Research Article

Does Exchange Rate Undervaluation Have a Symmetric or Asymmetric Effect on Economic Growth?

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Abstract: This paper investigates the asymmetric pass-through of real exchange rate undervaluation (Underval) on economic growth. The study using the autoregressive distributed lagged (ARDL) and non-linear autoregressive distributed lagged (NARDL) models reveals the complex and asymmetric effects of Underval on economic growth across different economies for the period 1984-2022. In developing countries, particularly those with floating exchange rate regimes, undervaluation can enhance economic performance by boosting exports and attracting foreign investment. However, in developing countries with fixed exchange rate regimes, undervaluation poses significant challenges and can lead to negative economic outcomes due to the rigidity and financial burdens associated with maintaining a fixed exchange rate. Conversely, developed countries and emerging markets exhibit a more muted response to underval, reflecting their greater economic stability and resilience. These findings highlight the importance of tailoring exchange rate policies to each country's specific economic context and exchange rate regime to optimize their impact on economic growth.

Keywords: NARDL model, exchange rate undervaluation, economic growth, asymmetric relation, developing countries

JEL Codes: O47, C32, E00

1. Introduction

A great deal of empirical literature highlights that exchange rate policies are very influential towards economic growth and development. Badly managed exchange rates will retard growth, destabilize economies, and aggravate imbalances in the macroeconomic arena. While much is known concerning the bad effects of misaligned exchange rates, very little attention has been paid to the conditions under which the real exchange rate (RER) affects gross domestic product (GDP) growth. Specifically, the role of undervaluation, which is a situation where the currency of the country is at a price below its market equilibrium value, has not been adequately explored. Undervaluation can, theoretically, be growth-promoting because it heightens the competitiveness of exports, although this effect will depend on the country, time period, and state of the economy.

For example, one would ask whether RER undervaluation has the same effect in developed and developing

countries. In fact, the relationship of RER to growth could well be conditioned by the dynamics of trade surplus and deficit economies, pre- and post-crisis periods, and a host of different exchange rate regimes. Apart from this, it would be relevant to ask whether currency undervaluation and overvaluation affect growth in similar ways and whether these relationships are linear or nonlinear.

The two related questions addressed in this paper are: First, does the exchange rate regime alter the effect of undervaluation on economic growth? Second, are upward and downward movements of RER symmetrically or asymmetrically related to growth? While these questions are relevant to the general discourse on exchange rates and growth, this paper focuses on four countries with different exchange rate regimes and economic characteristics: Germany, South Africa, Mexico, and Cameroon.

Germany is a case study of a developed country whose flexible exchange rate regime accompanies an extremely strong trade surplus. It is the largest economy in Europe and the fourth largest in the world in nominal terms. Other countries that are middle-income developing countries operating floating exchange rate regimes include South Africa and Mexico. Obviously, it is the case that South Africa is the largest economy in sub-Saharan Africa, while Mexico is the second biggest in Latin America. By contrast, Cameroon-a low-income nation-operates the Central African CFA [Communauté Financière Africaine (African Financial Community)]. franc [Countries that apply the West African CFA France include the West African Economic and Monetary Union, and these countries are: Benin, Burkina Faso, Ivory Coast, Guinea-Bissau, Mali, Niger, Senegal, and Togo], which is pegged to the Euro and hence operates under a fixed exchange rate regime.

This study tests whether the exchange rate undervaluation affects economic growth in a symmetric or asymmetric manner in the aforementioned four countries, applying two models: nonlinear autoregressive distributed lags and autoregressive distributed lags. This selection of countries will provide an opportunity to look into the diverse implications of different exchange rate regimes and levels of development: Germany, South Africa, Mexico, and Cameroon. By considering these diverse cases, this paper helps to build an understanding of how country regime characteristics-either of the exchange rate regime or the level of development-impact the perception of the impact of currency misalignment on growth.

1.1 *Contributions to knowledge*

This paper adds value to the existing literature on links between exchange rates and economic growth by the following: First, it explores symmetric and asymmetric effects of exchange rate undervaluation, thereby expanding nuanced relationships between currency misalignment and economic performance. Secondly, the comparative approach adopted in this study by considering countries with different regimes of exchange rates and levels of development yields fruitful results on the conditions under which currency undervaluation acts either as a spur or obstacle to growth. Methodologically, it contributes to the use of NARDL and ARDL models that allow capturing possible nonlinearities within the RER-growth relationship and hence provide a more general and robust framework for analyzing exchange rate dynamics.

In summary, this paper tries to tease out the relationship between exchange rate undervaluation and economic growth with a focus on symmetric and asymmetric impacts within the context of diverse economies. The results, though related to the four countries under scrutiny, try to make additions to the literature on exchange rate policy and growth dynamics.

2. Literature review

The relationship between RER and economic growth has been one of the major concerns among experts, with special attention to developing economies. Despite the extensive volume of research, one of the important debates on the influence of exchange rate undervaluation and overvaluation on growth is the symmetry/asymmetry of their effects, depending on the level of economic development and the exchange rate regimes. Next comes the review of both theoretical insights-say, the J-curve effect results of empirical findings in chronological order.

2.1 *Undervaluation and growth*

The seminal roots of utilizing RER undervaluation as a valid determinant for beneficent economic growth come from Dollar (1992), who provided the concept that undervaluation can give a significant boost to export competitiveness in an economy. The idea was further extended to the status quo by Sachs and Warner (1995), in studying the relationship between the degree of undervaluation and the growth performance of developing countries.

In extension, Rodrik (2008) went ahead and proposed that undervaluation increases the competitiveness of tradable sectors in developing countries, which, therefore, accelerates growth. His conclusion marks that undervaluation is the counterbalancing of market distortion occurring in the tradable goods sector.

In a more recent study, Bahmani-Oskooee and Gelan (2007) reiterated the view that undervaluation accelerates growth in low-income countries since it fosters exportation and hence industrialization. In their own view, this is because low-income countries often face market failure that undervaluation can overcome in its pursuit to promote economic development.

Razmi et al. (2012) gave additional empirical evidence which established undervaluation of RER to be strongly related to growth in countries whose economies depended highly on tradable goods. They maintained that undervaluation is instrumental in correcting market distortions that cause growth retardation.

On the other hand, however, Nouira and Sekkat (2012) still questioned this universality due to the fact that, aside from episodes of overvaluation, undervaluation on its own is not a uniform determinant of growth across developing countries, and this consensus precludes a uniform approach towards undervaluation policy.

More recently, Gopinath et al. (2022) reiterated the importance of undervaluation for developing economies, again arguing that undervaluation is a key component of escaping the middle-income trap, though the benefits of undervaluation vary with external economic conditions.

2.2 *Overvaluation and growth*

The RER overvaluation has also been widely recorded to have several deterring effects on economic growth. Easterly (2001) argued that the overvaluation results in shortages in foreign currencies and current account deficit distortions which the economies are bound to face. He put forward an argument that while temporary overvaluation may not have significant effects, continuous overvaluation may seriously impair growth in an economy bearing structural weaknesses.

Rodrik (2008) extended this hypothesis to include that the more persistent the overvaluation, the more damning the impact. Vieira et al. (2013) also established that large deviations from overvaluation result in misalignments that ultimately decrease competitiveness and inhibit growth, especially for emerging countries. Their research points out that one should be mindful of policies on exchange rates so as not to let deviations from overvaluation continue for too long. More recently, Coulibaly et al. (2024) present evidence of the negative growth effects of overvaluation in sub-Saharan Africa and note that overvaluation exacerbates trade deficits and inflationary pressures, which is particularly detestable in fragile economies.

2.3 *Symmetric vs. asymmetric effects of RER on growth*

In fact, it has been discussed in the literature whether such growth effects of RER misalignments are symmetric or asymmetric. Razmi et al. (2012), Seraj and Coskuner (2021), found that the effects of undervaluation and overvaluation are often asymmetrical; the negative impacts of overvaluation outweigh undervaluation, which may foster growth. In support, Bahmani-Oskooee and Saha (2024) reported asymmetric adjustments in exchange rates, implying that the negative effects of overvaluation are disproportionately larger compared to the positive effects of undervaluation, particularly in developing countries.

However, Tang (2015), in an empirical analysis of the economy of China, did not find any significant long-run relationship between RER misalignment and growth. According to him, this could be because the fixed exchange rate policy adopted by the Chinese economy may reduce the applicability of any findings that are relevant to other developing countries.

Sokolov et al. (2011) reiterate that undervaluation may not result in significant long-run growth dividends in fixed

exchange rate regimes such as China's. Recent contributions by Krekó (2020) have taken this debate one step further by analyzing asymmetric effects of exchange rate misalignments in the European Union. He shows evidence that while undervaluation can result in positive but diminishing returns for developed economies, overvaluation is associated with more pronounced growth slowdowns, especially during financial crises.

2.4 *Theoretical considerations of exchange rate misalignment*

The theoretical framework of RER misalignment and growth is focused on competitiveness and market correction. Especially relevant in this respect, the J-curve theory refers to how the initial negative effects of depreciation in the trade balance of a country might afterwards turn into improvements because of the rise in export competitiveness.

Rodrik believed that undervaluation is a policy mechanism to overcome market imperfections in the tradable sector, which subsequently leads to increased production and growth. However, Korinek and Servén (2010) cautioned that long-run benefits of undervaluation may be dissipated by inflationary pressures and asset bubbles and provided reasons for more judicious use of such policies.

2.5 *Symmetry of exchange rate effects*

This paper hence tries to determine whether undervaluation and overvaluation of exchange rates have symmetric or asymmetric effects on growth across different contexts. By applying nonlinear econometric approaches like NARDL and ARDL modelling, this paper investigates how exchange rate regimes mediate such relationships and contributes to the growing debate on exchange rate policy-economic growth.

3. Data and methodology
3.1 *Data*

Data consist of yearly time series for four countries from 1984 to 2022. The selected countries are Germany, Mexico, South Africa, and Cameroon. Autoregressive distributed lagged model (ARDL) and Non-linear Autoregressive distributed lagged model (NARDL) relationships are analyzed between the GDP growth and RER. The data necessary for the calculation of the variables have come from the World Bank databases.

As for the selected countries, the selection of these four countries is mainly to represent the diversity in exchange rate regimes and the level of economic development. Germany is a very high-income country with a GDP per capita (on PPP) exceeding 52,726.97 USD in 2023. It has a flexible exchange rate regime. After China, it is the world's second-largest exporting country, with the world's second-largest trade surplus which exceeds 300 billion USD annually. By nominal GDP measurements, it is the strongest economy in Europe and the 4th strongest in the world (World Bank, 2023a; Statistia, 2023).

With nearly 130 million people, a very rich cultural history and diversity, and immense natural resources, Mexico finds itself potentially to be among the 15 largest economies worldwide and the second-largest economy in the Latin American region, having strong institutions in macroeconomics, open to trade, and boasting a diversified manufacturing base integrated along global value chains. For the past three decades, Mexico has underperformed in growth, inclusiveness, and poverty reduction compared with other peer countries. Mexico's average annual economic growth was more than 2 percent between 1980 and 2022; hence, not much progress in convergence has been achieved toward the high-income economies. The Mexican economy grew by 3.2% in 2023, marking the second consecutive year of growth above 3%, while moderation after the post-pandemic rebound was expected. The multidimensional poverty rate, which is an official indicator, fell from 43.9% in 2020 to 36.3% in 2022; it has removed 8.8 million Mexicans from a situation of poverty, while extreme poverty, which represents the population that faces difficulties in exercising at least one of these rights, has fallen at a much slower pace. Employment and Gross Domestic Product levels before the pandemic have been recovered. Mexico's stable macroeconomic framework, along with the dynamism of the United States-with a solid manufacturing base-will sustain economic growth (World Bank, 2023b).

South Africa is the 2nd strongest economy and by far the largest GDP per capita in sub-Saharan Africa. Its GDP per capita (on PPP) is approaching to 15847 USD in 2023. Recently is trade balance has moved from a small deficit to a

small surplus. Like Mexico and Germany, it has a floating exchange rate regime (World Bank, 2023c; Statistia, 2024).

Finally, Cameroon is a low-income developing country with a GDP per capita (on PPP) of around 4840 USD in 2023. Nevertheless, it is the strongest economy in Central Africa. It uses common Central African CFA franc as its currency, which is also pegged to the euro. Therefore with its fixed exchange rate regime, Cameroon is substantially different from the previous three countries selected. With the selected four so different countries, we attempt to examine the symmetric and asymmetric effect of RER undervaluation on GDP growth. We do so in order to find out if the way the economic growth responds to currency undervaluation does change with changing economic conditions and structures (World Bank, 2023d), International Monetary Fund (IMF, 2023).

3.2 *Methods and procedure*

Rodrik (2008) mentioned that exchange rate undervaluation has a positive effect on growth but under this method, which is called the *PPP* approach, the nominal exchange rates (*XART*) and the *PPP* conversion rates (*PPP*) from the Penn World Tables (PWT) are used to calculate the real exchange rate for each country *i* at each time period *t*:

$$\ln\left(RER\right)_{it} = \ln\left(\frac{XRAT_{it}}{PPP_{it}}\right) \tag{1}$$

Taking into account the observation that non-tradable goods prices are lower in low-income countries in line with the Balassa-Samuelson theorem, Rodrik (2008) undertakes a correction via the regression below:

$$\ln\left(\widehat{RER}\right)_{it} = \alpha_0 + \alpha_1 \ln\left(RGDP\right)_{it} + f_t + e_{it} \tag{2}$$

Where *RGDP* is the per-capita GDP, f_t is the time fixed effect, and e_t is the error term. In the final step, the fitted values from the above regression are used to calculate the undervaluation index as below:

$$\mathrm{Under}_{it} = \ln(RER)_{it} - \ln\left(\widehat{RER}\right)_{it} \tag{3}$$

Under shows the undervaluation variable (an index value higher than one indicates an undervaluation of the exchange rate).

This paper, Implements the autoregressive distributed lag (ARDL) model to evaluate the responsiveness of economic growth to real exchange rate undervaluation. This methodology, was developed by Pesaran et al. (2001) in the symmetric form and extended by Shin et al. (2009) for the asymmetric case to test the short and long-term relationship between the variables. One important advantage of this approach is applicability even if the variables are integrated, stationary or mutually cointegrated. Hence it does not require that the series are integrated in the same order to find a possible cointegrating relationship between these variables. Another advantage is that this methodology has good statistical properties in small samples (see Delatte and Lopez-Villavcencio, 2012).

We estimate a non-linear ARDL (NARDL), as suggested by Shin et al. (2014). The NARDL is based on the following equation:

$$\Delta Gr_t = c + \alpha_0 Gr_{t-1} + \alpha_1^+ \, \text{Under}_{t-1}^+ + \alpha_1^- \, \text{Under}_{t-1}^- + \alpha_2^+ \, \text{Inv}_{t-1}^+ + \alpha_2^- \, \text{Inv}_{t-1}^- + \alpha_3^+ \, \text{Gov}_{t-1}^+ + \alpha_3^- \, \text{Gov}_{t-1}^-$$

$$+ \alpha_4^+ \, \text{Linf}_{t-1}^+ + \alpha_4^- \, \text{Linf}_{t-1}^- + \theta_i \sum_i^p \Delta Gr_{t-i} + \gamma_i^+ \sum_i^q \left(\Delta \, \text{Under}_{t+1-i}^+ + \Delta \, \text{Inv}_{t+1-i}^+ + \Delta \, \text{Gov}_{t+1-i}^+ + \Delta \, \text{Linf}_{t+1-i}^+ \right)$$

$$+ \gamma_i^- \sum_i^q \left(\Delta Under_{t+1-i}^- + \Delta \, \text{Inv}_{t+1-i}^- + \Delta \, \text{Gov}_{t+1-i}^- + \Delta \, \text{Linf}_{t+1-i}^- \right) + \varepsilon_t \qquad (4)$$

Where Gr is economic growth, Under hows the real exchange rate undervaluation, Inv presents the investment, Gov is government consumption, Linf shows the logarithm of inflation, p and q are the lag orders of the dependent and independent variables, respectively. The superscripts (-) and (+) show the negative and positive partial sum decomposition of lagged levels and first differences of real exchange rate undervaluation as Apergis and Vouzavalis (2018) mentioned.

$$\text{Under}_t^+ = \sum_{j=1}^T \max \left(\Delta P_j, 0 \right) \qquad (5)$$

and

$$\text{Under}_t^- = \sum_{j=1}^T \min \left(\Delta P_j, 0 \right) \qquad (6)$$

Alphas are the long-run parameters and cointegrating relationship can be obtained by dividing the αs by α_0 and testing for a long-run relationship by the bound test for the null,

$$H_0: \ \alpha_0 = \alpha_i^+ = \alpha_i^- = 0$$

In addition, asymmetries in the long and the short run can be tested as follows:

$$H_0: \ \alpha_i^+ = \alpha_i^-$$

and

$$H_0 = \sum_{i=0}^{q-1} \gamma_i^+ = \sum_{i=0}^{q-1} \gamma_i^- \qquad (7)$$

According to Wald test. The cumulative dynamic multiplier effects can be written as $m_h^+ = \sum_{j=0}^h \dfrac{\partial \text{Growth}_{t+j}}{\partial \text{Under}_t^+}$ and $m_h^- = \sum_{j=0}^h \dfrac{\partial \text{Growth}_{t+j}}{\partial \text{Under}_t^-}$, for $h = 0, 1, 2, \ldots$ (see Shin et al., 2014).

The coefficients γ^+ and γ^- capture the short-run adjustment of real exchange rate undervaluation to economic growth as Cuestas and Gil-Alana (2018) mentioned in their article.

4. Empirical results

First of all, we carry out unit root tests that were developed by Elliott et al. (1992) as a modification of Augmented Dickey-Fuller (1979) test to examine the stationary property of economic growth (Growth) and real exchange rate undervaluation (Underval). The results are presented in Table 1 below.

Table 1. Unit root test results

	Gr		Under		Inv		Gov		inf	
	Level	1st Diference	Level	1st Diference	Level	1st Diference	Level	1st Diference	Level	1st Diference
Cameroon	-2.59	-10.96***	-1.75	-6.32***	-2.04	-7.08***	-2.49	-7.13***	-4.66***	-
Mexico	-2.32	-4.80***	-2.41	-5.90***	-3.34**	-	-1.92	-5.53***	-11.24***	-
South Africa	-2.11	-7.27***	-2.13	-5.29***	-3.06**	-	-3.44**	-	-1.17	-12.61***
Germany	-2.23	-5.05***	-2.26	-6.30***	-2.14	-6.32***	-1.98	-5.46***	-3.13**	-

Source: Author's computation. Note 1: The null hypothesis is that there exists unit root. Note 2: (*), (**) and (***) indicate that the estimated parameters are significant at the 1%, 5%, and 10% significance level respectively.

For all the variables of Cameroon, except for inflation, and Inf, the ADF test statistic at the level is insignificant, as the test statistic is greater than the critical values. This, therefore, may mean that the series are nonstationary at their levels. After first differences are taken, all test statistics (Gr, Under, Inv, Gov) become highly significant. This implies these variables are integrated into order one.

Inflation (inf) is stationary at the level, significant at 1% hence I(0), stationary at the level.

The variables Gr, Under, and Gov are non-stationary at a level in Mexico. However, after first differencing, the test statistics become significant for the ADF test, hence, stationary. Inv and inf variables are stationary at level, hence I(0).

In South Africa, the variables Gr, Under and Inf are non stationary at level but become stationary when first differenced hence they are I(1). Investment-Inv and Government expenditure-Gov are stationary at the level, therefore they are I(0). All the variables in Germany, Gr, Under, Inv, and Gov are all non-stationary at the level but upon first differencing they become stationary, hence I(1). The inflation variable is significant at the level of 5% at the differenced level, hence I(0).

Table 2. Cointegration Test

	Cameroon	Mexico	South Africa	Germany
Cointegration Test F-Statistics	14.78***	8.25***	9.74***	19.47***

Source: Author's computation. Note 1: The null hypothesis is that there exists unit root. Note 2: (*), (**) and (***) indicate that the estimated parameters are significant at the 1%, 5%, and 10% significance level respectively.

The cointegration test results for four countries (Cameroon, Mexico, South Africa, and Germany) are presented in the Table 2. F-statistics are used to deduce the existence of a long-run relationship or, equivalently, cointegration among the variables under study.

This cointegration test takes the null hypothesis of no cointegration-that is, no long-run relationship-between the variables. Therefore, if the F-statistic turns out to be significant, we will go ahead and reject the null hypothesis, hence

concluding that cointegration exists between the variables or, alternatively, that a long-run relationship does exist. In all four countries, namely Cameroon, Mexico, South Africa, and Germany, F-statistics are significant at 1%, implying that there is cointegration. This therefore means that the variables in the respective models are cointegrated, hence sharing a long-run equilibrium relationship even if they may at times deviate in the short run from this relationship. In summary, the results confirm the existence of long-run associations among the variables for each country in the study.

Next, we turn our attention to asymmetry tests. An asymmetry test basically tests if the equation coefficients are equal or not. If they are equal then there is no asymmetry and if they are not equal then there is evidence of asymmetry. Table 3 presents the results for our selected countries.

Table 3. Asymmetry test statistics

Country	Long-run effect [+]	Long-run effect [-]	Long-run asymmetry	Short-run asymmetry
Cameron	0.00	0.00	0.00	0.00
Mexico	0.71	0.54	0.44	0.64
South Africa	0.26	0.12	0.88	0.76
Germany	0.42	0.70	0.19	0.79

Source: Author's computation. Note 1: Long-run effect [-] refers to a permanent change in the exogenous variable by -1. Note 2: Null hypothesis: Variable is not significant.

According to Table 3, there is an asymmetric relation between RER undervaluation and GDP growth in Cameroon both for the short-run and the long-run. The effect of RER undervaluation on GDP growth in the short run is significant because P-value is 0.00. As for the long-run effect of undervaluation, positive shocks in the long run, and negative shocks in the long run are significantly based on the zero P-values.

Also, Our results show that there is a symmetric relationship between the variables for Mexico, South Africa, and Germany in both the short-run and long-run with positive and negative shocks. According to these findings, we use non-linear ARDL (NARDL) model for Cameroon because of the asymmetric effect and the ARDL model for the remaining three countries. Table 4 shows the estimation results of NARDL model with two lags of independent variables for Cameroon.

The nonlinear autoregressive distributed lag regression results are presented for Cameroon in Table 4, with both the long-run and short-run estimates. This model allows us to test for asymmetric effects of the series of positive and negative changes in independent variables; the dependent variable is marked by [+], and [-], respectively.

With both the short- and long-run scenarios, as Table 4 suggests, determining the state of economic growth in Cameroon, most of the variables present significant asymmetries on the impact of changes in undervaluation, investment, government spending, and inflation. This means that positive and negative changes pertaining to the stated variables relative to their impacts on growth are imbalanced, and therefore any analysis of economic policies in consideration should address both short-run and long-run dynamics. The asymmetry in the responses of growth to positive versus negative changes in undervaluation, investment, government expenditure, and inflation are suggested by the long-run results. In sum, negative and positive shocks in undervaluation tend to reduce growth in the long run, but increases in investment and government expenditure do lead to increased growth. The relationships observed for the positive growth effects of reductions in investment and government expenditure, though interesting, are at best marginally significant.

Table 4. NARDL Regression Cameroon

Variable	Statistic	P-Value
Long-Run		
Gr(-1)	0.97	0.01
Under [+]	-0.56	0.06
Under [-]	-0.34	0.07
Inv [+]	0.08	0.09
Inv [-]	0.44	0.07
Gov [+]	0.23	0.06
Gov [-]	0.47	0.07
Linf [+]	-0.2	0.08
Linf [-]	-0.16	0.09
Short-Run		
Under	0.01	0.02
Inv	0.08	0.05
Gov	0.07	0.08
Linf	0	0.08

Source: Author's computation

Undervaluation and investment are statistically significant in their positive impact on growth in the short term, while government expenditure and inflation are not as important.

Results of the ARDL for the three countries-Mexico, South Africa, and Germany-are presented in Table 5. The ARDL model identifies not only the short-run but also the long-run relationship between the dependent variable (economic growth) and the independent variables, including undervaluation (Under), investment (Inv), government expenditure (Gov), and inflation (Linf).

In the long run, while undervaluation positively influences growth for Mexico and South Africa, it affects growth negatively (insignificant) in the case of Germany. The influence of investment on growth is positive in the long run for all the countries under study, though it is highest for South Africa. Long-run growth for both Mexico and Germany is positively influenced by government expenditure, but for Germany it is smaller. It is not statistically significant in the case of South Africa. The other long-run impact of inflation on growth, though negative in the case of Germany, is insignificant statistically in the case of Mexico and South Africa. All the error correction terms in the short-run bear a negative sign and are highly significant, suggesting thereby that any short-run deviation from the long-run equilibrium gets corrected relatively quickly in each country.

Table 5. ARDL Regression

Variable	Mexico	South Africa	Germany
	Coefficient		
Long-Run			
Under	0.09**	0.64**	-0.23
Inv	0.23*	0.37***	0.29***
Gov	0.36*	0.48	0.03*
Linf	-0.66	-0.58	-0.39*
Short-Run			
ECM(-1)	-0.94***	-0.83***	-0.92***
D(Under)	0.32***	-	-
D(Inv)	0.8*	0.32**	0.21***
D(gov)	-	0.15*	0.54***
D(Linf)	-	-	-

Source: Author's computation. Note 1: The null hypothesis is that there exists unit root. Note 2: (*), (**) and (***) indicate that the estimated parameters are significant at the 1%, 5%, and 10% significance level respectively.

In countries such as Mexico and South Africa, undervaluation acts to spur economic growth through competitiveness in exportation. An undervalued currency means domestic goods are cheap to foreign buyers, which enhances exports. As such, it raises production, scale economies, and reinvestments by firms producing for export. Undervaluation might also lure FDI, since foreign investors find it cheap to invest in an undervalued economy and thus contribute to its growth. Moreover, in developing or emergent markets such as Mexico and South Africa, undervaluation shelters domestic industries from foreign competition and may have the effect of promoting industrialization and, therefore, job creation. This would, over a succession of years, bring about higher productivity and economic growth. The effect of undervaluation may also be different in a highly developed and industrialized economy like Germany. Undervaluation creates inflationary pressures through higher import prices, as foreign currencies would become more expensive. Higher import prices would raise the cost of domestic firms relying on imported inputs and thus would probably erode competitiveness in the long run. Moreover, global trade imbalances may provoke protectionist countermeasures from the trading partners, which in turn will damage long-term growth.

In the short-run, undervaluation has a statistically significant positive impact on growth in Mexico but no such evidence of significant effect is reported for South Africa and Germany. The impact of investment is positive and consistent to determine a short-run growth in all three countries, though the strongest effect is observed in Mexico. Besides, investment consistently has a positive effective impact on the short-term growth for all the three countries, with the most robust effect seen in Mexico. No coefficients for any country were given out, which means inflation is supposed not to be an important short-run determinant of growth in the countries that are studied.

In the short term, undervaluation can have an even more immediate positive impact on export demand, which is evidenced in Mexico. Exporters in the short run may benefit immediately from their goods priced lower in foreign markets, revenues rise which could increase growth in the short run.

Table 6. Diagnostic Tests

Diagnostic Tests	Cameroon	Mexico	South Africa	Germany
Heteroskedasticity Test: Breusch-Pagan-Godfrey	0.15	0.80	0.18	0.10
Breusch-Godfrey Serial Correlation LM Test	0.38	0.37	0.42	0.47
Ramsey RESET test	0.12	0.70	0.28	0.11

Source: Author's computation. Note 1: The numbers presented in the Table are p-values.

Table 6 includes Cameroon, Mexico, South Africa, and Germany diagnostic tests of reliability and validity of the regression models. These tests are important in ensuring that estimates obtained from the model are robust and unbiased. The null hypothesis of the Breusch-Pagan-Godfrey test is no heteroskedasticity. Since all p-values are above the typical significance levels taken to be 1, 5, and 10%, respectively, we fail to reject the null hypothesis in any of these cases. This implies that no heteroskedasticity has occurred, and the variance of the error terms is constant in all models; thus, the regression results are reliable in this direction.

In Breusch-Godfrey Serial Correlation LM Test, the null hypothesis is one of no serial correlation in residuals. Because all p-values are greater than common significance levels, namely 1%, 5%, or 10%, we fail to reject the null hypothesis. That means none of the models reveal any evidence of serial correlation, and hence all models do not have a problem with autocorrelated errors and are well-specified in this regard. The null hypothesis of the Ramsey (1969) RESET test is that the model is correctly specified-i.e., there are no omitted important variables and the functional form is appropriate. Since all the p-values are well above conventional levels of significance of 1%, 5%, or 10%, one fails to reject the null hypothesis. This means that no evidence of model misspecification may be traced in any of the models, and thus the functional forms and the variables included appear appropriate.

All diagnostic tests suggest that the regression models for Cameroon, Mexico, South Africa, and Germany appear well-specified and hence reliable. Specifically:

There is no heteroskedasticity; the error terms are constant in variance.

There is no serial correlation of residuals and thus no correlation between successive errors.

The models are appropriately specified, with no omitted variable or misspecification of functional form.

These results give confidence in the robustness of the estimated coefficients and their interpretations in the context of the regression analysis.
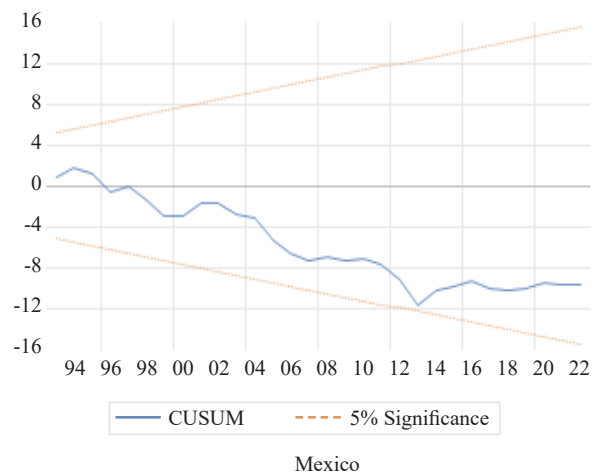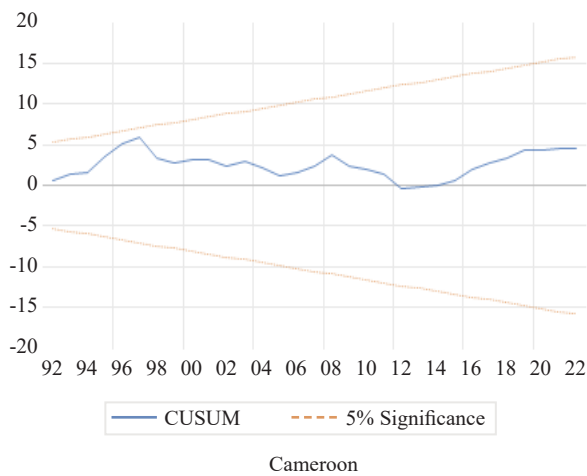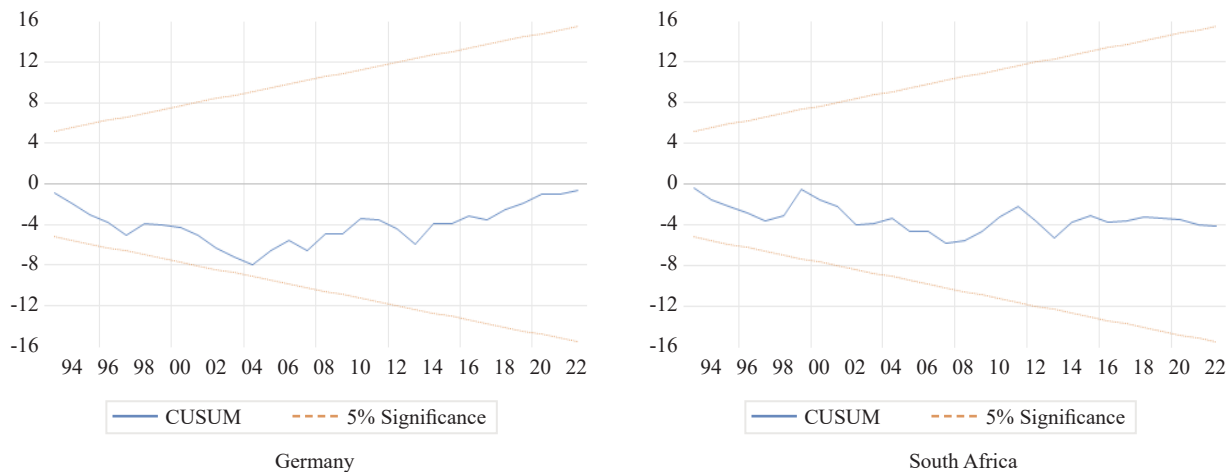

Cameroon

Mexico

Figure 1. CUSUM Test

Source: Author's computation

CUSUM tests reflecting the stability of estimated regression coefficients over time for Cameroon, Mexico, Germany, and South Africa are presented. Blue lines in Figure 1 show the cumulative sum of residuals, while red lines indicate critical boundaries at a chosen significance level, often set to 5%. Because the blue lines for all four countries lie inside the red lines, this suggests that the models are stable over time. In fact, there is no evidence of any structural breaks or instability in the estimated relationship, which supports the idea that the estimated regression coefficients are stable over the sample period. This stability increases the reliability of the long-run estimates and the short-run estimates of the model by showing that the results are robust and not susceptible to major changes in the underlying relationships.

4.1 *Discussion*

The empirical findings of this study contribute to an understanding of the RER undervaluation and economic growth relationship in different contexts. These results are compared to a large body of literature developed starting from 2016, exploring similar dynamics within different countries and economic structures. What follows is the comparison between the findings and the key recent contributions to this setting, underlining convergences and divergences of results.

The results for Mexico, where a positive relationship between RER undervaluation and growth in GDP is revealed, are consistent with a number of recent studies that focus on the role of undervaluation in developing economies. This shows that undervaluation could increase competitiveness in exports and boost growth, as affirmed by Rodrik in 2008, considering Mexico's managed floating exchange rate regime. According to Bussière et al. (2020), undervaluation has a tendency to favor countries with export-led growth strategies that are oriented mostly in emerging markets. Their result, therefore, shows an undervaluation that improves the trade balance and is conductive to higher economic output, supporting evidence from Mexico. Habib et al. (2017) also support the positive effects of undervaluation in emerging markets. It finds out that undervaluation stimulates growth by making exports more competitive, which comes in line with the results found for Mexico, where both short- and long-run undervaluation has a positive and significant effect on growth.

Magud and Sosa (2013) subscribe to this positive relationship between undervaluation and growth in a great many emerging markets, they note that this effect does not appear to be very persistent over time. In some cases, the continuous undervaluation may have an impact, which can be manifested in inflationary pressures and other imbalances. For Mexico, this permanent positive effect found in the study slightly goes against this argument, therefore implying that the economic structure and external sector dynamics of Mexico might have cushioned off such imbalances.

The results for South Africa reveal an insignificant relationship between RER undervaluation and the growth in GDP, which is consistent with some recent studies that put more weight on country contextual specificities, especially in the commodity export-based emerging economies.

Coulibaly et al. (2024) find in their study on African economies that in commodity export-driven countries like South Africa, it may be that the stimulant effect from undervaluation will not be the same compared to more diversified countries. This provides support for this study's findings of no significant effect of RER undervaluation on GDP growth due to the nature of South Africa's export structure.

Akinboade and Makina (2006) further argue that in this context, the effects of RER undervaluation on economic growth in South Africa will also be offset by domestic constraints such as infrastructure bottlenecks and labor market inefficiencies. This kind of structural factor could contribute to a lessening of the effectiveness of undervaluation as a growth strategy.

Irandoust, 2021, finds that undervaluation could still have a positive but delayed effect on growth in South Africa, contingent upon fixing the prevailing macroeconomic imbalances. The current results do not show such effects; probably due to the time series and model at hand.

The results for Germany also portray that the relationship between RER undervaluation and growth is insignificant, supporting recent literature arguing that undervaluation is less effective in the case of advanced economies dominated by non-tradable sectors.

Rodrik (2018) further reiterates that undervaluation strategies for countries such as Germany, with advanced and highly developed economies, are improbable to stimulate significant growth; their structure holds dominant balances relying on non-tradable services, hence rendering undervaluation an ineffective policy tool. Schnabl (2017), in their study on advanced economies, find that undervaluation does not affect growth significantly due to the higher share of value-added services and high capital and technology. This also explains the finding for Germany in this paper that undervaluation does not affect GDP growth. As developed by Lavoie (2021), exchange rate policies of developed economies assert that undervaluation can still be helpful in times of crisis to kick-start growth. Although in this paper, the results on Germany turn out to be insignificant, the works of Lavoie imply that undervaluation can boost growth in certain macroeconomic settings even for developed nations.

The asymmetric effects of RER undervaluation on growth in the NARDL results for Cameroon fall in with many previous studies, which have shown that different exchange rate dynamics need to be considered between negative and positive shocks. Tang (2015); Sokolov et al. (2011): Both studies insist that fixed exchange rate regimes, similar to the one in Cameroon, deepen the negative effects of undervaluation, since a country is less able to respond to external shocks. Confirming their results, it is found that the growth in Cameroon is very significantly negatively affected by positive and negative undervaluation shocks.

According to Bahmani-Oskooee and Saha (2024), this study also shows how undervaluation in countries with fixed exchange rate regimes can be harmful to growth, particularly in the presence of external shocks. A similar conclusion to that made for Cameroon has been replicated in the results, which indicate that both positive and negative shocks lower growth.

Jin et al. (2021) pointed out that negative effects could be underrated under fixed exchange rate regimes. Since they pointed to mitigating factors coming from structural reforms and trade diversification, the recent findings on Cameroon's data do not control for mitigation; probably due to the insufficiency of implemented structural reforms for the sample period.

These results bring critical implications to the policy of exchange rates, especially in view of recent literature. A number of empirical articles from 2016 mainly underline that undervaluation effectiveness depends on variables such as the regime of the exchange rate, economic structure, and the level of development. The case presented by Rapetti (2020) of undervaluation supporting growth in developing nations is definitely not a panacea. These authors stress that the effect of undervaluation is quite heterogeneous across countries, depending on their export structure and the setting of the macroeconomy. This supports the mixed results across Mexico, South Africa, and Germany within the current study.

Korinek and Servén (2016) posit that exchange rate undervaluation policies must be carefully adapted to the conditions of economic circumstances. For instance, undervaluation is found to contribute to growth in Mexico, but in South Africa or Cameroon, it is bounded by structural factors. In this regard, the conclusion that emerges from this study has large chunks of similarity with the recent additions of literature on RER undervaluation and economic growth. In the case of Mexico, an undervaluation in the currency is generally pro-growth, as it has wide support for other developing countries, while for South Africa and Cameroon, countries with somewhat more sophisticated economic structures, the effects turn out to be more ambiguous or negative. The results for Germany confirm what seems to be the consensus

in the literature: undervaluation as a growth strategy is not helpful for highly developed economies. This comparative analysis thus points out that, when considering the effects of RER undervaluation on growth, there is a need to consider country-specific factors like exchange rate regimes and economic structure.

5. Conclusion

In this study, the NARDL model is relied upon for Cameroon, while the ARDL model is applied in Mexico, Germany, and South Africa. Since after it was observed there were asymmetries in the data, Cameroon clearly presented its model. This allowed the fine workings of the Cameroon economy to be considered. On the other hand, the ARDL model was employed for Mexico, Germany and South Africa; the model was better suited for the symmetric relationships in the countries.

Our study has considered the effect of undervaluation of the real exchange rate on economic growth in a variety of economic settings: developing countries, developed countries, and emerging markets. It emerges clearly from this that RER undervaluation has a pronounced impact on economic growth in developing countries, whereas such an impact is quite muted in developed countries and emerging markets. This underlines once more the heterogeneous impact of the exchange rate policy across different economic environments.

Generally, an RER undervaluation policy in developing economies, especially those with floating exchange rate regimes, encourages economic growth. Export-led growth, increasing employment, and foreign exchange earnings with the promotional efforts of the domestic industries are all stimulated by this undervaluation process of export price competitiveness. But, fundamentally, the floating exchange rate regime brings about automatic adjustment based on market forces and reduces the extreme extent to which a government will be pressed to intervene. It is through this channel that export performance and foreign investment are mopped up and injected into the economy to stimulate overall growth.

However, when the regime is such that the developing country has a fixed exchange rate, the RER undervaluation has a set of more substantive problems affixed to it. The high level of government intervention needed to enforce the peg under the fixed regimes is very costly in nature and results in economic distortions. In this circumstance, a large undervaluation with a significant demand for foreign currency reserves raises the strain on the financial resources and often misleads to adverse economic results. Meanwhile, the fixed exchange rates deprive the economy of any flexibility in the face of an external economic shock, thus intensifying the negative impact of the undervaluation.

The effect of RER undervaluation on economic growth for developed countries will be relatively insignificant. Developed countries, characterized by high technological innovations, human development, and vigorous financial systems, will barely be affected by the exchange rate. Other factors drive the growth of the developed countries that are independent of the exchange rate policies, so its influence of RER undervaluation will be minor. Similarly, whereas sensitivity to changes in exchange rate is much higher than in developed countries, the mere economic structure and policy usually neutralize the undervaluation benefit.

5.1 *Policy recommendations*
5.1.1 *Developing country with floating exchange rate*

Export competitiveness: An increase in export competitiveness is a boon of using RER undervaluation. Policymakers should focus on infrastructure and trade facilitation to realize the benefits out of undervaluation.

Encourage Foreign Investment: That is, allow the space for investment to flow into the country. A good investment climate will attract foreign capital. This, in turn, helps to further spark economic growth. This includes ways of enhancing legal frameworks, regulatory environments, and the ease of doing business.

Control Exchange Rate Movements: There should be mechanisms for watching as well as controlling exchange rate movements. Excessive volatility could damage the benefits of undervaluation.

5.1.2 *Developing countries that implement the fixed rate system*

Revisit the exchange rate regime in place: Moving towards a more flexible exchange rate system if supporting the

level of fixed peg is evidently causing an economic burden on the economy. A floating or managed float system might be more suited to external shocks and likely to reduce the negative effect of undervaluation.

Strengthening Foreign Exchange Reserves: Enough reserves should be held to maintain the peg and at the same time cushion the eventual financial pressure that is associated with undervaluation through probably diversified reserve assets and other improved reserve management strategies.

Implement Structural Reforms: Deal with the underlying economic weaknesses which tend to be worsened because of the negative pass-through from undervaluation. Resilience can increase with structural reforms or policies at the fiscal level, public sector efficiency, and economic diversification.

5.1.3 *Developed economies*

Keep Investing in Innovation and Human Capital: Keep promoting technological innovation, education, and skills development to gain economic growth autonomously from those hazards whose results are influenced by the exchange rates.

Amplify Financial Stability: Make sure that financial systems and regulatory frameworks are firmly in place and that such financial systems should support economic stability, shielding it from external shocks.

5.1.4 *Emerging markets*

Design Exchange Rate Management Policy: Policies managing exchange rate volatility with the objective of reducing the effect of undervaluations. Countries, therefore, ought to take hybrid exchange rate systems that offer a balance between flexibility and stability.

Enhance Economic Resilience: Structural diversification of economies and institutional capacities which enable a better ability to absorb the impacts of the exchange rate.

In a general sense, therefore, the paper has shown the critical, complex and asymmetric impacts on economic growth in an attempt to diversify the economy. Devaluation tends to benefit developing countries more, on the other hand, due to export promotion and attraction of foreign investments, mainly those with floating exchange rates. This can have negative implications for developing countries with fixed exchange rates due to the possibility of regime re-adjustments and structural reforms. Developed and emergent markets show fewer sensitive responses to RER undervaluation, signifying that they are the most economically stable and resilient. This underlines the fact that exchange rate policies must be tailored in light of the economic context of individual countries so that they might make the most of this in relation to economic growth.

Conflict of interest

The authors declare there is no conflict of interest at any point with reference to research findings.

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