Real Exchange Rate Misalignments in Tanzania

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Bank of Tanzania

2019

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Abstract

The study uses a real exchange rate equilibrium (REER) technique to examine real exchange rate misalignments in Tanzania, through the cointegration technique. The empirical findings reveal that the real exchange rate misalignment has decreased significantly over recent years, and the real effective exchange rate has been evolving close to the long-term equilibrium. The findings strongly suggest that the underlying monetary and exchange rate policies were crucial in bringing the real exchange rate back to equilibrium in line with medium-term fundamentals recently. As a result, it is suggested that the existing monetary and exchange rate policies be maintained. While the monetary policy will contribute to real exchange rate stability through low inflation, flexible exchange rate policy will contribute to real exchange rate stability through nominal exchange rate adjustment.

Keywords: Foreign Exchange, Foreign Exchange Policy

JEL: F31, O24

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[1] The author(s)' opinions in this article are exclusively their own and do not necessarily reflect the Bank of Tanzania's position.

1.0 Background

The growing body of evidence about the role of the exchange rate as a crucial macroeconomic adjustment mechanism has increasingly stimulated analyses of the behaviour of the real exchange rate in many developing countries. This evidence is strongly rooted in both theoretical and empirical studies (Rodrik (2008), Hausmann et al. (2004), Abida (2010), Prasad, Rajan and Subramanian (2007) and Levy-Yeyati and Strzenegger (2007 among others). One of the key implications emerging from this literature is the notion of real exchange rate misalignment or the extent real exchange rate has diverged from its benchmark or equilibrium level. Many studies agree that correcting real exchange rate misalignment is one of the most critical prerequisites for enhancing economic performance and macroeconomic stability[2]. Real exchange rate misalignment may increase economic instability and distort investment decisions which result in welfare and efficiency costs. Furthermore, real exchange rate misalignment, particularly overvaluation, harms exports and GDP growth. The misalignments can also encourage capital flight with substantial welfare costs (Berg and Miao (2010), Eichengreen (2008)). In the export-led growth literature, there is a common view that links depreciation in the real exchange rate and economic growth with manufacturing (tradable sector) as the main operational channel (Rodrik (2008), Hausmann, Pritchet and Rodrik (2004)).

Knowledge about the extent real exchange rate is misaligned is thus of key interest to practitioners and researchers alike. The objective of the study is to derive (estimate) real exchange rate misalignments in Tanzania over the recent years to understand how the real exchange rate has responded to the ongoing macroeconomic and structural policies. Examining if a country's exchange rate is close to its equilibrium value also aids in determining future adjustment requirements and likely trajectories of economic fundamentals. The analysis in this study is extended to the recent years and therefore adds to the discussion about whether the

[2] See for example Abida (2010) and Atasoy et al. (2006).

concerns regarding current trends in the nominal exchange rates between Tanzania shilling and major foreign currencies are justified. The paper is organized as follows.

The next section provides a brief discussion of macroeconomic development in Tanzania, featuring in particular economic growth, current account, inflation and fiscal balance. Section 3 delves into theoretical and empirical literature on the determination of equilibrium real exchange rate. Section 4 provides the analytical methodology focusing on econometric frameworks for estimating the equilibrium real exchange rate and real exchange misalignments. Section five concludes by summarizing the findings and policy implications.

2.0 Macroeconomic Development

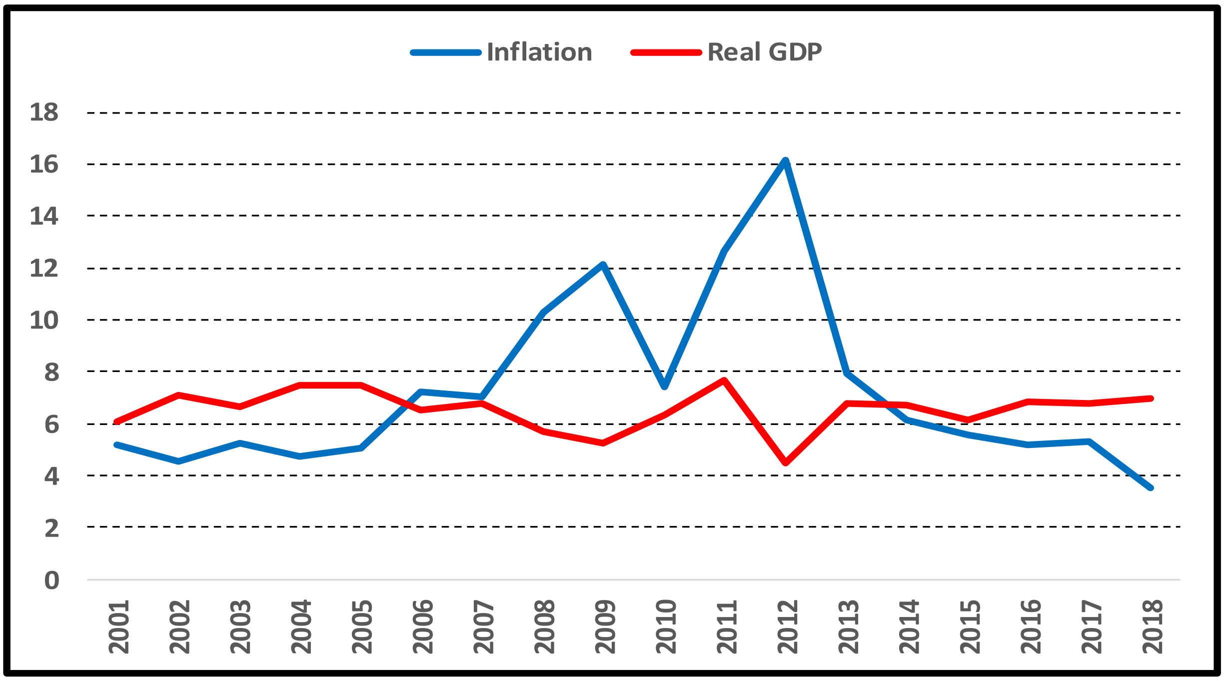
Tanzania has continued to experience strong macroeconomic performance thanks to prudent macroeconomic and structural policies whose implementation has been accelerated over the recent years. The economy sustained high economic growth, recording about an annual average growth of 7 percent in real domestic product for a decade before the onset of the COVID-19 pandemic which slowed the momentum to 4.2 percent (Figure 2.1).

Price stability has remained resilient, with average headline inflation being maintained within a single-digit during the past 10 years. Indeed, during the past 5 years, average headline inflation has been maintained below 5 percent. Development in the real exchange rate has reflected the underlying policy regime in particular exchange rate policy which has been determined by conditions in the foreign exchange markets. The behaviour of the real effective exchange rate has shown a significant degree of flexibility, with a record of some moderate depreciation over the recent years.

Fiscal performance has improved notably. For example, over the recent years, the fiscal deficit was well anchored below 5.0 percent of GDP (Figure 2.2). Efficiency in tax management and rationalization of government expenditure has been enhanced; with revenue mobilization measures being dedicated to meeting the county’s large developmental needs including infrastructure, investment in education as well as improvement in health services as stipulated in the five-year development plan and development vision 2025[3].

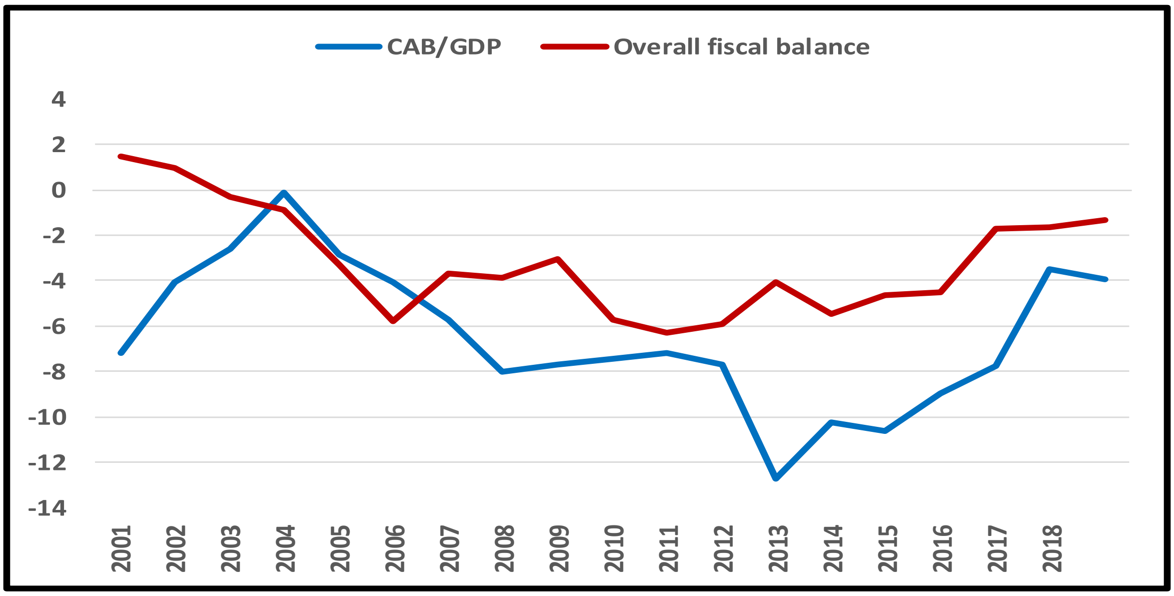
Current account development continued to mirror the inter-temporal pattern whereby today's current account balance reflects future current account surpluses arising from savings and investments that are being committed today. In this sense, the current account deficit realised today should not be necessarily construed as bad for the economy if that deficit is being financed by inflows of productive/investment resources. The widening of the current account has remained notable reflecting the rising of imports especially capital goods required for investment in various sectors including manufacturing, building and construction, and mining among others. The trend in the current account has also been attributed to external factors including terms of trade, the spike in international commodity prices, and supply and demand imbalances. Over the horizon, the internal and external balance trend has also been affected by intermittent global shocks including Great Financial Crisis (GFC), European Debt Crisis (EDC), the COVID-19 pandemic, and more recently Russia-Ukraine war.

Figure 2.1: Trend of inflation and GDP growth (right-hand scale)



[3] see TZA 1999 National Development Vision 2025

Figure 2.2: Trend of current account balance and fiscal balance



3.0 Literature review

3.1 Theoretical literature

Theoretical research on the determination of the real exchange rate has exploded in recent years. Edward (1989) posits a three-good economy (exports, imports, and nontraded items), a dual exchange rate system (fixed for trade transactions and flexible for financial transactions), and a demand for both local and foreign currency holdings. Under the steady-state, the real exchange rate is in equilibrium and based on the solution of the model, the real exchange rate is determined by the fundamental variables including tariff rates, terms of trade, capital flows and government consumption.

A study by Elbadawi (1994) extended Edwards (1989) and replaces tariff rates with a variable for trade openness arguing that this takes into account implicit trade restrictions such as quotas and exchange rate controls. The model predicts that the real exchange rate appreciates in face of technological progress and capital inflows. Technological progress will lead to substitution towards nontraded goods and thus lead to an increase in their price which in turn result in an appreciation of the real exchange rate. Likewise, a higher level of capital flows implies greater total assets, leading to an increase in aggregate demand which leads to pressure on the prices of non-traded goods. As noted by Atasoy and

Saxena (2006) technological progress will be associated with higher productivity growth in the traded goods sector. This leads to a trade surplus and therefore appreciation in the real exchange rate.

Elbadawi (1994) goes on to say that, depending on the relative size of income and substitution effect, a deterioration of terms of trade might lead to an appreciation or depreciation of the real exchange rate. If the conditions of trade deteriorate, demand shifts to nontraded commodities, resulting in an increase in the price of nontraded items and hence an exchange rate appreciation. However, deterioration in terms of trade could also reduce demand due to the income effect which could cause an exchange rate depreciation.

If the increase in government consumption is more related to non-traded goods, there will be an increase in the price of nontraded goods and lead to real exchange appreciation. Nonetheless, if government consumption is directed towards traded goods real exchange rate will depreciate.

Lastly, the increase in investment could cause a rise in the aggregate demand (similar to capital flows) leading to an increase in the price of non-traded goods hence resulting in an appreciation of the real exchange rate. Nevertheless, as Atasoy and Saxen (2006) note, there could be a supply-side effect which reduces prices in the affected sectors. If those sectors include the non-traded goods sector, it would result in real exchange rate appreciation.

The study by Nassif, Feijo and Araujo (2011) develop a Keynesian theoretical approach to the determination of real exchange rates for emerging economies. Instead of macroeconomic fundamentals, the long-run real exchange rate is modelled to be determined not only by structural dynamics and long-run policies but by both short-term macroeconomic policies and their indirect effect on other short-term economic variables. In this study, the actual real exchange rate is broken down into long-term and short-term components, both of which may be responsible for the deviations of the real exchange rate from its equilibrium path.

Villavicencio and Bara (2008) explore the real exchange rate behaviour in Mexico from 1960 until 2005 by developing a simple model of real exchange rate determination. The study indicates that the equilibrium real exchange rate is driven by relative GDP per capita, the real interest rates, and the net foreign assets.

Litsios and Pilbeam (2017) develop a model of real exchange rate determination focusing on different assets, including domestic and foreign bonds, domestic and foreign equities and domestic and foreign real money balances. The study found that financial assets play a significant role in the determination of the real exchange rate

3.2 Empirical literature

Three main strands of empirical literature for measuring real exchange rate misalignments exist (IMF (2006). These are the macroeconomic balance approach, external sustainability approach and behavioural equilibrium real exchange approach.

The medium-term macroeconomic balance framework examines the extent to which current exchange rates and policies are consistent with simultaneous internal and external equilibrium (IMF, 2006). The macroeconomic balance procedure (Bussiere, M., et al., 2004) is based on three phases. Estimating the equilibrium connection between current account balances and a set of fundamentals is the initial step. The current account norm is derived in the second stage based on the estimated relationship and medium-term predicted values of fundamentals. The needed exchange rate adjustment is determined in the third step to bridge the difference between the current account norm and the true current account balance. Current account norm is typically based on equilibrium solution to macroeconomic model and there is a large literature on potential factors that can influence the dynamics of current account including demographics, government fiscal policy, terms of trade, productivity, catching-up potential, trade openness, as well as institutional characteristics, among others (Bussiere et al. 2004). One key element to note is that the current account is related to the difference between domestic savings and investment via an accounting identity. The intertemporal character of the current account and the significance of consumption smoothing are highlighted in this identity (Rogoff, 1996). This method has the consequence that a current account deficit does not always imply an imbalance. It makes sense for a developing economy to borrow against its future earnings, hence the current account norm should not be zero.

The external sustainability approach belongs to the same thinking as in macroeconomic balance methodology, only that the way current account norm is derived differs (Lee et al. (2008)). In this approach, instead of being estimated using an econometric model, current account norms are determined using accounting principles to assure external debt sustainability. In addition to standard accounting identities, few assumptions are necessary for deriving current account norms using this approach. These include assumptions about the potential growth of the economy, inflation developments, and steady-state level of net foreign assets. Underlying external sustainability is an intertemporal budget constraint which requires that the present value of future primary (trade) surpluses is sufficient to pay for the country's outstanding external liabilities. In principle, to satisfy this constraint the country needs to ensure that the size of net foreign assets is stabilized relative to the size of the economy, and therefore avoid the building-up of assets or liabilities without bound,[4]

The behavioural equilibrium real exchange rate approach focuses on directly estimating a reduced form equilibrium real exchange rate using its long-run determinants (IMF (2006)). The approach consists of two main stages (Chin and Prasad (2003)). The first stage estimates a reduced-form relationship between the real exchange rate and a set of economic fundamentals using the econometric technique. This stage is mostly statistical although economic theory helps guide the choice of fundamentals and assessing the plausibility of the results. The second stage involves deriving the equilibrium level for the real exchange rate from this estimated relationship.

4.0 Analytical methodology

[4] See for example Bussiere, et. al (2009).

The real exchange rate misalignments, which is the deviation of the real exchange rate from its long-run equilibrium path can either be overvaluation or undervaluation (Wong, et al. (2011)). Overvaluation implies that the value of the currency is greater than its equilibrium and undervaluation means that the value of the currency is less than its equilibrium. Thus, to analyse the misalignments, the long-run equilibrium real exchange rate needs to be estimated and then assessed to the extent the actual real exchange rate has deviated from its equilibrium path over time. Following IMF (2006) Edwards (1989), Elbadawi (1996), and Sichei (2006) among others, this study employs a behavioural equilibrium real exchange rate approach to estimate real exchange rate misalignments for Tanzania.

4.1 Behavioural Equilibrium Real Exchange Rate Approach

This method has been widely used to estimate equilibrium real exchange rates in a variety of countries, including the IMF (2006) for member countries, Feyzio (1997) for Finland, Mkenda (2001) for Zambia, MacDonald and Ricci (2003) for South Africa, Mathisen (2003) for Malawi, and Eita and Sichei (2006) for Namibia.

This focuses on a single equation model of the real effective exchange rate as a function of medium-term economic determinants identified in Edward (op. cit.) and Elbadawi (op. cit.). These determinants have also been used by several econometric studies (Feyzio (1997), Mkenda (2001), MacDonald and Ricci (2003), Mathisen (2003) Eita and Sichei (2006). These determinants include relative productivity (PROD), commodity terms of trade (TOT), government expenditure (GOV), trade openness (OPEN) and net foreign assets (NFA). The specific role of these determinants to the model has been discussed in the theoretical section above. Given these determinants, the functional form of real effective exchange rate is given by:

$$REER = F(TOT, OPEN, GOV, PROD, NFA) \quad (1)$$

The co-integrating technique is used to investigate the relationship between the real exchange rate and its fundamentals. The advantage of this methodology is that the relationship that is found will hold in the long run. Following (Johansen (1988, 1991) and Johansen and Juselius (1990) the long-run relationship between the exchange effective rate and the fundamentals is defined as follows:

$$e_t = x_t{}' \beta + \omega_t \qquad (2)$$

Where e_t is the real effective exchange rate, x_t is the vector of fundamentals, β is the vector of cointegrating coefficients and z_t is the error term. If the exchange rate and variables are considered to be in equilibrium, then they should not deviate from each other too much for too long. This means that the error z_t should be stationary. The exchange rate that is predicted from this equation is the long-run equilibrium rate that is defined by the fundamentals at each period t.

The short-run dynamics consistent with the long-run equilibrium are modelled as an error correction mechanism (ECM):

$$\Delta e_t = \alpha z_{t-1} + \sum_{i=1}^{p} \gamma \Delta e_{t-i} + \sum_{i=0}^{q} \delta \Delta x_{t-i} + \sum_{i=0}^{s} \theta \Delta w_{t-1} + \varepsilon_t \qquad (3)$$

Here the change in the exchange rate is affected by its past changes, and by changes in the fundamentals and other short-run variables, w_t. If for instance the exchange rate in the last period was overvalued relative to the fundamentals, then z_{t-1} is positive. In this period the exchange rate corrects itself by an amount dictated by α .

4.1.2 Estimation

Estimation of the long-run and the short-run relationship between the real exchange rate and its determinants is undertaken in the context of the Autoregressive Distributed Lag Model (ARDL). According to Pesaran and Pesaran (1997), the ARDL method has many advantages compared to other methods of estimating cointegrating relationships. First, it can be applied for a small sample size as for the case of this study unlike other methods, secondly, it can simultaneously estimate the short-run and long-run dynamics of the model, thirdly it can be used with a mixture of I(0) and I(1) data and lastly it allows a possibility that different variables to have the different optimal number of lags. In the model, the long-run elasticities underpin the cointegration relationship while the short-run parameters are related to short-run dynamics.

Based on the ARDL model of order (2, 4, 1, 3, 5, 3) as selected through the AIC, both the short-run and the long-run parameter estimates of the real effective exchange rate model are obtained. The long-run elasticities obtained from the ARDL model are reported in **Table 4.4**. The signs of the estimated long-run coefficients appear to be in line with theoretical postulations.

In particular, coefficients related to terms of trade and degree of trade openness are negative and significant indicating that improvement of these variables tends to depreciate the real exchange rate. The coefficient of government spending is positive and significant, signifying that an increase in government expenditure appreciates the real exchange rate. This particular result confirms that much of the government expenditure was directed towards non-tradable.

Although the coefficients of productivity[5] and net foreign assets appear to have the expected signs, they are statically insignificant. The coefficient of adjustment (see **Annex 3**) of -0.39 indicates that approximately 39 percent of the misalignment of the previous year adjusts back to the long-run equilibrium in the current year. Following the estimations, the behavioural real effective exchange rates (BEER) are derived using the estimated long-run elasticities and the economic fundamentals specified in the model.

Following MacDonald and Ricci (2003) we use Hodrick-Prescott (HP)[6] filter, to capture the permanent components of this series which give us the equilibrium real exchange rate. Both BEER and PEER are reported in **Chart 4.5**.

Table 4.4: Long-run Elasticities

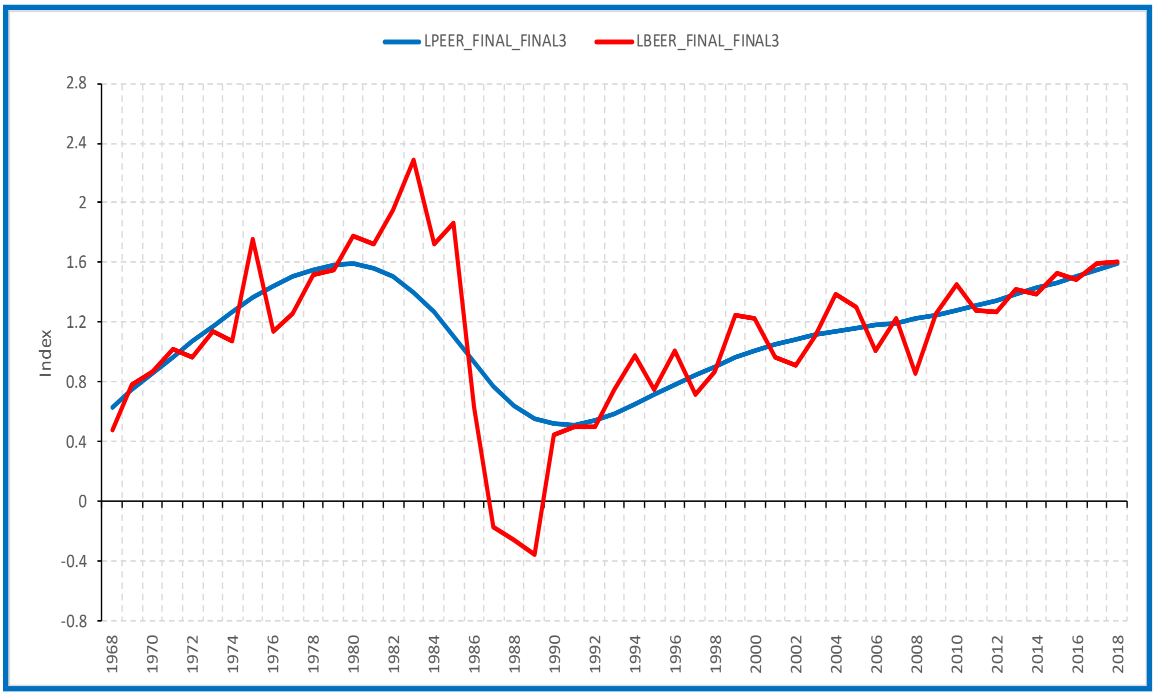
Levels Equation

[5] Balassa and Samuelson (*op.cit.*).

[6] Hodrick, R obert and Edward Prescott (1997)

Case 5: Unrestricted Constant and Unrestricted Trend				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
LTOT	-1.173454	0.316257	-3.710445	0.0015
LPROD	0.339306	0.277798	1.221414	0.2369
LOPEN	-0.916447	0.111043	-8.253107	0.0000
LGOV	1.521733	0.339267	4.485357	0.0003
LNFA	0.073837	0.155893	0.473637	0.6412

Chart 4.5: Behavioural and Permanent Real Effective Exchange Rate

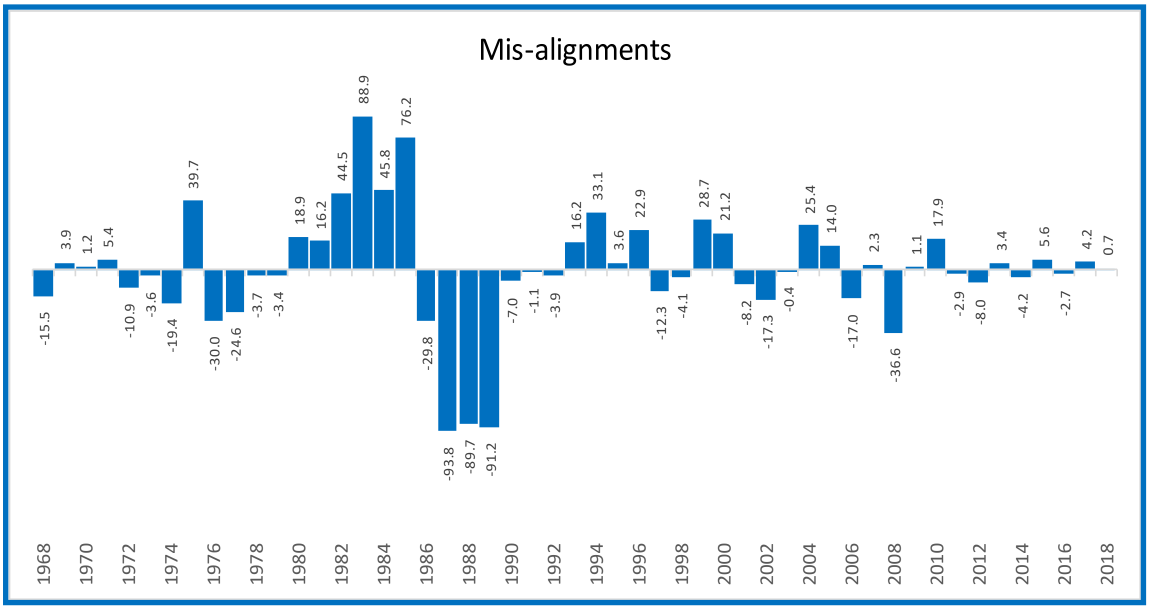


4.1.3 Real exchange rate and misalignments

The real exchange rate misalignments are derived by comparing the behavioural and permanent real effective exchange rates using the following formula: RER misalignment =((BEER-PEER)/PEER) *100. Based on the analysis, the currency is overvalued if the value of the misalignment is positive and undervalued if the value of the misalignment is negative. The results of misalignment are depicted in **Chart 4.6.**

The estimations offered chequered results reflecting a mixture of overvaluation and undervaluation. Overall, the real effective exchange rate has evolved towards stability and over the recent years (2015-18) it has been broadly in line with its long-run equilibrium. This development broadly reflects the increasing pace in the implementation of prudent macroeconomic and structural policies that are currently in place.

Chart 4.6: Real Exchange Rate Misalignments



5.0 Conclusion and Policy Implication

This study has conducted the assessment of real exchange rate misalignments in Tanzania using the real exchange rate equilibrium (REER) approach and focusing on cointegration empirical analysis. In this approach, the equilibrium real exchange rate is estimated as a function of medium-term fundamentals that includes commodity terms of trade, relative factor productivity, government spending, degree of trade openness and net foreign assets. The misalignments were then obtained as deviations of the equilibrium real exchange rate from its current value.

The empirical results show that over the recent years the real exchange rate misalignment has declined substantially, and the real effective exchange rate has remained almost in line with the long-run equilibrium.

These results strongly confirm that the underlying monetary and exchange rate policies have played a critical role in the recent adjustment of the real exchange rate to the equilibrium level in line with the medium-term fundamentals. Accordingly, it is recommended to sustain the strengthening of the current monetary and exchange rate policies. Whilst, monetary policy will enhance stability in the real exchange rate through a low inflation mechanism, the flexible exchange rate policy will contribute to the stability of the real exchange rate through adjustment of the nominal exchange rate.

In addition, it is imperative to continue with the current efforts of improving structural conditions which include among others liberalization of the capital account, enhancing trade liberalization through engagements in regional integrations, and deepening industrialization to create value addition of exports. This latter measure is critical to mitigating the shocks arising in the global markets.

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Annex

(i) Data source and definition

The dependent variable is the CPI-based multilateral real effective exchange rate (REER). The real effective exchange rate is constructed as the trade-weighted average of the real exchange rate. Data for the real exchange rate are from countries' central banks and the IMF. The commodity terms of trade is defined as the export price index to the import price index. Data on this variable are drawn from the World Bank database. Relative productivity is computed as a ratio of GNP per worker for Tanzania relative to the average GNP per worker for the OECD countries. In particular, using data on the labour force from Global Development Finance and GNP from the IMF, the ratio of GNP to the labour force is computed to get data on GNP per worker for Tanzania. The same method is applied to obtain GNP per worker for the OECD countries. The government spending variable is measured as the ratio of government spending to nominal GDP and is drawn from the IMF's International Financial Statistics (IFS) database. The degree of openness is computed as the ratio of the sum of exports and imports to the nominal gross domestic product (GDP). Data on exports, imports and GDP are from the IMF's International Financial Statistics database. The variable net foreign assets is defined as total foreign assets (less official gold holding) minus total liabilities to foreigners and are drawn from the IMF's International Financial Statics (IFS) database. The variable net foreign assets is scaled by nominal values of the GDP. To take into account developments that may generate structural breaks, dummy variables were included in the model. All variables are in logs.

Descriptive statistics of all variables are described in **Table 1.1**.

Table 1.1 Summary Statistics

	REER	TOT	PROD	OPEN	GOV	NFA
Mean	176.3885	0.970871	0.341530	32.47205	18.49966	6.749475
Median	139.9559	0.972041	0.330852	32.92230	17.79770	8.035171
Maximum	483.8679	1.602216	0.501630	51.26297	31.53437	15.62027
Minimum	93.64725	0.672467	0.182332	15.79967	8.973275	-8.891348
Std. Dev.	88.13992	0.237052	0.084153	10.22524	5.948622	5.707841
Skewness	1.587536	0.498162	0.256377	-0.077681	0.327242	-0.928947
Kurtosis	5.266375	2.488897	2.011008	1.790751	2.209316	3.678913
Jarque-Bera	32.33727	2.664509	2.637169	3.158644	2.238753	8.314469
Probability	0.000000	0.263882	0.267514	0.206115	0.326483	0.015651
Sum	8995.812	49.51443	17.41802	1656.074	943.4827	344.2232
Sum Sq. Dev.	388432.3	2.809682	0.354088	5227.781	1769.305	1628.973
Observations	51	51	51	51	51	51

(ii) Stationarity

Co-integration analysis requires a non-stationary time series of the same order of integration. We use several unit root tests including Philip and Perron (PP) Augmented Dickey-Fuller (ADF). The results of this test are reported in Table 1.1. The PP test shows that all variables have unit roots in levels except for net foreign assets. However, the variables become stationary after the first difference, indicating that the variables are integrated of order one (I(1)). The PP test was complemented by Augmented Dickey-Fuller (ADF) test. The findings of this test are reported in Table 1.2. Findings of this test also indicate that the variables are I(1). These variations in the order of integration among variables provide support for the use of the ARDL model[7].

[7] Pesaran and Pesaran (*op.cit.*)

Table 1.2: Unit Root Test (Phillips Peron)

Null Hypothesis: The variable has a unit root							
				At Level			
		LTOT	**LPROD**	**LREER**	**LOPEN**	**LGOV**	**LNFA**
With Constant	t-Statistic	-1.9951	-1.5071	-1.6292	-2.1710	-1.7970	-5.1450
	Prob.	**0.2880**	**0.5219**	**0.4605**	**0.2191**	**0.3778**	**0.0001**
		No	**No**	**No**	**No**	**No**	***
With Constant & Trend	t-Statistic	-2.9502	-1.7693	-2.2506	-2.2676	-2.0507	-5.4276
	Prob.	**0.1563**	**0.7046**	**0.4521**	**0.4431**	**0.5598**	**0.0002**
		No	**No**	**No**	**No**	**No**	***
Without Constant & Trend	t-Statistic	-1.8494	0.3360	-0.4697	-0.7090	-0.2405	-0.5251
	Prob.	**0.0618**	**0.7785**	**0.5070**	**0.4046**	**0.5946**	**0.4843**
		*	**No**	**No**	**No**	**No**	**No**
				At First Difference			
		d(LTOT)	**d(LPROD)**	**d(LREER)**	**d(LOPEN)**	**d(LGOV)**	**d(LNFA)**
With Constant	t-Statistic	-7.1097	-5.7688	-4.1182	-5.2456	-6.1125	-18.6433
	Prob.	**0.0000**	**0.0000**	**0.0021**	**0.0001**	**0.0000**	**0.0000**
		***	***	***	***	***	***
With Constant & Trend	t-Statistic	-7.0334	-5.7021	-4.0747	-5.1876	-6.0443	-18.6105
	Prob.	**0.0000**	**0.0001**	**0.0124**	**0.0005**	**0.0000**	**0.0000**
		***	***	**	***	***	***
Without Constant & Trend	t-Statistic	-7.1136	-5.7841	-4.1368	-5.2729	-6.1743	-18.8460
	Prob.	**0.0000**	**0.0000**	**0.0001**	**0.0000**	**0.0000**	**0.0000**
		***	***	***	***	***	***
Notes:							
a: Lag Length based on SIC							
b: Probability based on MacKinnon (1996) one-sided p-values.							

Source: Author's calculations from EViews

Annex 1.2: Unit root test results, ADF

Null Hypothesis: the variable has a unit root							
				At Level			
		LTOT	**LPROD**	**LREER**	**LOPEN**	**LGOV**	**LNFA**
With Constant	t-Statistic	-1.9680	-1.5071	-2.1571	-2.3394	-1.8551	-1.9319
	Prob.	**0.2996**	**0.5219**	**0.2242**	**0.1641**	**0.3503**	**0.3154**
		no	**no**	**no**	**no**	**no**	**no**
With Constant & Trend	t-Statistic	-2.7827	-1.6276	-2.8100	-2.4428	-1.9856	-2.2320
	Prob.	**0.2103**	**0.7677**	**0.2008**	**0.3540**	**0.5944**	**0.4619**
		no	**no**	**no**	**no**	**no**	**no**
Without Constant & Trend	t-Statistic	-1.7677	0.4121	-0.5747	-0.7847	-0.4135	-0.3714
	Prob.	**0.0733**	**0.7984**	**0.4633**	**0.3712**	**0.5292**	**0.5456**
		*	**no**	**no**	**no**	**no**	**no**
				At First Difference			
		d(LTOT)	**d(LPROD)**	**d(LREER)**	**d(LOPEN)**	**d(LGOV)**	**d(LNFA)**
With Constant	t-Statistic	-7.1091	-6.0515	-4.1182	-5.2660	-6.1166	-17.1819
	Prob.	**0.0000**	**0.0000**	**0.0021**	**0.0001**	**0.0000**	**0.0000**
		***	***	***	***	***	***
With Constant & Trend	t-Statistic	-7.0331	-6.0004	-4.0747	-5.2089	-6.0493	-17.0417
	Prob.	**0.0000**	**0.0000**	**0.0124**	**0.0005**	**0.0000**	**0.0000**
		***	***	**	***	***	***
Without Constant & Trend	t-Statistic	-7.1136	-5.9923	-4.1368	-5.2923	-6.1778	-17.3638
	Prob.	**0.0000**	**0.0000**	**0.0001**	**0.0000**	**0.0000**	**0.0000**

		***	***	***	***	***	***
Notes:							
Lag Length based on SIC							

Source: Author's calculations from EViews
Note: (*) Significant at the 10%; (**) Significant at the 5%; (***) Significant at the 1% and (no) Not Significant

(iii) Determination of lag length

To determine the lag length, the analysis focused on several competing estimators including Schwarz Bayesian Criterion (SC), Hanna-Quin Criterion (HQ), Akaike Information Criterion (AIC), Log-Likelihood Ratio (LR) as well as Final Prediction Error (FPE)[8]. All the estimators (AIC, LR, HQ, SC and FPE) provide different optimal lag lengths. These variations in optimal lag length provide further support for the use of ARDL which has the flexibility of choosing the appropriate lag length for each variable[9]. The results of these estimators are reported in **Table 1.3.**

Table 1.3: Lag Length Test

VAR Lag Order Selection Criteria						
Endogenous variables: LREER LTOT LPROD LOPEN LGOV LNFA						
Exogenous variables: C						
Sample: 1972 2018						
Included observations: 44						
Lag	**LogL**	**LR**	**FPE**	**AIC**	**SC**	**HQ**
0	-29.10920	NA	1.79e-07	1.494008	1.730197	1.582888
1	188.6582	370.6679	7.95e-11	-6.240774	-4.587451*	-5.618618
2	239.1855	73.10339	4.62e-11	-6.858959	-3.788501	-5.703525*
3	286.9332	56.89085*	3.44e-11*	-7.358860	-2.871268	-5.670149
4	323.1485	33.90366	5.28e-11	-7.368021*	-1.463295	-5.146033
* 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						

Source: Author's calculations from EViews

(iv) Co-integration test

[8] See for example Schwarz (1978) and Hannan and Quinn (1979).
[9] Pesaran and Pesaran (*ibid.*)

The study applies the Johansen cointegration test to establish the long-run relationship among the variables. According to trace statistic, the test indicates 6 cointegrating relations and 1 cointegration relation according to the Max-Eigen value statistic. The findings of this test are reported in **Table 4.3**.

Table 1.4: Johansen System Cointegration Test

Sample (adjusted): 1972 2015							
Included observations: 44 after adjustments							
Trend assumption: Linear deterministic trend							
Series: LREER LTOT LPROD LOPEN LGOV LNFA							
Lags interval (in first differences): 1 to 3							
Unrestricted Cointegration Rank Test (Trace)							
Trace Test					**Maximum Eigen Value Test**		
Hypothesized No. of CE(s) No. of CE(s)	**Eigenvalue**	**Trace Statistic**	**0.05 Critical Value**	**Prob.****	**Max-Eigen Statistic**	**0.05 Critical Value**	**Prob.****
None *	0.657525	140.2243	95.75366	0.0000	50.36319	40.07757	0.0025
At most 1 *	0.464769	89.86110	69.81889	0.0006	29.37766	33.87687	0.1569
At most 2 *	0.449449	60.48345	47.85613	0.0021	28.05127	27.58434	0.0436
At most 3 *	0.261015	32.43217	29.79707	0.0243	14.21642	21.13162	0.3475
At most 4 *	0.237198	18.21575	15.49471	0.0190	12.72558	14.26460	0.0863
At most 5 *	0.110248	5.490170	3.841465	0.0191	5.490170	3.841465	0.0191
Trace test indicates 6 cointegrating eqn (s) at the 0.05 level							
Max-Eigen value test indicates 1 cointegrating eqn(s) at the 0.05 level							
* denotes rejection of the hypothesis at the 0.05 level							
**MacKinnon-Haug-Michelis (1999) p-values							

Source: Author's calculations from EViews

Annex 1.5: Estimation Results

ARDL Error Correction Regression				
Dependent Variable: D(LREER)				
Selected Model: ARDL (2, 4, 1, 3, 5, 3)				
Case 5: Unrestricted Constant and Unrestricted Trend				
Included observations: 46				
ECM Regression				
Case 5: Unrestricted Constant and Unrestricted Trend				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	3.321353	0.435393	7.628394	0.0000
@TREND	-0.022805	0.003847	-5.927932	0.0000
D(LREER(-1))	0.330218	0.100929	3.271771	0.0040
D(LTOT)	-0.230825	0.088376	-2.611836	0.0171
D(LTOT(-1))	0.263061	0.119576	2.199944	0.0404
D(LTOT(-2))	-0.156448	0.091270	-1.714132	0.1028

D(LTOT(-3))	-0.151931	0.083781	-1.813438	0.0856
D(LPROD)	0.579606	0.132001	4.390905	0.0003
D(LOPEN)	-0.379744	0.068657	-5.531011	0.0000
D(LOPEN(-1))	0.368037	0.097815	3.762594	0.0013
D(LOPEN(-2))	0.275694	0.088459	3.116629	0.0057
D(LGOV)	0.335041	0.079546	4.211910	0.0005
D(LGOV(-1))	-0.793057	0.134052	-5.916061	0.0000
D(LGOV(-2))	-0.657569	0.111944	-5.874078	0.0000
D(LGOV(-3))	-0.375562	0.103356	-3.633669	0.0018
D(LGOV(-4))	-0.158863	0.072415	-2.193776	0.0409
D(LNFA)	0.106933	0.025873	4.132941	0.0006
D(LNFA(-1))	0.134902	0.036911	3.654843	0.0017
D(LNFA(-2))	0.099938	0.027591	3.622113	0.0018
D1984	0.263670	0.062786	4.199480	0.0005
D2009	-0.002981	0.044340	-0.067235	0.9471
CointEq(-1)*	-0.380427	0.096143	-7.701276	0.0000
R-squared	0.925863	Mean dependent var		-0.012244
Adjusted R-squared	0.860994	S.D. dependent var		0.150097
S.E. of regression	0.055961	Akaike info criterion		-2.622377
Sum squared resid	0.075160	Schwarz criterion		-1.747809
Log likelihood	82.31467	Hannan-Quinn criter.		-2.294759
F-statistic	14.27268	Durbin-Watson stat		2.050417
Prob(F-statistic)	0.000000			

Source: Author's calculations from EViews