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Asymmetric effect, non-linear ARDL, and the J –Curve analysis among East African community members

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Abstract

When a country's balance of trade persistently records deficits, the most important policy is to devalue the exchange rate. This article aims to explore the symmetric effect of the exchange rate and its transmission channels on the trade balance. The recently developed method of Non-linear Autoregressive Distributed Lag (ARDL) was utilized for Quarterly data from 1990 Q1 to 2019 Q4 in unexplored areas of East African Community (EAC -5) members. The study found the presence of robust symmetric and asymmetric negative effects of exchange rate changes on trade balance only in Uganda, both in the short-run and long-run. Meanwhile, there was no evidence of robust J-curve phenomena within EAC members. Generally, the application of exchange rate policy in improving trade imbalance is doubted within the EAC region.

Keywords: EAC; Exchange rate; J –curve; nonlinear ARDL.

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1. Introduction

When a country's balance of trade persistently records deficits, the most important policy is to devalue the exchange rate. Economic theory suggests that real devaluation (currency depreciation) improves trade balance if Marshall- Lerner (ML) is satisfied. Later it was proven empirically that, even if the ML condition is met, the balance of trade may still deteriorate (see, Bahmani and Oskoee, 1985; Thorbecke and Smith, 2010). In a more recent extensive review of past studies analyzing ML conditions, Bahmani-Oskooee & Gelan, (2012) concluded that the argument that ML condition is met does not hold.

As a result, the effect of devaluations (currency depreciation) of exchange rates on the balance of trade has been an issue of intense debate among both, academicians and policymakers. It is believed that the response of trade balance after real devaluations differs in the short and long run. It is suggested that, after the real devaluations (currency depreciation) of the exchange rate, the trade will worsen (deficits) in the short run, but the trade balance improves from deficits to surplus in the long run; which generates a shape called J-curve. Nevertheless, one common assumption of previous studies was that the adjustment of the exchange rate on the trade balance is symmetric; which implies that if the devaluation of currency (depreciation) improves the trade balance, then appreciation retards the trade balance (Obeng & Nsiah, 2018).

Meanwhile, most of the previous studies relied on the standard ARDL method developed by Pesaran et al (2001) which assumes linear relationships among the variables within the regressions. However, since the development of recent methods of nonlinear ARDL (NARDL) by Shin et al. (2014), the third group of studies has emerged to re-examine the J-curve for the different economies since early 2015. For example, Bahmani-Oskooee and Fariditavana (2016) for the US and its six major trading partners, Bahmani-Oskooee and Fariditavana (2016) for Canada, China, Japan, and the US, and Bahamni-Oskoee and Kanitpong (2017) for seven Asian countries.

The NARDL has enabled the test to determine whether changes in the exchange rate on trade balance are symmetric or asymmetric. Such examination is important for policymaking in international economies, especially for emerging economies that are in a policy dilemma to ensure effective and efficient use of available economic resources. This study aims to uncover this gap in the EAC-5 countries, whereby to the best of the author's knowledge, the discussion on the subject matter is still lacking. For example, the study by Bahmani-Oskoee and Gelan (2012) in African countries was very limited to only using the ARDL method and exploited only two countries within the EAC region.

1.1. Purpose of study

As the region is still in the process of monetary union, whereby protocol for the establishment was signed on 30 November 2013, this study would be useful and timely. Furthermore, it is worth examining the effectiveness of monetary policy which includes exchange rate fluctuations, hence understanding its effects on trade flows. This article consists of four further main sections. The second section explores empirical studies related to the topic, while the third section describes the methodology. The fourth section discusses the results and their implications, while the final section ends with a conclusion and recommendations.

2. Materials and Method

Following the literature review, domestic income, foreign income, and real effective exchange rate were identified to be the main determinants of trade balance in each country. Thus, following the literature we adopt the following specification:

$$LnTB = \beta_O + \beta_1 Y_{yd}, _t + \beta_2 YW_t + \beta_3 REFX_t + \varepsilon_t \quad \text{.....(1)}$$

TB is the trade balance, measured as a country's imports divided by her exports to the rest of the world. It measures the trade balance in nominal or real terms . This study TB denotes a measure of Tanzania's trade balance of industry i with respect to her trading partner at the period t . Equation (1), Y is a measure of domestic economic income with the proxy of GDP; as the domestic economy grows, its imports rise, so an estimate of β_1 is expected to be positive. On the other hand, an increase in world income (YW) is expected to increase exports, henceforth β_2 is expected to be negative.

The choice of imports over exports is due to the definition of a real effective exchange rate, $REFX$. By way of construction, since a decline $REFX$ reflects a real depreciation, if it is to improve the trade balance, the trade balance must be defined as imports over exports. Thus, REFX represents a real effective exchange rate and due to its construction, should there be a real depreciation of the domestic currency, it will stimulate exports and discourage imports, hence an estimate β_3 is expected to be positive. The data for all variables were collected from UNCTAD online database 2018. To capture short-run dynamics, an error correction modeling format has to be incorporated. This is done by adopting Pesaran et al.'s (2001) bounds testing approach known as linear ARDL.

We suspect the reason that previous studies as modeled in equation (1) failed to support the J-curve effect is due to the belief that there is a symmetric effect of exchange rate on the trade balance. To this end, to detect if there is a symmetry or asymmetry effect of exchange rate changes on the trade balance, this paper utilizes the idea of Shin et al. (2014) to separate depreciations from appreciations. For this, the movement of the $LnREFX$ variable is decomposed into positive (dollar appreciation) and its negative (dollar depreciation) partial sum as:

$LnREFX = LnREFX_0 + LnREFX^+_t + LnREFX^-_t$ where $LnREFX^+$ and $LnREFX^-$, are partial sum process of positive and negative changes in $LnREFX$. To be specific, we can represent as:

$$POS = LnREFX_t^+ = LnREFX = \sum_{p=1}^{t} LnREFX_p^+ = \sum_{p}^{t} \max(\Delta LnREFX_{p,}, 0), \quad \text{.....(3)}$$

$$NEG = LnREFX_t^- = LnREFX = \sum_{p=1}^{t} LnREFX_p^- = \sum_{p}^{t} \max(\Delta LnREFX_{p,}, 0), \quad \text{.....}$$

To this end, concerning Shin et al. (2014), we replaced $LnREFX$ equation (2) with POS and NEG variables as in (4):

$$\Delta LnTB = \alpha + \sum_{k=1}^{k} \phi \Delta LnTB_{t-k} + \sum_{k=0}^{k} \rho \Delta Y_{yd,t-k} + \sum_{k=0}^{k} \lambda \Delta YW_{t-k} + \sum_{k=0}^{k} \eta \Delta POS_{t-k} + \sum_{k=0}^{K} \pi NEG_{t-k} + \quad \text{..... (4)}$$
$$\delta_1 LnTB_{t-1} + \delta_2 LnY_{yd,t-k} + \delta_3 LnYW_{t-k} + \delta_4 LnPOS_{t-k} + \delta_5 LnNEG_{t-k} + \xi$$

The introduction of new variables in the model (4) allows us to test whether any shock in the exchange rate has asymmetric or symmetric effects on Tanzania's trade balance (LnY) with its trading partners

$(LnYW)$. The ECM model (4) is the so-called nonlinear ARDL model and nonlinearity comes through the partial sum or cumulative sum process of generating the two new variables POS and NEG. Shin et al. (2013) made a clear justification to apply Pesaran et al.'s (2001) bounds testing approach to model (4).

3. Results

In this section, we present the findings of both the linear ARDL model (2) and non-linear ARDL model (4) for each of the EAC countries namely Burundi, Uganda, Kenya, Rwanda, and Tanzania. Since African countries started to liberalize their economies in terms of free exchange rate and trade openness in the early 1990s, the study utilizes quarterly data from the first quarter (Q1) of 1990 to the fourth quarter (Q4) of 2019. For any missing quarterly data from any country, we used the interpolation method by Denton (1971) as the best technique to generate data from a lower frequency (annual data) to a higher frequency (quarterly data). The method is widely recommended by IMF as it is relatively simple, robust, and well-suited for large-scale applications . Since the interpolation process occurred with transient movement at the beginning of the interpolated series, reviews 10 software uses Cholette's (1984) modification of Denton's original method to remove such problem (Chen, Di Fonzo, Howells & Marini, 2014).

Given our sample size, the maximum lag set is eight, with Akaike's Information Criterion (AIC), used as a criterion for model selection. Meanwhile, all results presented in Table 1 are obtained from the optimum model selected. All estimates with their diagnostics test results for linear ARDL labeled L-ARDL and non-linear ARDL labeled N-ARDL are given in Table 1. To have a clear understanding, the results were categorized into three separate panels; panel A constitutes short-run estimates, panel B presents long-run estimates and panel C on diagnostics tests. As commonly practiced, the results of the statistical interpretation were denoted as (*) and (**) statistical significant at 10 and 5 percent respectively. A stability test is also important to ensure that our selected model is stable at a given period. The CUSUM and CUSUMSQ tests were used to analyze the stability. The letter 'S' denotes that the model is stable, while the letter 'U' implies that the model is not stable. Before estimating the long-run effect of the exchange rate the unit root test revealed that all data are stationary after the first difference.

Moving further, an analysis of the asymmetric effect of exchange rate on trade balance using NARDL is also presented in Table 1 for all five countries. Similarly, the results remain only significant both in the short and long run in Uganda while others are insignificant. This can be attributed to the fact that the volume of imports and export do not respond adequately to changes in the exchange rate and inelastic demand of trade flows in EAC members. Comparing the results of linear and non-linear effects in Uganda in the short and long run, both symmetric and asymmetric (depreciation or appreciation) have negative effects on trade balances. This implies that the monetary policy of Uganda attached to exchange rate control has to be implemented with great caution.

This can be claimed due to the inelastic import demands of the Ugandan economy while its export still relies on agricultural products and raw materials which are vulnerable to higher risks of price fluctuation. For the control variables, World (foreign) income has a positive significant effect on trade balances in Kenya and Uganda for the short-run period, while in the long run, the effect remains positive only in Uganda. However, the effect of world income has a negative effect on the trade balances of Kenya and Tanzania in the long run, implying as world income grows, imports of Kenya and Tanzania also grow contrary to our expectations. For domestic income, the effect is insignificant in all countries both in the short and long run.

				1. Rwanda					
Lags	0	1	2	3	4	5	6	7	8
$\Delta LnTB$		-0.075 (0.00)*	-0.26 (0.00)*	-0.26 (0.00)*	-0.63 (0.01)*	-0.92 (0.00)*	-0.66 (0.08)*	0.55 (0.06)*	
ΔLnY	0.00(0.99)								
$\Delta LnYW$	0.73 (0.23)	-0.09 (0.41)	0.17 (0.89)	-0.57 (0.26)	0.47 (0.00)	-0.04 (0.00)			
$\Delta LnREFX$		-0.304 (0.85)							
Panel B:	**Long-run estimates**								
	Constant	ΔLnY	$\Delta LnYW$	$\Delta LnREFX$					
	-77.13	0.01(0.99)	0.03(0.01)*	0.35(0.86)					
Panel C:	**Diagnostic test statistics**								
	F	ECM_{t-1}	LM	RESET	CUSM	CUSM^2	R^2		
	10.16*	-0.01(0.00)	2.52	0.14	S	S	0.62		
Section II:	**Full information estimates of non-linear ARDL model (8)**								
Panel A	**Short-run estimates**								
$\Delta LnTB$									
ΔLnY	1.39(0.12)								
$\Delta LnYW$	-0.9(0.4)								
ΔPOS	-0.51(0.12)								
ΔNEG	-0.62(0.14)								
Panel B	**Long-run estimates**								
	Constant	ΔLnY	$\Delta LnYW$	ΔPOS	ΔNEG				
	-0.02(0.0)*	0.08(0.2)	-0.44(0.2)	-0.41(0.23)	-0.16(0.2)				
Panel C:	**Diagnostic test**								
	F	ECM_{t-1}	LM	RESET	CUSM	CUSM^2	R^2		
	12.92*	-0.01	5.52	0.51	S	S	0.75		

Table 1

Symmetric and Asymmetric effects of exchange rate changes on the trade balance

2.Kenya

Lags	0	1	2	3	4	5	6	7	8
$\Delta LnTB$		-0.98(0.01)*							
ΔLnY	-1.93 (0.18)								
$\Delta LnYW$	6.86 (0.18)								
$\Delta LnREFX$	-1.17 (0.26)								

Panel B:	Long-run estimates						
	Constant	ΔLnY	$\Delta LnYW$	$\Delta LnREFX$			
	-84.83	-1.96 (0.18)	6.95 (0.10)**	-1.19 (0.26)			
Panel C:	Diagnostic test statistics						
	F	ECM_{t-1}	LM	RESET	CUSM	CUSM^2	R^2
	26.01	-0.0(0.01)	5.2	0.25	S	S	0.8
Section II:	**Full information estimates of nonlinear ARDL model (8)**						
Panel A	**Short-run estimates**						
$\Delta LnTB$		-1.3(0.02)					
ΔLnY		0.04(0.3)					
$\Delta LnYW$		0.21(0.02)*					
ΔPOS		0.7(0.2)					
ΔNEG		-0.21(0.3)					
Panel B:	**Long-run estimates**						
	Constant	ΔLnY	$\Delta LnYW$	ΔPOS	ΔNEG		
	319.12(0.00)*	-0.72(0.12)	-0.21(0.01)*	0.55(0.21)	-0.21(0.2)		
Panel C:	**Diagnostic test statistics**						
	F	ECM_{t-1}	LM	RESET	CUSM	CUSM^2	R^2
	14	-0.01(0.0)*	6.9	3.5	S	S	0.8

3.Uganda

Lags	0	1	2	3	4	5	6	7	8
$\Delta LnTB$		-0.92(0.01)*							
ΔLnY	-0.28 (0.00)*								
$\Delta LnYW$	0.14 (0.03)*								
$\Delta LnREFX$	-3.30 (0.02)*								

Panel B:	**Long-run estimates**			
	Constant	ΔLnY	$\Delta LnYW$	$\Delta LnREFX$
	-167.90	-0.30 (0.00)	0.14 (0.03*)	-0.35* (0.02)

Panel C:	**Diagnostic test statistics**						
	F	ECM_{t-1}	LM	RESET	CUSM	CUSM^2	R^2
	23.27	-0.0(0.0)*	2.52	3.4	S	S	0.8
Section II:	**Full information estimates of nonlinear ARDL model (8)**						
$\Delta LnTB$		-2.76(0.01)*					
ΔLnY		-75.49(0.21)					
$\Delta LnYW$		34.49(0.01)*					
ΔPOS	-0.3(0.20)*						
ΔNEG	-2.91(0.01)						
Panel B	**Long-run estimates**						
	Constant	ΔLnY	$\Delta LnYW$	ΔPOS	ΔNEG		
	0.56(0.01)*	-0.35(0.11)	0.24(0.01)*	-0.13(0.01)*	-0.05(0.0)*		
Panel C	**Diagnostics test statistics**						
	F	ECM	LM	RESET	CUSM	CUSM^2	R^2
	14	-0.1(0.01)*	5.35	5.25	S	S	0.

				4. Tanzania					
Lags	0	1	2	3	4	5	6	7	8
$\Delta LnTB$		-0.08	-0.13	-0.26	0.22	-0.19	-0.10	-0.06	0.21
		(0.35)	(0.12)	(0.00)*	(0.02)*	(0.01)*	(0.17)	(0.34)	(0.0)*
ΔLnY	-13.70	0.09	-0.86	0.33	0.20	-0.17	0.05	0.01	-0.07
	(0.63)	(0.01)*	(0.04)*	(0.56)	(0.06)*	(0.00)*	(0.00)*	(0.15)	(0.11)
$\Delta LnYW$	0.56	-0.17	0.35						
	(0.00)*	(0.00)*	(0.00)*						
$\Delta LnREFX$	-0.01	0.41	-0.07	0.02	-0.22	-0.02	0.08		
	(0.00)	(0.00)*	(0.00)*	(0.20)	(0.99)	(0.10)**	(0.00)*		
Panel B:	**Long-run estimates**								
	Constant	ΔLnY	$\Delta LnYW$	$\Delta LnREFX$					
	-124.92	-0.42	0.17	-0.90					
	(0.06)	(0.00)*	(0.01)*	(0.39)					
Panel C:	**Diagnostic test statistics**								
	F	ECM_{t-1}	LM	RESET	CUSM	CUSM^2	R^2		
	6.42	0.01(0.00)*	5.97	-0.14(1)	S	S	0.8		
Section II:	**Full information estimates of nonlinear ARDL model (8)**								
$\Delta LnTB$	-0.01(0.0)*								
ΔLnY	-0.11(0.1)								
$\Delta LnYW$	-0.21(0.23)								
ΔPOS	-0.51(0.11)								
ΔNEG	-0.31(0.21)								

Panel B	**Long-run estimates**						
	Constant	ΔLnY	$\Delta LnYW$	ΔPOS	ΔNEG		
	100	-0.03(0.12)	-0.1(0.01)*	-0.1(0.12)	-0.25(0.1)		
Panel C:	**Diagnostic test statistics**						
	F	ECM_{t-1}	LM	RESET	CUSM	CUSM^2	R^2
	12	-0.2(0.01)*	2.5	0.14	S	S	0.80

				5.Burundi					
Lags	0	1	2	3	4	5	6	7	8
$\Delta LnTB$		-0.87(0.0)*							
ΔLnY	-0.04(0.02)*								
$\Delta LnYW$	0.02(0.23)								
$\Delta LnREFX$	0.03(0.23)								
Panel B:	**Long-run estimates**								
	Constant	ΔLnY	$\Delta LnYW$	$\Delta LnREFX$					
	-100.02(0.0)*	-0.04(0.0)*	0.01(0.3)	0.04(0.21)					
Panel C:	**Diagnostic test statistics**								
	F	ECM_{t-1}	LM	RESET	CUSM	CUSM^2	R^2		
	12.5	-0.01(0.0)*	5.25	2.5	S	S	0.8		
Section II:	**Full information estimates of nonlinear ARDL model (8)**								
Panel A	**Short-run estimates**								
$\Delta LnTB$		-0.81(0.0)*							
ΔLnY	-1.97(0.2)								
$\Delta LnYW$	0.09(0.28)								
ΔPOS	-0.05(0.8)								
ΔNEG	-0.08(0.7)								
Panel A	**Long-run estimates**								
	Constant	ΔLnY	$\Delta LnYW$	ΔPOS	ΔNEG				
	-100.2(0.3)	-0.73(0.1)	5.52(0.01)*	-1.1(0.7)	-0.0(0.8)				
Panel C	**Diagnostic test statistics**								
	F	ECM_{t-1}	LM	RESET	CUSM	CUSM^2	R^2		
	10.2	0.01(0.01)*	2.5	2.53	S	S	0.8		

4. Discussion

Panel A (Table 1) suggests that among EAC members, only Uganda and Tanzania have a real exchange rate of at least one significant (at a 5 percent level of significance) short-run negative coefficient. However, for Uganda, both short and long-run coefficients of exchange rates were negative and significant. In most cases, these results support the views of Bahmani-Oskoee and Gelan (2012) who also found the absence of J-curve in Kenya and Burundi, and other African countries. The significant negative coefficient attached to the exchange rate at lower lag followed by the significant positive coefficient at higher lag is only evidenced in Tanzania, which implies traditional 'J-curve' phenomena. These results somehow contradict those suggested in Bahmani-Oskoee and Gelan (2012) who found no J-curve exists in Tanzania.

Considering, the new definition of the J-curve according to Rose and Yellen (1989), none of the cases for exchange rate were positive and significant in the long run, which implies J-curve does not exist. The results are aligning with Rose and Yellen (1989) and Bahmani-Oskoee and Fariditavana (2015). The significant long-run negative coefficient attached to the exchange rate exists only in the case of Uganda, implying devaluation of currency worsens its trade balance. The cointegration results are only meaningful for F-test or ECMt-1 is significant. Looking at the F-test results, it is greater than its upper bound critical value of 3.52 for four countries out of five, which implies cointegration is meaningful to all EAC members except Kenya.

However, when using the other technique of lagged error correction term ECMt-1 for the previous insignificant F-test for Kenya, the result was negatively significant, which implies the cointegration is meaningful and supports adjustment towards equilibrium in all countries. For the control variables, both in the short and long run, world (foreign) income improves trade balances in Uganda and Tanzania as expected. Also, for domestic income, it has a negative significant effect as expected both in the short and long run in Burundi, Uganda, and Tanzania, which implies that as domestic income increase deteriorates trade balance of member countries. The negative effect of domestic income is also consistent with Bahmani–Oskoeeet al (2018) for China, South Africa, and Russia. This suggests that these countries have to adopt an import substitution policy to favor their domestic production. Panel C presents the results of diagnostics statistics whereby all countries passed the selected diagnostics tests. The stability test of CUSUM and CUSUM SQ both imply that the model is stable in all countries which are indicated by the letter 'S'.

5. Conclusion

The results from LARDL suggest that among the EAC members only Uganda and Tanzania carry a real exchange rate of at least one significant (at a 5 percent level of significance). The short-run negative coefficient, signifying the evidence of J-curve, is only found in Tanzania. As for Uganda, both short and long-run coefficients of exchange rates were negative and significant.

For the control variables, both in the short and long run, world (foreign) income improve trade balances only in Uganda and Tanzania. Also, domestic income has a negative significant effect both in the short and long run in Burundi, Uganda, and Tanzania. This implies that these countries have to adopt an import substitution policy to favor their domestic production. Similarly, the result from NARDL shows that the effect of the exchange rate remains negative and only significant both in the short and long run in Uganda while others were insignificant.

Comparing the results of linear and nonlinear effects in Uganda for the short and long run, both symmetric and asymmetric (depreciation or appreciation) effect have negative effects on trade balances. This implies that the monetary policy of Uganda attached to exchange rate control has to be implemented with great caution. Once again, it seems monetary policy attached to the exchange rate does not influence the trade balance of EAC members.

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