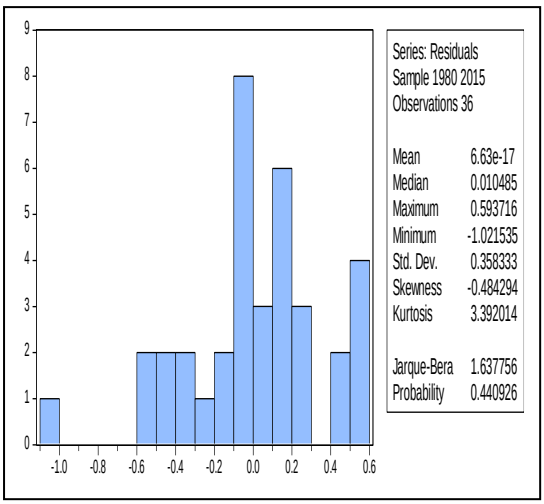
F-statistic	2.580173	Prob. F(1,33)	0.1177
Obs*R-squared	2.538100	Prob. Chi-Square(1)	0.1111

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 07/15/16 Time: 02:06
Sample (adjusted): 1981 2015
Included observations: 35 after adjustments

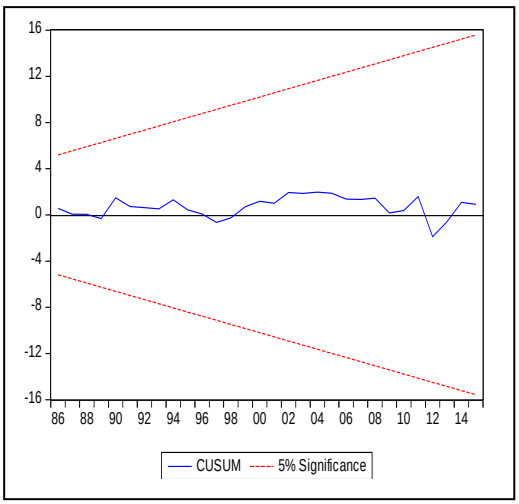
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.085422	0.038827	2.200052	0.0349
RESID^2(-1)	0.267470	0.166514	1.606292	0.1177

R-squared	0.072517	Mean dependent var	0.119733
Adjusted R-squared	0.044412	S.D. dependent var	0.196227
S.E. of regression	0.191820	Akaike info criterion	-0.409075
Sum squared resid	1.214231	Schwarz criterion	-0.320198
Log likelihood	9.158805	Hannan-Quinn criter.	-0.378394
F-statistic	2.580173	Durbin-Watson stat	1.937211
Prob(F-statistic)	0.117738		

Appendix 05



Appendix 06



Appendix 07

Vector Error Correction Estimates
Date: 07/15/16 Time: 02:02
Sample (adjusted): 1980 2015
Included observations: 36 after adjustments
Standard errors in ( ) & t-statistics in [ ]

CointegratingEq:	CointEq1
LER(-1)	1.000000
TBR(-1)	0.178141
	(0.03547)
	[5.02284]
LNX(-1)	0.260771
	(0.21293)
	[1.22467]
LTED(-1)	-0.267364
	(0.35529)
	[-0.75252]
C	-6.950745

Error Correction:	D(LER)	D(TBR)	D(LNX)	D(LTED)
CointEq1	-0.050041	-2.433086	-0.275155	0.022823
	(0.01529)	(0.66709)	(0.12781)	(0.02968)
	[-3.27373]	[-3.64732]	[-2.15286]	[0.76901]
D(LER(-1))	-0.003085	-10.17756	-5.098710	-0.211536
	(0.17943)	(7.83066)	(1.50029)	(0.34839)
	[-0.01719]	[-1.29971]	[-3.39848]	[-0.60719]
D(TBR(-1))	0.003328	0.466876	0.104720	0.000692
	(0.00424)	(0.18495)	(0.03544)	(0.00823)
	[0.78521]	[2.52431]	[2.95524]	[0.08409]
D(LNX(-1))	0.021599	0.281493	-0.508421	0.028867
	(0.01528)	(0.66667)	(0.12773)	(0.02966)
	[1.41387]	[0.42224]	[-3.98047]	[0.97327]
D(LTED(-1))	0.036878	3.714863	-1.128121	0.353806
	(0.08544)	(3.72867)	(0.71438)	(0.16589)
	[0.43163]	[0.99630]	[-1.57915]	[2.13279]
C	0.053669	0.037570	0.665073	0.071214
	(0.01691)	(0.73794)	(0.14138)	(0.03283)
	[3.17393]	[0.05091]	[4.70404]	[2.16911]
R-squared	0.326218	0.355224	0.485209	0.212281
Adj. R-squared	0.213921	0.247762	0.399410	0.080994
Sum sq. resids	0.064283	122.4300	4.494101	0.242333
S.E. equation	0.046290	2.020148	0.387044	0.089876
F-statistic	2.904959	3.305563	5.655208	1.616926
Log likelihood	62.82187	-73.11415	-13.62823	38.93554
Akaike AIC	-3.156771	4.395231	1.090457	-1.829752
Schwarz SC	-2.892851	4.659151	1.354377	-1.565833
Mean dependent	0.060415	-0.223611	0.140482	0.099512
S.D. dependent	0.052210	2.329193	0.499427	0.093753

Determinant resid covariance (dof adj.)	6.68E-06
Determinant resid covariance	3.22E-06
Log likelihood	23.30249
Akaike information criterion	0.260973
Schwarz criterion	1.492599