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Abstract

Exchange rate overshooting explains the daily behaviour of exchange rates. Irrespective of the importance of this prodigy, not enough studies specifically in the African context have been conducted. Hence, the study aims to investigate the validity of the overshooting hypothesis in a panel of African countries. It is informed by the Dornbusch model of exchange rate overshooting. The random effects technique is employed to test for this relationship during the sample period of 1985 to 2016, with the findings of the study revealing evidence of exchange rate overshooting.

Keywords: Real Exchange Rate Overshooting; Dornbusch Model of Exchange Rate Overshooting; Real Exchange Rate

1. Introduction

The exchange rate overshooting hypothesis explains exchange rate fluctuations by monitoring changes in exchange rates, while attempting to determine the consistencies of exchange rate variations with rational expectations formation (Dornbusch, 1976).

The overshooting hypothesis and exchange rate variations is best explained by the Dornbusch model (Feuerriegel, Wolff and Neumann, 2016). According to the model, a short-run reaction (depreciation or appreciation) greater than the long-run reaction, in relation to a change in market fundamentals presents an incidence of exchange rate overshooting. Therefore, changes in market fundamentals exert an excessively great short-run effect on exchange rates (Carbaugh, 2015).

In any model where adjustments in some markets is not instantaneous, probabilities of the occurrence of exchange rate overshooting are increased. When the adjustment is gradual, exchange rate overshooting may be associated with an anticipated adjustment process when goods prices adjust gradually. When instantaneous adjustments in markets do not occur, exchange rate overshooting accompanies anticipated adjustment processes in which goods prices adjust gradually (Krueger, 1983).

Exchange rate overshooting causes gradual appreciation in the nominal exchange rate along the equilibrium path until a new steady state is achieved. Likewise, with the real exchange rate, a shock causes it to depreciate and gradually appreciate until attaining its long-run equilibrium value (Romelli, Terra and Vasconcelos, 2015). Volatile exchange rates intensify exchange rate overshooting (Carbaugh, 2015).

From previous studies by (Frenkel, 1982; Sichei, 2005; Chiliba, 2014; Mtenga, 2015; Tareq and Rabbi, 2015), studies involving African countries are still scanty. Chiliba, Alagidede and Schaling (2016) resonate this by stating that research on exchange rates mostly focuses on developed economies and neglect developing countries, specifically, sub-Saharan countries. This study adds to the dearth of literature on the overshooting phenomenon in African countries.

Essentially, the study contributes to the body of literature by employing the real exchange rate instead of the nominal exchange rate in testing the overshooting hypothesis. Apart from Buiter and Miller (1981) and Cavallo et.al (2005) most previous studies (such as Siregar and Pontines, 2005; Tareq and Rabbi, 2015) employed the nominal exchange rate and not the real exchange rate. The real exchange rate was preferred for this study because it accounts for different price adjustments. Unlike the nominal exchange rate, the real exchange rate always floats. The real exchange rate manages to move through price-level changes even in a regime of a fixed nominal exchange rate. Employing the nominal exchange rate in place of the real exchange rate is limited because the long-run effect of monetary policy on the real exchange rate is concealed. In addition to using the real exchange rate, the study uses current and high frequency data to explore exchange rate overshooting.

The study is organised as follows. Section 2 presents the literature review. Sections 3 and 4 present the methodology, the estimated empirical model and empirical results. Section 5 concludes the study.

2. Literature Review

The study identifies with the Dornbusch model of exchange rate overshooting which offers a simplified macroeconomic framework for the study of exchange rate fluctuations. Exchange rate overshooting is vital since it clarifies the daily depreciation or appreciation of exchange rates. Thus, the study reviews previous research which focused on exchange rate overshooting.

Buiter and Miller (1982) examined the relationship between real exchange rate overshooting and the costs of decreasing inflation. The model consisted of nominal inertia in both the level of labour costs and trend rate of growth. Findings showed that early overshooting in the exchange rate did not reduce the output costs of steady-state inflation. Papell (1984) validated the overshooting hypothesis for the Deutsche Mark and Dollar exchange rate for Germany and the United States. Driskill (1981) estimated a reduced-form exchange-rate equation using Swiss-USA data and found evidence of short-run exchange-rate overshooting.

Engel and Flood (1985) investigated an exchange rate model with sticky prices and current account-based wealth effects. The study revealed inhibited overshooting of the Dornbusch model due to the presence of wealth in the sticky price model. Bahmani-Oskooee and Kara (2000) investigated overshooting in the Turkish economy using error correction modelling and cointegration methods. Different versions of the monetary model of exchange rate determination were applied for the analysis. Results showed the Turkish lira following a path defined by monetary approach to exchange rate determination. Moreover, the lira overshot as a reaction to quick increases in the Turkish relative money supply in both the short-run and the long-run.

Bahmani-Oskooee and Panthamit (2006) tested the overshooting hypothesis in Thailand, Korea, Indonesia, Malaysia and the Philippines. The study found evidence of overshooting in the short-run and found money to be neutral in the long-run. According to the neutrality of money paradigm, neutral money is insignificant in explaining the exchange rate in the long-run.

Sichei et.al (2005) employed the Dornbusch (1980) and Frankel (1979) overshooting model using the Johansen cointegration technique to estimate the nominal rand-USD exchange rate. The study showed an appropriate overshooting model and sticky commodity prices in South Africa. Chiliba (2014) employed the autoregressive distributed lag (ARDL) approach to re-examine the validity of the overshooting hypothesis for the United States Dollar/Zambian Kwacha (USD-ZMK) exchange rate. The study did not uncover any evidence of exchange rate overshooting.

Mtenga (2015) examined the behaviour of the exchange rate in a partly dollarized economy of Tanzania. The model examined the overshooting hypothesis of the Tanzanian Shilling and the United States Dollar exchange rate using the Structural Vector Autoregression (SVAR). Delayed overshooting due to a contractionary monetary policy was detected; the exchange rate appreciated for more than a year before being restored to equilibrium. The presence to overshooting was attributed to the underdevelopment of the Tanzanian foreign exchange market and imperfect information on the correct type of monetary policy shock. The delayed overshooting phenomenon is inconsistent to the Dornbusch hypothesis as the model proposed that overshooting occurs instantly after a shock and not with a delay.

As mentioned in previous sections, most of the reviewed studies employed the nominal exchange rate to test for overshooting. A disadvantage of exclusively employing the nominal exchange rate is the inability to capture the long-run effect of monetary policy on the real exchange rate. The real exchange rate is a better economic indicator as it is adjusted for different price levels and reflects true economic competitiveness of a country. This study employed the real exchange rate.

3. Methodology

3.1. Empirical Model for Real Exchange Rate Overshooting

The study adapted an empirical model from Chiliba (2014) with the variables exchange rates, money supply, real GDP, interest rates and inflation rates. However, instead of the nominal exchange rate, the real exchange rate is used like Buiter and Miller (1982). The real exchange rate is employed because it better reflects the true state of the economy as it is adjusted for different price levels. Broad money is used to denote money supply. All variables are transformed into logarithms to circumvent the assumption that variables are linearly related to the dependent variable (Chow, 1997).

The model is specified as follows:

$$LRER_{i,t} = \alpha_0 + \alpha_1 LMS_{i,t} + \alpha_2 LINF_{i,t} + \alpha_3 LRIR_{i,t} + \alpha_4 LGDP_{i,t} + \varepsilon_{i,t} \qquad (1)$$

Where $LRER_{i,t}, LMS_{i,t}, LINF_{i,t}, LRIR_{i,t}, LGDP_{i,t,}$ are real exchange rate, broad money, inflation rate, real interest rates, real GDP and the error term.

Broad money includes long-term bank deposits and financial assets not instantly convertible into cash (Cooke, 1996). An increased money supply leads to currency depreciation and a decrease leads to currency appreciation (Krugman and Obstfeld, 2009). A rise in inflation results in the depreciation of the real exchange rate while a decrease in inflation normally appreciates the real exchange rate. Real interest rates are adjusted for the effects of inflation, they exhibit real costs. Economic theory stipulate that higher real interest rates result in currency appreciation. The gross domestic product has an inverse relationship with exchange rates. Real appreciation (depreciation) decreases (increases) annual real GDP growth (Habib, Mileva and Stracca, 2016).

3.2. Data Description

The study employed annual data for the period 1985 to 2016. The choice of the period and variables employed were purely motivated by data availability. The study used a sample of seven African countries which are Algeria, Lesotho, South Africa, Uganda, Gambia, Zambia, and Sierra Leone. Data was sourced from Quantec which provides economic and financial data from sources such as the International Monetary Fund, the World Bank and Central Banks of individual countries. Table 1 presents a detailed description of the data:

Table 1: Data description

Variable	**Definition**	**Measure or computation**	**Source**
RER	Real exchange rate	Real effective exchange rate	Quantec database, www.quantec.co.za
LMS	Money supply	Broad money supply	Quantec database, www.quantec.co.za
LINF	Inflation	Inflation	Quantec database, www.quantec.co.za
LRIR	Real interest rates	Real interest rates	Quantec database, www.quantec.co.za
LGDP	Gross domestic product	Gross domestic product	Quantec database, www.quantec.co.za

Source: Author

3.3. Estimation Technique

Most static panel data models employ the covariance estimators (pooled panel data), fixed effects and random effects estimators. Homogeneous cross-sectional units employ pooled ordinary least squares panel model while unit-specific or time-specific effects employ the fixed effects model. Fixed effects entail nonrandom quantities accounting for heterogeneity. Random subject specific effects that are not correlated with the regressors (independent variables) are called random effects models (Baltagi, 2010). In the context of this study, the random effects panel data estimation technique was employed for the annual period of 1985 to 2016.

The fixed effects model and random effects model are expressed as follows:

Fixed Effects Model:

$$y_{it} = \alpha_1 + \sum_{k=1}^{k} \beta_k x_{kit} + u_{it}$$

$$i = 1, \ldots, N, \qquad t = 1, \ldots, T \tag{2}$$

Random Effects Model:

$$y_{it} = \sum_{k=1}^{k} \beta_k x_{kit} + (\alpha_i + u_{it}),$$

$$i = 1, \ldots, N, \qquad t = 1, \ldots, T \tag{3}$$

The index i differentiates subjects and spans from 1 to N. N is the number of subjects (cross sectional unit). A subject is observed T times and the index t differentiates the observation times from 1 to T. k is the number of the explanatory variables (Baltagi,2010).

The advantages of the fixed effects and random effects models include the production of unbiased estimates of β, however, those estimates are subject to high sample-to-sample variability for fixed effects. Random effects models permit the possible estimation shrunken residuals. Shortcomings of these models include the requirement of the estimation of per unit which reduces the model's power and increase the standard errors of the coefficient estimates (Clark and Linzer, 2015).

3.3.1. Hausman test

The study uses the Hausman test to decide on an appropriate model between a random effects and fixed effects model. Under the null hypothesis, H is distributed chi-square with degrees of freedom equating the number of regressors in the model. The probability value, $p < 0.05$ indicates the normal levels of significance at which the two models are different enough to reject the null hypothesis. That is, the decision to reject the random effects model in support of the fixed effects model. An insignificant difference ($p > 0.05$) is an indication that the Hausman test does not follow that the random effects estimator. It is free from bias and is preferred over the fixed effects estimator (Clark and Linzer, 2015).

3.3.2. Panel Unit Root Tests

Given the importance of testing for univariate characteristics of data, this study applies panel unit root tests. These test for stationarity in a panel series with the Augmented Dickey Fuller (ADF) regression for panel data as the baseline framework (Mućk, 2017). The Levin, Lin and Chu (LLC) test, Im, Pesaran and Shin (IPS test) and the Fisher type test were used in this study. The LLC test assumes homogeneity in a series, the IPS is more flexible than the LLC test and the Fisher-type test joins p-values of individual statistics (Mućk, 2017).

4. Estimation Results

4.1. Stationarity Tests

The stationarity results of the LLC, IPS and ADF Fisher tests are presented in Table 1:

Table 1: Stationarity Test Results

Method	LRER	LMS	LRIR	LGDP	LINF
LLC: Individual intercept	-5.04465 (0.0000)*	-1.57274 (0.0579)	-4.52552 (0.0000)*	-7.91123 (0.0000)*	-4.27504 (0.0000)*
Individual Intercept and Trend	-3.33967 (0.0004)*	-2.87003 (0.0021)*	-4.47245 (0.0000)*	-8.87388 (0.0000)*	-6.72690 (0.0000)*
IPS: Individual intercept	-3.79146 (0.0001)*	-1.47875 (0.0696)	-5.37802 (0.0000)*	-7.92957 (0.0000)*	-4.31199 (0.0000)*
Individual Intercept and Trend	-2.85266 (0.0022)*	-2.61331 (0.0045)*	-5.18951 (0.0000)*	-10.2182 (0.0000)*	-5.87397 (0.0000)*

ADF Fisher: Individual intercept	53.5352 (0.0000)*	23.3625 (0.0546)	61.1945 (0.0000)*	89.7434 (0.0000)*	49.3973 (0.0000)*
Individual Intercept and Trend	30.5170 (0.0065)*	35.1803 (0.0014)*	61.0652 (0.0000)*	104.015 (0.0000)*	65.6381 (0.0000)*

*p-values are in parentheses ()

* indicates rejection of the null hypothesis of unit root at 5% level of significance
Lag selection criteria: Automatic selection of maximum lags
Values in parenthesis are the probability values relating to the test statistic.

The tested variables are integrated of the same order. They are I(0) at levels of the panel unit root tests, meaning that they are all stationary. Thus, the null hypothesis is rejected in favour of the alternative hypothesis. To affirm and obtain robust results, the LLC test, the IPS and ADF Fisher unit root tests were applied. All tests showed the same results. Tests for cointegration are not performed because the variables are of order zero, implying that they do not share a common trend therefore they cannot be cointegrated.

4.1.2. Hausman Test

The next step entailed choosing the appropriate panel data estimation method. The Hausman's test was employed to examine random versus fixed effects models (Baltagi, 2005).

- **Test Hypothesis**:

Null Hypothesis: Random effects model is appropriate

Alternative Hypothesis: Fixed effects model is appropriate

Table 2: Hausman Test

Test Summary	**Chi-Sq. Statistic**	**Chi-Sq. d.f**	**Prob.**
Cross-section random	3.761340	4	0.4393

Given the results of the Hausman test, the random effects model was employed. Table 3 displays the estimated long-run relationship.

Table 3: Random Effects Model

Dependent Variable: LRER

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	5.765568	0.285327	20.20689	0.0000
LRIR	-0.015108	0.003666	-4.120735	0.0001***
LMS	-0.261138	0.071540	-3.650228	0.0003**
LINF	-0.003248	0.001746	-1.860264	0.0642*
LGDP	-0.003239	0.022644	-0.143046	0.8864
**10 % statistically significant.* ***5 % statistically significant.* ****1 % statistically significant.*				

The random effects model shows the relationship between the dependent variable LRER and its explanatory variables. The relationship between the real exchange rate and money supply is negative in accordance with economic theory. In the overshooting model, an increase in the money supply can cause the exchange rate to overshoot its long-run level in the short-run. The results suggest exchange rate overshooting in the selected countries as the relationship between the real exchange rate and money supply is statistically significant. The relationship between the real exchange rate and inflation is inverse and statistically significant. A 1% rise in inflation results in the depreciation of the real exchange rate by 0.003%. Although statistically significant, the relationship between real exchange rates and real interest rates is in defiance of economic theory. Economic theory stipulates that higher real interest rates should lead to currency appreciation. The gross domestic product has a negative relationship with real exchange rates as stated by economic theory; however, it is statistically insignificant in the stipulated model.

5. Conclusion

The study empirically investigated the validity of the overshooting hypothesis in Algeria, Lesotho, South Africa, Uganda, Gambia, Zambia, and Sierra Leone. This study was motivated by the lack of studies on the overshooting phenomenon in African countries and it is informed by the Dornbusch model of exchange rate overshooting. The study used the Pooled OLS Regression Model to pool all observations and estimates extensive regression. After applying the Hausman test, the Random Effects Model was selected for analysis.

The relationship between the real exchange rate and money supply conformed to economic theory thus suggesting exchange rate overshooting in the selected African countries. In the overshooting model, an increase in the money supply can result in the exchange rate overshooting its long-run level in the short-run. The relationship between the real exchange rate and money supply was statistically significant.

Based on the results of the study, suggestions are that the selected countries could adjust interest rates to restrain the intensity of real exchange rate overshooting. Also, the selected countries may vary money supply to offset overshooting adjustments of the real exchange rate caused by demand for money shocks. Reducing or controlling real exchange rate overshooting promotes economic growth and competitiveness thereby improving the general economic landscape of these countries.

References

BAHMANI-OSKOOEE, M., Kara, O. (2000). Exchange rate overshooting in Turkey. Economics Letters, 68(1), 89-93.

BAHMANI-OSKOOEE, M., Panthamit, N. (2006). Exchange Rate Overshooting in East Asian Countries. Emerging Markets Finance and Trade, 42(4), 5-18.

BALTAGI, B. H. (2005). Econometric Analysis of Panel Data. Wiley, Chichester.

BALTAGI, B.H. (2010). Panel Data: Theory and Applications. Physica-Verlag, Heidelberg.

BUITER, W.H., Miller, M.H. (1982). Real Exchange Rate Overshooting And The Output Cost Of Bringing Down Inflation. European Economic Review, 18(1), 85-123.

CARBAUGH, R. (2015). International Economics. Thomson South-Western, Indiana.

CAVALLO, M., Kisselev, K., Perri, P., Roubini, N. (2005). Exchange Rate Overshooting and the Costs of Floating. FRB of San Francisco. Working Paper. No. 2005-07. https://www.frbsf.org/economic-research/files/wp05-07bk.pdf [Accessed November 28, 2018].

CHILIBA, L. (2014). A Re-Examination of the Exchange Rate Overshooting Hypothesis: Evidence from Zambia. Thesis, Johannesburg: University of the Witwatersrand Business School. http://hdl.handle.net/ [Accessed November 28, 2018].

CHILIBA, L., Alagidede, P., Schaling. E. (2016). A Re-Examination of the Exchange Rate Overshooting Hypothesis: Evidence from Zambia. Southern African Business Review, 20(1), 468-491.

CHOW, G.C. (1997). Dynamic Economics: Optimization by the Lagrange Method. Oxford University Press, New York.

CLARK, T.S., Linzer, D.A. (2015). Should I Use Fixed Or Random Effects? Political Science Research and Methods, 3(2), 399-408.

COOKE, A.J. (1996). Economics and Construction. Macmillan International Higher Education, London.

DORNBUSCH, R. (1976). Expectations and Exchange Rate Dynamics. Journal of Political Economy, 84(6), 1161-1176.

DRISKILL, R.A. (1981). Exchange-Rate Dynamics: An Empirical Investigation. Journal of Political Economy, 89(2), 357-371.

ENGEL, C.M., Flood, R.P. (1985). Exchange Rate Dynamics, Sticky Prices and the Current Account. Journal of Money, Credit and Banking, 7(3), 312-327.

FEUERRIEGEL, S., Wolff, G., Neumann, D. (2016). News Sentiment and Overshooting Of Exchange Rates. Applied Economics, 48(44), 4238-4250.

HABIB, M.M., Mileva, E., Stracca, L. (2016). The Real Exchange Rate and Economic Growth: Revisiting the Case Using External Instruments. Journal of International Money and Finance, 73 (Part B), 386-398.

KRUEGER, A.O. (1983). Exchange Rate Determination. Cambridge University Press, Cambridge.

KRUGMAN, P.R., Obstfeld, M. (2009). International Economics: Trade and Policy. Harper Collins, New York.

MTENGA, T.L. (2015). The Role of Exchange Rate in Small Open Economies: The Case of Tanzania. Thesis (Doctoral). Cape Town, South Africa.

MUĆK, J. (2017). Econometrics of Panel Data. https://web.sgh.waw.pl [Accessed November 28, 2018].

PAPELL, D.H. (1984). Activist Monetary Policy and Exchange-Rate Overshooting: The Deutsche Mark/Dollar Rate. Journal of International Money and Finance, 3(3), 293-310.

ROMELLI, D., Terra, C., Vasconcelos, E. (2015). Current Account and Real Exchange Rate Changes: The Impact of Trade Openness. Thema Working paper no.2014-10. University of Cergy-Pontoise, France.

SICHEI, M.M., Gebreselasie, T.G., Akanbi, O.A. (2005.) An Econometric Model of the Rand-Us Dollar Nominal Exchange Rate. Working Paper: 2005-14. http://www.up.ac.za/dspace/bitstream/2263/4509/1/Sichei_Econometric [Accessed November 28, 2018].

SIREGAR, R. Y., Pontines, V. (2005). External Debt and Exchange Rate Overshooting: The Case of Selected East Asian Countries. Working Paper. The University of Adelaide. https://ideas.repec.org/p/adl/wpaper/2005-14.html [Accessed November 28, 2018].

TAREQ, M.A., Rabbi, F. (2015). Exchange Rates "Overshooting": An Empirical Study of Bangladesh and India. Australian Academy of Accounting and Finance Review, 1(1), 86-102.