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Exchange Rate Misalignment in Rwanda. Does Export Diversification Matter?

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Abstract

Export diversification is a key instrument that helps developing economies to hedge against price volatility and external shocks. Export diversification helps to reduce macroeconomic volatility, notably exchange rate misalignment by alleviating and stabilizing export revenue and domestic output. The main objective of this paper is to estimate the equilibrium fundamental exchange rate misalignment and investigate the role of export diversification in reducing real exchange rate misalignment in Rwanda. We employ quarterly data, covering the period 2000Q1-2022Q4. Building on the behavioral equilibrium exchange rate (BEER) Approach, we estimate the relationship between the real effective exchange rate and economic fundamentals using single equation cointegration-based techniques, particularly the dynamic ordinary least squares (DOLS) model. To derive the level of REER misalignment, the estimated equilibrium real exchange rate results are used, along with the Hodrick-Prescott filter to obtain sustainable levels of REER and decompose REER into their permanent and cyclical components. The main results indicate that the real effective exchange rate is in line with the economic fundamentals. Alternating episodes of undervaluation and overvaluation are identified. The obtained level of REER is not too high, and the identified episodes of undervaluation and overvaluation are not persistent to cause loss of competitiveness in the external sector. We also estimated the link between real exchange rate misalignment taken in absolute values and export diversification. The results point to the fact that export diversification reduces exchange rate misalignment in Rwanda. Accordingly, we recommend implementing policies to diversify Rwanda's export base. Greater diversification of exports would make Rwanda less vulnerable to exogenous shocks and more protected against the risks of short-term devaluation.

KeyWords: Exchange Rate Misalignment, Export Diversification, Dynamic Ordinary Least Squares.

JEL Classification Numbers: F41, F13, C22.

1. Introduction

Exchange rates are key macroeconomic prices and their variation affect economic activity, prices, interest rates, and trade flows. Over the recent past, the dynamics of the real effective exchange rates in developing and emerging countries have been characterized by large swings, strong volatility, and persistent misalignments (Carrera, et al., 2020). Significant and persistent real exchange rate misalignments, i.e. , the deviation of actual RER from its equilibrium level, indicate macroeconomic imbalances that may cause macroeconomic crises, especially when it exceeds a certain threshold level, leading to disruptive exchange rate adjustment (Kubota, 2009). For instance, currency overvaluation may have a reducing effect on economic growth, put pressure on exporter industries, particularly manufactures, which reduce export volumes and encourage imports and constrain export diversification, foster currency crises and political instability and conflict (Ambaw, et al., 2022). Therefore, policymakers and markets need to have knowledge on these currency misalignments, overvaluation or undervaluation, and what policy actions are in place to address these volatilities (Borowski & Couharde, 2003). In this context, one of the key policy instruments is export diversification, which is premised on the fact that for developing economies, export expansion has become vital in making international integration an efficient tool for development. An important argument is that diversification helps developing economies to hedge against price volatility and external shocks (Tran, et al., 2020).

This paper investigates the role of export diversification in correcting persistent RER misalignment in Rwanda. We begin by estimating the equilibrium real exchange rate, determine the level of real exchange rate misalignment, and generate the export diversification index, which is regressed against the exchange rate misalignment indicator, along with other relevant determinants of RER misalignment. Several studies that examined this topic in Rwanda remains limited and have mainly focused on measuring the level of exchange rate misalignments without attempting to relate it to the export diversification. For instance, (Nuwagira & Kigabo, 2014) estimated the exchange rate misalignment using quarterly data from 2000Q1 to 2012Q1 and derives a long-run Behavioural Equilibrium Exchange Rate (BEER). Similarly, (Nuwagira & Muvunyi, 2016) using quarterly data spanning the period 2000Q1 to 2015Q4, analysed the impact of the real exchange rate on the Rwandan external competitiveness, using the BEER method to determine the level of the exchange rate misalignment and tested the Marshall-Lerner condition. Both studies found evidences of exchange rates misalignments. Muvunyi, et al., (2022) Using quarterly data, covering the period 2000Q1-2020Q4 and 5-year period medium term projections, re-assessed Rwanda's exchange rate and external sector competitiveness applying the three complementary approaches proposed by the IMF consultative group on exchange rate issues (CGER). The results pointed to an average exchange rate misalignment of 13.4 percent, suggesting that Rwanda's exchange rate is overvalued in real effective terms. While the relationship between exchange rate misalignment and export diversification is lacking for Rwanda, similar studies have been conducted especially in the context of developing economies. Notable contributions include Cottet & Madariaga (2012) who show heterogeneity among Franc Zone Countries in terms of export diversification due to different modes of diversification used by different countries. Gnimassoun (2017) indicate that the concentration of Franc Zone Countries exacerbates the adverse effect of real exchange rate misalignment.

In view of this, this paper makes a contribution to the ongoing debate on the role of export diversification in correcting Rwanda's real exchange rate misalignment. The novelty of this research lies in the fact that we construct export diversification index, used as a policy instrument to mitigate the size and persistence of RER misalignment.

This link can be explained as follows: First, aggregate productivity gains and the exploitation of economies of scale that result from export diversification can reduce pressure on prices across the economy, allowing countries to maintain external competitiveness. Diversification therefore appears to be a solution to limiting the risks of political instability and export revenue volatility by alleviating the impact of external shocks such as terms of trade shocks (Haddad, et al., 2013). The objective of this paper is therefore to examine, on the basis of cointegration based estimators, especially DOLS, and FMOLS the role of export diversification on both the size and the persistence of real exchange rate misalignments in Rwanda. To attain this objective, the first step is to identify the economic fundamentals that influence real exchange rate. This study draws on the literature on the determinants of the real exchange rate. The second step, the identified fundamentals are regressed against real exchange rate, which along with Hodrik-Prescott filter are used to obtain sustainable values of RER. The third step is to subtract the generated equilibrium exchange rate from the actual exchange rate to obtain RER misalignment, and finally, relate the established exchange rate misalignment with export diversification. Our main finding indicate that export diversification plays a central role in limiting RER misalignment in Rwanda, a result that is consistent with (Dubas, 2009).

The rest of the paper is the organized as follows. Section 2 reviews the empirical literature on the relationship between RER misalignment and export diversification. Section 3 elaborates both the theoretical model and the empirical models used in study. Section 4 reports the estimation results of equilibrium exchange rate and real exchange rate misalignment as well as the estimated relationship between RER misalignment and export diversification. Section 5 provides conclusion and policy recommendations.

2. Empirical Literature

In this study, we combine two important strands of literature. The first relates to the estimation of equilibrium real exchange rate, which along with the HP filter is used to obtain RER misalignment indicator. The second strand focuses on the role of export diversification in reducing the magnitude of real exchange rate misalignment.

Several empirical studies have been undertaken to estimate the long-run equilibrium and the associated RER misalignment. These studies have mostly followed techniques related to reduced form real exchange rate equilibrium (ERER) models such as fundamental equilibrium exchange rate (FEER) and Behavioral equilibrium exchange rate (BEER). Some have used single equation approach, while others employed the cross-section and panel frameworks.

The first strand of literature has mainly focused on the estimation of the equilibrium exchange rate. (Chinn & Prasad, 2003), employed the macroeconomic balance

(MB) approach to determine the factors that directly and indirectly affect the current account fluctuations. They used cross-section and panel data models for 18 industrial and 71 developing countries, and the results show that the current account deficit is positively related to fiscal balance and international investment position deficit, with an addition case of developing countries of which the dependence of foreign financial inflows positively affect the current account. On the other hand, the countries' level of openness tends to negatively affect the current account balance.

Dvornak et al; (2003) applied the MB approach in Australia; to determine the medium-term macroeconomic factors that affect the exchange rate, i.e. its relationship with the current account. They have started with two hypotheses; firstly, is that the internal macroeconomic balance is achieved with the economy is performing at the potential level, secondly, the external balance is achieved when the exchange of flows (current and financial flows) between two countries are on equilibrium, no matter how their individual current accounts are performing. In their empirical analysis, they estimate how elasticities between the current account and the output for Australia, then the estimate the exchange rate adjustment to reduce the gap between the current national saving and optimum level derived from the model. However, they conclude that the model does not explain how to make the exchange rate policy adjustments in order to reduce the gap.

With the fear of large fluctuations of hard currencies in medium-term, (Borowski & Couharde, 2003) tried to determine the macroeconomic balances between major countries vis-à-vis to their exchanges rate, since these fluctuations may cause world macroeconomic instability. They went further from the MB model and used panel equilibrium exchange rate model in selected industrial countries, by applying the fundamental equilibrium exchange rate, using the data until 1995 and with the medium-projections up to 2000. They suggested adjustment of the Dollars, Yen and Euro, to be aligned with the fundamentals.

As articulated by the Washington consensus, a country's exchange rate should remain competitive to continue supporting its exports and ultimately its growth while ensuring that it remains consistent with macroeconomic objectives in the medium term (Williamson, 2008). In light of this view, in a given country there exists an equilibrium real exchange rate (ERER) that satisfies its macroeconomic balance. Hence, any deviation of the RER from its equilibrium will hamper internal balance (economic growth) and sustainability of the external balance (current account) (Rodrik, 2008).

Other studies, however, have provided theoretical and empirical evidences that not all deviations from the ERER could negatively affect growth and exports. Indeed, Rodrik (2008) showed that while RER overvaluation harms growth and current account balance, the RER undervaluation improve them, mostly in developing countries. Sekkat, et al., (2011), found evidence supporting the view of (Rodrik, 2008) and showed that under the sample of 52 developing countries and using the REER model, they deliberately choose the policy to keep their exchange rate undervalued in order to strengthen the price competitiveness in their manufacturing exports sector.

Zhang (2002), estimated the behavioural equilibrium exchange rate (BEER) in Hong Kong and China for the period 1984-1988 and included four economic fundamentals, namely TOT, net exports/GDP, private investment and trade openness in their specification. They found that RER was overvalued during the period 1983Q3-1985Q2, and in 1984Q1, at around 20 percent. After the second half of 1985, the currency tended to adjust back towards the equilibrium. Leung & Ng (2007), also estimated the equilibrium RER for Hong Kong and China, covering the period 1987-2006. Using key economic fundamentals such as productivity, terms of trade, and government consumption as share of GDP, they found a modest undervaluation of the real exchange rate in the late 1990s.

Cheng & Orden (2005), use the BEER framework to estimate RER misalignment in India during the period 1975-2002. The RER was overvalued during the 1980-1990 and in 1990 the overvaluation was more than 10 percent, however, in the aftermath of 1991 crisis, the RER adjusted towards the equilibrium. Bénassy-Quéré, et al., (2008) used a panel data methodology to estimate the misalignments of bilateral and multilateral real effective exchange rates of G20 currencies. As a result, they find that the currencies of five Asian countries were overly undervalued at the beginning of 2006. These results also indicate that lack of exchange rate adjustment in Asian countries has an impact.

Limited on other misalignments against the US dollar and in addition, the bilateral misalignments between the United States and the other countries depend mainly on misalignments of the exchange rate of all countries. Baffes, et al., (1999) building on the work of Edwards, 1989; Devarajan, et al., 1993 and Elbadawi & Soto, 1994) on the determination of RER by the single-equation model, estimated the RER and the degree of misalignment of countries such as Cote d'Ivoire and Burkina Faso. They adopted a three-pronged methodology. An estimate of the long-term relationship, an estimation of the model parameters and the computation of degree of misalignment and conclude that the devaluing the currency depends on the fundamentals, the degree of misalignment of the RER and the speed of the internal and external adjustment mechanisms seem to restore the macroeconomic balance.

Lossifov & Loukoianova (2007) examined the factors that influence the equilibrium exchange rate in Ghana. They followed a vector error correction model (VECM). The results indicate that the long-term variations in the real exchange rate are explained by the real GDP growth rate, the interest rate differential, the real world prices of the exported raw materials. These results also show that when the RER deviates from its equilibrium trajectory, it reverts back to it between 2 and 3 years.

Couharde et al., (2011), estimated the currency misalignment of the CFA zone countries and assessed how their real effective exchange rates converge to their equilibrium level between 1985 and 2007. To attain this, they estimated the long-run relationship between actual effective exchange rates and their economic fundamentals through the panel cointegration techniques, especially the ordinary dynamic-least-squares developed by Kao & Chiang, (2000) and Mark & Sul (2003). The results from their study found that the real appreciation of CFA zone countries in 2000s didn't translate into a real overvaluation, with exceptions of some countries. They also found that the adjustment of the REER towards the equilibrium levels differ among the CAF zone.

With regard to country specific studies, Nuwagira & Muvunyi (2016) studied the impact of the real exchange rate on the Rwandan external competitiveness, using the Behavioral Equilibrium Exchange Rate (BEER) method to determine the level of the exchange rate misalignment and the Marshall-Lerner condition. The long-run BEER drew a relationship between the REER with the fundamentals factors, and the coefficients highlighted that some of the factors that influence RER under-valuation. These factors include the increase in government expenditure and the decrease of terms of trade and other factors help to explain RER over-valuation, while the increased in foreign financial inflows and the supply side of output. In addition, the study found that the Marshall-Lerner condition for Rwanda does not hold given that the improvement in trade balance relies so much on foreign demand than exchange rate depreciation. In addition, Nuwagira & Kigabo (2014) examined the RER misalignment using quarterly data spanning the period 2000Q1 to 2012Q4 using the BEER approach. Their results indicate the existence of episodes of overvaluation and undervaluation with the level of misalignment ranging between 0.04 percent and 2.3 percent.

Muvunyi et al., (2019) used this external sustainability approach to evaluate the Rwandan current account deficit vulnerability to the level of net foreign assets, on a sample drew up to 2017 (the benchmark), and considering 2018 – 2021 as medium-term projections. The results showed that the current account gap at the benchmark was higher, but it would lower-down with the medium-term projections, suggesting a small RER adjustment in order to close the gap. Muvunyi et al., (2022) using quarterly data, covering the period 2000Q1-2020Q4 and 5-year period medium term projections, re-assessed Rwanda's exchange rate and external sector competitiveness applying the three complementary approaches proposed by the IMF consultative group on exchange rate issues (CGER). The results pointed to an average exchange rate misalignment of 13.4 percent, suggesting that Rwanda's exchange rate is overvalued in real effective terms.

The second strand of literature relates to the limiting the effects of real exchange rate misalignments. Our focus is limited to previous related work conducted on developing countries. Broadly speaking, much of the work has focused on the effects of the exchange rate regime on exchange rate misalignments (Burkart & Coudert, 2002; Calvo & Reinhart, 2002; Coudert & Couharde, 2009; Dubas, 2009 and Bikai & Owoundi, 2016). On the other hand, related work has focused on the effects of institutional quality (Nouira & Sekkat, 2015). Sovereign wealth funds (Raymond, et al., 2017). Financial development (Aghion, et al., 2009), (Allegret, et al., 2014) and currency crises (Dubas, 2009). Up until now, very few studies have attempted to identify export diversification as a variable that can influence real exchange rate misalignment. The first studies that looked at this link showed that real exchange rate stability favours export diversification (Sekkat & Varoudakis, 2000; Melitz, 2003; Rodrik, 2008; Agosin, et al., 2011; Freund & Pierola, 2012 and Wondemu & Potts, 2016).Very few studies have focused on the influence of export diversification on real exchange rate misalignments (Bodart & Carpantier, 2016) and recently (Nvuh, et al., 2021) whose results indicate that export diversification not only reduces the magnitude of currency misalignment, but also facilitates the adjustment of the real exchange rate towards its long-run dynamics.

3. Methodology

3.1. Theoretical Model

The main aim of this section is to demonstrate through a simple theoretical framework how structural factors such as export diversification can affect the relationship between the RER of a small exporting country and the price of its main export. To do so, we present a model of a small open economy. We build upon the model developed by Bodart, et al., (2012), which extends the model of Gregorio & Wolf (1994). The model is anchored on the following key assumptions of the model. First, the economy produces two goods, a primary product that is not consumed locally (and thus exported entirely), and a non-tradable good that is only available to the domestic consumer. Second, private agents can also consume an imported consumer good. They therefore derive their utility from the consumption of the locally produced non-tradable good and the imported good. Third, domestic agents take the world market price of the exported goods and the imported consumer good as their price. In what follows, exported, non-tradable and imported goods are denoted as X, N *and* M.From the production side, it is assumed that the exported primary good Y_x is produced with a technology combining capital K_x and labour L_x . However, the production of non-tradable goods Y_n requires only labour. Perfect mobility of labour is assumed in both sectors, but capital is specific to the exportable sector. The production function of these two goods follows a Cobb-Douglas specification.

$$\alpha_x L_x^{\alpha} K_x^{1-\alpha} \tag{1}$$

$$Y_x = \alpha_n L_n \tag{2}$$

Where α_x and α_n are exogenous factors of production with sequence limit . Moreover, in this model, the domestic price of the exported product is assumed to be determined by the purchasing power parity in the long-run.

$$P_x = EP_x^* \tag{3}$$

where E is the nominal exchange rate, defined as the rate of domestic currency per unit of foreign currency and P_x^* is the foreign price. Let w be the wage rate paid to labour and r the domestic interest rate,

From the theoretical foundations of profit-maximization, we can derive the following expressions relating the price of each good to the price of factors of production, constituting capital and labour shares in output received in a perfectly competitive equilibrium:

$$P_x \left(\frac{\varphi_x}{\alpha_x}\right) w^{\alpha} r^{1-\alpha} \tag{4}$$

$$P_n = \frac{w_n}{\alpha_n} or\ \vartheta_n = \alpha^{-\alpha} (1-\alpha)^{-(1-\alpha)} \tag{5}$$

Let us now assume that q is the real exchange rate defined as the ratio between the price of the non-tradable goods and the price of the tradable good (exportable good). Combining equations (4) and (5), we obtain the following expression:

$$q = \frac{P_x}{P_n} = \left(P_x^{(1-\alpha)}\right) \alpha_x \alpha_n^{-\alpha} \vartheta^{-1} r (1-\alpha)_{\alpha}^{1} \tag{6}$$

So far, we have defined the real exchange rate as the relative price of the non-tradable good in terms of the tradable good. But it can also be defined in different ways. For instance, it is very common to define the real exchange rate as the ratio of the domestic consumer price index P to the foreign consumer price index expressed in the domestic currency EP^*Since $P = P_n^{\gamma} (EP_m^*)^{1-\gamma}$ and $P^* = P_m^*$, we obtain:.

$$q^{'} = \frac{P}{EP^*} = P_n^{\gamma} (EP_m^{\gamma})^{-\gamma} \tag{7}$$

Where P_m^* is the foreign price of imported consumer good. We can easily illustrate that the two real exchange rates are related as follows:

$$q^{'} = q^{\gamma} (P_x^*) (w_x^*)^{-\phi\gamma} \left(\frac{\phi_m}{\alpha_m}\right)^{-\gamma} \tag{8}$$

As a result, we obtain:

$$\sum \left(q^{'}; P_x^*\right) = \gamma \left[\sum (q; P_x^*) + \phi\right] \tag{9}$$

The relationship in equation (9) indicate the elasticity of the real exchange rate with respect to the foreign price. To examine whether the degree of export diversification affects the magnitude of the real exchange rate response to international commodity price shocks, we extend model (1) to include the production of a second tradable good and make further assumption that this new tradable good is a manufacturing good, produced but not consumed in the domestic market. We also assume that the production of the manufactured good $Y_d$involves two intermediate inputs, the primary productX_d and an intermediate input produced by the foreign economy (G_d^*):

$$Y_d = \alpha_d X_d^n G_d^{*1-\eta} \tag{10}$$

In equilibrium, the price of the manufacturing good is determined as follows:

$$P_d = \frac{\vartheta_n}{x_d} p_x^n P_f^{1-\eta} \tag{11}$$

Where P_f is the price of the foreign intermediate good in domestic currency when $P_f = EP_f^*$ and $.\vartheta_d = \eta^{\eta} (1-\eta)^{-(1-\eta)}$

In this new framework, we redefine the real exchange rate (q) as the ratio between the price of the non-tradable good and a composite price of the two exportable goods and this gives:

$$\overbrace{q} = \frac{P_n}{P_t} or\ P_{t=} P_t^t P_d^{(1-t)} \tag{12}$$

In what follows, the analysis is limited to the case where the exchange rate is fixed and capital is perfectly mobile. Under these assumptions, we obtain through several direct substitutions that the elasticity of $\overbrace{q}$ with respect to P_x^* gives us:

$$\sum \left(\overbrace{q}; P_x^*\right) = \left(\frac{1-\alpha}{\alpha}\right) + (1-\eta)(1-\varepsilon) \tag{13}$$

This elasticity is then greater than the corresponding elasticity obtained in the model with an exportable good (see equation 9). This model indicate that the degree of export diversification can affect the magnitude of the change in the real exchange rate in response to a global commodity price shock. In particular, this model suggests that when commodity prices rise (fall), countries with broadly diversified exports should experience a larger appreciation (depreciation) of their real exchange rate than countries with weakly diversified exports. This result comes from the fact that the variation of P_x

leads to a less than proportional variation of P_d. The inclusion of a second good does not affect the expression of q' and thus the elasticity $\sum(q';\ P_x^*)$is independent of the degree of export diversification.

3.2. Construction of Export Diversification Index

The most frequently used indices to measure the degree of export diversification are Herfindahl, Gini, and Theil. This study opts to use the Herfindah index as it is the most widely used empirically in measuring exports diversification and easiest to compute. In their study Bajaj et al. (2023) posited that the HHI is a simple, more robust and comprehensive measure for export diversification.

The Herfindahl index (or Herfindahl-Hirschman Index, HHI) sums the squared shares of each commodity in total exports.

The index is computed as follows:

$H = \sum_k^n S_k^2$....(14)

Where, $S_k = X_k / \sum_{k=1}^n X_k$ is the share of the export line i in total exports, with X_k being the value of the exported good k.

Thereafter, equation above is normalized for simplicity and becomes:

$$H = \frac{\sum_{k=1}^n (S_k)^2 - 1/n}{1 - 1/n} \tag{15}$$

Conceptually, the HHI is a concentration index and not a diversification index. It ranges between zero and one. In the extreme case, the HHI is equal to zero when diversification is maximal ($n$lines exported in equal quantities), whereas its value is equal to unit when concentration reaches a maximum (one single export line). Interpreted in terms of vulnerability, when the index is closing one, a country is thus entirely dependent on a small number of products for its exports.

One major drawback of the HHI is that it does not take into account the effect of new products on exports diversification. In fact, due to the quadratic form in the equation, this index gives a very heavy weighting to products that account for a large share of total export, making it less sensitive to the appearance of new export products, as individual shares become extremely small as soon as there is inequality across product categories.

In trying to examine the relevance of the above mentioned drawback in the context of Rwanda's export data, we analyzed the effect of new products on export diversification over 2012-2022 and found that on average new products represent a small share of total exports. Specifically, using the definition of Klinger and Lederman (2006)[1], we found that over 2020-2022, the share of new products to total exports represent 5.9 percent of total exports and are hence less likely to affect the HHI. Besides, of these new products, only two products represent nearly 90 percent of their total exports value in 2022.

3.3. Empirical Model Specification

To estimate the real exchange rate misalignment, we follow the reduced form equilibrium exchange rate approach, particularly the behavioural equilibrium exchange rate (BEER) model proposed by MacDonald & Clark (1998). This is an empirical approach that is based on economic fundamentals that influence real exchange rate behaviour. To obtain the measures of real exchange rate misalignment, we compute the deviation of actual real exchange rate from its equilibrium value and this deviation is known in literature as exchange rate misalignment. Its empirical assessment is with a challenge in a sense that the equilibrium real exchange rate is unobservable, thus the starting point to addressing this is to define the concepts of real exchange rate and equilibrium real exchange rate.

The RER is domestic relative price of traded to non-traded goods, expressed as $reer_t = E * \frac{P_t^*}{P_n}$, where E is the nominal exchange rate, P_t and P_n are prices of tradables and non tradables, respectively. In his pioneering work (Nurkse, 1945) defines ERER as the value of RER that induces both the internal and external equilibrium, given sustainable values of relevant variables achieving this objective.

Despite the fact that BEER approach is part of the complementary approaches proposed by the IMF's consultative group on exchange rate issues (CGER), it is chosen over other approaches such as Macroeconomic balance (MB) and external sustainability (ES) due to the fact that it is more pragmatic given that it directly

[1] There is no common definition about new product. This study adopted the definition of Klinger and Lederman (2006), which requires three distinct periods to define what is new product. First, an initial period to confirm that the good was never before exports, a period during which the discovery can emerge and then a final period when the discovery is confirmed to be an established export. For our case, the three episodes were set as 2012-2014, 2015-2019 and 2020-2022 respectively. 2015 was the year when the campaign of "Made in Rwanda" began.

computes an equilibrium exchange rate for each country as a function of medium to long term fundamentals of the real exchange rate. It therefore does not require to make assumptions on the long-run values of economic fundamentals, while the other two approaches are highly influenced by normative assumptions. Indeed, Thorstensen et al., (2014) contend that the BEER approach minimises the subjectivity in the estimation of equilibrium RER and its misalignment by using a set of economic fundamentals that explain real exchange rate behaviour. Secondly, the macroeconomic balance approach does not take into account long-run stock effects via the net foreign position and the stock of capital. In this paper we use fundamentals akin to (Berg & Miao, 2010; MacDonald & Vieira, 2010 and Comunale, 2017). Our empirical model is thus specified as:

Where $t = 1.......,\ T$ denote time period, $reer_t$ is the real effective exchange rate, $open_t$is the degree of trade openness, nfa_t is net foreign assets, $prod_t$ is productivity proxied by real per capita gross domestic product, gov_t is government consumption as percentage of GDP, $\alpha = (1, ...4)$ are parameters to be estimated and ε_t is the error term.

3.4. Estimation strategy

The procedure to estimate the equilibrium real exchange rate is implemented in five steps. Firstly, in line with conventional practice in econometrics, we test for unit root to determine the order of integration of used variables. Secondly, we estimate cointegration based on reduced rank regression approach due to Johansen (1988) to confirm the presence of cointegrating relations to check whether there is existence of a long-run relationship between the real exchange rate and the fundamentals. Thirdly, we estimate the long run parameters of equilibrium RER using single equation cointegration based estimators such as dynamic ordinary least squares (DOLS) model and fully modified ordinary least squares (FMOLS). Fourthly, derive sustainable values of economic fundamentals of RER by decomposing RER into their permanent and cyclical components, implemented via Hodrik-Prescott (HP) filter and compute the misalignment measure, given by $mis_t = reer_t - ereer_t$

Where mis_t is the equilibrium real exchange rate and where positive (negative) values of indicate overvaluation (undervaluation). Finally, we regress the generated export diversification index, along with other relevant determinants of real exchange rate misalignment against RER misalignment indicator to check whether export diversification reduces RER misalignment in Rwanda.

The Single equation cointegration estimators such as the fully Modified Ordinary Least Squares (FMOLS) developed by Phillips & Hansen (1990) and Pedroni (2000) and the Dynamic Ordinary Least Squares (DOLS) estimator developed by Saikkonen (1991), Kao & Chiang (2000), Stock & Watson (1993) and Mark & Sul (2003) are advantageous in a sense that these estimation techniques generate consistent parameter estimates and correct for endogeneity.

Despite the fact that (Pedroni, 1996) finds that the DOLS method has higher size distortions than FMOLS, Kao & Chiang (2000) indicate that the FMOLS method can be more biased than DOLS. In this study, we apply the DOLS technique to determine the long-run determinants of the real effective exchange rate. This approach improves OLS by addressing the problem of small sample bias and dynamic sources of bias given that it corrects for endogeneity by adding leads and lags. While DOLS is chosen for this study, we use it, along with complementary estimators such as fully modified ordinary least squares (FMOLS) and canonical cointegration regression (CCR).

3.5. Definition Variables and Data Sources

The series in equation (16) are constructed as follows. The real exchange rate is the inflation adjusted and trade weighted nominal exchange rate, computed by multiplying the nominal effective exchange rate by the ratio of foreign price to domestic price, given by $reer_t = \sum_{t=1}^{k} neer_t * \frac{P^*}{P}$ The real exchange rate misalignment indicator is the exchange rate deviation from the equilibrium level based on Hodrick-Prescott (HP) filter, constructed as $mis = reer_t - ereer_t$. Net foreign assets is calculated as difference between assets and liabilities$nfa = total\ assets - total\ Liabilities$this definition follows (Lane & Milesi-Ferretti, 2007). Relative productivity proxied by real per capita GDP is calculated as nominal GDP divided by the total population and its growth rate is given by $ngdppc\_gr = ngdppc - ngdppc_{t-1} - 1$.

Government expenditure is the total government expenditure, including recurrent and capital spending divided by GDP. Openness is measured as the sum of exports and imports divided by GDP, calculated as $open = \frac{x+m}{gdp}$ All the series are expressed in natural logarithms. We use quarterly data, covering the period 2000Q1-2022Q4 and data is sourced from World Bank's world economic outlook database (WEO) and National Bank of Rwanda database.

3.6. Estimating Exchange Rate Misalignment and Export Diversification Nexus

After generating the RER misalignment and export diversification index, we proceed to estimate the link between real exchange rate misalignment and export diversification in terms of size of RER misalignment. Accordingly, we estimate the impact of export diversification on the size of misalignments, this is implemented by regressing export diversification, along with other relevant variables against RER misalignment indicator. Similar to (Dubas, 2009), we take RER misalignment in absolute terms. The model is specified as:

$$|mis| = \beta_0 + \psi divers_t + \gamma divers_{t-1} + \phi Z_t + \varepsilon_t \qquad (17)$$

Where $|mis_t|$ is the misalignment indicator expressed in absolute value, β_0 is the intercept, ψ is the parameter estimate for export diversification index ($divers_t$), γ is the coefficient that captures the persistence in export diversification, Z_t is vector of exogenous variables including financial depth measured by the ratio of broad money to GDP $\left(\frac{M_3}{GDP}\right)$, terms of trade and openness. In terms of expected signs, countries with significant financial development have a stable exchange rate. We therefore assume that financial development reduces misalignments. Therefore, the expected sign is negative. We expect terms of trade changes to be associated with a positive sign. The sign of export diversification index with respect to RER misalignment is expected to be negative given that increased export diversification reduces RER misalignment.

4. Empirical Results

4.1. Results of Behavioral Exchange Rate Model

Our empirical analysis starts with checking the stochastic properties of data. The unit root results indicate that except for real GDP per capita growth, financial depth and export diversification index, all other variables are integrated of order one (see appendix 1). Given that variables used in our estimations are integrated of different orders, we tested for Johansen cointegration and the results point to one cointegrating vector given that the trace statistic is less than the critical value at 5 percent only at rank 3 (see results in appendix).

Turning to the BEER model results, Table 1 presents the results of the reduced form model based on single equation cointegration estimators such as DOLS, FMOLS and CCR, with a particular focus on DOLS. We estimated the long-run relationship between the real effective exchange rate and a set of economic fundamentals. The estimated coefficients are presented in columns (1) - (3).

All variables included in our empirical specification are statistically significant, with correct signs, implying that the real exchange rate is influenced by economic fundamentals. Broadly speaking, improvement in relative productivity, government spending and net foreign assets leads to real exchange rate appreciation, while increased degree of trade openness induces real exchange rate depreciation.

The coefficient of openness emerges positive and statistically significant, this implies that trade restrictions in terms of higher tariffs, resulting in higher demand for non-traded goods leads to higher domestic prices that induce real exchange rate appreciation.

The coefficient of productivity is positive and statistically significant, indicating that productivity gains relative to trading partners induces real exchange rate appreciation, a phenomenon well known in literature as "Balassa- Samuelson effect". Government expenditure turns out to be positive and statistically significant, this is due to the fact that higher government expenditure translates into higher demand for non-traded goods leading to the rise in prices of non-traded goods, resulting in the real appreciation of exchange rate.

The coefficient of net foreign assets is positive and statistically significant, implying that higher net foreign assets induce real exchange rate appreciation given that Rwanda has received substantial amounts of capital inflows, which allows it to afford a more appreciated REER.

The coefficient of trade openness is negative and statistically significant, this implies that improvement in trade openness leads to lower tariffs, resulting in higher demand for tradable goods and higher prices for foreign goods that induce real exchange rate depreciation. Despite the ambiguity that surrounds the sign of the coefficient associated with trade openness, several empirical studies support a negative relationship between the real exchange rate and trade openness (Dubas, 2009) (Elbadawi & Soto, 2012).

Table 1: BEER Estimation Results BEER Estimation Results

VARIABLES	(1) DOLS	(2) FMOLS	(3) CCR
Productivity	0.192***	0.210**	0.235*
	(0.069)	(0.106)	(0.123)
Openness	-0.129**	-0.117	-0.141
	(0.064)	(0.109)	(0.126)
Net foreign Assets	0.120***	0.051	0.061
	(0.037)	(0.067)	(0.073)
Government spending	0.441***	0.363***	0.360**
	(0.071)	(0.136)	(0.141)
Constant	2.042***	2.350***	2.249***
	(0.291)	(0.542)	(0.596)
Observations	89	91	91
R-squared	0.526	0.170	0.290

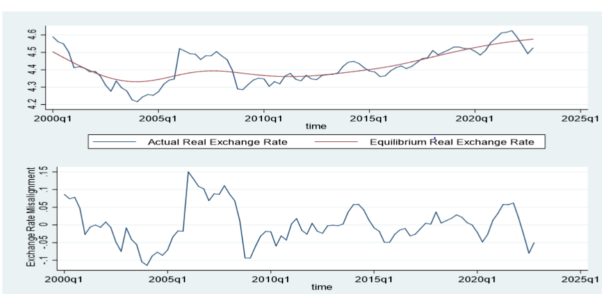
Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Source: Authors' Estimations

4.2. Exchange Rate Misalignment in Rwanda

The estimated results of the BEER model, coupled with the (Hodrick & Prescott, 1997) HP filter are used to derive the sustainable values of economic fundamentals, whereby HP filter decomposes REER into their permanent and cyclical components[2] and thus the level of misalignment is computed as the difference between the actual real effective exchange rate and the equilibrium real effective exchange rate, which is the permanent component.

Figure 1 below depicts the level of misalignment over the entire sample period. From the figure 2, we were able to identify different but alternating episodes of overvaluation and undervaluation. While overvaluation and undervaluation are not the desirable outcome for long-run REER stability, the estimated level of RER misalignment is not prolonged and not very high. Considering the last five years (20quarters), Rwanda's real effective exchange rate is overvalued by 8 percent, suggesting that Rwandan franc should depreciate by 8 per cent in real effective terms to restore REER to its sustainable levels.

Figure 1: Evolution of Rwanda's REER Misalignment



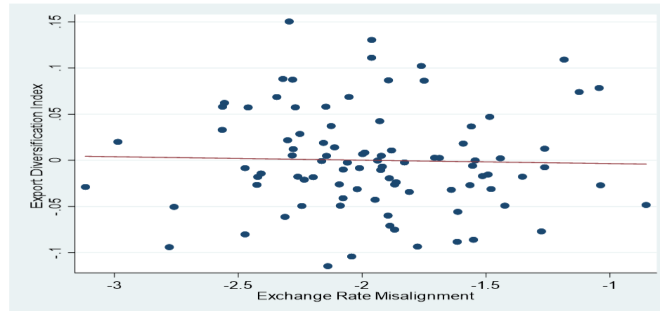
Source: Authors' Estimations

4.3. Size of RER misalignments and Export Diversification

Prior to computing the magnitude of RER misalignment in relation to export diversification, we first checked for the correlation between the two variables.

The scatter diagram in figure 2 indicate that exchange rate misalignment is negatively correlated to export diversification, suggesting that export diversification reduces the size of RER misalignment in Rwanda.

Figure 2: Correlation between Exchange Rate Misalignment and Export Diversification



Source: Authors' Estimations

Table 2 reports the results of the size of RER misalignment measure with respect to export diversification.

Table 2: Results on the Size of Absolute Misalignment

VARIABLES	DOLS
Export diversification	-0.035***
	(0.007)
Openness	-0.001***
	(0.000)
Terms of trade	0.038**
	(0.015)
Financial depth	-0.051***
	(0.013)
Constant	0.037
	(0.071)
Observations	89
R-squared	0.469

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Source: Authors' Estimation

As expected, the coefficient of export diversification is negative and statistically significant, implying that Rwanda could reduce potential real exchange rate misalignments by putting in place strategies to diversify its export base. Greater diversification of exports would make Rwanda less vulnerable to exogenous shocks and more protected against the risks of short-term devaluation.However, policy makers should be cognizant of the fact that diversification strategies are processes that are implemented in the medium to long term.

The coefficient of trade openness is negative and statistically significant, indicating that the more Rwanda opens up to the rest of the world, the more it trades and attracts capital from trading partners thereby minimising the level of RER misalignment.

[2] Since we use quarterly data , we extract the trend components of RER using the Hodrick-Prescott filter, following a conventional smoothing parameter value =1600

The coefficient of terms of trade turns out to be positive and statistically significant, implying that improvement in the terms of trade increases export prices, contributing to high level of RER misalignment.

The coefficient of financial depth/development is negative and statistically significant, implying that it is RER misalignment reducing, a result that is in line with (Devereux & Lane, 2003) who indicate that domestic financial development helps in stabilizing exchange rates in developing countries through intertemporal smoothing by households and firms. Dubas (2009) also highlights the role of financial development in reducing the size of RER misalignments. Indeed, the periods of banking crises have been associated with large and significant misalignments.

5. Conclusion and Policy Recommendation

The main objective of this paper is to estimate the equilibrium real exchange rate and misalignment and examine the role of export diversification in reducing real exchange misalignment in Rwanda. We employ quarterly data, covering the period 2000Q1-2022Q4. Building on the behavioural equilibrium exchange rate approach, we estimate the relationship between the real effective exchange rate and economic fundamentals using single equation cointegration based techniques, particularly DOLS. To check for the robustness of our main results, we also use the complementary estimators such as FMOLS and CCR.

To derive the level of REER misalignment, the estimated equilibrium real exchange rate results are used along with Hodrick-prescott filter to obtain sustainable levels of REER and decompose REER into their permanent and cyclical components and thus the level of REER misalignment is calculated as the difference between the actual real effective exchange rate and the equilibrium real effective exchange rate. The main results indicate that the real effective exchange rate is in line with the economic fundamentals. The obtained level of REER is not too high and the identified episodes of undervaluation and overvaluation are not persistent to cause loss of competitiveness of the external sector.

We also estimated the link between real exchange rate misalignment taken in absolute values and export diversification and the results points to the fact that export diversification reduces exchange rate misalignment in Rwanda. Accordingly, we recommend that policies to diversify Rwanda's export base should be implemented. Greater diversification of exports would make Rwanda less vulnerable to exogenous shocks and more protected against the risks of short-term devaluation. However, policy makers should be cognizant of the fact that diversification strategies are processes that are implemented in the medium to long term. With regard to REER misalignment, effective monitoring of exchange rate developments remains vital to avoid higher levels of volatility which could lead to poor performance of the country's tradable sector.

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Appendices

Appendix 1: Unit Root Test Results

Variables		Critical Values			
	ADF	**1 %**	**5%**	**10%**	**Conclusions**
Lreer	7.81	4.06	3.46	3.15	I(1)
Lrgdppc_gr	8.65	4.06	3.46	3.15	I(0)
Lopen	11.37	4.06	3.46	3.16	I(1)
Ltot	3.15	4.06	2.88	2.58	I(1)
Lnfa	9.88	4.06	3.46	3.15	I(1)
Lfindepth	4.07	4.06	3.45	3.15	I(0)
Gov_gdp	12.39	4.06	3.46	3.15	I(1)
Ldivers_hhi	5.68	4.06	3.45	3.15	I(0)

Source: Authors' Estimation

Appendix 2: Results of Johansen Tests for Cointegration

Maximum Rank	**Eigenvalue**	**Trace Statistic**	**Critical value at 5 %**
0	-	279.1143	192.89
1	0.61998	193.0040	156.00
2	0.49416	132.3474	124.24
3	0.36720	91.6213*	94.15
4	0.29787	60.1479	68.52
5	0.26387	32.8829	47.21
6	0.14439	19.0045	29.68
7	0.12930	6.6818	15.41
8	0.06987	0.2357	3.76
9	0.00264		