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Original Article

Exchange Rate Misalignment and Economic Growth: The Case of Maghreb Countries

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Abstract*: This study examines the impact of real exchange rate misalignment (RER) on long-term growth in Tunisia, Algeria, and Morocco, three countries that are part of the Maghreb region, between 2000 and 2020. In order to determine misalignment, we first estimate equilibrium RER using the Fundamental Equilibrium Exchange Rate (FEER) technique. Second, we estimate a dynamic panel growth model that incorporates our measure of misalignment with the conventional growth factors. According to the findings, there's a negative coefficient for RER misalignment, indicating that long-term growth is either aided or hindered by a higher depreciated (or appreciated) RER. Consequently, the difference between RER and its equilibrium level would decrease under an adequate exchange rate strategy.*

Keywords: *Equilibrium Real Exchange rate, Economic Growth, Misalignment.*
JEL Classification : *C23, F31, O47*

I. INTRODUCTION

In international macroeconomics, the assessment of equilibrium values of the real exchange rate (RER) has always been significant, especially given the current state of global imbalances. In fact, since the mid-1990s, which marked the beginning of a time when global disparities in emerging nations increased – the acceleration of the process of international financial opening has generated a growing disconnection between the variability of the RER and growth economic (Béreau et al. 2009).

In this context, it seems principally interesting to focus on the effect of currency misalignments on economic growth, as persistent RER deviations are likely to affect countries' economic growth. There is little doubt that the economy's balance may be impacted by the notable and ongoing mismatch of the RER with respect to the equilibrium level. An extensive body of empirical and dramatic research indicates that one of the most important markers of a nation's economic susceptibility is RER misalignment. According to Kaminsky et al. (1998), an overvaluation of a currency is frequently an indication of inconsistent macroeconomic policy actions, which can raise the possibility of speculative attacks, result in an unmanageable current account deficit, and raise external debt. Conversely, it is expected that the undervaluation of the RER – which could be attributed to competitive devaluations – could drive the exchange rate to a level that encourages exports and promotes economic growth. As a result, a crucial query relates to the evaluation of the equilibrium exchange rate, which is the measurement of misalignment.

Jongwanich (2009) showed that certain countries have often used persistent deviations from the equilibrium exchange rate to boost their exports and their economic growth, whose implications, in terms of reducing unemployment, are perceptible. According to the Washington Consensus, the impact of overvaluation is very different from that of undervaluation. Overvaluation actually leads to external imbalance, and in order to restore exterior balance, growth may need to be slower. On the other hand, undervaluation can lead to overheating of economic activity and excess inflation. This should, therefore, harm growth in the medium term (Morvillier, 2020). According to Rodrik (2008), deviations from fundamental macroeconomic variables are greater than deviations from purchasing power parity and the impact in terms of overvaluation is different from undervaluation. Indeed, overvaluation is bad in the sense that it reduces the tradable goods sector, even if this overvaluation is dictated by the fundamentals of the economy. At the same time, undervaluation is good for similar reasons.

According to Mazorodze (2021), long-term misalignments are likely to induce distortions in the relative prices of tradable goods compared to non-tradable goods, with the possibility of generating a certain instability. The effects are different depending on whether it is an overvaluation or an undervaluation. Indeed, while undervaluation improves competitiveness, stimulates national production, investment, and exports, and reduces imports with a combination of all these previous effects on the improvement of the current balance of GDP and employment, overvaluation generally reflects a certain inconsistency in macroeconomic policy decisions with an increase in the probability of the appearance of the balance of payments and exchange rate crises which contribute to a deterioration in economic growth (Fontaine, 2005).

This paper's goal is to use panel data approaches to examine the relationship between RER mismatch and economic expansion in three Maghreb countries—Tunisia, Morocco, and Algeria—between 2000 and 2020. Testing a model specification for the long-run equilibrium RER, using the results to estimate the RER misalignment, and evaluating the results' resilience when incorporated as a variable of explanation in the panel model's economic growth constitute one of the paper's primary empirical contributions. Here, we use the system Generalized Method of Moments (GMM) estimator for dynamic panels (Arellano and Bover, 1995; Blundell and Bond, 1998) to address the issues of unobserved country effects and endogenous regressors in a dynamic context.

The remainder of the document is structured as follows: The literature on basic RER equations and the effect of RER misalignment on growth is presented in Section 2. The real-world estimation of equilibrium RER and currency misalignment is covered in Section 3. The association between growth in the economy is estimated in Section 4. Finally, section 5 presents the conclusions and comments on policy implications.

II. REVIEW OF THE LITERATURE

In the present section, we briefly describe the empirical literature on two key issues for our analysis: (a) the measurement of RER misalignment and (b) its impact on economic growth.

A) On the Measurement of RER Misalignment

The measurement of RER misalignment is based on the notion of fundamental equilibrium exchange rate (FEER). This price (called "equilibrium RER") was defined by Nurkse (1945) as the relative price which allows internal and external equilibrium to be achieved simultaneously. As for Edwards and Savastano (1999) they studied the literature on measuring RER misalignment and argued that most empirical analyses can be classified: (a) single-equation models and (b) general equilibrium simulation models. The relative pricing of traded and non-traded products that concurrently reaches internal as well as external equilibrium is known as RER in both approaches.

For his part, Edwards (1989) defined the equilibrium real exchange rate as the relative price of tradable goods compared to that of non-tradable goods, which, all other things being equal, simultaneously ensures internal equilibrium and equilibrium external to the economy. The actual exchange rate in equilibrium is not static. Its value depends on those of the other determining variables of internal and external balance, called "fundamentals" of the real exchange rate (international capital flows, terms of trade, commercial policy, level - and composition - of public spending, productivity progress, etc.). The equilibrium real exchange rate is thus determined solely by its fundamentals.

The majority of the single-equation method's efforts have depended upon the research of Edwards (1989) and Obstfeld and Rogoff (1995, 1996) in order to derive simplified versions of the equilibrium RER from a wide range of theoretical models. The standard empirical method is to link the real RER to the exchange rate that would be compatible with the medium-term fundamentals—public expenditure, trade policy, terms of trade, fiscal policy, and other factors—that determine the equilibrium exchange rate. In this case, a prolonged RER divergence from the equilibrium trajectory results in a misalignment. Among other things, insufficient trade, exchange rates, and macroeconomic policies may cause a mismatch.

In this paper, we use the single equation method. With this method, the equilibrium exchange rate is first estimated by calculating an equilibrium connection between the RER and a set of fundamentals. The equilibrium exchange rate is then calculated using the fundamentals' medium-term values and coefficients. The misalignment of the exchange rate is defined as the discrepancy between the equilibrium value and the actual exchange rate.

The RER is a broad summary measure of the prices of one country to the price of another country or group of countries. It can generally be expressed as RER = P / EP*, where P is the domestic price index, P* is the foreign price index, and E is the nominal exchange rate (units of foreign currency per domestic currency). Note that our definition of RER implies that an increase (decrease) in RER denotes a real appreciation (depreciation) of the local currency.

In addition, we use the annual real effective exchange rate (REER), which is calculated by multiplying the nation's nominal exchange rate by the annual index of domestic prices (also known as the consumer price index) for a certain country (i).

We thus estimate the equilibrium REER equation from the model specified in Berg and Miao (2010):

$$q_{i,t} = \alpha_i + \beta_1 prod_{i,t} + \beta_2 govc_{i,t} + \beta_3 invest_{i,t} + \beta_4 open_{i,t} + \varepsilon_{i,t} \quad (1)$$

Where subscripts i and t represent country and time indexes, respectively, and α_i and $\varepsilon_{i,t}$ are country-specific intercepts and disturbance terms. $q_{i,t}$ is the REER, $prod_{i,t}$ stands for the relative productivity in the traded-goods sector (relative to the

non-traded goods one), $govc_{i,t}$ is the government consumption (as a share of GDP), $invest_{i,t}$ is the investment (as a share of GDP) and $open_{i,t}$ is the trade openness. All variables are in logarithms.

Equation (1), which serves as the foundational equation for our calculation of the equilibrium REER, embodies our core long-run REER equation and has multiple verifiable predictions. Firstly, the Balassa-Samuelson model states that if productivity increases more quickly in the tradables sector than in the non-tradables sector, salaries in the tradable sector will rise; as a result, pushing up wages in the non-tradables sector and increasing the relative price of non-tradables (i.e., a real appreciation). Since there isn't enough productivity data available for many nations, we use the actual GDP per capita as a substitute, as suggested by Coudert and Couharde (2008). Secondly, there should be a decrease in REER with more openness. Trade liberalization causes a shift in demand away from nontraded products by lowering domestic prices of tradables. Real depreciation should result from non-tradable prices falling, assuming some fairly realistic cross-price elasticities. According to Tera and Valladares (2010), the total of imports and exports divided by GDP serves as a proxy for openness. Third, depending on the proportion of tradable products in the pertinent spending wicker baskets the anticipated trends on government investment and consumption are unclear. For instance, a rise in government spending should result in an appreciation of the REER if the government spends comparatively greater amounts on non-tradable products.

The ability to gauge the REER's degree of misalignment is one of the motivations behind identifying its determinants. The discrepancy between the observed and equilibrium REERs is reflected in the misalignment in the REER. Calculating equilibrium REER is not simple, though. Suppose we could detect the equilibrium level of the factors. In that case, Arberola (2003) suggests that establishing a long-run cointegration connection between the REER and its determinants would provide an estimate of the equilibrium rate. Thus, we must separate the macro fundamentals' constant values from their short-term oscillations in order to compute the long-run equilibrium REER.

Macroeconomic time series can be filtered or broken down using a variety of techniques. Here, we derive the permanent (equilibrium) component of the basic variables using the Hodrick and Prescott (HP) framework (1997). In fact, the eternal components of the fundamentals—calculated using the HP filter—are fed into the estimated model to get the equilibrium REER. Since these permanent elements are defined as sustainable values, they align with the idea of equilibrium. In order to set the long-run misalignment for each nation to zero, the equilibrium REER is normalized (via the country-specific intercept).

At each point in time, the RER misalignment is calculated as the difference between the observed REER and its predicted equilibrium value; that is, we compute:

$$MIS_{it} = q_{it} - \hat{q}_{it} \tag{2}$$

Where $\hat{q}_{it}$ is the predicted REER value from equation (1). If the difference is positive (negative), we observed over (under) valuation of local currency.

B) Evidence on RER Misalignment and Economic Growth

Ebaidalla (2014) claims that RER misalignment is a significant macroeconomic policy variable that is used to forecast future exchange rate moves between floaters and assess whether nations with fewer flexibility regimes need to adjust their exchange rates. This is especially true for developing nations. On the one hand, persistent overvaluation of exchange rates may indicate a need for relative price adjustments and a potential slowdown in economic growth. On the other hand, the RER misalignment might serve as a tool to impact the real status of the economy since the RER oscillations determine production and consumption decisions between domestic and foreign commodities. As a result, several nations have made an effort to keep their currencies depreciated in order to promote growth via exports.

The literature on equilibrium RER dates back to the 1960s (Balassa, 1964), and more empirical investigations on RER misalignment and growth have been published in the second half of the initial decade of the new century. The measurement of exchange rate misalignment has not been agreed upon in the literature since some studies base their findings on deviations from PPP. At the same time, other research concentrates on the RER's departure from a certain equilibrium level. The idea that long-lasting overvaluation processes are good predictors of potential currency crises (Frankel and Rose, 1996) and ultimately affect relative price adjustment and produce an adverse relationship with development is another topic that is regularly explored in the literature on RER misalignment.

For their part, Razin and Collins (1997) studied the relationship between economic growth and RER misalignment, considering that there are two possible channels through which RER misalignment could improve economic growth. First, it might have an impact on both domestic and international investment, which would have an impact on the process of capital

accumulation, a well-known growth driver. Subsequently, a redirected RER may have an effect on the tradeable goods industry and its global competitiveness. They discovered that whereas extremely strong overvaluation seems to be linked to slower growth, intermediate to high (but not very high) devaluation appears to be linked to faster growth by examining the association between RER misalignment and economic growth. Considering the aforementioned, one could contend that RER misalignment can skew pricing signals, cause resource misallocation across industries, and have a detrimental effect on growth.

Aguirre and Calderon (2005) are among those who have used the measure of RER misalignments as departures of actual exchange rates from equilibrium for 60 countries between 1965 and 2003. They demonstrated that RER misalignments impede growth, but the effect is non-linear: growth decreases are greater as the amount of the misalignments increases. Although huge undervaluations impede growth, modest to moderate undervaluations promote growth. These findings hold up when the equilibrium RER is taken into account. Similarly, Hausmann et al. (2005) discovered potential nonlinearities in the link between development and RER misalignments for eighty events in which growth increases by at least two percentage points over at least eight years. They also claimed that RER depreciation is one of the elements involved in the happening of such growth-accelerating occurrences.

In fact, using dynamic panel data techniques for 60 countries over the 1965-2003 period, Aguirre and Calderon (2005) found that RER misalignments hinder economic growth but that the effect is nonlinear: the greater the declines in economic growth, the greater the misalignments. Although significant undervaluation harms economic growth, small or moderate undervaluation stimulates it. These results are robust when we control the movements of the equilibrium RER. Likewise, Hausmann et al. (2005) found possible irregularities in the correlation among growth and TCR misalignments were detected over eighty instances in which growth accelerates by at least two percentage points and continues for at least eight years. They concluded that the depreciation of the RER is one of the factors associated with the occurrence of such episodes of growth acceleration.

For their part, Gala and Lucinda (2006) advanced a dynamic panel data analysis using variations and system GMM methods used for 58 countries over the 1960-1999 period, with an assessment of RER misalignment that included the Balassa-Samuelson effect along with additional growth regression control variables such as human and material capital, the organizational environment, inflation, the output gap, and terms of trade shocks. They contended that an actual depreciated (appreciated) exchange rate is related to faster (slower) economic growth.

For his part, Eichengreen (2008) developed a historical review of the literature on RER and growth, drawing attention to the possible mechanisms by which a competitive RER improve economic growth. Avoiding real overvaluation may simply encourage optimally balanced growth of sectors producing traded – and non-traded – goods. Alternatively, there may be non-pecuniary externalities associated with the production of exportable goods (firm-external learning-by-doing effects) that do not exist to the same degree in other activities – meaning that Market forces, left to their own devices, can produce a TCR. It's too high. The major policy advice for these countries is to keep their RER competitive and low volatility, as they are mostly effective in recovering growth according to developmental situations, such as Asia's rapidly expanding economies to the east.

As for Rodrik (2008), he examined the link between RER misalignment and economic growth for a panel of 184 countries over the 1950-2004 period. Using real per capita GDP data, he created an indicator that measures the degree of RER undervaluation after accounting for the Balassa-Samuelson effect. He discovered that overvaluation inhibits economic progress while undervaluation promotes it. Most countries have great economic growth periods when their currencies are undervalued. In fact, there is limited evidence of nonlinearity in the connection among a country's RER and economic growth. A rise in undervaluation stimulates economic growth just as much as a drop in overvaluation. The magnitude and statistical importance of the derived coefficient for RER undervaluation are greater in developing countries, which tend to be defined by organizational instability and failure of the market.

For their part, Berg and Miao (2010) developed an empirical investigation on RER misalignment and economic growth in order to compare the results with Rodrik (2008) and what they call the *Washington Consensus* (WC) view, which is based on a fundamental equilibrium exchange rate model.

They demonstrated that the WC and Rodrik views of the role of misalignment in economics are observationally equivalent for the major economic growth regressions. However, there are some identification issues because the factors that determine RER misalignment also seem probable to serve as explanation variables in the growth rate regression. The empirical results confirm Rodrik's (2008) findings in the sense that not only are overvaluations bad, but undervaluations are also favorable for growth, which contradicts the WC position.

In fact, using a sample of 83 countries over the 1970-2004 period, Elbadawi et al. (2012) investigated the impact of aid and overvaluation on economic growth and exports. They discovered that aid promotes economic growth (with declining returns)

while inducing an overvaluation. Overvaluation slows growth, but this effect is mitigated by financial growth. They also showed that overvaluation has a negative on export diversification and sophistication.

For their part, Couharde and Sallenave (2013) determined, for a large sample of developed and emerging countries, the value of currency misalignments from which they observed a regime shift in economic growth over the 1980-2009 period. Misalignments, characterized by the difference between the present real exchange rate and its equilibrium equivalent, originate via the behavioural equilibrium exchange rate (BEER) model. They demonstrated that the misalignments index plays a significant impact in the reversal of economic progress. Although their currency's undervaluation benefits their economic growth, emerging countries' economic growth strategies cannot be based on this assumption. They linked this conclusion to the negative impacts of devaluation, as in "original sin.

In a similar vein, Toulaboe (2017) studied the size of real exchange rate misalignment (RER) in 7 developing Asian countries and Japan. An analytical framework is created for determining the equilibrium RERs, which are subsequently used to calculate the RER misalignment. The model's estimation results showed that RERs were misaligned in the majority of Asian countries over the sample period, however not to the amount suggested in certain research. They contended that real exchange rates in these nations are generally compatible with the basics of the economy and that the level of assessed RER misalignment is not worrisome.

As for Shaik and Gona (2021), they showed that, there is a short-run relationship between exchange rate, inflation rate, interest rate and GDP over the 1990-2017 period. They determined that in India, the extent of the exchange rate and its variables had an impact on the level of growth. They advocated for technical advancement in every area of the Indian economy, as well as reducing surplus and overbudgetary inflation and implementation to the bare minimum in order to avoid the ideal of foreign borrowing, which would inevitably lead to external debt and services. The Indian government could indicate the way forward by shifting its investment portfolio towards government-funded projects.

On the other hand, Ayele (2022) studied the main drivers of real effective exchange rate (REER) misalignment and its effect on the economic growth of East African least developed countries (LDCs) over the 1980-2019 period. They discovered that the REER of LDCs were considerably misaligned during the research period. The REER rises in response to improved trade terms and net foreign asset position but falls in response to increased trade openness and broad money supply in the long run. They also determined that an increase in real investment and human capital would boost GDP per capita, whereas an increase in transparency, net foreign assistance inflows, and REER misalignment would reduce it in the long run. Over the short run, the REER misalignment would hinder Ethiopia's economic growth while boosting Kenya's. They recommended that central banks and policymakers of East African LDCs should initiate consistent macroeconomic policies and regulatory frameworks focusing on the main drivers of equilibrium REER to correct currency misalignment and to support their promising economic growth.

Similarly, Goncalves and Rodrigues (2023) explored the relationship between real GDP growth rate and the deviations from the equilibrium exchange rate, as different types of countries might exhibit different dynamics, and macro variables cannot easily capture region-specific heterogeneity. In fact, they discovered that variations from the equilibrium exchange rate slow down real economic growth despite the income category using annual data for 103 countries between 1996 and 2016. They also found that the consequences are most noticeable in advanced economies, low-income developing countries, and emerging economies. Additionally, they proposed that regimes with fixed and intermediate exchange rates significantly impede economic growth.

More recently, Ugurlu and Razmi (2023) examined economic, institutional, and policy factors that help explicate the within-country variation in RER undervaluation in a baseline panel of 68 developing and 39 developed countries over the 1989-2013 period. They showed a systematic relationship between less undervalued RERs and increases in the proportion of output from the non-tradable sector, the import intensity of exports, and capital account openness. They added that there is a link between RER overvaluation and democratic bodies and autonomous central banks.

In the section that follows, we present our empirical estimation with the goal of expanding the set of factors that determine the RER to include consumption by the public, openness to trade, and investment from private parties, in addition to variations in per capita income. The actual RER is then subtracted from its anticipated value to determine the RER misalignment. This study aims to examine the impact of RER misalignment in our model of economic growth, using the GMM system for estimate.

III. ESTIMATING EQUILIBRIUM RER AND ITS MISALIGNMENT

In this part, three nations in the Maghreb region—Tunisia, Algeria, and Morocco—will have their equilibrium REER and misalignment estimated using econometric methods. For the years 2000–2020, we use annual data to estimate equation (1).

This research employs an econometric approach based on panel unit root and cointegration tests. We start by looking for unit roots in different series. Secondly, we assess whether the real functional exchange rate and the underlying macroeconomic principles are cointegrated. Lastly, we estimate the long-run variables that will be used in the subsequent calculations of the relevant misalignment and the real equilibrium exchange rate.

A) Panel Unit Root Tests

We next utilize the Im, Pesaran, and Shin (2003) -IPS to test for the presence of unit roots on panel data. A new, more adaptable, and computationally straightforward unit root testing method for panels—referred to as a statistic—is suggested by IPS utilizing the probability framework. This method permits the simultaneous analysis of stationary and nonstationary series. Additionally, residual serial correlation, group-to-group heterogeneity in the dynamics, and error variances are all permitted by this test. The subsequent equation is estimated as the foundation for the IPS test:

$$\Delta y_{i,t} = \rho_i y_{i,t-1} + \alpha_{m,i} d_{m,t} + \sum_{j=1}^{p_i} \lambda_{i,j} \Delta y_{i,t-j} + \varepsilon_{i,t} \ , \ t = 1,...,T \ , \ i = 1,...,N \qquad (3)$$

Where T is the number of observations over time, N denotes the number of individual members in the panel and $d_{m,t}$ contains deterministic variables. The null hypothesis is defined as $H_0 : \rho_i = 0$ for all $i = 1,...,N$ and the alternative hypothesis is $H_a : \rho_i \prec 0$ for $i = 1,...,N_1$ and $\rho_i = 0$ for $i = N_1 + 1,...,N$, with $0 \prec N_1 \leq N$ that allows for some (but not all) of individual series to have unit roots.

IPS (2003) computed separate unit root test for the N cross-section units and defined their $t-bar$ statistic as a simple average of the individual ADF statistics t_{iT} for the null as: $t-bar = (1/N)\sum_{i=1}^{N} t_{iT}$. IPS (2003) assume that t_{iT} are i.i.d. and have finite mean and variance.

Therefore, the standardized $t-bar_{N,T}$ statistic converges to a standard normal distribution $N \to \infty$ under the null hypothesis. In order to propose a standardization of the $t-bar_{N,T}$ statistic, the values of the mean and the variance have been computed via Monte Carlo methods for different values of T and p_i's and tabulated by IPS (2003). The results of each one of our five variables are reported in Table 1, where all the tests have a unit root under the null hypothesis.

Table 1: Panel unit root tests of IPS

	Variables in levels		Variables in first differences	
	Constant	**Constant with trend**	**constant**	**Constant with trend**
Real effective exchange rate	-0.42 (0.47)	-0.06 (0.49)	-2.54*** (0.00)	-1.36* (0.06)
Productivity	5.6 (1.20)	2.3 (0.95)	-3.22*** (0.00)	-3.25*** (0.00)
Trade Openness	1.58 (0.85)	-0.74 (0.21)	-4.85*** (0.00)	-4.51*** (0.00)
Private Investment	-0.67 (0.11)	-0.4 (0.21)	-4.3*** (0.00)	-5.31*** (0.00)
Government consumption	-0.11 (0.31)	-0.3 (0.44)	-3.29*** (0.00)	-3.11*** (0.00)

Notes: Robust standard errors are in parentheses below the coefficients. *p < 0,1 ; ***p < 0,01.

Table 1 shows that, in accordance with IPS (2003), the panel unit root tests verify that all variables are stationary in their initial variations but nonstationary in levels. We now examine if there is a long-term correlation between the factors that determine the real effective exchange rate and the rate itself.

B) Cointegration Tests

For dynamic panels with multiple regressors, Pedroni (1999, 2004) provided residual-based testing for the null of cointegration in which individual variation in the long-term slope coefficients and short-run dynamics is allowed. Individual heterogeneity fixed impact and trending terms are permitted under the test, and the regressors in the cointegrating regressions are not subject to any exogeneity constraints.

Especially, the tests ask for the residual's estimation from static cointegrating long-run relation for a time series panel of observables y_{it}:

$$y_{it} = \alpha_i + \delta_i t + \beta_{1,i} x_{1,it} + \beta_{2,i} x_{2,it} + ... + \beta_{k,i} x_{k,it} + e_{it}\ ,\ t = 1,...,T\ ;\ i = 1,...,N \qquad (4)$$

Where as usual, T is the number of observations over time and N is the number of units in the panel. It is possible to interpret the model (3) as N different equations, each of which has K regressors. The variables y_{it} and x_{it} are assumed to be I(1) for each member i of the panel, and under the null of no cointegration, the residual e_{it} will also be I(1). α_i and δ_i are scalars denoting fixed effects and unit-specific linear trend parameters, respectively, and β_i are the cointegration slopes; note that all these coefficients are permitted to vary across individuals so that considerable heterogeneity is allowed by this specification.

Pedroni examines the application of seven residual-based panel cointegration statistics: three—referred to as "group mean cointegration statistics"—and four—referred to as "panel cointegration statistics"—which are based on pooling the data across the between-dimension.

Another distinction between the two sets of tests is based on the alternative hypothesis specification. In fact, even if both sets of tests verify the null hypothesis of no cointegration: $H_0 : \rho_i = 1\ \forall i$

Where ρ_i is the autoregressive coefficient of estimated residuals under the alternative hypothesis ($\hat{e}_{i,t} = \rho_i \hat{e}_{i,t-1} + v_{i,t}$), the alternative hypothesis specification is different:

- the panel cointegration statistics impose a common coefficient under the alternative hypothesis, which results $H_a^w : \rho_i = \rho \prec 1,\ \forall i$

- the group mean cointegration statistics allow for heterogeneous coefficients under the alternative hypothesis and its results $H_a^b : \rho_i \prec 1\ \forall i$.

It is straightforward to observe that the first category of four statistics includes a type of non-parametric variance ratio statistic, a panel version of a non-parametric Phillips and Perron (1988) ρ -statistic, a non-parametric form of the average of the Phillips and Perron t -statistic and an *ADF* type t -statistic.

The second category of panel cointegration statistics is based on a group mean approach and includes a Phillips and Perron type ρ -statistic, a Phillips and Perron type t -statistic and an *ADF* type t -statistic. The comparative advantage of each of these statistics will depend on the underlying data-generating process.

The proper mean, and variance correction terms are utilized after the panel cointegration test statistics are calculated, resulting in asynchronously standard naturally distributed test statistics.

$$\frac{\chi_{N,T} - \mu\sqrt{N}}{\sqrt{v}} \Rightarrow N(0,1)$$

Where $\chi_{N,T}$ is one of the seven statistics of Pedroni, μ and v are the functions of moments of the underlying Brownian motion functionals. The appropriate mean and variance adjustment terms for different numbers of regressors and different panel cointegration test statistics are given in Table 2 in Pedroni (1999).

Pedroni (2004) explored finite sample performances of the seven statistics. He showed that in terms of power, all the proposed statistics do fairly well for T >100. Moreover, Pedroni's (1997) simulations showed that for a small time span (T <20), the between dimension (group t-statistic) is the most powerful. Given our relatively short time span (T = 63), we will pay

particular attention to the group parametric-t statistic ($ADF - stat$) when testing for cointegration. The results of panel cointegration tests are displayed in Table 2.

Table 2: Pedroni's panel cointegration tests

	Test Statistic	p-value
Panel cointegration tests		
$v - stat$	0.08	0.46
$rho - stat$	1.41	0.92
$PP - stat$	-0.22	0.41
$ADF - stat$	-2.47***	0.003
Group mean cointegration tests		
$rho - stat$	-4.55***	0.00
$PP - stat$	-1.08	0.13
$ADF - stat$	-2.22**	0.013

Notes: *(resp.**, ***): rejection of the null hypothesis at the 10% (resp. 5%,1%) significance level. Lags selected according to the SIC with a maximum lag length of 3.

Since Pedroni's (2004) simulations demonstrated that the group-mean parametric test is more effective than the other tests in small numbers of samples, we are able to determine which null hypothesis of no cointegration is rejected in our research. We are able to turn to estimate the long-term connection between the REER and its contributing factors.

C) Equilibrium RER and Misalignment

According to panel unit root and cointegration tests, our series of products has been incorporated into order 1. As a result, we can proceed to estimate the long-run relationship (1). To do that, we use Pedroni's (1999, 2004) Fully-Modified Ordinary Least Squares (FMOLS) technique. In this regard, the FMOLS estimation procedure offers a significant advantage compared to alternative methods like the Pooled Mean Group (PMG) method proposed by Pesaran et al. (1999) and the Dynamic Ordinary Least Squares (DOLS) method established by Kao and Chiang (2000) in that. In contrast, slope homogeneity must be met; short-term heterogeneity is permitted for each panelist. Table 3 displays the cointegration vector that was generated.

Table 3: Cointegration vector

Dependant variable: Real effective exchange rate		
Productivity differential	0.54***	
		(2.81)
Trade openness	-0.32***	
		(-2.52)
Government consumption	0.41***	
		(2.42)
Private investment	1.16***	
		(6.73)

Notes: t-stat in parentheses. *** indicates significance at 1 %.

The panel cointegration estimation results (Table 3) appear to be in accordance with previous theoretical and empirical literature. All long-term coefficient estimates are extremely significant (at the 1% significance level), with the predicted signals in accordance with theory.

Furthermore of the statistical importance of our parameters, we have an interest in their economic impact, particularly when considering the consequences of different policies on the REER. These findings, in particular, demonstrate that the production disparity influences long-term REER fluctuations in the Maghreb region. Indeed, a 1% increase in domestic tradable productivity relative to non-tradables (in comparison to the analogous variable for partner trading nations) raises a country's equilibrium REER by around 0.54%. The government's consumption coefficient is positive and statistically noteworthy. In fact, a positive surprise to public consumption results in long-term REER appreciation, confirming our forecast that rising global demand for non-tradable products leads to price increases. The REER appreciates as government consumption rises. A 1% rise in the government spending-to-GDP ratio raises the REER by 0.41%. An increase of 1% in investment (as a percentage of GDP) results in a more than 1.16% increase in the equilibrium REER. The negative coefficient related to the variable of trade openness suggests that trade liberalization will result in a REER degradation of 0.32%.

Using our estimates, we compute the measure of misalignment (MIS_{it}) as the deviations of the REER from its equilibrium level, where the latter is obtained by feeding the estimated model with the permanent components of the fundamentals (estimated with the Hodrick-Prescott filter). These persistent components are defined as sustainable levels, which aligns with the notion of equilibrium.

IV. GROWTH AND RER MISALIGNMENT

After introducing macroeconomic basics for estimating RER misalignment, we are now ready to study the effect of RER misalignment on growth in the economy using the System GMM dynamic panel estimate technique.

A) Econometric Methodology

To study the effect of RER misalignment on economic growth, we include misalignment of explaining factors in our growth regression. Following Berg and Miao (2010), we estimate the following modification of the conventional growth regression:

$$\Delta y_{i,t} = \beta X_{i,t} + \theta MIS_{i,t} + \mu_t + \eta_i + \varepsilon_{i,t} \quad (5)$$

Where $y_{i,t}$ is the log of real GDP per capita, $X_{i,t}$ is a vector of contemporaneous and lagged values of growth determinants expressed in logarithm terms, $MIS_{i,t}$ denotes RER misalignment, η_i represents unobserved country-specific factors and μ_t is a period-specific effect. The time-specific effect, μ_t, allows us to control for international conditions that change over time and affect the growth performance of countries in the sample while η_i accounting for unobserved country-specific factors that both drive growth and are potentially correlated with the explanatory variables.

Following Berg and Miao (2010), we preserve several common determinants. The theory of neoclassical growth states that the economic growth rate is determined by the economy's initial condition. The conditional convergence hypothesis holds that other factors being equal, nations with a smaller gross domestic product per capita are projected to grow faster due to higher marginal returns on capital assets. To correct for conditional convergence, we take the economy's initial position into account by calculating the initial level of real GDP per capita. Based on recent breakthroughs in endogenous growth theory, we incorporate factors that represent trade policy, macroeconomic stability programs, and institutions. We evaluate the following potential determinants: (i) trade openness (in percentage of GDP), (ii) government consumption (in percentage of GDP), which serves as a fiscal policy measure, (iii) investment (in percentage of GDP), and (iv) trade terms. Finally, we include RER misalignment in our analysis of the impact of exchange rate overvaluation and undervaluation on economic development.

B) Estimation Technique

Our estimation technique handles endogeneity and unexpected national factors. To account for heterogeneity and nation-specific unknown features, we employ the System GMM dynamic panel estimating technique. The justification for using System GMM is the fact that the presence of weak instrumentation indicates asymptotically that the variance of the coefficient grows. In small samples, the coefficients can be biased. To mitigate the potential bias and inaccuracies associated with the use of Difference GMM (Arellano and Bond, 1991), Arellano and Bover (1995) and Blundell and Bond (1998) created a system of regression analyses in differences and degrees. The instruments used for the regression in differences are the explanatory variables' lagged levels, whereas the explanatory variables' lagged differences are the regression in levels instruments. These are regarded as suitable instruments under the presumption that, while there may be an association among the levels of explanatory variables and the nation-specific effect, there isn't a relationship between those variables' variances and the nation-specific effect.

Two specification tests assess the System GMM estimator's consistency. The Sargan test of over-identifying constraints assesses the instrument's overall reliability. The failure to dismiss the null hypothesis lends credibility to the model. The second test looks at the null hypothesis that the incorrect term isn't correlated in series. Again, the failure to reject the null hypothesis lends credibility to the model.

C) Empirical Results

Table 4 shows our regression estimates utilizing the System GMM estimation technique. As we present our findings, we should point out that the specification tests - both the Sargan test of over-identifying limitations and the test for higher-order correlation - verify our regressions for inferences. That is, our instruments have no relationship with the error term, and the latter does not exhibit a higher-order serial correlation.

Let us first discuss the results for the control factors. All explanatory variables have the anticipated sign, regardless of the sign or size of the misalignment. The initial GDP per capita coefficient is negative, indicating that the conditioned convergence hypothesis is supported: countries with lower GDP per capita grow faster while other growth drivers remain constant. According to neoclassical theory, the economy's starting point is an important factor of growth. The investment variable also has the correct sign, as there's a positive link between capital accumulation and development. Trade openness also has a positive effect on growth. Thus, the more that nations are outward-oriented, the better it is for economic growth. These findings are consistent with those of Cottani et al. (1990), Aguire and Calderon (2005), and Dufrénot et al. (2009), as well as the neoclassical approach, which holds that the beneficial effect of trade on development can be explained by comparative advantages, whether in the availability of resources or technological differences (Béreau et al. 2009). The terms of trading, which reflect changes in worldwide demand for a country's exports as well as production costs, are advantageous and statistically negligible from 1980 to 2008. Government consumption enters negatively and not significantly, yet, as Toulaboe (2006) emphasizes, there appears to be an agreement that consistent and increasing government balance can stymie economic progress.

Turning to our key variable of interest, we discover a negative substantial association between growth and RER misalignment. This finding suggests that when the RER mismatch develops, economic development will slow. On the other hand, a corresponding increase in REER overvaluation (say, 1%) would result in a growth decrease of about 0.03 percentage points. This finding is consistent with those of Rodrik (2008), Berg and Miao (2010), Aguirre and Calderon (2005), Gala and Lucinda (2006), and Eichengreen (2008), who found that a discounted REER is advantageous to long-run growth, whereas an inflated REER is detrimental.

Our work leads to a critical policy suggestion that is particularly pertinent to the Maghreb nations. These nations should steer clear of protracted periods of REER appreciation and rather implement economic policies that maintain the REER at a competitive level, which usually corresponds with a more declined REER in relation to its equilibrium level.

Table 4. RER misalignment and economic growth

Dependant variable: Growth rate of GDP per capita	
Initial GDP per capita	-0.047***
	(-2.01)
RER Misalignment	-0.03***
	(-2.82)
Terms of trade	0.021
	(1.14)
Openness	0.012*
	(1.33)
Government Consumption	-0.011
	(-0.21)
Investment	0.039
	(0.24)
Constant	0.19
	(0.7)
Specification Tests (p-values)	
- Sargan Test	0.39
- 2nd order Correlation	0.85

Notes: t-stat in parentheses. *, ** and *** indicates significance at 10%, 5% and 1% respectively.

V. CONCLUSION

In this study, the connection between RER misalignment and economic growth in Tunisia, Algeria, and Morocco—three nations in the Maghreb region—is examined from 2000 to 2020. Since RER misalignment cannot be observed, the FEER approach has been used to determine the equilibrium exchange rate. Next, misaligned series are derived from the measured REER's divergence from equilibrium. We have then evaluated their effect on economic growth by means of dynamic panel data approaches, which allows us to address the possibility of endogenous regressors as well as the problem of undetected nation-specific effects. Our empirical assessment of the System GMM panel model for growth demonstrates that the predicted coefficient for RER misalignment is statistically significant and negative, implying that real GDP growth is positively impacted by a higher real depreciated exchange rate and negatively impacted by a higher REER appreciation. According to the estimated coefficient of RER misalignment, annual per capita GDP growth can be lowered by 0.03% for every 1% rise (appreciation) in RER misalignment. This finding emphasizes the likelihood of increases in real per capita GDP for nations that adopt significant

and suitable exchange rate adjustments to lessen RER misalignment. To put it another way, it should be important for nations, particularly those in the Maghreb, to keep their REER at a suitable level.

VI. REFERENCES

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[57] See appendix for data definitions and sources.

Appendix. Definitions and Sources of Variables Used in Regression Analyses

Variable	Definition	Source
Real Effective Exchange Rate	Real Effective Exchange Rate Index (2010=100)	WDI (2024)
Government Consumption	General government final consumption expenditure as a % of GDP	WDI (2024)
Productivity	Real GDP per capita (constant 2015 US$)	WDI (2024)
Private Investment	Gross fixed capital formation as a % of GDP	WDI (2024)
Trade Openness	Sum of exports and imports of goods and services as a % of GDP	WDI (2024)
Terms of Trade	The ratio between the index of export prices and the index of import prices.	WDI (2024)
GDP per capita growth	Log difference of real GDP per capita	WDI (2024)
RER Misalignment	Difference between real effective exchange rate and its estimated equilibrium value	Author Construction