




THE ASYMMETRIC INDIRECT IMPACT OF REAL EXCHANGE RATE ON ECONOMIC GROWTH THROUGH FOREIGN TRADE: AN ASYMMETRIC ARDL PANEL MODEL



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ABSTRACT

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This paper aims to examine the combined effect of trade openness and real exchange rate on economic growth. We use an asymmetric ARDL panel model on a sample of Middle Eastern and North African (MENA) countries with data from 1990 to 2018. The results of the linear model prove, for the long-run component, that all variables, except government consumption, are significant. In addition, the interaction term between trade openness and the real exchange rate is negative and has a significant impact on economic growth at the 5% level. The results of the short-run component show that all variables are significant. The error correction adjustment coefficient is, however, negative but not significant. As a result, the linear model cannot be used to adjust the variables of the short-run dynamic to long-run equilibrium. The findings of the nonlinear model point to a positive and significant asymmetric effect of the interaction variable for both upward and downward movements on the economic growth in the long run. In other words, the findings of the study suggest that trade openness and real exchange rate need to be combined to enhance GDP growth. The results of the nonlinear short run component show that the impact of the interaction term between trade openness and real exchange rate on economic growth is significantly negative for both positive and negative variations.

Contribution/Originality: This study is one of very few studies that have investigated the combined effect of trade openness and real exchange rate on economic growth. Additionally, this is the first study in which the asymmetric nonlinear ARDL model is used to analyze the relationship between these variables in MENA countries.

1. INTRODUCTION

The Middle East and North Africa (MENA) is a diverse region. Affected by economic and political transformations, it retains a higher and better growth potential. It enjoys a privileged geographical location with access to large markets; a young and increasingly educated population; and comparative advantages in several sectors such as industry, renewables, and tourism. However, with the escalating conflicts, the eruption of civil wars (especially after the Arab Spring in 2011) and, recently, the persisting decreases in oil prices, return to growth prospects in the short term are bleak. According to World Bank estimates, regional GDP growth is expected to remain at around 2.8% in 2015. For this reason, MENA economies implement reforms to identify and improve determinants of economic growth.

To measure a country's economic growth, international organizations use GDP. GDP is a macroeconomic aggregate and is the most representative of the economy. Much research has been done to study economic growth and its determinants, and one of the most traditional models is Solow's model. Solow (1956) concluded that physical capital alone is not enough to explain growth over time. Indeed, subsequent research has highlighted four main determinants of growth: consumption, investment, public investment expenditure, and trade balance. Therefore, the exchange rate is relevant to GDP through trade balance. Accordingly, our interest in this paper lies in checking whether the exchange rate could be an alternative determinant of economic growth through its impact on trade.

2. LITERATURE REVIEW

The effect of exchange rate variables on a country's growth rate may be more or less visible in one category of variables than in others. An example would be openness to international trade, for which the theory of endogenous growth claims a positive link with economic growth. It has become conventional that opening an economy promotes economic growth. Such a relationship is even considered a stylized fact (Romer, 1989). In addition to comparative advantages and economies of scale, the most open economies are the most able to integrate technological progress and benefit from expanding markets (Barro & Sala-i-Martin, 1995). The nature of the link between foreign exchange and growth becomes clearer through the exchange rate (Busson & Villa, 1997). A low real exchange rate could increase exports through a competitiveness effect. Promoting exports eases external constraints and can import capital not produced locally, which promotes growth.

2.1. Relationship between Economic Growth and Trade Openness

In the current context of globalization, it is natural to wonder about the relationships between external trade and economic growth. If we manage to clearly establish the positive and significant impact of openness on growth, this will encourage governments of developing countries wishing to improve their position to adopt trade liberalization policies. Previous relevant research did not reach a clear and definitive answer to the relationship between openness and growth. The theoretical literature on growth and international trade overwhelmingly asserts that trade stimulates long-term economic growth. The dominant theoretical belief is that open economies, and therefore those more active in international trade, grow faster than closed ones (Edwards, 1993). Since then, international trade has been seen as an important determinant of productivity and growth among other determinants. Then, its contribution depends on its weight on economic activity. In the relevant literature, an important finding reveals that countries active in the international market tend to be more productive than their relatively closed counterparts. The latter produce only for their domestic market through an increase in exports and the expansion of the production scale (Helpman & Krugman, 1985).

Romer (1990) and Ethier (1982) argue that international trade allows countries to import intermediate inputs from abroad that are not domestically produced. This can help boost productivity in the manufacturing sector. In addition, better access to imported superior quality inputs (intermediate goods and equipment) encourages foreign companies to set up in countries with reduced customs tariffs (Blalock & Gertler, 2008).

On the other hand, international trade contributes to an efficient allocation of resources and can lead to faster growth. Such a move can be translated into greater accumulation of factors, especially for countries with advanced technological diffusion and knowledge (Almeida & Fernandes, 2008; Barro & Sala-i-Martin, 1997; Romer, 1986).

Although the conclusions of the very first studies are in favor of a positive effect of international trade on economic growth, there is still controversy on this subject. Indeed, some rather pessimistic authors argue that international trade could have negative effects on economic growth (Lucas Jr, 1988; Redding, 1999; Young, 1991). Then, conclusions on the link between international trade and growth become more empirical than theoretical. Empirically, the evidence on the nature of the trade-economic growth relationship is inconclusive and varies

according to the authors, the methodology adopted and, above all, the choice of trade liberalization indicators. Bearing this in mind, we reviewed some studies carried out on the relationship between trade and economic growth.

Examining panel data from 20 OECD countries, [Felbermayr, Prat, and Schmerer \(2011\)](#) concluded that greater trade openness is key to reducing the unemployment rate. In addition, trade liberalization is able to increase the overall productivity of differentiated sectors, the efficiency of economic performance, and also employment opportunities for both skilled and unskilled labor ([Loganathan, Sukemi, & Kogid, 2011](#)). [Busse and Koeniger \(2015\)](#) explained that trade integration is often considered as a main determinant of economic growth. Studying panel data of a sample of developed and developing countries from 1971 to 2005, they argue that the effect of trade in dynamic panel estimates primarily depends on the specification of trade. From theoretical and empirical perspectives, they specified trade in terms of the volume of exports and imports as a proportion of lagged total GDP (considering the human capital as an input into the production function). With this trade measure, they found a positive and very significant impact on economic growth. [Wong \(2007\)](#) studied the effects of trade openness on the productivity of Ecuadorian manufacturing sectors during the 1997–2003 period. The results indicated a positive and significant effect of trade openness on the productivity of manufacturing industries, in particular export-oriented industries, in the years following the implementation of trade reforms, but a drop in productivity after 2000 due to economic shocks. [Njikam \(2009\)](#) examined the relationship between trade openness and industrial performance in Cameroon by highlighting the importance of infrastructure for industrial development. The author compared the impact before and after trade openness in a sample of 29 industries during the import substitution period (1986–1994) and after the 1995–2003 trade reform. This study showed that trade openness has a positive impact on industrial development if the conditions of infrastructure are met. Focusing on sub-Saharan and emerging African countries, [Asiedu \(2002\)](#) and [Bartels, Napolitano, and Tissi \(2014\)](#) concluded that trade openness fosters an increase in inward foreign direct investment (FDI) flows from these countries by emphasizing its effect on reducing transaction costs. [Okafor, Piesse, and Webster \(2015\)](#) found that trade liberalization enjoys a prominent place in the attractiveness of sub-Saharan African countries to FDI. These results were confirmed by [Shah and Khan \(2016\)](#) on a set of emerging countries and by [Sharifi-Renani and Mirfatah \(2012\)](#) in Iran from 1980 to 2006.

In a study on the Cote d'Ivoire during the 1965–2014 period, [Keho \(2017\)](#) showed that trade openness has positive effects on short- and long-term growth. In addition, the author found a strong complementarity between trade openness and capital formation to promote economic growth.

[Silajdzic and Mehic \(2018\)](#) examined the effect of trade openness on economic growth in Central and Eastern European countries from 1995 to 2013. They used two distinct estimation methods – the dynamic least squares dummy variable method (LSDVC) and the Prais–Winsten correlation with panel-corrected standard errors (PCSE) method. Their results indicated that trade openness positively relates to economic growth, not only from the export side, but also from the increase of imports from technologically advanced EU countries.

Using annual data observed over the 1970–2016 period, [Bonga-Bonga and Kinfack \(2019\)](#) assessed the relationship between trade openness and economic growth in 38 African countries. To that end, they used a panel smooth transition regression (PSTR) model that reflects the associated variables' nonlinearity and endogeneity. The results showed that African countries are not homogeneous, especially in terms of openness to trade and economic growth. The authors also found that, in reference to their growth rate, the relationship between trade openness and economic growth varies from one country to another. Conversely, there is a positive relationship between middle- and high-income countries. [Huchet, Le Mouël, and Vijil \(2018\)](#) suggested that countries exporting higher quality products and new varieties are growing faster. They estimated an endogenous growth model with a panel of 169 countries during 1988 to 2014 using the generalized method of moments (GMM) estimator. They added that openness to trade may impact growth negatively for countries which specialize in low quality products.

Studying Botswana using the ARDL bounds testing approach, [Malefane \(2020\)](#) found that if the exports to GDP ratio, trade openness index, and the total trade to GDP ratio are used as indicators for trade openness, trade

openness would have an important, positive effect on economic growth both in the short and long terms. However, when the import-to-GDP ratio was used as a measure of trade openness, the study did not find any important short-term or long-term effects of trade openness on economic growth.

More recently, Sumbal, Chen, Ramzan, and Abbas (2020) found an indirect link between trade openness and economic growth in a sample of developed and developing nations observed from 1980 to 2014. When human capital accumulation is seen as an interfering variable, trade openness can have a negative effect on economic growth in countries where human capital accumulation is poor.

2.2. Relationship between Economic Growth and Exchange Rate

The exchange rate is an important topic in the global economics debate. According to Medel, Camilleri, Hsu, Kania, and Touloumtzoglou (2015), modern macroeconomics strongly depends on the dynamics of the exchange rate. Several authors have indicated that exchange rate volatility has a positive impact on economic growth by influencing the shock adjustment mechanism (Edwards & Levy-Yeyati, 2005; Levy-yeyati & Sturzenegger, 2003). Other authors (Belke & Gros, 2001; Demir, 2010; Doğanlar, 2002; Pozo, 1992) have pointed out that the impact of exchange rate volatility on some macroeconomic aggregates negatively affects economic growth, including foreign trade, employment, and investment. However, there were no significant impacts of exchange rate movements found in other studies (Bahmani-Oskooee, 1998; Upadhyaya & Upadhyay, 1999).

McKinnon and Ohno (1997) suggested that elevated exchange rate volatility affects prices of internationally-traded goods because foreign investors apply a risk premium to compensate for exchange rate movements, limiting economic growth by reducing international capital flows into the economy.

According to Belke and Gros (2001) and Belke and Setzer (2003), exchange rate volatility supports the wait-and-see approach. They stated that businesses also pay additional lower costs for employment choices similar to investment, such as recruitment costs and the expense of capital supply for a specific activity. Consequently, a rise in exchange rate volatility could deter companies from creating employment opportunities.

On the empirical side, an abundance of research has confirmed the major effect of exchange rate fluctuations on economic growth; Korkmaz (2013) found a causal link between exchange rate and economic growth in nine European countries observed during the period between 2002 and 2011.

Bleaney and David (2001) showed that exchange rate volatility has a negative impact on investment but not on economic growth in 14 sub-Saharan African nations observed from 1980 to 1995.

Hua (2012) referred to the various impacts of the real exchange rate on economic growth in 29 Chinese provinces between 1987 and 2008. In the event that a real exchange rate appreciation has negative implications on economic growth through a deterioration of foreign competition in the tradable market and a lack of employment-creating activities, it also has positive effects on economic growth through the promotion of human capital and capital intensity. Aman, Ullah, and Khan (2013) examined data on Pakistan from 1976 to 2010 and found that the real exchange rate positively influenced economic growth via export promotion incentives and increasing foreign direct investment. These results were also confirmed by Long, Abasimi, and Fan (2019) in Cambodia over the 1995–2017 period. Barguelli, Ousama, and Mourad (2018) suggested that real and nominal exchange rate volatility negatively affects economic growth in 45 developing and emerging countries, observed between 1985 and 2015. They also showed that the impact of exchange rate volatility is influenced by the exchange rate regime and financial openness, with volatility becoming more negative as countries implement financial openness and flexible exchange rate regimes.

According to Olofsson (2019), exchange rate volatility had a negative effect on economic growth in a sample of 36 countries over 17 years, from 2000 to 2016. The author gathered evidence on bidirectional causality, indicating that exchange rate volatility affects economic growth and, reversely, economic growth affects exchange rate volatility. These results were confirmed by Hussaini, Aguda, and Nordiana (2019), who studied a sample of English-

speaking West African countries from 1980 to 2017. Rabhi and Haoudi (2020) examined the relationship between exchange rate and economic growth in Morocco from 1988 to 2016. Their results showed that exchange rate volatility only had a short-term effect that would not encourage long-term market competitiveness and would thus eradicate systemic trade deficits. Karahan (2020) found that the impact of exchange rates on Turkey's economic growth was negative during the 2002–2019 period. The same results were found by Fatbardha, Hysa, Ugur, Mirela, and Marian (2020) in 14 Central and Eastern European countries between 2002 and 2018. They proposed that policymakers should pursue various strategies to preserve the exchange rate's stability to promote economic growth. However, given the divergence in the results presented by several researchers, our aim is to determine the impact of exchange rate on economic growth through foreign trade in MENA economies.

3. MATERIALS AND METHODS

3.1. Sampling and Data Collection

In order to examine the short- and long-term relationships between our variables, we used a nonlinear autoregressive distributed lag (ARDL) approach to study ten Middle Eastern and North African countries¹ (MENA). The study period spans over 28 years, from 1990 to 2018, and all data was downloaded from the World Bank.

3.2. Econometric Approach

We employed an econometric approach using the nonlinear panel ARDL model to capture the asymmetric effect of the interaction variable between real exchange rate and trade (REX*TRAD) on economic growth (GDP). The underlying concept is based on the nonlinear ARDL model of Shin, Yu, and Greenwood-Nimmo (2014), which uses negative and positive partial sum decompositions to describe the asymmetric effect in the short and long runs. The ARDL model has two major advantages over classical cointegration approaches. First, even with a limited sample size, the nonlinear ARDL model performs efficiently (Romilly, Song, & Liu, 2001), and second, the nonlinear ARDL model can be turned using variables that are stationary at level $I(0)$ or first difference $I(1)$, or also fractionally integrated (Kao, 1999; Pedroni, 2004; Pesaran, 1997) to capture the long- and short-term dynamics between the variables. Two techniques, proposed by Pesaran (1997), Pesaran and Yongcheol (1999), and Boufateh and Saadaoui (2020) are used in this study to estimate non-stationary dynamic heterogeneous panel data models; the first one is the mean group (MG), which estimates N time-series equations and computes the average of the coefficients, while the second, the pooled mean group (PMG) estimators, uses a combination of the pooling of coefficients and their averages.

3.2.1. Panel ARDL: The Linear Model

To use the nonlinear version of the ARDL model, it is more appropriate to begin with the linear form of ARDL, as proposed by Pesaran, Shin, and Smith (2001). The basic principle behind this method is to assume a symmetric reaction of economic growth to changes in the interaction variable (REX*TRAD) in the first stage, and in the second stage to tolerate both positive and negative changes in the interaction variable (REX*TRAD) (asymmetry assumption). The linear panel ARDL representation is written as follows, according to Pesaran et al. (2001):

¹ Tunisia, Algeria, Morocco, Israel, Saudi Arabia, Bahrain, Iran, Armenia, Cyprus, and Malta.

$$\begin{aligned} \Delta GDP_{it} = & \alpha_i + \gamma_{1i} GOV_{i,t-1} + \gamma_{2i} POP_{i,t-1} + \gamma_{3i} REX_{i,t-1} + \gamma_{4i} REX * TRAD_{i,t-1} + \gamma_{5i} TRAD_{i,t-1} \\ & + \sum_{j=1}^{p_1} \delta_{1ij} \Delta GOV_{i,t-j} + \sum_{j=1}^{p_2} \delta_{2ij} \Delta POP_{i,t-j} + \sum_{j=1}^{p_4} \delta_{3ij} \Delta REX_{i,t-j} \\ & + \sum_{j=1}^{p_5} \delta_{4ij} \Delta (REX * TRAD)_{i,t-j} + \sum_{j=0}^{p_6} \delta_{5ij} \Delta TRAD_{i,t-j} + \varepsilon_{it} \end{aligned} \quad (1)$$

Where GDP is the gross domestic product, GOV is government consumption, POP is population, REX is the real exchange rate, TRAD is trade openness, REX*TRAD is the interaction variable between real exchange rate and trade openness, α_i is a constant, the short-term parameters are measured by δ_{sij} ($s=1,2,3,4,5$), the long-term parameters are measured by γ_{ki} ($k=1,2,3,4,5$), and ε_{it} is an error term. The numbers of lags on the first-differenced variables are fixed by the Akaike information criterion (AIC) or the Schwarz information criterion (SIC). Equation 1 can be rewritten as:

$$\begin{aligned} \Delta GDP_{it} = & \varphi_i + \sum_{j=1}^{p_1} \delta_{1ij} \Delta GOV_{i,t-j} + \sum_{j=1}^{p_2} \delta_{2ij} \Delta POP_{i,t-j} + \sum_{j=1}^{p_4} \delta_{3ij} \Delta REX_{i,t-j} \\ & + \sum_{j=1}^{p_5} \delta_{4ij} \Delta (REX * TRAD)_{i,t-j} + \sum_{j=0}^{p_6} \delta_{5ij} \Delta TRAD_{i,t-j} + \lambda_i ect_{i,t-1} + \varepsilon_{it} \end{aligned} \quad (2)$$

Where, the term $ect_{i,t-1}$ is an error correction parameter in Equation 2, this term can be written as:

$$ect_{i,t-1} = GDP_{i,t-1} - \theta_{1i} POP_{i,t-1} - \theta_{2i} REX_{i,t-1} - \theta_{3i} REX * TRAD_{i,t-1} - \theta_{4i} TRAD_{i,t-1}$$

The term λ_i denotes the adjustment speed of the model to long-run equilibrium. θ_{1i} ; θ_{2i} ; θ_{3i} and θ_{4i} are respectively measured as: $-\frac{\gamma_{2i}}{\gamma_{1i}}$; $-\frac{\gamma_{3i}}{\gamma_{1i}}$; $-\frac{\gamma_{4i}}{\gamma_{1i}}$; $-\frac{\gamma_{5i}}{\gamma_{1i}}$ and $-\frac{\gamma_{6i}}{\gamma_{1i}}$.

To take into account the asymmetric nonlinear relationship, it is more appropriate to use an asymmetric nonlinear ARDL approach in panel form, as proposed by Shin et al. (2014).

3.2.2. Panel ARDL: The Nonlinear Model

The nonlinear version of the panel ARDL estimates the asymmetric responses of GDP to the interaction variable ($REX * TRAD$). In this study, we adopted the asymmetric approach, as suggested by Shin et al. (2014), which decomposes the interaction variable ($REX * TRAD$) $_{i,t}$ in two components to detect both upward and downward changes of ($REX * TRAD$) $_{i,t}$ (see Equation 3 below).

$$(REX * TRAD)^+_{i,t} = \sum_{j=1}^t \Delta (REX * TRAD)^+_{i,j} = \sum_{j=1}^t \max(\Delta REX * TRAD^+_{i,j}, 0) \text{ and}$$

$$(REX * TRAD)^-_{i,t} = \sum_{j=1}^t \Delta(REX * TRAD)^-_{i,j} = \sum_{j=1}^t \min(\Delta REX * TRAD^-_{i,j}, 0) \quad (3)$$

The final version of the ARDL nonlinear panel model integrating short and long-term asymmetry can be written as follows:

$$\begin{aligned} \Delta GDP_{it} = & \eta_i + \gamma_{1i}GDP_{i,t-1} + \gamma_{2i}GOV_{i,t-1} + \gamma_{4i}POP_{i,t-1} + \gamma_{5i}REX_{i,t-1} + \gamma_{6i}TRAD_{i,t-1} \\ & + \gamma^+_{7i}(REX * TRAD)^+_{i,t-1} + \gamma^-_{7i}(REX * TRAD)^-_{i,t-1} + \sum_{j=1}^{p_1} \delta_{1ij}\Delta GDP_{i,t-j} \\ & + \sum_{j=1}^{p_2} \delta_{2ij}\Delta GOV_{i,t-j} + \sum_{j=1}^{p_4} \delta_{4ij}\Delta POP_{i,t-j} + \sum_{j=1}^{p_5} \delta_{5ij}\Delta REX_{i,t-j} \\ & + \sum_{j=1}^{p_4} \delta_{6ij}\Delta TRAD_{i,t-j} \\ & + \sum_{j=0}^{p_6} (\delta^+_{7ij}\Delta(REX * TRAD)^+_{i,t-j} + \delta^-_{7ij}\Delta(REX * TRAD)^-_{i,t-j}) + \epsilon_{it} \quad (4) \end{aligned}$$

Where γ^+_{7i} and γ^-_{7i} , detect the long-term asymmetry, and δ^+_{7ij} and δ^-_{7ij} capture the short-term asymmetry.

The asymmetric error correction form of Equation 4 is:

$$\begin{aligned} \Delta GDP_{it} = & \tau_i + \sum_{j=1}^{p_2} \delta_{2ij}\Delta GOV_{i,t-j} + \sum_{j=1}^{p_4} \delta_{4ij}\Delta POP_{i,t-j} \\ & + \sum_{j=1}^{p_5} \delta_{5ij}\Delta REX_{i,t-j} + \sum_{j=1}^{p_4} \delta_{6ij}\Delta TRAD_{i,t-j} + \sum_{j=0}^{p_6} (\delta^+_{7ij}(\Delta REX * TRAD)^+_{i,t-j} \\ & + \delta^-_{7ij}(\Delta REX * TRAD)^-_{i,t-j}) + \zeta_i ect'_{i,t-1} + \epsilon_{it} \quad (5) \end{aligned}$$

Where $ect'_{i,t}$ is the asymmetric error correction parameter, and ζ_i : denotes the adjustment speed of the model to long-run equilibrium.

4. RESULTS AND INTERPRETATIONS

According to the Jarque–Bera test statistics, all variables are not normally distributed.

Table 1. Descriptive statistics.

	GDP	GOV	POP	EXCH	TRAD	(REX*TRAD)
Mean	13219.55	17.73586	1.690345	1.052411	1.000776	1.028101
Median	9495.000	17.30000	1.600000	1.015550	0.799000	0.804162
Maximum	34745.80	34.20000	7.800000	2.963300	3.259000	3.178395
Minimum	886.0000	9.200000	-2.400000	0.326700	0.292000	0.250608
Std. Dev.	10599.07	4.600078	1.401622	0.251516	0.605570	0.607580
Skewness	0.299457	0.473825	1.042319	2.853552	1.779544	1.621984
Kurtosis	1.546018	3.038207	7.232084	21.11405	5.894742	5.293340
Jarque–Bera	29.87920	10.86897	268.9296	4358.337	254.3135	190.7081
Probability	0.000000	0.004363	0.000000	0.000000	0.000000	0.000000
Observations	290	290	290	290	290	290

From Table 1, it is clear that the Jarque–Bera statistic rejects the null hypothesis of normal distribution at the 1% level. Skewness and kurtosis are different respectively from 0 and 3 for all variables. Table 2 shows that all of the variables are not stationary at level but stationary at first difference. ARDL models are convenient in these cases as they can be used to investigate the statistical relationship between all our variables.

Table-2. Panel unit root test.

Test			GDP	GOV	POP	REX	TRAD	(REX*TRAD)
LLC	Level	Intercept	-1.71128** (0.0435)	-2.14266** (0.0161)	-5.80966*** (0.000)	0.45495 (0.675)	-0.77933 (0.2179)	-0.12229 (0.5487)
		Inter and trend	-0.01276 (0.4949)	-1.70195** (0.0444)	2.3337 (0.9902)	0.10090 (0.5402)	2.3337 (0.9902)	-0.17426 (0.4308)
	First Diff.	Intercept	-9.31658 (0.0000)***	5.88030 (0.0000)***	-5.05518 (0.0000)***	-9.81350*** (0.0000)	-8.77593*** (0.0000)	-4.36435*** (0.0000)
		Inter and trend	-8.04248*** (0.0000)	-3.92358*** (0.0000)	-2.71746*** (0.0033)	-9.33292*** (0.0000)	-7.45005*** (0.0033)	-2.82750*** (0.0023)
IPS	Level	Intercept	0.85322 (0.8032)	-1.74680** (0.0403)	-6.24866*** (0.0000)	0.04534 (0.5181)	-0.77283 (0.2198)	2.68971 (0.9964)
		Inter and trend	-0.52767 (0.2989)	-0.32942 (0.3709)	3.1137 (0.9991)	-0.40411 (0.3431)	0.54395 (0.7068)	0.08118 (0.5324)
	First Diff.	Intercept	-7.54685*** (0.0000)	-7.39077*** (0.0000)	-6.58795*** (0.0000)	-9.75719*** (0.0000)	-8.19276*** (0.0000)	-6.69167*** (0.0000)
		Inter and trend	5.40511*** (0.0000)	-5.93601*** (0.0000)	-5.12492*** (0.0000)	-8.48173*** (0.0000)	-6.63553*** (0.0000)	-5.21256*** (0.0000)
ADF	Level	Intercept	15.4207 (0.7519)	34.5051** (0.0229)	93.6432*** (0.0000)	17.8037 (0.6003)	21.1898 (0.3860)	10.8194 (0.9508)
		Inter and trend	26.4403 (0.1518)	21.4353 (0.3719)	9.2354 (0.9034)	22.3460 (0.3220)	14.2400 (0.8181)	18.4706 (0.5564)
	First Diff.	Intercept	94.7592*** (0.0000)	91.2970*** (0.0000)	90.0918*** (0.0000)	119.192*** (0.0000)	101.939*** (0.0000)	82.7477*** (0.0000)
		Inter and trend	67.8974*** (0.0000)	69.6941*** (0.0000)	72.3495*** (0.0000)	134.270*** (0.0000)	77.4148*** (0.0000)	62.7025*** (0.0000)
Breitung	Level	Inter and trend	-0.79621 (0.2130)	0.32758 (0.6284)	-0.43756 (0.3309)	-1.17815 (0.1194)	-1.49515* (0.0674)	-0.52209 (0.3008)
	First Diff.	Inter and trend	-3.60281*** (0.0002)	-5.19264*** (0.0000)	-1.38420* (0.0831)	-5.81152*** (0.0000)	-5.80344*** (0.0000)	-4.06026*** (0.0000)

Note: Values in () are probabilities.

As mentioned above, we begin with the linear version, considered as the benchmark, before estimating the asymmetric approach of the nonlinear ARDL panel. The main idea is to examine the short-term dynamics and their adjustment to the long-run situation that captures the relationship between growth, trade, and the real exchange rate. Then, we relax the hypothesis of the interaction variable (REX*TRAD) asymmetry and we estimate the nonlinear model.

Table-3. Linear panel ARDL estimation.

Variable	Coefficient
Long Run Equation	
GOV	-0.016424 (0.6620)
POP	0.593515* (0.0506)
REX	2.219426** (0.0375)
REX*TRAD	-6.204803** (0.0198)
TRAD	6.664524** (0.0134)
Short Run Equation	
COINTEQ01	-0.024298 (0.1137)
D(GOV)	-0.010707** (0.0210)
D(POP)	0.141770** (0.0306)
D(REX)	0.496788** (0.0206)
D(REX*TRAD)	-0.635634** (0.0270)
D(TRAD)	0.862165** (0.0486)
C	0.152013* (0.0528)

Note: ***, **, and * denote 1, 5, and 10% levels of significance, respectively, while values in () are probabilities.

4.1. Results of the Linear Model

The results of the linear ARDL panel model (see Table 3) are divided into two components: the long-term component and the short-term component. For the long-term component, the findings show, first, that GDP elasticity to real exchange rate and trade is significantly positive at the 5% level, which corroborates the results of Aman et al. (2013) and Long et al. (2019). An increase in the real exchange rate of 1% leads to an increase in economic growth of 2.21%. Second, the long-term component shows the negative and significant effect of the interaction variable (REX*TRAD) on GDP at the 5% level.

The results of the short-run component show that all variables are significant. Specifically, trade is significantly positive at the 5% level, which is consistent with the results of Romer (1986), Barro and Sala-i-Martin (1997), and Almeida and Fernandes (2008). However, the interaction variable (REX*TRAD) is significantly negative at the 5% level. However, the error correction adjustment coefficient is negative but not significant. As a result, the linear model cannot be used to adjust the variables of the short-run dynamic to long-run equilibrium.

4.2. Results of the Nonlinear Model

In the long run, the results of the nonlinear ARDL model (see Table 4) after decomposing the interaction variable (REX*TRAD) into two partial sums, show a significant negative impact of real exchange rate on economic

growth at the 1% level, which is in line with the results of Olofsson (2019), Hussaini et al. (2019), Fatbardha et al. (2020), and Karahan (2020). The finding also indicates that the direct impact of trade openness is negative on GDP but not significant, which is not consistent with previous studies (Lucas Jr, 1988; Redding, 1999; Young, 1991). The integration of the asymmetry assumption of the interaction variable ($REX * TRAD$) shows a positive and significant impact for both upward and downward movements on economic growth. In other words, the finding of the study suggests that trade openness and real exchange rate need to combine to enhance GDP growth. A negative or positive change ($REX * TRAD$) of 1% leads to an increase in economic growth by 2.32%. Such findings corroborate the presence of an asymmetric effect where, unlike the linear approach, the negative and positive fluctuations of the interaction variable always exert a positive impact on economic growth, which can be considered in itself proof of asymmetry.

Table-4. Nonlinear panel ARDL estimation.

Variable	Coefficient
Long Run Equation	
	0.043479*** (0.0020)
GOV	-0.014662 (0.7847)
POP	-2.760168*** (0.0036)
REX	2.323594** (0.0216)
$REX * TRAD^-$	2.329107** (0.0311)
$REX * TRAD^+$	-0.689034 (0.5625)
TRAD	
Short Run Equation	
COINTEQ01	-0.053888 (0.1323)
D(GOV)	-0.016151*** (0.0055)
D(POP)	0.090559** (0.0255)
D(REX)	0.698234** (0.0114)
D($REX * TRAD^-$)	-0.994376** (0.0392)
D($REX * TRAD^+$)	-0.934040** (0.0155)
D(TRAD)	1.153412** (0.0298)
C	0.623174* (0.0851)

Note: ***, **, and * denote 1, 5, and 10% levels of significance, respectively, while values in () are probabilities.

The results of the nonlinear short-run component show that all elasticities are significant. In particular, the exchange rate is significantly positive at the 5% level, which contradicts the results of Hooper and Kohlhagen (1978), Pozo (1992), and Fatbardha et al. (2020). However, the impact of the interaction term between trade openness and the real exchange rate ($REX * TRAD$) on growth is significantly negative for both positive and negative variations at the 5% level. The coefficients of trade openness are positive and statistically significant at the 5% level, which is consistent with several pieces of literature (Almeida & Fernandes, 2008; Barro & Sala-i-Martin,

1997; Blalock & Gertler, 2008; Romer, 1986). The nonlinear adjustment coefficient (error correction term) is negative but not significant, reflecting the absence of a return of the variables to long-term equilibrium.

5. CONCLUSION

This study used an asymmetric ARDL panel to establish the determinants of economic growth in a sample of Middle Eastern and North African countries. We used an econometric approach founded on the ARDL nonlinear panel model to detect the asymmetric effect of the interaction term between trade openness and the real exchange rate (REX*TRAD) on economic growth.

The results of the linear model prove, for the long-run component, that all variables except government consumption are significant. In addition, the interaction term between trade openness and the real exchange rate is negative and has a significant impact on economic growth at the 5% level. The results of the short-run component show that all variables are significant. However, the error correction adjustment coefficient is negative but not significant. As a result, the linear model cannot be used to adjust the variables of the short-run dynamic to long-run equilibrium. The findings of the nonlinear ARDL model show that government consumption and the real exchange rate have a significant effect on economic growth at the 1% level. The integration of the asymmetry assumption of the interaction variable (REX*TRAD) shows a positive and significant impact for both upward and downward movements on economic growth. A negative or positive variation of 1% would increase growth by 2.32%. These results confirm the presence of an asymmetry effect since, unlike the linear approach, the negative and positive fluctuations of the interaction variable always exert a positive impact on economic growth, which can be considered proof of asymmetry. The findings of the nonlinear short-term component show that all variables are significant. The nonlinear adjustment coefficient is negative but not significant, indicating the absence of the adjustment of the variables to the long-run condition. The coefficients of trade openness are positive and statistically significant at the 5% levels, which is consistent with previous studies (Almeida & Fernandes, 2008; Barro & Sala-i-Martin, 1997; Blalock & Gertler, 2008; Romer, 1986). Our findings point to the need for policymakers to stabilize the exchange rate to promote economic growth through trade. Indeed, the relationship between the exchange rate and economic growth is indirect via trade, and asymmetric in the short and long runs.

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