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A cross-country analysis of the determinants of the real effective exchange rate in fifteen Sub-Saharan African countries

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Abstract

This paper employs an Autoregressive Distributed Lag (ARDL) approach to examine the long-run and short-run determinants of the real effective exchange rate in fifteen Sub-Saharan African (SSA) countries using annual data spanning from 1980 to 2015. Not surprisingly, the findings show that the determinants vary from one country to another. Terms of trade, GDP per capita, net foreign assets and trade openness are found to be key factors that cause fluctuations in the real effective exchange rate of most of these countries in the long-run. Whereas in the short-run, the drivers of the real effective exchange rate differ from country to country. We further observe that there is also a difference in the speed that each country adjusts back to the equilibrium level of their real effective exchange rate whenever there is a shock in the latter.

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1. Introduction

The relationship between exchange rate and its determinants has largely been investigated both theoretically and empirically. Different approaches (for instance, the flexible price monetary model (Frankel 1976), the portfolio balance model (Branson et al. 1977), the redux model (Obstfeld and Rogoff 1995), the behavioural equilibrium exchange rate model (Clark and MacDonald 1999), the fundamental equilibrium exchange rate model (Williamson 1994) amongst others) have been developed and employed to study the factors influencing exchange rate, but there is still a lack of consensus concerning the use of particular factors for a particular country in exchange rate determination. Nevertheless, among the most commonly used factors include: terms of trade (Ghura and Grennes 1993, Drine and Rault 2015), trade openness (Aron et al. 1997, Chudik and Mongardini 2007, Elbadawi et al. 2012), GDP per capita (Edwards 1989, Kim and Korhonen 2005), investment (Edwards 1988, Chudik and Mongardini 2007) and net foreign assets (Carrera and Restout 2008, Nouira and Sekkat 2015). Research in this area has gathered more importance in the last decade following the global financial crisis of 2007-2008. However, far too little attention has been paid to Sub-Saharan African (SSA) countries despite that maintaining exchange rate stability is one key ingredient to promote economic growth through export diversification in these countries. Very few empirical studies have focused on the determinants of exchange rate in these countries: Botswana (Iimi 2006, Iyke and Odhiambo 2017), Kenya (Musyoki et al. 2012), Ghana (Loukoianova and Iossifov 2007, Amoah and Aziakpono 2017), Nigeria (Ibrahim 2016), Madagascar (Cady 2003), Malawi (Mathisen 2003), South Africa (Aron et al. 1997; MacDonald and Ricci 2004, De Jaher 2012, Frankel 2007, Iyke and Odhiambo 2015) and a panel of SSA countries (Ghura and Grennes 1993, Chudik and Mongardini 2007, Ouattara and Strobl 2008, Elbadawi et al. 2012).

With this in mind, the aim of this study is to examine the determinants of the real effective exchange rate in fifteen SSA countries. In this context, this study makes a threefold contribution. First, it adds up to the strand of the empirical literature by investigating both the long-run and short-run determinants of the real effective exchange rate in fifteen SSA countries, including countries such as Cameroon, Central African Republic, Ethiopia, Niger, Senegal, Sudan, Uganda and Zambia for which to our knowledge no evidence up to date is available, within a single country estimation framework. Specifically, a country-by-country analysis is performed instead of including them within a panel for investigation. Second, in contrast to existing empirical studies in this area of the literature, instead of applying a predetermined empirical model to all countries, the present study innovates by using the Bayesian Model Averaging (BMA) techniques for the identification of potential factors that may influence the real effective exchange rate to better model the determinants of the latter in each of these countries. Finally, this study considers the dynamic nature in exchange rate determinant modelling, an aspect often overlooked in the literature, by applying an Autoregressive Distributed (ARDL) model.

This paper is divided into four sections, including this introduction. The second section describes the methodology and the data used. This is followed by the presentation and discussion of the empirical findings in the third section, while the last section provides some concluding remarks.

2. Methodology and data

Following the literature on the determinants of exchange rate in SSA and developing countries (see for instance, Edwards 1988, Drine and Rault 2006, Chudik and Mongardini 2007, Elbadawi et al. 2012, Nouira and Sekkat 2015, Iyke and Odhiambo 2017) together by taking in account the internal and external equilibria of these countries, the following relationship has been established:

$$REER = f(FUNDAMENTALS) \tag{1}$$

where *REER* is the real effective exchange rate of the home country, and *FUNDAMENTALS* consist of a set of determinants of exchange rate used in literature: terms of trade (*TOT*), trade openness (*OPEN*), real GDP per capita (*GDP*), investment (*INV*), government consumption (*GOV*), inflation rate (*INF*), official development assistance (*ODA*), net foreign assets (*NFA*), capital inflow (*CAPINF*) and money supply (*MS*).

In an attempt to better assess the country's trade capabilities and its current import and export situations, the real effective exchange rate is used as a measurement of the country's exchange rate. It is defined as the ratio of the consumer price index (CPI) of the home country to the geometrically weighted average of the consumer price indices of trading partners multiplied by the nominal effective exchange rate of the home country. An increase in the real effective exchange rate index implies an appreciation of the home country's currency against the basket of currencies of trading partners.

The terms of trade is defined as the ratio of the price of a country's exports over the price of its imports. Terms of trade is expected to have a positive impact on the real effective exchange rate. Many empirical studies have shown that an improvement in terms of trade leads to the appreciation of the exchange rate (see Drine and Rault 2006, Ghura and Grennes 1993, Dufrénot and Yehoue 2005). In this study, the net barter terms of trade, defined as the percentage ratio of the export unit value indexes to the import unit value indexes, is used.

Trade openness is used as an indicator of trade policy restrictions such as tariffs and quotas. It is defined as the ratio of the sum of imports and exports of goods and services measured as a share of gross domestic product. Protection of domestically produced goods via restrictions on cross-border trade (for instance, import tariffs and non-tariff barriers) leads to higher domestic prices and thus to the appreciation of the exchange rate.

Following Edwards (1989) and previous empirical studies on developing countries, we use the real GDP per capita to capture the productivity effect on exchange rate. The productivity effect refers to the Balassa-Samuelson effect. According to this hypothesis, productivity leads to an appreciation of the home country's exchange rate.

For investment, we employ the ratio of total investment to GDP. An increase in the ratio of investment to GDP will increase absorption. As a result, this will worsen the current account and leads to the depreciation of exchange rate. However, some empirical studies noted that the expected sign is unclear as including investment in the theoretical model results in supply-side effects, which are dependent on the relative factor intensities across sectors (see Edwards 1988, Mathisen 2003, Chudik and Mongardini 2007).

Since we cannot decompose public spending into public spending in tradable and non-tradable sectors, we use the variable *GOV* to capture the influence that public spending in the non-tradable goods has on the real effective exchange rate. An increase in government consumption means that there is a higher demand for the non-tradable sector as compared to the tradable one, and as a result, this boosts the relative prices of non-tradable goods, causing exchange rate to appreciate.

Inflation is expected to cause real depreciation in the long term. This is because it raises the nominal interest rate (the Fisher effect), which reduces real money demand, and thus real financial wealth. Consumption falls and saving rises, since they depend on real wealth. The higher saving implies an improved trade account in equilibrium, which requires a real exchange rate depreciation.

The net official development assistance as a ratio of GDP is used as a proxy for aid flows. According to the "Dutch disease" hypothesis, an increase in aid flows will lead to the appreciation of the exchange rate. If aid flows are spent on imports of intermediate goods that raise output in the non-traded sector, this supply effect may lead to a falling price of non-traded goods, and hence a real depreciation. This turns out to be relevant for middle-income countries.

The net foreign assets as a share of GDP is used as a proxy for the country's net external position. An increase in capital inflows from abroad leads to a higher demand for domestic currency. As a result, exchange rate appreciates.

According to the monetary model of exchange rate determination developed by Frenkel (1976), an increase in money supply causes exchange rate to depreciate. This is also supported by empirical studies conducted using the monetary approach of exchange rate determination (see Kia 2013 and Shevchuk 2014). Due to the unavailability of data on money supply, this study employs broad money as a percentage of GDP as a measurement of money supply[1].

In an attempt to uncover the long-run and short-run relationships between the real effective exchange rate and its determinants in these countries and in the presence of a mixture of I(0) and I(1) data series, this study adopts the Autoregressive Distributed Lag (ARDL) approach (see Pesaran et al. 2001, Nkoro and Uko 2016). In line with this, the ARDL model can be represented as follows:

$$\Delta reer_{it} = \alpha_0 + \gamma_y reer_{it-1} + \gamma_x X_{it-1} + \sum_{j=1}^{p-1} \beta_j \, \Delta reer_{it-j} + \sum_{k=1}^{q-1} \delta_k \, \Delta X_{it-k} + \mu_t \quad (2)$$

where $reer_{it}$ is the log of the real effective exchange rate for country i, while X_{it} represents the log of each fundamental variable for country i; μ_t is the white noise error term, and Δ is the first difference operator; γ_y and γ_x are the long-run coefficients; β_j and δ_k are the short-run coefficients[2].

Moreover, since consensus has not been formed about which determinants to be included in a model for a particular country, the Bayesian Model Averaging (BMA) techniques are used to cater for model uncertainty and reduce selection bias in regression modelling (Raftery et al. 1997, Steel 2019). Indeed, the latter allow one to select potential determinants of the real effective exchange rate for each country from the above-mentioned variables. Additionally, before the application of the ARDL approach, the optimal lag length of each variable is selected using the Schwarz Information Criterion (SIC).

3. Results and Discussion

This study uses annual data spanning from 1980 to 2015 for fifteen SSA countries (see Appendix for list of countries). The ADF unit root test shows that our models consist of a mixture of both I(0) and I(1) variables, thus favouring the use of the ARDL approach. The existence of a long-run relationship among the variables in the selected models is verified using the ARDL-bounds testing approach. The F-statistics fall outside the upper bound and are statistically significant (see Table A2 in Appendix). The null hypothesis of no cointegration is thus rejected for all countries. This indicates that there is a long-run relationship among the variables. Moreover, the results from the stability and residual diagnostic tests also reveal that the selected models are stable and correctly specified. On the other hand, the R-squared values,

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[1] A brief description of the independent variables and their data sources are given in Appendix.

[2] In order to provide better and consistent results, we transform all data in logarithmic form. The logarithmic form does not only reduce the variability in the data sets (Feng et al. 2014, Boutabba 2014) but offsets any exponential trends in them (Ongan and Demiröz 2005). This also eases the interpretation and comparison of the results in terms of percentage change.

which quantify the good-of-fitness of our regression models, are above 92 percent in all cases (see Table A3 in appendix). This proves that the selected models fit our data.

The long-run and short-run coefficient estimates are reported in Table A3 (Appendix) and Table A4 (Appendix) respectively. According to the estimation results presented in Table A3 (Appendix), a rise in the GDP per capita, as suggested by the Balassa-Samuelson hypothesis, leads to the appreciation of the real effective exchange rate for all countries, except for Botswana, Ghana, Malawi and Nigeria. An improvement in terms of trade is also associated with the appreciation of the real effective exchange rate, except for Botswana, Cameroon and Senegal. An increase in trade openness causes a depreciation in the real effective exchange rate except for Cameroon. On the other hand, an increase in investment leads to a depreciation in the real effective exchange rate except for Kenya. Moreover, government consumption is found to exert a positive impact on the real effective exchange rate except for South Africa; the latter leads to the appreciation of the real effective exchange rate in these countries. Furthermore, it can be observed that net foreign assets cause the real effective exchange rate in most countries to decrease (7 out of 15 countries). The empirical findings also reveal similar results for money supply and capital inflow for the countries investigated. An in-depth analysis of the results shows that on average a 1 percent increase in terms of trade, GDP per capita, government consumption, investment and official development assistance cause the real effective exchange rate to increase on average by 0.50, 0.66, 0.34, 0.08 and 0.20 percents respectively. On the other hand, on average a 1 percent increase in trade openness, inflation, net foreign assets, capital inflow and money supply cause the real effective exchange rate to decrease by 0.43, 0.11, 0.49, 0.42 and 0.65 percents respectively. The findings corroborate with existing studies conducted on SSA and developing countries (see Aron et al. 1997, Drine and Rault 2006, Chudik and Mongardini 2007, Elbadawi et al. 2012). In terms of income levels, it can be observed from the table, that trade openness and net foreign assets are key drivers of the real effective exchange rate in upper middle income countries while terms of trade, GDP per capita and net foreign assets prove to be important for lower middle income countries. For low income countries, the real effective exchange rate in most of these countries (4 out of 6) is particularly affected by terms of trade and GDP per capita.

It can be seen from Table A4 (Appendix) that the coefficient of the error-correction term is statistically significant and negative for all countries. Its absolute value is also smaller than one. This not only validates the long-run relationship among the variables but also reflects the convergence of the real effective exchange rate towards its long-run equilibrium (Banerjee et al. 1998). Moreover, the estimates of the speed of adjustment vary from -0.22 to -0.99. This disparity in the speed of adjustments across countries has been highlighted in previous studies (Elbadawi and Soto 1994, 1997). A closer look at the error correction terms reveals that on average, 70 percent of the adjustment in the real effective exchange rate takes place within a year for all countries investigated. The results also show that upper middle income countries tend to adjust their real effective exchange rate back to its equilibrium level faster than other countries (with more than 85 percent of disequilibrium from the previous year's shock eliminated within a year). Zooming to the lower middle income and low income countries, it can be found that on average low income countries tend to eliminate much more of the disequilibrium that occurs in their previous year's real effective exchange rate within a year (on average 74 percent) as compared to the lower middle income countries (on average 49 percent). Thus, low income countries adjust more quickly whenever there is a shock in their real effective exchange rate.

Furthermore, it can be observed that the short-run dynamics also differ from country to country (see Table A4 in Appendix). For upper middle income countries, it can be seen that in the short-run, the real effective exchange rate in these countries is influenced by the lags of terms of trade, GDP per capita and net foreign assets. In lower middle income countries, the latter is particularly affected by the lags terms of trade and trade openness in most cases. As for low-income countries, in addition to these two variables (lags of terms of trade and trade openness), the lags of the real effective exchange rate also prove to be significant in most countries. In particular, in the short-run, the real effective exchange rate tends to appreciate due to an increase that occurs in the previous period's real effective exchange rate.

4. Conclusion

This article examined the determinants of the real effective exchange rate in fifteen SSA countries using annual data (1980-2015) and an ARDL bounds testing approach. The results showed that both the long-run and short-run determinants of the real effective exchange rate change according to the country investigated. A difference was noted in the sign, size and statistical significance of the estimated coefficients. Indeed, these countries do not share the same characteristics: they differ in terms of their location, level of development, the extent of openness to international trade, and policies adopted for exchange rate and capital controls. The findings are relevant to policy makers as they shed light on the various determinants of and their interplay with the exchange rates, thus increasing the understanding of exchange rate determination in these countries. The findings also suggest that each country should devise and reinforce its own policy with respect to exchange rate and capital controls to sustain its currency in equilibrium, and hence, enhancing their global competitiveness. Future research may look at country-wise cases for more specific research and policy implications and also engage in comparison with other sample of countries.

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Appendix

Table A1. Data

Variable	Definition	Source
tot	Net barter terms of trade index (2000 = 100)	
open	Trade (% of GDP)	
gdp	GDP per capita (constant US$)	
gov	General government final consumption expenditure (% of GDP)	WDI database of World Bank
inf	Consumer prices (annual %)	
oda	Net official development assistance as a share of GNI	
nfa	Net foreign assets as a share of GDP	
ms	Broad money (% of GDP)	
capinf	Foreign direct investment, net inflows (% of GDP)	
inv	Investment (% of GDP)	WEO database of IMF

Note: Variables are in logarithmic form.

Table A2. ARDL bounds F-test

Country	F-Statistics
Botswana	3.12*
Cameroon	5.66***
Central African Republic	9.28***
Ethiopia	4.53**
Ghana	26.67***
Kenya	9.62***
Madagascar	5.18***
Malawi	5.22***
Niger	27.21***
Nigeria	5.98***
Senegal	3.68**
South Africa	3.59*
Sudan	12.48***
Uganda	7.09***
Zambia	4.75***

Notes: Estimated with unrestricted intercept and no trend; ***,**,* denote significance at the 1% , 5% and 10% levels respectively.

Table A3. Long-run estimates

	Regressors										
	tot_t	$open_t$	gdp_t	inv_t	gov_t	inf_t	nfa_t	oda_t	ms_t	$capinf_t$	R^2
Upper Middle Income											
Botswana	-0.158*	-0.212**	-0.034			-0.133***	-0.160***	-0.024***			0.9955
South Africa	0.381	-1.482***	2.632***		-1.573***		-1.863***				0.9587
Lower Middle Income											
Cameroon	-0.188***	0.301*	0.514***		0.644***	0.106*					0.9596
Ghana	1.323***	-0.323***	-1.880***	-0.089			0.813*				0.9899
Kenya	1.759	1.818	2.414**	0.954*			3.743**				0.9951
Nigeria	1.090***	-0.342*	-1.597***		1.241***		-1.821**		-1.009***		0.9341
Senegal	-0.618*	0.354	2.117***	-0.392*			-2.011***	0.624**			0.9883
Sudan	0.763*	0.089	-0.934							-0.776***	0.9904
Zambia	0.549***	-0.502***	0.037			-0.337***	-0.398***				0.9968
Low Income											
Central African Republic	0.090*	-0.257	1.377***	-0.135**				0.278***			0.9707
Ethiopia	0.037	-0.170	0.582***							-0.058**	0.9630
Madagascar	0.419***	-0.483***	1.916***		1.061***		0.609***	-0.098**			0.9921
Malawi	0.718***	-0.016	-1.478***	-0.103*	0.339**				-0.300**		0.9560

Regressors

	tot_t	$open_t$	gdp_t	inv_t	gov_t	inf_t	nfa_t	oda_t	ms_t	$capinf_t$	R^2
Low Income											
Niger											
	1.095**	0.214	-2.540				-3.340**		0.015		0.9986
Zambia											
	0.549***	-0.502***	0.037			-0.337***	-0.398***				0.9968
Average	0.5035	-0.4346	0.6597	0.0811	0.3424	-0.1061	-0.4921	0.1951	-0.6544	-0.4170	

Notes: ***,**,* denote significance at the 1% , 5% and 10% levels respectively; Dependent variable: *reer*[3].

[3] Full results available upon request.

Table A4. Short-run estimates

					Regressors					
Upper Middle Income										
Botswana										
	Δtot_t	$\Delta open_t$	Δgdp_t	Δinf_t	Δnfa_t					ECM_{t-1}
	-0.149*	-0.175**	-0.451***	-0.063**	-0.171***					-0.8545***
South Africa										
	$\Delta reer_{t-1}$	$\Delta open_t$	Δgdp_t	Δgov_t	Δgov_{t-1}	Δnfa_{t-1}				
	0.208**	-1.310***	3.151***	-0.953***	0.834***	1.489***				-0.9459***
Lower Middle Income										
Cameroon										
	Δtot_t	$\Delta open_t$	Δgdp_t	Δinf_t	Δgov_t					
	-0.103**	0.165***	-0.463**	-0.035***	0.677***					-0.5219***
Ghana										
	$\Delta reer_{t-2}$	Δtot_t	Δtot_{t-1}	$\Delta open_t$	Δinv_t					
	0.240***	0.659***	-0.833***	-0.212*	-0.175***					-0.6279***
Kenya										
	$\Delta reer_{t-3}$	Δtot_{t-2}	Δtot_{t-3}	$\Delta open_t$	$\Delta open_{t-1}$	Δgdp_{t-3}				
	-0.426**	-0.941***	-0.344**	0.268**	-0.614***	-1.863***				-0.3715***
Nigeria										
	Δgov_t	Δnfa_t								
	0.542***	-2.010**								-0.9006***
Senegal										
	Δtot_t	Δtot_{t-1}	Δtot_{t-2}	$\Delta open_t$	Δgdp_t	Δgdp_{t-1}	Δoda_{t-1}	Δoda_{t-2}	Δnfa_t	
	0.552***	0.294***	0.324***	-0.160**	1.264***	1.714***	-0.335***	-0.242***	-1.100***	-0.4879***

	Regressors									
Lower Middle Income										
Sudan										ECM_{t-1}
	$\Delta open_t$	$\Delta open_{t-2}$	$\Delta capinf_t$	$\Delta capinf_{t-1}$	$\Delta capinf_{t-2}$	Δnfa_t	Δnfa_{t-1}	Δoda_t		
	0.197*	0.349***	0.098*	0.169**	0.396***	2.509***	-0.694***	-0.111**		-0.5608***
Low Income										
Central African Republic										
	Δtot_t	Δtot_{t-1}	Δtot_{t-2}	$\Delta open_t$	Δoda_t	Δoda_{t-1}				
	0.668***	0.213**	0.521***	-0.507***	0.116***	-0.164***				-0.9699***
Ethiopia										
	$\Delta open_t$	$\Delta capinf_t$								
	-0.314*	-0.039***								-0.8666***
Madagascar										
	$\Delta reer_{t-1}$	Δtot_{t-1}	$\Delta open_{t-1}$	Δgdp_{t-1}	Δgov_t	Δgov_{t-1}	Δgov_{t-2}	Δnfa_t	Δnfa_{t-1}	
	0.978***	-0.784***	0.833***	-2.694***	0.901***	-0.584***	-0.308***	0.409***	-0.225***	-0.7789***
Malawi										
	$\Delta reer_{t-1}$	Δtot_t	$\Delta open_t$	Δinv_t	Δgov_{t-1}	Δms_{t-1}	Δms_{t-2}			
	0.503***	0.375***	-0.275***	-0.106**	-0.287***	0.590***	0.125**			-0.7384***
Niger										
	$\Delta reer_{t-1}$	$\Delta reer_{t-2}$	$\Delta reer_{t-3}$	Δtot_{t-1}	Δtot_{t-2}	Δtot_{t-3}	$\Delta open_t$	$\Delta open_{t-1}$	$\Delta open_{t-3}$	
	0.626***	0.521***	0.509***	-1.320***	-0.877***	0.169**	-0.966***	-1.045***	-1.055***	-0.8822***
Uganda										
	$\Delta reer_t$	Δtot_t	Δtot_{t-1}	Δtot_{t-2}	Δtot_{t-3}	Δgdp_{t-1}	Δinf_t	Δinf_{t-1}	Δinf_{t-2}	
	0.695***	-0.604***	-0.653***	-0.579***	-0.330***	2.056***	0.073***	0.099***	0.088***	-0.2202***

Notes: See Table A3.; Δ is the first difference operator; Only significant short-run results are reported.