Real Exchange Rate Misalignment and Economic Growth in the Maghreb Countries

It has long been recognized in academic and policy debates that domestic policies play an important role in explaining economic growth. The paper investigates the role of real exchange rate (RER) misalignment on long-run growth in three countries of the Maghreb countries (Tunisia, Algeria and Morocco) over the period 2000-2020. We first estimate equilibrium RER relying on the Fundamental Equilibrium Exchange Rate (FEER) approach, from which misalignment is derived. Second, we estimate a dynamic panel growth model in which among the traditional determinants of growth, our measure of misalignment is included. The results indicate that the coefficient for RER misalignment is negative, which means that a more depreciated (appreciated) RER helps (harms) long-run growth. Asa consequence, an appropriate exchange rate policy would close the gap between RER and its equilibrium level.

Keywords: *Equilibrium Real Exchange rate, Economic Growth, Misalignment, Panel Cointegration tests.*

JEL Classification: *C23, F31, O47*

Introduction

The assessment of equilibrium values of the real exchange rate (RER) has always been an important issue in international macroeconomics, especially in the current context of global imbalances. Indeed, since the mid of the 1990s – the beginning of a period characterized by the increasing of emerging countries to global imbalances – the accelerating international financial integration process has engendered a growing disconnection between RER variability and growth (Béreau et al. 2009).

Within this context of growing international financial integration and global imbalances, it seems particularly interesting to focus on the impact of currency misalignments on growth sine persistent RER gaps are likely to affect the economic growth of countries. Indeed, the significant and persistent deviation of RER from equilibrium level, i.e., RER misalignment, could have implications on the balance of the economy. There is a vast theatrical and empirical literature that suggests that RER misalignment is one of the key indicators in identifying a country's economic vulnerability. As Kaminsky and al. (1998) underline, an overvaluation of the currencies is often the sign of the inconsistency of the decisions of macroeconomic policies that may lead to an unsustainable current account deficit, increasing external debt and the risk of possible speculative attacks. On the opposite, it is expect that RER undervaluation – which could be attributed to competitive devaluations – may drive the exchange rate to a level that encourages exports and promote growth. Consequently, an important question

concerns the measure of misalignment that is the evaluation of equilibrium exchange rate.

The interest of studying the link between currency misalignment and growth is particularly notable for China. Chinese authorities have been frequently accused of maintaining the value of the yuan against major currencies at a very low level to finance China's spectacular growth, through the promotion of its exports. This export-led growth has generated surging Chinese current account surpluses, creating a major source of tension among trading partners who experienced important trade deficits with China (especially the United States and the European Union). The persistent misalignment of the yuan – and more generally of other emerging Asian currencies – may thus be a key factor influencing global imbalances.

Our aim in this paper is to investigate the relationship between RER misalignment and economic growth in three countries of the Maghreb countries (Tunisia, Morocco and Algeria)using panel data techniques during the period 2000-2020.One of the main empirical contributions of the paper is to test a model specification for the long-run equilibrium RER and then use these to obtain estimated RER misalignment and assess how robust the results are when they are included as an explanatory variable in the panel growth model. Here, we use the System Generalized Method of Moments (GMM) estimator for dynamic panels (Arellano and Bover, 1995; Blundell and Bond, 1998) to deal with the problems of unobserved country effects and endogenous regressors in a dynamic setting.

We organize the paper in 5 sections. Section 2reviews the literature on fundamental RER equations and the impact of RER misalignment on growth. Section 3 deals with the empirical estimation of both equilibrium RER and currency misalignment. Section 4 estimates the relationship between economic growth and a set of explanatory variables, by paying a special attention to the impact of RER misalignment. Finally, section 5 concludes.

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) his impact on economic growth.

On the Measurement of RER Misalignment

In the present paper, the measurement of RER misalignment relies on the notion of the fundamental equilibrium exchange rate (FEER). This (called "equilibrium RER") was defined by Nurkse (1945) as the relative price that helps attain internal and external equilibrium simultaneously. Edwards and Savastano (1999) survey the literature on the measure of RER misalignment and they found that most empirical efforts can be classified: (a) single equation models and (b) general equilibrium simulation models. In both approaches the RER is defined as

the relative price of traded and non-traded goods that achieves simultaneously external and internal equilibrium.[1]

The single-equation approach have usually derived reduced forms for the equilibrium RER from a wide variety of theoretical models and most of these efforts have been based on Edwards (1989) and Obstfeld and Rogoff (1995, 1996). The general empirical approach is to relate the actual RER to that exchange rate that would be consistent with the medium term fundamentals driving the equilibrium exchange rate, such as fiscal policy and the terms of trade, government spending, trade policy, among other factors. Here, misalignment occurs when RER deviation from the equilibrium path is persistent. Misalignment could arise - among other factors - due to inadequate macroeconomic, trade and exchange rate policies.

We follow the single-equation approach in this paper. This approach consists of (a) estimating an equilibrium relationship between the RER and a set of fundamentals, (b) then using the coefficients and the medium-term values of the fundamentals to compute the equilibrium exchange rate, and (c) finally computing the exchange rate misalignment as the difference between the actual exchange rate and the equilibrium value.

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.

We also use the annual real effective exchange rate (REER) defined as the annual index of domestic prices (consumer price index)for a country (i) toward the annual index of the prices of main trading partners, multiplied by the nominal exchange rate of the 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.[2] All variables are in logarithms.

[1]Edwards (1989) defines internal equilibrium as the sustainable equilibrium in the market of non-traded goods – which is compatible with the unemployment rate at its natural level. External equilibrium occurs when the current account position can be financed with sustainable capital flows – that is, when the intertemporal budget constraint is satisfied.

[2]See appendix for data definitions and sources.

Equation (1) represents our fundamental long-run REER equation - the baseline equation for ourestimation of the equilibrium REER - and has several testable predictions. First, according to the Balassa-Samuelson, if productivity in the tradables sector grows faster than in the non-tradables sector, the resulting higher wages in the tradables sector will put upward pressure on wages in the non-tradables sector, resulting in a higher relative price of non-tradables (i.e., a real appreciation). As productivity data by sectors are not available for a sufficient number of countries, we follow Coudert and Couharde (2008) in using a proxy given by the real GDP per capita. Second, an increase in openness should cause REER depreciation. Trade liberalization reduces the domestic prices of tradables causing a demand shift away from nontraded goods. Under some fairly reasonable cross price elasticities assumptions, nontradable prices should fall, producing a real depreciation. Following Tera and Valladares (2010), openness is proxied by the sum of exports and imports over GDP. Third, the expected signs on government consumption and investment are ambiguous, depending on the share of tradable goods in the relevant spending baskets. For example, if government spends relatively more non-tradable goods, an increase in government consumption should lead to an REER appreciation.

One of the reasons for finding the determinants of the REER is to be able to estimate his degree of misalignment. The misalignment in the REER corresponds to the difference between the observed and the equilibrium REER. However, computing equilibrium REER is not straightforward. Indeed, as mentioned by Arberola (2003), finding a long-run cointegration relationship between the REER and it determinants would yield an estimate of the equilibrium rate if we were able to observe the equilibrium level of the determinants. Therefore, to calculate the long-run equilibrium REER we need to isolate the permanent values of the macro fundamentals from their short-run fluctuations.

There are several procedures to filter or decompose macroeconomic time series. Here, we use the Hodrick and Prescott (HP) framework (1997) to obtain the permanent (equilibrium) components of the fundamental variables.[3] Indeed, the equilibrium REER is obtained by feeding the estimated model with the permanent components of the fundamentals (estimated with the HP filter) These permanent components are characterized as sustainable levels and are therefore consistent with the concept of equilibrium. The equilibrium REER is normalized (through the country-specific intercept) so that the long-run misalignment for each country is set equal to zero.

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:

$$MIS_{it} = q_{it} - \hat{q}_{it} \qquad (2)$$

[3]In general, time series are viewed as the sum of transitory and permanent components, and the HP filter captures the smooth path of the trend component by minimizing the sun of squares of its second difference.

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.

Evidence on RER Misalignment and Economic Growth

The RER misalignment is a key macroeconomic policy variable, particularly in the case of developing countries, being used to predict future exchange rateshifts among floaters and to evaluate the need to adjust the exchange rate among countrieswith less flexible regimes. On the one hand, sustained exchange rate overvaluation could constitute a warning sign of adjustment of relative prices and a possible decline in theaggregate growth rate of the economy. On the other hand, since the RER fluctuations determine production and consumption choices between domestic and foreigngoods, the RER misalignment could be used as a tool to influence the actualstate of the economy. Thus, there were countries which had tried to maintain their currenciesundervalued in order to stimulate growth through the channel of exports.

The literature on equilibrium RER goes back to the 1960s (Balassa, 1964) and the second half of the first decade of the new century has shown an increase in the number of empirical studies on RER misalignment and growth.[4] The literature on exchange rate misalignment has not reached a consensus in terms of how misalignment is measured, since part of the literature is based on deviations from PPP while other studies focus on the deviation of the RER from some equilibrium level. Another issue that is frequently examined in the literature on RER misalignment is the notion that overvaluation processes that last for a significant period of time are good indicators of possible currency crises (Frankel and Rose, 1996) and ultimately have an impact on relative price adjustment and create a negative correlation with growth.

Razin and Collins (1997) investigate the relation between economic growth and RER misalignment considering that there are two possible channels through which RER misalignment might influence growth. First, it could influence domestic and foreign investment, by influencing the capital accumulation process which is a well known engine of growth. Second, a RER that is out of line could affect the tradables sector, and the competitiveness of this sector in respect of the rest of the world. In exploring the relationship between RER misalignment and economic growth, they found that while very high overvaluation appears to be associated with slower growth, moderate to high (but not very high) undervaluation appears to stimulate growth. In light of the above discussion, it can be argued that RER misalignment can distort price signals, result in misallocation of resources across sectors, and generate a negative impact on growth.

The work developed by Aguirre and Calderon (2005) is among those using a measure of RER misalignmentsas deviations of actual exchange rates from their equilibrium for 60 countries over 1965-2003 using panel and time series

[4]See Rodrik (2008), Eichengreen (2008), Berg and Miao (2010), Gala and Lucinda (2006), and Aghion and al. (2006) for recent panel data studies on RER misalignment and growth. On the role of exchange rate regimes and misalignments in developing countries, see Coudert and Couharde (2008).

cointegration methods. Using dynamic panel data techniques they find that RER misalignments hinder growth but the effect is non-linear: growth declines are larger, the larger the size of the misalignments. Although large undervaluations hurt growth, small to moderate undervaluations enhance growth. These results are robust when controlling for movements in the equilibrium RER. Hausmann and al. (2005) also recognize potential non-linearities in the relationship between growth and RER misalignments for eighty episodes when growth accelerates by at least two percentage points and that acceleration lasts for at least eight years. Their main empirical finding is that RER depreciation is one of the factors associated with the occurrence of such growth accelerating episodes.

Gala and Lucinda (2006) developed a dynamic panel data analysis using Difference and System GMM techniques, for a set of 58 countries from 1960 to 1999, with a measure of RER misalignment incorporating the Balassa-Samuelson effect and other control variables for the growth regression such as physical and human capital, institutional environment, inflation, the output gap and terms of trade shocks. The main empirical evidence supports the argument that a real depreciated (appreciated) exchange rate is associated to higher (lower) growth rates.

Eichengreen (2008) develops a historical review of the literature on RER and growth, focusing attention on possible mechanism through which a competitive RER fosters growth. Avoiding real overvaluation may simply encourage the optimally balanced growth of traded – and nontraded – goods producing sectors. Alternatively, there may be nonpecuniary externalities associated with the production of exportables (learning by doing effects external to the firm) that do not exist to the same degree in other activities – meaning that market forces, left to their own devices, may produce a RER that is too high. The main policy recommendation therefore is for such countries is to keep their RER at a competitive level and with lower volatility since they are mainly useful for jump-starting growth based on development experiences, such as the high growth East Asian economies.[5]

Rodrik (2008) is one of the recent studies on RER misalignment and growth, with estimation results for a set of 184 countries and time series data from 1950 to 2004. The author develops an index to measure the degree of RER undervaluation adjusted for the Balassa-Samuelson effect using real per capita GDP data. The main empirical result is that overvaluation hurts growth, undervaluation facilitates it. For most countries, high growth periods are associated with undervalued currencies. In fact, there is a little evidence of non-linearity in the relationship between a country's RER and its economic growth. An increase in undervaluation boots economic growth just as well as a decrease in overvaluation. The magnitude and statistical significance of the estimated coefficient for RER undervaluation is

[5]See Aghion and al. (2006) on RER volatility and factor productivity, which is different from the impact on factor accumulation (growth). The authors found that countries with a significant degree of RER variability experience slower productivity growth and the magnitude of such is negatively associated with the degree of financial development.

higher for developing countries due to the fact that such countries are often characterized by institutional fragility and market failures.[6]

Berg and Miao (2010) develop an empirical investigation on RER misalignment and 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.[7] Their main result is that WCand the Rodrik views of the role of misalignment in growth are observationally equivalent for the main growth regressions but there are some identification problems since the determinants of RER misalignment are also likely to be explanatory variables in the growth regression. The empirical findings support those from Rodrik (2008) in the senses that not only are overvaluations bad but undervaluations are also good for growth, a result that it is not consistent with the WC view.

Elbadawi et al. (2012) investigated the nexus between foreign aid, exchange rate misalignment, and economic growth in SSA. Contrary to conventional wisdom, they do not found aid to be a major contributor to exchange rate overvaluation. In addition, they found that aid fosters growth but its impact is weaker in countries with overvalued exchange rates. Furthermore, they found that overvaluation reduces growth but its negative effect is ameliorated by financial development.

Based on panel smooth transition regressions, 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, defined as the difference between the current real exchange rate and its equilibrium counterpart, are derived from the behavioural equilibrium exchange rate (BEER) approach. Their findings showed that our misalignments index plays a key role in the reversal of trend growth. Although the undervaluation of their currency acts positively on their growth, emerging countries cannot base their strategy on this finding to promote growth. They related this result to the adverse effects of depreciation, as in ‘‘original sin’’. The implications of their findings, in terms of economic policy, clearly emphasize the economic leverage role of undervaluation: it remains a powerful cyclical instrument but has to be, nevertheless, employed with precautionary to be globally and internationally consistent.

Toulaboe (2017) examined the size of real exchange rate misalignment (RER) in seven developing Asian counties and Japan. An analytical framework is developed to estimate the equilibrium RERs, which are then used to derive the RER misalignments. The estimation results from the model indicated that RERs

[6]Rodrik (2008) incorporates other variables in the growth models (panel and cross-section regressions), including: lagged growth, initial income level (convergence), institutions (Rule of Law), government consumption, terms of trade, inflation, gross domestic saving, years of education, time and country dummies.

[7] The first measure of RER misalignment (ε_{it}^{ppp}) is the same as in Rodrik (2008), using real per capita GDP to capture the Balassa-Samuelson effect, while the second measure (ε_{it}^{FEER}) is based on the FEER view and incorporates additional variables (terms of trade, openness, investment and government consumption).

have been misaligned in most of the Asian countries during the sample period, although not to the extent claimed in some studies. The real exchange behavior in these countries is mostly consistent with the economic fundamentals and the magnitude of measured RER misalignment is not alarming.

Shaik and Gona (2021) showed that there is a short-run relationship between exchange rate, inflation rate, interest rate and GDP. They concluded that in India, the factors that influence the level of growth rate are extent of exchange rate and its variables. They recommended the need to be technologically inclined in all sectors of Indian economy; excess and over budgetary inflation and implementation should be cut to barest minimal level to avert the ideal of external borrowing which most consequently result in external debt and services. The Indian government should show the path of redirecting its investment profile by channeling it towards capital projects of the government.

Ayele (2022) examined 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 period 1980–2019. The panel results revealed that the REER of LDCs were significantly misaligned for the study period. The REER appreciates for an improved terms of trade and net foreign asset position, while it depreciates for an increased trade openness and broad money supply in the long-run. Their results also confirmed that the GDP per capita would improve for an increase in real investment and human capital, while it decline for an increase in openness, net foreign aid inflows and REER misalignment in the long-run. The ARDL bound testing results generally support the panel estimation results. In the short-run, the REER misalignment would impede growth of Ethiopia while it promotes growth of Kenya. Thus, the central banks and policy makers of East African LDCs should initiate a 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.

Goncalves and Rodrigues (2023) investigated the heterogeneous relationship between per capita economic 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. Using annual data for 103 countries during the 1996-2016 period, their findings imply that deviations from the equilibrium exchange rate reduce the pace of real economic growth, regardless of income category, documenting that the effects are most pronounced for advanced economies, followed by low income developing countries and, finally, for emerging economies Their results also suggested that fixed and intermediate exchange rate regimes severely slow down economic growth.

Ugurlu and Razmi (2023) investigated economic, institutional, and policy factors that help explain the within-country variation in RER undervaluation in a baseline panel of 68 developing and 39 developed countries over the period 1989-2013. Their results indicated that increases in the share of non-tradable sector output, imported input intensity of exports, and capital account openness is systematically associated with less undervalued RERs. They also provided evidence that independent central banks and democratic institutions are linked to

RER overvaluation. Their key findings are robust to using alternative specifications, measures, estimation techniques, samples, and additional control variables. A preliminary comparison of Latin America and East Asia suggests interesting support for our key findings.

One of the main contributions of our empirical estimates in the next section is to extend the determinants of RER including not only differences in per capita income but also the government consumption, openness and investment. In order to measure RER misalignment we then subtract the actual RER from its estimated value. The main purpose of this transformation is to investigate the role of RER misalignment in our growth model, based on the System GMM estimation.

Estimating Equilibrium RER and its Misalignment

The present section attempts to describe the econometric methods used to estimate the equilibrium REERand its misalignment for 3 countries of the Maghreb countries (Tunisia, Algeria and Morocco). To estimate equation (1), we use annual data over the period 2000-2020.

The econometric methodology used in this paper is based on panel unit root and cointegration tests. First, we test for unit root in various series. Second, we test for cointegration between the real effective exchange rate and the underlying macroeconomic fundamentals. Finally, we estimate thelong-run parameters that we later use for computing the real equilibrium exchange rate and thecorresponding misalignment.

Panel Unit Root Tests

To test for the presence of unit roots on panel data, we use the Im, Pesaran and Shin (2003) –IPS thereafter-. IPS using the likelihood framework, suggest a new more flexible and computationally simple unit root testing procedure for panels (which is referred as $t-bar$ statistic), that allows for simultaneous stationary and non-stationary series. Moreover, this test allows for residual serial correlation and heterogeneity of the dynamics and error variances across groups. The IPS test is based on the estimation of the following equation:

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

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) compute separate unit root test for the N cross-section units and define 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 as $N\to\infty$ 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)
Openness	1.58 (0.85)	-0.74 (0.21)	-4.85*** (0.00)	-4.51*** (0.00)
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: p-values in parentheses. * (resp.**,***): rejection of the null hypothesis at 10% (resp. 5%, 1%) significance level. Lags selected according to the SIC with a maximum lag length of 3.

As indicated in table1, the tests of panel unit root of according to IPS (2003) confirm that all variables are nonstationary in levels but stationary in first differences. We now test for the existence of a long-run relationship between the real effective exchange rate and its determinants.

Cointegration Tests

Pedroni (1999, 2004) proposes a residual-based test for the null of cointegration for dynamic panels with multiple regressors in which the short-run dynamics and the long-run slope coefficients are permitted to be heterogeneous across individuals. The test allows for individual heterogeneous fixed effects and trend terms and no exogeneity requirements are imposed on the regressors on the cointegrating regressions.

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

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

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 this coefficients are permitted to vary across individuals, so that considerable heterogeneity is allowed by this specification.

Pedroni considers the use of seven residual-based panel cointegration statistics, four basedon pooling the data along the within-dimension (denoted 'panel cointegration statistics') andthree based on pooling along the between-dimension (denoted 'group mean cointegrationstatistics').

Another distinction between the two sets of test is based on the alternative hypothesisspecification. In fact, even if both sets of test 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 alternativehypothesis ($\hat{e}_{i,t} = \rho_i \hat{e}_{i,t-1} + v_{i,t}$), alternative hypothesis specification is different:

- the panel cointegration statistics impose a common coefficient under the alternativehypothesis which results: $H_a^w : \rho_i = \rho \prec 1,\ \forall i$
- the group mean cointegration statistics allow for heterogeneous coefficients under thealternative hypothesis and it 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-statisticand an *ADF* type t-statistic.

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

After the calculation of the panel cointegration test statistics the appropriatemean and variance adjustment terms are applied, so that the test statistics areasymptotically standard normally distributed.

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

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 number ofregressors and different panel cointegration test statistics are given in Table 2 inPedroni (1999).[8]
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 small time span (T <20),the betweendimension (*group t-statistic*) is the most powerful.Given our relatively short time span (T = 29), we will pay a particular attention to the group parametric-t statistic ($ADF-stat$)whentesting for cointegration. The result 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 simulations made by Pedroni (2004) show that, in small samples, the group-mean parametric-test is more powerful than the other tests, we can conclude that the nullhypothesis of no cointegration is rejected in our study, and now turn to the estimation of the longrun relationship between the REER and its determinants.

Equilibrium RER and misalignment

As revealed from panel unit root and cointegration tests, our series are integrated of order 1 andcointegrated. It is thus possible to proceed to the estimation of the long-run relationship (1). To this end, we rely on the Fully-Modified Ordinary Least Squares (FMOLS) methodologypioneered by Pedroni (1999, 2004). In this sense, the advantage of the FMOLS estimation procedure over other techniques such as the Pooled Mean Group(PMG) method proposed by Pesaran and al. (1999) and the Dynamic Ordinary Least Squares (DOLS) method developed by Kao and Chiang (2000) is that, while slope homogeneity is imposed, short-run heterogeneity is allowed for each member of the panel.The cointegration vector obtained is displayed in table 3.

[8]This table contains the mean and variance values for the cases when there is no heterogeneous intercept, or when there is a heterogeneous intercept or/and a time trend in the heterogeneous regression equation. kis the number of regressors without taking the heterogeneous deterministic terms into account.

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)
Investment	1.16***
	(6.73)

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

The results from the panel cointegration estimation (Table 3) appear consistent with the theoretical and empirical literature.[9] All long-run coefficient estimates are highly significant (at 1% significance level), displaying expected signs according to theory.

In addition to the statistical significance of our parameters, we are interested in their economic impact, especially when thinking about the effects of alternative policies on the REER. In particular, these results show that the productivity differential contributes to long term REER variations in the Maghreb region. Indeed, a 1% in the domestic productivity of tradables relative to non-tradables (relative to the corresponding variable for trading partner countries) tends to appreciate a country's equilibrium REER by about 0.54%. The government consumption coefficient is positive and statistically significant. Indeed, a positive shock on public consumption engenders a long-term REER appreciation that confirms our expectation that a rise of global demand of non-tradable goods leads to increase in prices. An increase in government consumption is associated with an appreciation of the REER. A 1% increase in government spending to GDP ratio will appreciate the REER by 0.41%. An increase in the investment (as % of GDP) of 1% is associated with an appreciation of the equilibrium REER of more than 1.16%. Negative coefficient corresponding to the variable of trade opening indicates that commercial liberalization will cause an REER depreciation of 0.32%.

Using our estimates, we compute the measure of misalignment (MIS_{it}) as the deviations of the REERfrom 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 permanent components are characterized as sustainable levels and are therefore consistent with the concept of equilibrium.

[9]Comparable findings in the literature include Chinn (1997) for productivity; Elbadawi and Soto (1997) for trade openness and investment; Maeso-Fernandez et al. (2002) for government consumption.

Growth and RER Misalignment

Having introduced macroeconomic fundamentals for calculating RER misalignment,we are now in position to investigate the impact of RER misalignment on the economic growth by adopting the System GMM dynamic panel estimation method.

Econometric Methodology

To investigate the impact of RER misalignment on economic growth, we add misalignment among explanatory variables in our growth regression. Following Berg and Miao (2010), we estimate the following variation of thestandard 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 valuesof 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 to control for international conditions that change over time and affect the growthperformance of countries in the sample, while η_i accounts for unobserved country-specificfactors that both drive growth and are potentially correlated with the explanatory variables.

Following Berg and Miao (2010) we retain various usual determinants. According to the neoclassicalgrowth theory, the economic growth rate is a function of the initial position of the economy. Theconditional convergence hypothesis states that, other things being equal, countries with lowerGDP per capita are expected to grow more due to higher marginal returns on capital stock. Weaccount for the initial position of the economy through the initial level of real GDP per capita tocontrol for conditional convergence (see Barro and Sala-i Martin (1996) among others). Relying onsome developments of the endogenous growth theory, we include determinants reflecting tradepolicies, macroeconomic stabilization policies and institutions. Among those potential determinants,we consider the following variables: (i) trade openness (in percentage of GDP), (ii) government consumption (in percentage of GDP), usedas an indicator of fiscal policy, (iii) investment (in percentage of GDP) and (iv) the terms of trade. Finally, to these usual determinants, we add RER misalignment in order to investigate the impact of exchange rate overvaluation and undervaluation oneconomic growth.

Estimation Technique

Our estimation technique addresses issues of endogeneity and unobserved country characteristics. Therefore, to account for endogeneity and country-specific

unobserved characteristics, we use the System GMM dynamic panel estimation method.The option to use System GMM is based on the argument that the existence of weak instruments implies asymptotically that the variance of the coefficient increases and in small samples the coefficients can be biased. To reduce the potential bias and inaccuracy associated with the use of Difference GMM (Arellano and Bond, 1991), Arellano and Bover (1995) and Blundell and Bond (1998) develop a system of regressions in differences and levels. The instruments for the regression in differences are the lagged levels of the explanatory variables and the instruments for the regression in levels are the lagged differences of explanatory variables. These are considered as appropriate instruments under the assumption that although there may be correlation between the levels of explanatory variables and the country specific effect, there is no correlation between those variables in differences and the country specific effect.

The consistency of the System GMM estimator is assessed by two specification tests. The Sargan test of over identifying restrictions tests the overall validity of the instruments. Failure to reject the null hypothesis gives support to the model. The second test examines the null hypothesis that the error term is not serially correlated. Again, failure to reject the null hypothesis gives support to the model.

Empirical Results

In Table 4 we report our regression estimates using the System GMM estimationtechnique. Before we describe our results, we should mention that the specification tests - boththe Sargan test of over-identifying restrictions and the test for higher order correlation - validate our regressions for inference. That is, our instruments are not correlated with the errorterm and the latter does not display higher order serial correlation.

Let us first comment the results relating to the control variables. All the explanatory variables have the expected sign, whatever the sign and the size of the misalignment. The initial GDP per capita coefficient isnegative, meaning that the conditional convergence hypothesis is evidenced: holding constantother growth determinants, countries with lower GDP per capita tend to grow faster. The initial position of the economy is thus a significant determinant of growth, as recognised by theneoclassical theory.The investment variable has also the right sign sincethere exists a positive relationship between capital accumulation and growth. Trade opennessalso positively affects growth. Thus, themore countries are outward-oriented the more this contributes favorably to economic growth. These results are in line with those found by Cottani and al. (1990), Aguire and Calderon (2005) and Dufrénot and al. (2009), and, more generally with the neoclassical approach according towhich the positive impact of trade on growth is explained by comparative advantages, be they in resource endowment or differences in technology (see Béreau and al. 2009).The terms of trade,[10]which capture both

[10]There is no consensus about the impact of terms of trade on economic growth. While some studies point the fact that an increase in terms of trade lead to an increase in investment and thus economic performance (Bleaney and Greenaway (2001), Blattman and al. (2003)), other,

changes in international demand for a country's export and the cost of production, are positive and statistically insignificant over the period 1980-2008. Government consumption enters negatively and none significantly, although, as underlined by Toulaboe (2006), there seems to be a consensus that consistent and increasing government balance can hinder economic growth.

Turning now to our main variable of interest, we find that there is a negative and significant relationship between growth and RER misalignment. This result implies that growthwould decline in response to increases in the RER misalignment.On the other hand, a similar increase in the REER overvaluation (say, 1 %) would imply a growth decline of approximately 0.03 percentage points. This result is consistent with those of Rodrik (2008), Berg and Miao (2010), Aguirre and Calderon (2005), Gala and Lucinda (2006) and Eichengreen (2008) in the sense that an undervalued REER is beneficial for long-run growth, while the opposite is true for an overvalued REER.

The crucial policy recommendation to stem from our work, which is especially relevant for Maghreb countries, is that such countries should avoid periods of long lasting REER appreciation and instead adopt economic policies that are able to keep the REER at a competitive level, which most of the time should be associated with a more depreciated REER relative 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.

as Eicher and al. (2008) show that an improvement in terms of trade decreases economic growth in the long term. In this study, we expect a positive sign of this variable, reflecting the income effect according which a rise in terms of trade lead to foster accumulation and thus economic growth (Wong, 2010).

Conclusion

This paper explores the relationship between RER misalignment and economic growth in three countries of the Maghreb region (Tunisia, Algeria and Morocco) over the period 2000-2020. As RER misalignment is not observable, equilibrium exchange rate have been estimated relying on the FEER methodology. Misalignment series are then obtained by the deviation of the observed REER from its equilibrium level. We have then assessed their impact on economicgrowth using dynamic panel data techniques in order to address both the issue of unobserved country-specific effects and the possibility of endogenous regressors. Our empirical estimation of the System GMM panel growth model has shown that estimated coefficient for RER misalignment is negative and statistically significant, which means that a more real depreciated exchange rate helps real GDP growth while the opposite is true for a REER appreciation. The estimated coefficient of RER misalignment suggests that a 1% increase (appreciation) in RER misalignment can reduce annual per capita GDP growth by 0.03%. This resulthighlights that countries that pursue major and appropriate exchange rate reforms to reduce RER misalignment are very likely to record gains in real per capita GDP. In other words,it should be relevant for countries, especially Maghreb countries, to maintain their REER at its appropriate level.

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Appendix. *Definitions and Sources of Variables Used in Regression Analyses*

Variable	Definition	Source
Real Effective Exchange Rate	Real Effective Exchange Rate index (2000=100)	WDI (2023)
Government Consumption	General government final consumption expenditure as a % of GDP	WDI (2023)
Productivity	Real GDP per capita (constant 2000 US$)	WDI (2023)
Investment	Gross fixed capital formation as a % of GDP	WDI (2023)
Trade Openness	Sum of exports and imports of goods and services as a % of GDP	WDI (2023)
Terms of Trade	Ratio of export to import prices (2000=100)	WDI (2023)
GDP per capita growth	Log difference of real GDP per capita	WDI (2023)
Initial GDP per capita	Initial value of ratio of total real GDP to total population	WDI (2023)
RER Misalignment	Difference between real effective exchange rate and its estimated equilibrium value	Author construction