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Heterogeneous relationship between growth and exchange rate misalignment: Evidence for African Countries?

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Abstract---The aim of this study is to analyze the heterogeneous relationship between economic growth and exchange rate misalignment in Africa. We employ the Grouped Fixed Effect (GFE) estimator. The study is based on annual data covering 38 African countries over the period 1996-2019. Three groups of countries were endogenously identified, revealing a differential impact ranging from -0.038796 to -0.001293. Our results primarily indicate that exchange rate misalignments reduce the pace of real economic growth, regardless of the income level. Moreover, these effects are more pronounced for low-income countries. Finally, fixed exchange rate regimes, followed by intermediate regimes, slow down economic growth more than flexible regimes. The major innovation of this study lies in the use of the Grouped Fixed Effect (GFE) estimator. It has allowed for the extension of the study to cover the entire African continent, in contrast to previous studies.

Keywords---Real equilibrium exchange rate, Misalignments, Economic growth, Grouped fixed effect estimator, Africa.

JEL Code: F43, C1, O47, R1.

1. Introduction

The question of exchange rate alignment remains a major concern for researchers and policymakers. According to Ramos-Herrera and Sosvilla-Rivero (2023), exchange rate misalignments are the root cause of numerous serious macroeconomic problems, hindering the pace of real economic growth. Similarly, Williamson (1983) asserts that the costs of misalignments are high for the global economy, leading to inefficient resource allocation, external imbalances, and false signals for the market.

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Exchange rate misalignment is perceived through the overvaluation and undervaluation of the real exchange rate (RER). Naja (1998) identifies RER overvaluation as the primary culprit for weak global economic performance. Mbaye (2013) argues that misalignment is linked to macroeconomic imbalance. Iqbal et al. (2023) demonstrate that exchange rate misalignment negatively impacts India's economic growth. Misalignments can also result in low economic efficiency and capital flight (Dollar, 1992). Akram and Rath (2018) find a negative relationship between RER misalignments and total factor productivity growth in most countries.

Regarding Africa, Elbadawi et al. (2012), employing the generalized method of moments system on Sub-Saharan Africa, find that overvaluation reduces growth, but its negative effect is mitigated by financial development. Owoundi (2015), using the generalized method of moments system, shows that the gain associated with undervaluation is nearly nonexistent in Sub-Saharan Africa. Ayele (2022), using Pooled Mean Group (PMG), OLS, and ARDL, demonstrates that misalignment hinders Ethiopia's growth while favoring that of Kenya. Amor et al. (2023), using NARDL, show that RER misalignments have a negative impact on economic growth in Tunisia.

In contrast to these studies in Africa, our study covers all regions of the continent (Sub-Saharan Africa and North Africa). Additionally, we employ the Grouped Fixed Effects (GFE) method. The relevance of this approach lies in its ability to easily control for unobserved time heterogeneity in panel data (Bonhomme and Manresa, 2015). Furthermore, GFE models are less sensitive to the assumptions of variable stationarity, making them more robust in the analysis of data with different trends across groups. GFE models allow for explicit testing of hypotheses concerning group heterogeneity, which can provide valuable insights into the underlying structure of the data. The GFE estimator enables us to relax the strict assumption that all countries follow the same time trend. Moreover, our study focuses solely on African countries and covers the period 1996-2019.

The remainder of the document is structured as follows: Section 2 presents a literature review, Section 3 outlines the study's methodology, Section 4 describes the data used in the analysis, Section 5 presents the results and discussion. Finally, Section 6 contains the conclusion and policy implications.

2. Literature Review

A substantial body of literature explores the connection between real exchange rate (RER) misalignments and economic growth. However, a synthesis of these studies reveals mixed results. Fidora et al. (2021) view real misalignments as an instrument to gauge a country's performance in terms of price competitiveness, while Guzman et al. (2018) provide theoretical foundations for stable and competitive RER policies as suitable tools for promoting economic growth. Ramos-Herrera and Sosvilla-Rivero (2023), applying the new fixed effects group estimator developed by Bonhomme and Manresa (2015) for 103 countries during the period 1996-2016, demonstrate that misalignments reduce the pace of real economic growth. Loayza et al. (2005) reach the same conclusion considering 78 nations. Using panel data techniques on 58 countries, Razin and Collins (1999) and Aguirre and Calderon (2005) emphasize the importance of RER misalignments in reducing growth. Ayele

(2022) examines the impact of RER misalignment on the economic growth of the least developed countries in East Africa (LDCs) using Pooled Mean Group (PMG) estimators, OLS, and ARDL cointegration tests over the period 1980-2019. The results reveal that, in the short term, RER misalignment hinders Ethiopia's growth while favoring that of Kenya.

In contrast, Krek'o and Oblath (2020) use the PPP adjusted for relative development and find that overvaluations (undervaluations) are linked to lower (higher) economic growth for European countries during the period 1995-2016. Similarly, Amor et al. (2023), using the nonlinear autoregressive distributed lag (NARDL) estimator, show a negative impact of real dinar overvaluation on Tunisia's growth performance, while undervaluation has no significant impact. Rodrik (2008), based on the Balassa-Samuelson (BS) approach, concludes that an imbalance (RER undervaluation) contributes to growth. Other empirical evidence suggesting an inverse relationship between undervaluation and growth is provided by Ribeiro et al. (2020) and Usalan (2018). Additionally, Gala (2007) finds a negative relationship between overvaluations and economic growth for 58 developing countries during the period 1960-1999. In a similar vein, Sallenave (2009) detects a negative impact of real exchange rate overvaluation on economic growth based on the BEER approach for G20 countries. Nyong (2005) establishes a negative link between misalignment and economic performance in Nigeria.

Elbadawi et al. (2012), using the generalized method of moments system on a sample of 32 Sub-Saharan African countries, find that overvaluation reduces growth, but its negative effect is mitigated by financial development in Sub-Saharan Africa. Similarly, Husain et al. (2005) observe that countries seem to benefit from increasingly flexible exchange rate systems as they become richer and develop financially. Imbs & Wacziarg (2003) also show that this negative effect is mitigated by export diversification in the case of OECD countries.

Owoundi (2015), using the generalized method of moments system on a sample of 16 Sub-Saharan African countries, demonstrates that the gain associated with undervaluation is nearly zero regardless of the exchange rate regime. Ribeiro et al. (2020) conclude that once income distribution and technological capabilities are taken into account, the direct impact of real exchange rate misalignments on growth becomes statistically nonsignificant.

As evident, there is no consensus on the link between exchange rate misalignment and economic growth. We contribute to the empirical literature by paying attention to different dynamics and specific heterogeneity that cannot be captured by macroeconomic variables, applying the fixed effects group estimator to study the relationship between economic growth and currency misalignments for the sample of 38 African countries during the period 1996-2019.

3. Methodology

3.1. Econometric Model

Our model is inspired by that of Ramos-Herrera and Sosvilla-Rivero (2023), which is the Solow model augmented with an exchange rate misalignment, specified as follows:

$$y_{it} = \alpha + \gamma y_{i,t-1} + \sum_{j=1}^n \delta_{ij} X_{ijt} + \beta MIS_{it} + \varepsilon_{it} \quad (1)$$

Where y_{it} represents the real GDP growth rate, $y_{i,t-1}$ is the logarithm of the initial real GDP per capita (to capture the "catch-up effect" or the conditional convergence of the economy towards its equilibrium state), X_{ijt} ($j = 1, \dots, n$) is a set of control variables, MIS_{it} is the deviation from the equilibrium exchange rate, and ε_{it} denotes the error term.

As covariates for economic growth, we selected the following variables: the population growth rate in percentage ($POPG_{it}$); the ratio of gross capital formation to GDP (GKF_{it}) as a proxy for investment; life expectancy at birth, a proxy for the level of human capital (HK_{it}); trade openness, measured by the sum of exports and imports over GDP ($OPEN_{it}$); and macroeconomic stability, measured by the inflation rate (INF_{it}). According to the literature, we anticipate a negative impact on economic growth from the variables $POPG_{it}$ and INF_{it} and a positive impact from GKF_{it} , HK_{it} and $OPEN_{it}$. The basic empirical model is as follows:

$$y_{it} = \alpha_i + \varphi y_{i,t-1} + \delta_1 POPG_{it} + \delta_2 GKF_{it} + \delta_3 INF_{it} + \delta_4 HK_{it} + \delta_5 OPEN_{it} + \beta MIS_{it} + \varepsilon_{it} \quad (2)$$

3.2. Estimation Method

We use the GFE estimator, which allows us to relax the strict assumption that all countries follow the same time trend. This method is inspired by the works of Bonhomme and Manresa (2015). It allows us to explore the heterogeneous effects of exchange rate misalignment on economic growth. The GFE estimator enables us to relax the strict assumption that all countries follow the same time trend. Consequently, we assume that the countries in our sample follow different time trends. In this context, our empirical model (equation 2) can take the following form:

$$g_{rj} = z'_{it} \theta + \alpha_{g_{rjt}} + \vartheta_{it}, \quad i = 1, \dots, N, t = 1, \dots, T \quad (3)$$

Where $g_{rj} \in [1, \dots, G]$ represents membership in a group, z_{it} denotes the covariates assumed not to be correlated over time with the error term ϑ_{it} but can be arbitrarily correlated with the unobserved group-specific heterogeneity $\alpha_{g_{rjt}}$. Countries within the same group share the same time profile, and the number of groups is decided or estimated by the researcher. The fundamental assumption is that the composition of the group does not change over time.

Our model is modified to allow for time-invariant additive fixed effects. Subsequently, the "within" transformation is applied to both dependent and

independent variables, and we estimate the model with variables in deviations from the "within" mean. The newly transformed variables are denoted as $\check{g}_{it} = g_{it} - \bar{g}_{it}$, $\check{z}_{it} = z_{it} - \bar{z}_{it}$ etc. The GFE in equation (2) with the transformed variables, assuming θ is common to all groups, results from minimizing the following expression:

$$(\hat{\theta}, \hat{\alpha}, \hat{\gamma}) = \underset{(\beta, \alpha, \gamma) \in \Theta^G \times A^{TG} \times \Gamma G}{\operatorname{argmin}} \sum_{i=1}^T \sum_{t=1}^T (\check{g}_{it} - \check{z}'_{it} \theta_{g_{ri}} - \check{\alpha}_{g_{rij}t})^2, \quad (4)$$

where the minimum is taken over all possible groupings $\gamma = (g_{r1}, \dots, g_{rN})$ of N units into G groups, common parameters θ , and group-specific time effects α . T is the number of periods. The parameter spaces θ and A are subsets of R^K and R , respectively. We denote by γ the set of all $\check{\alpha}_{g_{rij}t}$'s, and by α the set of all g_{rj} 's. Thus, $\alpha \in \Gamma G$ designates a particular grouping of the N units, where ΓG is the set of all groupings of $\{1, \dots, N\}$ into at most G groups.

For computational reasons, an alternative characterization is presented, based on concentrated variables of group membership. The best group for each country is then determined by:

$$\hat{g}_{rj}(\hat{\theta}, \hat{\alpha}) = \underset{(\beta, \alpha) \in \Theta \times A^{TG}}{\operatorname{argmin}} \sum_{i=1}^N \sum_{t=1}^T (\check{g}_{it} - \check{z}'_{it} \theta - \check{\alpha}_{g_{rj}(\beta, \alpha)t})^2, \quad (5)$$

where the minimum g_{rj} is chosen in case of a non-unique solution. The GFE estimator of $(\hat{\theta}, \hat{\alpha})$ could be expressed as follows:

$$(\hat{\theta}, \hat{\alpha}) = \underset{(\beta, \alpha) \in \Theta \times A^{TG}}{\operatorname{argmin}} \sum_{i=1}^N \sum_{t=1}^T (\check{g}_{it} - \check{z}'_{it} \theta - \check{\alpha}_{\hat{g}_{rj}(\beta, \alpha)t})^2, \quad (6)$$

where $\hat{g}_{ri}(\hat{\theta}, \hat{\alpha})$ is given by (6), and the group probabilities are unbounded and specific to the individual.

To minimize expression (7), two approaches are possible. The first uses a simple iterative approach and is suitable for small datasets, while the second, leveraging recent developments in data clustering, is preferable for larger-scale problems. In this paper, the first option is employed in the empirical application.

We performed GFE computations with the number of groups GG ranging from 1 to 8, and we calculated the Bayesian Information Criterion (BIC) to assess the statistical advantage of having more groups to determine the optimal number of groups (separately for each outcome variable).

In our case, the regression equation takes the following form:

$$y_{it} = \phi y_{it-1} + \delta_1 INF_{it} + \delta_2 HK_{it} + \delta_3 OPEN_{it} + \delta_4 POPG_{it} + \delta_5 GKF_{it} + \beta MIS_{it} + \alpha_{jit} + \varepsilon_{it} \quad (7)$$

where α_{jit} denotes the specific group time-fixed effect, encompassing both group fixed effects and time-fixed effects. Once the group membership is established, the coefficients of MIS_{it} in our empirical application can vary across groups. Additionally, equation (7) is estimated using a two-stage least squares (2SLS) methodology, with standard errors clustered by country, employing exogenous variables and lags of the endogenous variable (exchange rate misalignment) as instruments. This method accounts for any potential endogeneity of the exchange rate misalignment. This process will be referred to as the GFE-2SLS estimator.

4. Presentation of Data

Our data are sourced from multiple outlets. Exchange rate data are extracted from EQCHANGE by Couharde et al. (2018). This database utilizes the BEER approach following Clark and McDonald (1999) and has been employed by Ramos-Herrera and Sosvilla-Rivero (2023). Apart from exchange rate misalignments, the rest of our explanatory variables consist of the most common factors considered in the literature: population growth rate, gross capital formation, inflation rate, human capital, and degree of openness. These data primarily come from the World Bank's World Development Indicators (2021). We use GDP per capita at constant 2010 market prices, real economic growth rate, population growth rate, index of human capital, trade openness, and the consumer price index. Precise definitions of variables and data sources are presented in Table 1.

Table 1: Definition of Variables and Data Sources

Variable	Description	Source
Real economic growth rate (y)	Growth rate of real Gross Domestic Product (annual %).	World Development Indicators (World Bank)
Population growth rate (POPG)	The annual population growth rate for year t is the exponential growth rate of midyear population from year $t-1$ to t .	World Development Indicators (World Bank)
Gross capital formation ratio (GKF)	Gross fixed capital formation (% of GDP) includes equipment purchases, land improvements, schools, hospitals, construction of roads, plants, offices	World Development Indicators (World Bank)
Inflation rate (INF)	Inflation measured by the Consumer Price Index (annual %).	World Development Indicators (World Bank)
Human capital (HK)	Human capital is measured using life expectancy at birth (in years) as a proxy.	World Development Indicators (World Bank)
Degree of openness (OPEN)	It is the sum of exports and imports of goods and services (% of GDP)	World Development Indicators (World Bank)
Misalignment (MIS)	It is the difference between real effective exchange rates and their equilibrium real effective exchange rates.	Couharde et al. (2018)
Initial income per capita (y_{t-1})	GDP percapita	World Development Indicators (World Bank)

Source: Author

The results of the correlation matrix show that there is a weak correlation between the explanatory variables of the model.

Table 2. Correlation matrix

	Mis	Hk	Inf	Popg	Open	Gkf	y	y_{t-1}
Mis	1.0000							
Hk	-0.2191	1.0000						
Inf	0.1356	-0.0554	1.0000					
Popg	-0.0373	-0.1530	0.0566	1.0000				
Open	-0.0765	0.2403	0.1026	-0.2554	1.0000			
Gkf	-0.1977	0.3207	-0.0462	-0.0420	0.1703	1.0000		
y	-0.0772	0.5811	-0.0353	-0.1375	0.3709	0.2842	1.0000	
y_{t-1}	-0.0171	0.4325	-0.1725	-0.2571	0.2914	0.3468	-0.2713	1.0000

Source: authors

Based on the results of the correlation analysis, we applied the Variance Inflation Factor (VIF) test to formally verify the presence of multicollinearity in the model. Table 3 reveals low multicollinearity among the model's variables. With an average VIF value of 1.15, this indicates an absence of collinearity between the variables, ensuring that the unique contribution of each variable is clearly identifiable.

Table 3. VIF test

Variable	VIF	1/VIF
Hk	1.42	0.705912
Open	1.20	0.835404
Popg	1.16	0.860571
Gkf	1.12	0.896666
Mis	1.08	0.924020
Inflation	1.07	0.932229
y_{t-1}	1.03	0.970813
Mean VIF	1.15	

Source: authors

Table 4 presents the descriptive analysis of the variables.

Table 4. Descriptive analysis of the data

Variable	Mean	Std. dev.	Min	Max	Observation
y	5.073222	0.992834	-4.4000012	11,02999	912
Gkf	20.86124	2.162942	12.424358	79.40108	912
Mis	-0.027316	0.049110	-0.8892942	1.402073	912
Hk	26.91136	2.293466	14.098164	76.59331	912
Inf	4.138462	0.400512	-3.233384	13.10560	912
Popg	2.560241	0.276505	-1.131516	16.62554	912
Open	0.335013	0.095546	0.0151541	1.412723	912
y_{t-1}	3.292161	0.394653	2.2795146	4.207122	912

Source: authors

Figure 1 presents the evolution of the average exchange rate misalignment for the 38 African countries in our sample from 1996 to 2019, categorizing them as Low-Income Developing Countries (LIDC) and Emerging Market Economies (EM).

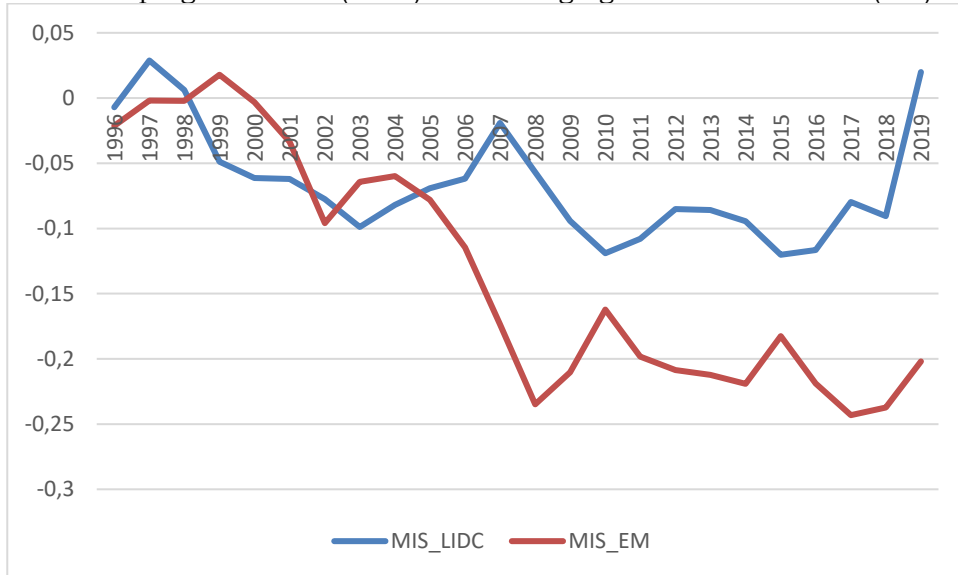


Figure 1. Misalignment by Income Classification: 1996-2019.
Sources: Authors

Figure 2 illustrates the evolution of the average exchange rate misalignment for the 38 African countries in our sample, covering the period from 1996 to 2019, and categorizes them based on their adoption of fixed, intermediate, or flexible exchange rate regimes.

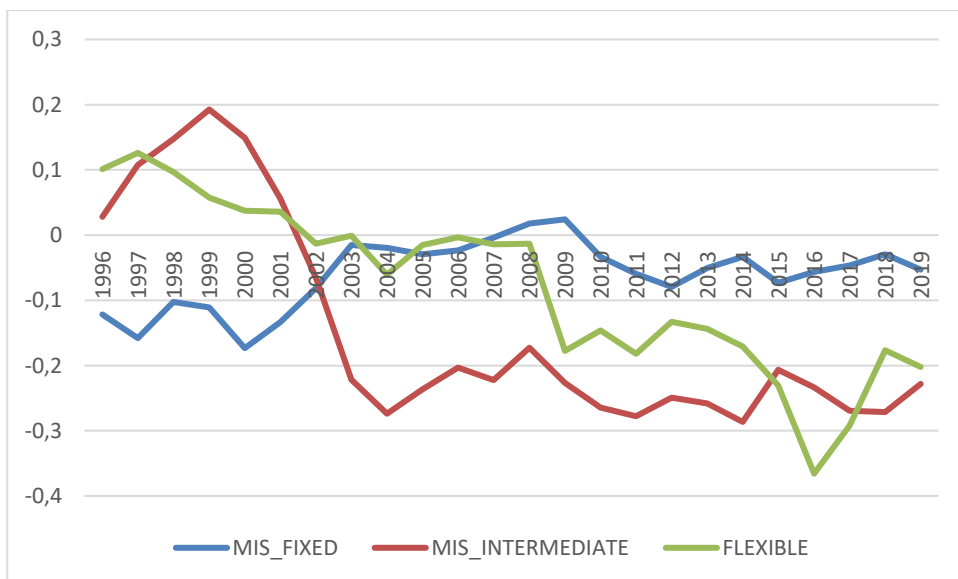


Figure 2. Misalignment by adopted exchange rate regime: 1996-2019.
Sources: Authors

5. Results and Discussions

Table 5 presents the estimation results for equation (7) using the GFE, and GFE-2SLS methods. To account for correlated unobserved heterogeneity, the GFE estimator is utilized. Finally, the GFE-2SLS technique is applied to consider the possibility of endogeneity of the exchange rate misalignment.

Our main variable is highly significant. Specifically, the higher the misalignment of the real effective exchange rate, the lower the real economic growth, regardless of the methodology used. According to the GFE-2SLS results, an additional point on deviations from the equilibrium exchange rate is associated with a reduction in the growth rate of 0.006079 in the GFE-2SLS estimation.

Table 5. Results of the Reference Model Estimations

	GFE	GFE-SLS
y_{it-1}	-0.00216*** (-7.200)	-0.00213*** (-10.142)
popg_{it}	-0.00117*** (-8.357)	-0.00112*** (-6.222)
hk_{it}	0.0012* (1.714)	0.0013** (2.166)
open_{it}	0.00103*** (7.357)	0.00101*** (3.258)
inf_{it}	-0.00012*** (-4.00)	-0.00014*** (-3.414)
mis_{it}	-0.00601 *** (-5.008)	-0.00607*** (-5.950)
gkf_{it}	0.00056* (1.694)	0.00059** (2.107)
Constant	-0.00121*** (-3.781)	-0.00118*** (-4.0689)
Country FE	No	No
Group FE	Yes	Yes
Year FE	Yes	Yes
Group-year FE	Yes	Yes
N	1178	1178
R²	0.3204	0.3217
BIC	-5801.3362	-5893.576
RMSE	0.0167	0.0151

Notes: The numbers in square brackets represent the p-values. The numbers in parentheses are t-statistics. *, **, and *** indicate significance at the 10%, 5%, and 1% levels respectively.

Source: authors

It is noteworthy that the Bayesian Information Criterion (BIC) value of the GFE-2SLS estimation is lower than the objective function values of the GFE estimations, suggesting that part of the heterogeneity among countries varies over time in our sample, thus justifying the use of the GFE-2SLS estimator.

Regarding the usual explanatory factors of economic growth, they exhibit signs consistent with the literature. In particular, we observe that the lag of real GDP per capita is negatively associated with economic growth. As expected, higher inflation rates are linked to lower real economic growth per capita. Another significant explanatory variable is the population growth rate, which is negatively associated with the standard of living. On the other hand, the ratio of gross capital formation, human capital, and the degree of openness have a positive impact on real economic growth. These results are consistent with those of Owoundi (2015), Elbadawi et al. (2012), and Ramos-Herrera and Sosvilla-Rivero (2023).

The GFE-2SLS model endogenously identifies three groups (the number was chosen using information on BIC change). The estimated classification of countries belonging to each group is listed in Table 6, and Figure 3 provides a map of countries in each group.

Table 6. Endogenous Classification by Groups of Countries Detected Based on the Misalignment Coefficient

Group 1	IMF Income Class	World Bank Income Class	Region	Aggregate RR	CRR
Angola	LIDC	LM	Sub Saharan Africa	F	1
Gabon	LIDC	UM	Sub Saharan Africa	F	1
Morocco	EM	LM	North Africa	INT	2
Namibia	EM	UM	Sub Saharan Africa	F	1
Seychelles	EM	H	Sub Saharan Africa	INT	2
South Africa	EM	UM	Sub Saharan Africa	FL	3
Tunisia	EM	LM	North Africa	INT	2
Group 2	IMF Income Class	World Bank Income Class	Region	Aggregate RR	CRR
Algeria	EM	LM	North Africa	INT	2
Benin	LIDC	LM	Sub Saharan Africa	F	1
Cape Verde	LIDC	LM	Sub Saharan Africa	F	1
Cameroon	LIDC	LM	Sub Saharan Africa	F	1
Congo	LIDC	LM	Sub Saharan Africa	F	1
Ivory Coast	LIDC	LM	Sub Saharan Africa	F	1
Egypt	EM	LM	North Africa	INT	2
Gambia, The	LIDC	L	Sub Saharan Africa	INT	2
Ghana	LIDC	LM	Sub Saharan Africa	INT	1
Kenya	LIDC	LM	Sub Saharan Africa	INT	2
Madagascar	LIDC	L	Sub Saharan Africa	FL	3

Mali	LIDC	L	Sub Saharan Africa	F	1
Nigeria	LIDC	LM	Sub Saharan Africa	INT	2
Senegal	LIDC	L	Sub Saharan Africa	F	1
Sierra Leone	LIDC	L	Sub Saharan Africa	INT	2
Tanzania	LIDC	LM	Sub Saharan Africa	INT	2
Zambia	LIDC	LM	Sub Saharan Africa	FL	3
Group 3	IMF Income Class	World Bank Income Class	Region	Aggregate RR	CRR
Burkina Faso	LIDC	L	Sub Saharan Africa	F	1
Burundi	LIDC	L	Sub Saharan Africa	INT	2
Central African Republic	LIDC	L	Sub Saharan Africa	F	1
Comoros	LIDC	LM	Sub Saharan Africa	F	1
Equatorial Guinea	LIDC	UM	Sub Saharan Africa	F	1
Ethiopia	LIDC	L	Sub Saharan Africa	INT	2
Guinea-Bissau	LIDC	L	Sub Saharan Africa	F	1
Lesotho	LIDC	LM	Sub Saharan Africa	F	1
Niger	LIDC	L	Sub Saharan Africa	F	1
Democratic Republic of Congo	LIDC	L	Sub Saharan Africa	INT	1
Rwanda	LIDC	L	Sub Saharan Africa	INT	2
Tchad	LIDC	L	Sub Saharan Africa	F	1
Togo	LIDC	L	Sub Saharan Africa	F	1
Uganda	LIDC	L	Sub Saharan Africa	FL	3

Notes: Country classification considers both the International Monetary Fund (IMF) and World Bank rankings. The exchange rate regimes classification is based on the framework proposed by Ilzetzki et al. (2019).

Source: author

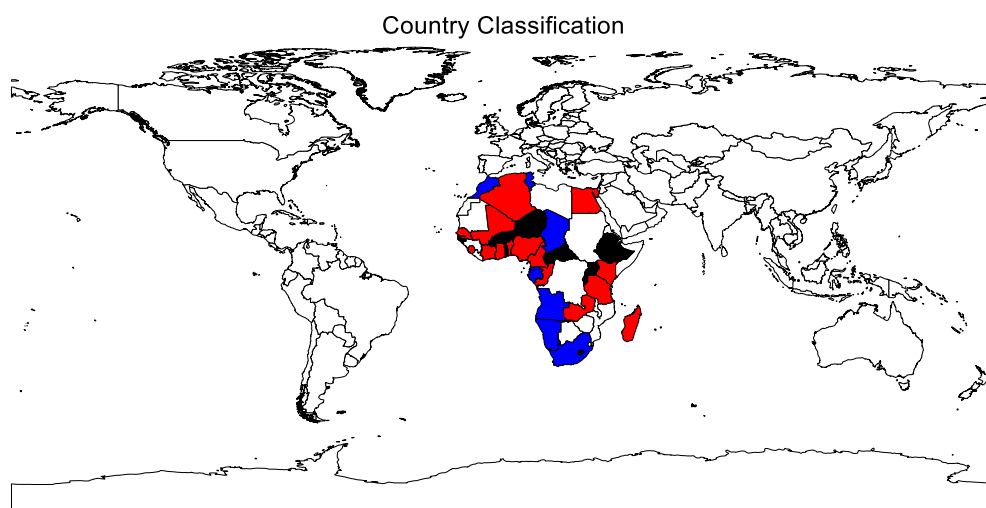


Figure 3. Effect of Exchange Rate Misalignment Changes on Economic Growth by Country Groups.

Note: Group 1 is represented by the color blue, Group 2 by the color red, and Group 3 by the color black.

Source: authors

We further estimate the model, taking into account specific slopes by introducing interactions between MIS_{it} and group indicator variables to examine whether exchange rate misalignment affects real economic growth per capita differently across groups. Table 7 presents the results, where the estimated effect for group 1 is the largest, while that for group 3 is the smallest. As shown in Table 7, the coefficient of the interaction term is negative and highly significant for all groups, with the estimated impact ranging from -0.038796 in group 1 to -0.001293 in group 3.

Our results align with those of Ramos-Herrera and Sosvilla-Rivero (2023) and Razin and Collins (1999), who identify that Africa has experienced pronounced misalignments, suggesting a decrease in real per capita output by 0.6 percentage points due to a 10% overvaluation. Moreover, considering 60 economies over a long period, Aguirre and Calderon (2005) emphasize that a 5% increase in the degree of misalignment would result in a 20 basis points decline in annual growth.

The most significant effect is observed in Group 3, characterized by the implementation of a fixed exchange rate regime, specifically category 1 in the coarse classification of exchange rates. Group 3 consists of twelve low-income Sub-Saharan African economies classified as developing. Group 1 is the least affected by misalignments. This group is composed of mixed-income classification countries, featuring fixed, intermediate, and flexible exchange rate regimes. Additionally, a significant number of these economies exhibit higher governance quality indicators.

Table 7. Heterogeneous Effects by Country Groups

	GFE-2SLS
y_{it-1}	-0.00217*** (-3.741)
pop_{it}	-0.00114*** (-4.384)
hk_{it}	0.00124** (7.294)
open_{it}	0.00103*** (4.478)
inf_{it}	-0.00016*** (-3.200)
gkf_{it}	0.00042*** (5.250)
group1*mis_{it}	-0.00129*** (-4.161)
group2*mis_{it}	-0.00342*** (-7.434)
group3*mis_{it}	-0.03879*** (-14.528)
Constant	-0.00127*** (-9.307)
Group FE	Yes
Year FE	Yes
Group-year FE	Yes
N	1178
R²	0.3216
AIC	-5898.159
RMSE	0.0139

Note: In the estimation, we include the same explanatory variables as in Table 1, as well as interactions between MISit and dummy variables Group i (i = 1,2,3), which take the value one if the country belongs to the corresponding group i and zero otherwise. Refer to Table 6 for the list of countries belonging to each group. Numbers within brackets represent t-statistics. *, **, and *** indicate significance at 10%, 5%, and 1%, respectively.

Source: Author

Our results align with those of Ramos-Herrera and Sosvilla-Rivero (2023) and Naja (1998), who argue that real exchange rate misalignments are one of the most critical factors contributing to the weakness of global economic performance. In addition, we estimated the model using alternative country group classifications based on income levels, sub-regions, and exchange rate regimes to confirm the validity of the empirical results.

Table 8. Heterogeneous Effects by Group Using Alternative Country Group Classifications

	GFE-2SLS (1)	GFE-2SLS (2)	GFE-2SLS (3)
y_{it-1}	-0.03174*** (-24.796)	-0.03142*** (-22.056)	-0.03281*** (-24.125)
pop_{git}	-0.00240*** (-4.528)	-0.00262** (-13.789)	-0.00291** (-8.558)
hk_{it}	0.00735* (43.235)	0.00754* (32.782)	0.00746** (5.040)
open_{it}	0.00131*** (8.733)	0.00157*** (5.064)	0.00173*** (6.653)
inf_{it}	-0.00124*** (-5.904)	-0.00128*** (-3.764)	-0.00131*** (-5.458)
gk_{fit}	0.00256** (5.953)	0.00259*** (6.815)	0.00273** (8.531)
eme*mis_{it}			-0.01326*** (-12.165)
lic*mis_{it}			-0.04624*** (-22.019)
naf*mis_{it}	-0.00425** (-1.995)		
ssa*mis_{it}	-0.00912*** (-5.211)		
fixed*mis_{it}		-0.0218*** (-0.00073)	
intermediate*mis_{it}		-0.01837*** (-9.324)	
flexible*mis_{it}		-0.00493*** (-3.243)	
Constant	-0.00392*** (-3.161)	-0.00374*** (-4.109)	-0.00383** (-3.613)
Group FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Group-year FE	Yes	Yes	Yes
N	1178	1178	1178
R²	0.1543	0.1590	0.1564
AIC	-5823.173	-5831.258	-5857.654
RMSE	0.0213	0.0218	0.0216

Notes: EME and LIC are dummy variables that take the value 1 if the country belongs, respectively, to Emerging Market Economies (EME) and Low-Income Developing Countries (LIC) or zero otherwise. NAF, SSA are dummy variables that take the value 1 if the country is located, respectively, in North Africa and Sub-Saharan Africa or zero otherwise. Fixed, Intermediate, and Flexible are dummy variables that take the value 1 if the country is classified, respectively, in a fixed, intermediate, or flexible exchange rate regime, or zero otherwise (Ilzetzi et al., 2019) (see appendix). Numbers within brackets represent t-statistics. *, **, and *** indicate significance at 10%, 5%, and 1%, respectively.

Source: Author

As shown in Table 8, regardless of the income group, misalignments of the equilibrium exchange rate negatively influence economic growth. Similar results are obtained, among others, by Ramos-Herrera and Sosvilla-Rivero (2023) for 103 countries, by Iqbal et al (2023) for India, by Elbadawi et al. (2012) for 32 Sub-Saharan African countries, by Gala (2007) for 58 developing countries, by Sallenave (2009) for G20 countries, and by Loayza et al. (2005), considering 78 nations or by Dollar (1992) analyzing 85 developing countries. However, the impact is much higher for low-income developing countries in Africa. Fixed exchange rate regimes contribute more to the reduction in economic growth, followed by intermediate exchange rate regimes, and finally flexible exchange rate regimes. This fact is emphasized by Ramos-Herrera and Sosvilla-Rivero (2023) and Aguirre and Calderon (2005), who argue that the adjustment to equilibrium is faster in economies with more flexible exchange rates than in fixed or intermediate regimes. Regarding the two African sub-regions (North Africa and Sub-Saharan Africa), the results confirm a negative link between exchange rate misalignments and economic performance. However, this link seems more pronounced for Sub-Saharan African countries than North African economies. This result was found by Elbadawi et al. (2012) in Sub-Saharan Africa. They show that one of the main factors explaining economic growth in Sub-Saharan Africa is the inadequacy of stabilization policies to exchange rate misalignments.

6. Conclusion and Policy implications

The question of whether and how exchange rate misalignment influences economic growth has captured researchers' attention. However, while the number of these studies is relatively substantial, the answer is controversial. In this article, we contribute to the literature by applying the Grouped Fixed Effect (GFE) method proposed by Bonhomme and Manresa (2015) instead of a standard fixed-effects estimator to examine whether the relationship between per capita economic growth and the deviation from the equilibrium exchange rate may differ substantially among different country groups. We use a sample that includes data for 38 African, emerging, and developing economies over the period 1996-2019.

The results suggest that the relationship between exchange rate misalignment and growth varies across country groups, reinforcing the hypothesis of a heterogeneous relationship between exchange rate misalignment and economic growth. In particular, the GFE estimator endogenously divides the sample into three groups that exhibit differentiated estimated impacts of exchange rate misalignment on economic growth (ranging from -0.0387967 in group 1 to -0.001293 in group 3). Furthermore, exchange rate misalignments reduce the pace of real economic growth, regardless of income category, with more pronounced effects for low-income developing countries. This result could be linked to the structural characteristics of countries (institutions, financial system, trade, and their level of development) as discussed by Rodrik (2008) and Elbadawi et al. (2012).

Additionally, our results also indicate that fixed exchange rate regimes followed by intermediate regimes slow down economic growth more than flexible regimes. The findings align with theoretical predictions and partial results reported in the literature. We believe that our results may have practical significance for national policymakers and international organizations responsible for global economic

monitoring. Moreover, they provide theoretical insights for academics interested in identifying determinants of growth and factors contributing to growth differences in observed data.

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Declaration of competing interest

The authors declare no conflicts of interest.

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Annexes

Table A-1. Classification by Ilzetzki et al. (2019)

Classification by Ilzetzki, Reinhart, and Rogoff (2019)	Grouped classification
No separate legal tender or currency union	Fixed
Pre announced peg or currency board arrangement	
Pre announced horizontal band that is narrower than or equal to $\pm 2\%$	
De facto peg	
Pre announced crawling peg; de facto moving band narrower than or equal to $\pm 1\%$	Intermediate
Pre announced crawling band that is narrower than or equal to $\pm 2\%$ or de facto horizontal band that is narrower than or equal to $\pm 2\%$	
De facto crawling peg	
De facto crawling band that is narrower than or equal to $\pm 2\%$	
Pre announced crawling band that is wider than or equal to $\pm 2\%$	
De facto crawling band that is narrower than or equal to $\pm 5\%$	
Moving band that is narrower than or equal to $\pm 2\%$ (i.e., allows for both appreciation and depreciation over time)	
De facto moving band $\pm 5\%$ / Managed floating	Flexible
Freely floating	
Freely falling	Not considered
Dual market in which parallel market data is missing.	

Table A-2. List of African Countries by Exchange Rate Regimes

Exchange Rate Regimes	Countries
Fixe	Angola, Benin, Burkina Faso, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Congo, Cote d'Ivoire, Equatorial Guinea, Gabon, Guinea-Bissau, Lesotho, Mali, Namibia, Niger, Senegal, and Togo.
Intermédiaire	Algeria, Burundi, Democratic Republic of Congo, Egypt, Ethiopia, Gambia, Ghana, Kenya, Morocco, Nigeria, Rwanda, Seychelles, Sierra Leone, Tanzania, Tunisia.
Flexible	Madagascar, South Africa, Uganda, Zambia.

Table A-3. Classification of African countries by income level according to the International Monetary Fund (IMF)

Country groups by income	Countries
Emerging Market economies (EM)	Algeria, Egypt, Morocco, Namibia, Seychelles, South Africa, Tunisia,
Low-Income Developing Countries (LIDC)	Angola, Benin, Burkina Faso, Burundi, Cape Verde, Cameroon, Central African Republic, Chad, Comoros, Democratic Republic of the Congo, Republic of the Congo, Côte d'Ivoire, Equatorial Guinea, Ethiopia, Gabon, Gambia, Ghana, Guinea-Bissau, Kenya, Lesotho, Madagascar, Mali, Niger, Nigeria, Rwanda, Senegal, Sierra Leone, Tanzania, Togo, Uganda, Zambia.

Table A-4. List of African Countries by Region

Region	Countries
North Africa	Algeria, Egypt, Morocco, Tunisia,
Sub-Saharan Africa	Angola, Benin, Burkina Faso, Burundi, Cape Verde, Cameroon, Central African Republic, Chad, Comoros, Democratic Republic of the Congo, Republic of the Congo, Côte d'Ivoire, Equatorial Guinea, Ethiopia, Gabon, Gambia, Ghana, Guinea-Bissau, Kenya, Lesotho, Madagascar, Mali, Namibia, Niger, Nigeria, Rwanda, Senegal, Seychelles, Sierra Leone, South Africa, Tanzania, Togo, Uganda, Zambia